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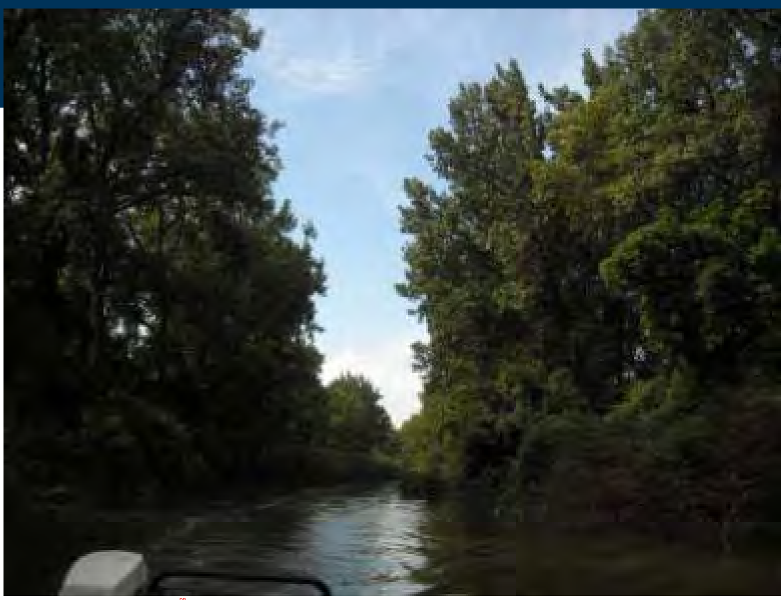
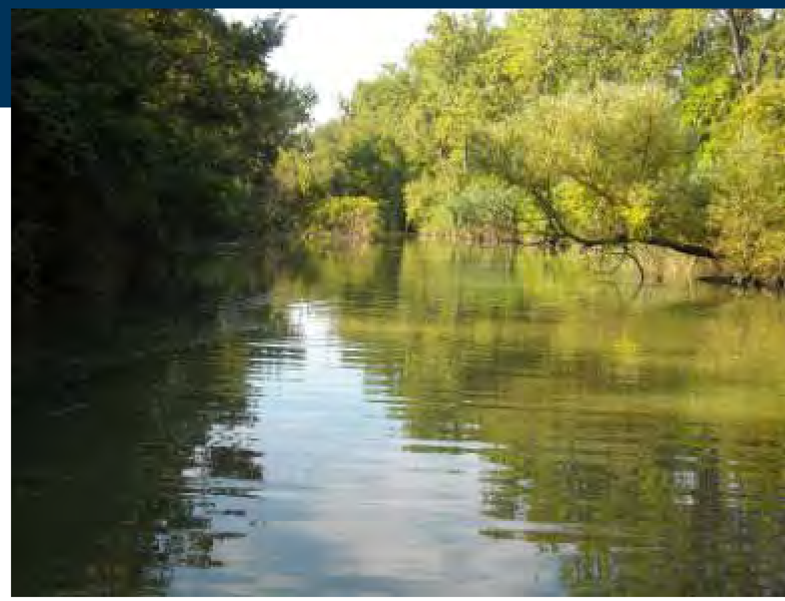

Duck and Otter Creeks Great Lakes Legacy Act Data Gap Investigation Report

April 25, 2012

Project No. 72606001

Prepared For
Duck and Otter Creek Industrial Partners

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Great Lakes Legacy Act Report

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Cardno ENTRIX Project No. 72606001

Prepared for
Duck and Otter Creek Industrial Partners

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Acronyms

AOC	Area of Concern
AVS	acid volatile sulfide
BSAF	sediment to biota accumulation factor
DOCIP	Duck and Otter Creek Industrial Partners
EqP	equilibrium partitioning
foc	organic carbon fraction
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
IBI	Index of Biotic Integrity
IVG	simulated *in vivo* gastrointestinal fluid
Koc	organic carbon partitioning coefficient
OEPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
QHEI	Qualitative Habitat Evaluation Index
RBP	rapid bioassessment protocol
SEM	simultaneously extracted metals
SVOC	semivolatile organic compounds
TBD	to be determined
TOC	total organic carbon
USEPA	United States Environmental Protection Agency

Executive Summary

Duck and Otter Creeks are located within the Maumee River Area of Concern (AOC). An AOC is an area where the International Joint Commission (IJC) has identified beneficial use impairments (BUIs) as described by the 1987 Annex to the Great Lakes Water Quality Agreement of 1978. A full discussion of the Maumee AOC is located in the Maumee River Remedial Action Plan (RAP) [Maumee RAP, TMACOG and Ohio Environmental Protection Agency (2006)] The Maumee AOC is approximately 775 square miles in size and includes Swan Creek, Ottawa River (Ten Mile Creek), Duck Creek, Otter Creek, Grassy Creek, Cedar Creek, and Crane Creek. In 1992, the AOC area was extended to the east to include Turtle Creek, Packer Creek, and the Toussaint River (Maumee RAP and Duck & Otter Creeks Partnership, Inc. 2006).

In the late Nineteenth Century, these streams and others in the region were modified when a large forested wetland complex called the “Great Black Swamp” was drained. The drainage process facilitated new land uses by settlers, and began a complex history of urban, industrial and residential land uses (TMACOG 1991) on the watersheds of Duck and Otter Creeks. Previous investigations determined that several chemical constituents are present in the sediments of these streams at concentrations that exceed benchmarks for aquatic life. The biological communities of Duck and Otter Creeks have been identified as impaired. For the Duck and Otter Creek watersheds, the beneficial use impairments include the loss of habitat and adverse impacts to fish, wildlife, benthic invertebrates and overall aesthetics of the watershed (Maumee RAP, TMACOG and OEPA 2006).

Prior to 2009 several studies had been conducted on the Duck and Otter Creeks; however, there was still a need for crucial information to understand the degree of impairment and potential causes of the impairment. These “data gaps” needed to be “filled” to support future environmental decisions. The Duck and Otter Creek Industrial Partners (DOCIP) and the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) identified several data gaps for these creeks and entered into a Project Agreement under the Great Lakes Legacy Act (GLLA) to conduct an investigation to address the data gaps in 2010. This document includes the results from that 2010 investigation.

Study Design

The 2010 investigation was designed to address the data gaps that were not completely addressed during previous studies. The data gaps that were addressed included:

- Measurements of the bioavailability of contaminants;
- Characterization of subsurface and surface sediment chemistry;
- Evaluation of habitat resources;
- Performance of more rigorous sediment toxicity testing; and,

- Investigation of conditions in urbanized, nonnon-industrial streams in the region.

Samples were collected from selected locations in Duck Creek, Otter Creek, and two nearby streams in urbanized but non-industrialized areas. Grassy Creek in Perrysburg, OH and Amlosch Ditch in Oregon, OH were identified as urban streams most similar to Duck and Otter Creeks. Samples were collected near the headwaters of both of these urban comparison streams, and the same suite of measurements as those used for Duck and Otter Creeks were completed.

Study Methods

There were three main components of the 2010 data gap investigation:

- Bulk sediment chemistry, sediment toxicity, and the community of sediment-dwelling animals, along with a qualitative evaluation of habitat were assessed in the surface layer (0-6 inches depth). In addition, the bioavailable fractions of surface sediment chemicals were measured;

- Tissue samples from fish and sediment-dwelling (benthic) invertebrates were analyzed chemically; and,

- Subsurface sediment chemistry was measured in sediment cores from selected locations.

Study Results

Each component of the data gap investigation is summarized below.

Field Observations & Measurements of Physical Sediment Characteristics

- During sample collection, field crews recorded observations of visible sheens and odors that were believed to be petroleum in several sampling locations. Neither sheens nor petroleum odors were reported in Duck Creek, Grassy Creek or Amlosch Ditch. Field observations varied in Otter Creek. Sheens and petroleum odors were reported for most of the sample locations in Otter Creek in the section downstream of Millard Avenue. Sheen and odor were infrequently observed in the middle and upstream reaches of Otter Creek: both sheen and odor were reported at a single location between Yarrow and Consaul Streets. Slight sheens without odor were reported at one upstream location downstream of Oakdale Avenue, and another upstream of Broadway Street.

- Surficial stream sediments were generally fine-grained, and were typically dominated by either silt or sand; gravel was common at two locations in Otter Creek near the Toledo Water Department works, and at one location near Ravine Park in Duck Creek. The total organic carbon content of stream sediments were generally in the range of 3% to 5% on a dry weight basis, with several locations in Duck Creek measured at concentrations greater than 6%.

Chemistry – Multiple Lines of Evidence

Multiple lines of evidence (e.g. bulk sediment, pore water, tissue) were examined to evaluate each class of sediment contaminants, and current theories and measurements were utilized to assess whether the contaminants are available to the biological species that inhabit theses streams. Chemical classes that had been identified as potential risk drivers in previous investigations included petroleum hydrocarbons, specifically the polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and metals. A brief discussion of each of the chemical classes is below.

Bulk Sediment Chemistry

- Total Petroleum Hydrocarbons (TPH) were measured at elevated concentrations in several sediment samples, and were generally greater in Otter Creek, than in the other streams. Gasoline-range organic (TPH-GRO) hydrocarbons were not detected sediment samples from Duck and Grassy Creeks. In Otter Creek, GRO hydrocarbons were detected in most samples that were collected from lower Otter Creek (north of Millard Avenue), one location between Millard Ave and York St., and the location between Consaul and Yarrow Streets. Gasoline range hydrocarbons were also detected in the Amlosch Ditch location. Diesel-range and residual range organic hydrocarbons (TPH-DRO and TPH-RRO respectively) were commonly detected in sediment samples from Duck and Otter Creeks, and both urban comparison streams.

- Polycyclic aromatic hydrocarbons (PAHs), which represent the components of petroleum that are generally most closely associated with adverse effects to aquatic organisms, were also measured in bulk sediment. The concentrations of the 16 priority pollutant PAHs in bulk sediments exceeded the probable effects concentration in Amlosch Ditch, at several locations in Otter Creek between Oakdale Avenue and Wheeling Street, and in the sample in Otter Creek located between Yarrow and Consaul Streets. The bulk sediment benchmark for PAHs was not exceeded in either Duck or Grassy Creek samples.

- Polychlorinated biphenyls (PCBs), and semivolatile organic compounds (SVOCs) other than PAHs, were not detected at concentrations that exceeded conservative benchmarks for bulk sediments in any of the 2010 data gap investigation samples.

- As was observed in previous studies, the concentrations of some metals in some sediment samples from Duck and Otter Creeks exceeded conservative benchmarks. Many metals are a natural component of soil and sediment due to the weathering of materials that comprise the Earth’s crust (i.e., naturally-occurring background) and as the result of human activities such as the combustion of fossil fuels and use of pesticides (i.e., anthropogenic background). Although this study did not define a numerical background concentration for each of the metals that were evaluated, it is important to note that background concentrations of metals unrelated to specific contributions from a potential industrial source frequently exceed conservative screening levels in urban streams in Northwest Ohio.

Bioavailable Fraction Chemistry

In addition to measurements of bulk sediment chemistry, the bioavailable fraction of sediment contaminants was measured using specific extractions that mimic biological exposures and calculations that estimate the portion of the chemicals that can be available for absorption by sediment-dwelling animals. These measurements are summarized below:

- The bioavailability of organic compounds was evaluated using equilibrium partitioning (EqP) theory which is based on a knowledge that contaminants in sediment pore water represent the fraction that is most available to sediment-dwelling organisms and can be used to most accurately predict adverse effects, and that the organic carbon content of sediments determines the pore water concentrations of organic contaminants at equilibrium. The calculations used to for EqP-based evaluations are commonly referred to as "TOC normalization." EqP-based sediment benchmark for discrete fractions of petroleum hydrocarbons have been developed; however, the eight fractions for which benchmarks are available do not coincide with the TPH-GRO, TPH-DRO and TPH RRO analyses that were conducted for this data gap investigation. There is no accurate method for calculating eight fractions of hydrocarbons from the three ranges of TPH that are available, so is was not possible to use the petroleum hydrocarbon benchmarks to quantitatively interpret the bioavailable component of the TPH ranges in Duck and Otter Creeks data set.

- Other petroleum components may contribute to petroleum toxicity, but, for the DGI data set, quantitative methods are only available for the PAHs. The TOC-normalized PEC for 16 priority pollutant PAHs was exceeded only in the surface sediment sample from Amlosch Ditch. The TOC-normalized PEC for 16 priority pollutant PAHs was not exceeded in any of the other samples from Duck, Otter or Grassy Creeks. EqP-based ecological screening benchmarks (ESBs) were not exceeded in any of the sediment samples collected in 2010. An evaluation of PAH concentrations measured in sediment pore waters, which are believed to represent the primary route of exposure to sediment-dwelling organisms, were greater than pore water-based benchmarks at three locations in lower Otter Creek. Pore water PAH concentrations were also significantly correlated with lethality in the toxicity test organisms. PAH concentrations were greater than benchmarks only in the tissue sample of sediment-dwelling invertebrates from Amlosch Ditch. PAH concentrations in fish and invertebrate tissue samples from Duck, Otter and Grassy Creeks did not exceed benchmark concentrations.

- PCBs were not detected at concentrations that exceeded EqP-based sediment benchmarks (e.g. are normalized to the content of sediment TOC). PCB concentrations in tissue samples of fish and sediment – dwelling invertebrates were low, and did not exceed benchmark concentrations.

- The bioavailability of metals in sediments was assessed using the EqP approach, which involves comparing the relative concentrations of volatile sulfides and metals that are simultaneously extracted by cold acid and the fraction of organic carbon [(SEM-AVS)/foc]. These values for all sediment samples were less than the sediment quality benchmark.

- The concentrations of metals in sediment pore water, which is generally accepted as the biologically-available fraction, and a primary route of exposure for sediment-dwelling organisms, did not exceed the respective ambient water quality criteria.

Arsenic bioaccessibility was measured using an in-vitro gastrointestinal (IV-G) method that simulates the human digestive system. Arsenic bioaccessibility in sediment samples from Duck and Otter Creek ranged from 29.8% to 57.6 %.

Sediment Toxicity

Sediment toxicity was measured by exposing larvae of the midge (*Chironomus dilutus*) to field-collected sediments for 10 days. Midge survival was significantly less than the laboratory controls at one location near the mouth of Otter Creek. Midge growth was less than laboratory controls at three locations in lower Otter Creek. When only the study locations within Amlosch Ditch and Duck, Otter and Grassy Creeks were evaluated, midge growth was significantly less at only two locations in lowest reach (Segment A) of Otter Creek. There was a significant negative correlation between the sum of PAH toxic units in sediment pore water and growth (biomass) of the midge *C. dilutus* larvae.

Based on a lack of relationships between bulk sediment chemistry and toxicity test results in a previous study, two classes of chemicals that had not previously been assessed were measured for the 2010 data gap investigation.

- Pyrethroid pesticides, which have been observed to result in sediment toxicity in other water bodies, were detected at trace concentrations in a few sediment sampling locations, but did not exceed benchmarks associated with toxicity to sediment-dwelling organisms.

- Ammonia concentrations in sediment pore water samples were greater than the associated surface water quality criteria; ammonia concentrations in the overlying water of the sediment toxicity testing chambers remained low throughout the test. Ammonia concentrations in pore water were not correlated with lethality or growth inhibition of the test organisms.

Benthic Macroinvertebrate Communities

The structure of the benthic macroinvertebrate community, which includes those insects, crustaceans, and other small animals that live in association with stream sediments, was evaluated by three metrics. The total number of taxa, which is a measure of biodiversity, ranged from 2 to 12. The lowest diversity was observed in Otter Creek near the Millard Avenue Bridge (approximately 2 miles upstream from the bay), while the greatest diversity was observed in upper Otter Creek, upstream of Broadway Road (approximately 7.8 miles upstream from the bay). The number of taxa in Duck Creek ranged from 7 to 9; and the same range was observed in the urban comparison streams. Invertebrate taxa that are considered to be sensitive to pollution and disturbance were present in about half of the sample locations. Sensitive taxa comprised more than 60% of the benthic community in Amlosch Ditch, but were absent from Grassy Creek. Sensitive taxa represented about one-fifth of the community in Duck Creek, and were present in four of the eight locations in Otter Creek. Tolerant invertebrate taxa were present in all sample locations, and dominated the benthic community in 10 of 13 locations, including the Grassy Creek location.

Qualitative Habitat Evaluations

The habitat evaluation involved two qualitative assessments; one assessment was conducted within the stream channels, and the other evaluated land use characteristics of the stream watersheds. The results of these evaluations are summarized below:

- The Qualitative Habitat Evaluation Index (QHEI) scores for Duck, Otter and Grassy Creeks and Amlosch Ditch ranged from 23 to 42 of a maximum possible score of 100. In-stream habitat evaluation indicated that physical stressors associated with: siltation; low gradient; lack of natural, in-stream structures; lack of riparian vegetation; and channelization appear to be factors that could limit the structure of the biological communities.

- The watershed land use evaluation indicated that hydraulic alterations resulting from conversion of the majority of the watershed to more than 20% impervious surface could be decreasing base flow and increasing stormwater runoff. There are a large number of storm sewer outfalls (51) in the Segments C and D of Otter Creek between Oakdale Avenue and Consaul Street/Corduroy Road that may deliver scouring flows during precipitation events that could adversely affect biological communities. The storm sewer outfalls could also deliver contaminants from the watershed that make source identification for sediment-associated chemicals difficult.

Conclusions

- The highest PAH concentrations in sediment pore waters occurred at the same locations where the growth of the midge *C. dilutus* was inhibited in the sediment toxicity test. The data from this study suggest that PAHs in sediment pore water could be contributing to the observed sediment toxicity in lower Otter Creek. The poor benthic community structure in lower Otter Creek is generally consistent with the results of the sediment toxicity test.

- PCBs, metals, pyrethroid pesticides, and non-PAH SVOCs can be ruled out as sources of toxicity in the 2010 Data Gap Investigation data set because these classes of contaminants generally are not elevated in sediments, or are not bioavailable. Ammonia concentrations are at levels of concern in the pore water of several sediment samples; however, sediments at many of those locations were not toxic to midge larvae so the available site data suggest that sediment-associated ammonia is not affecting the benthic community structure or contributing to sediment toxicity in the laboratory.

- The in-stream habitat quality ranged from very poor to poor, which implies the biological communities in these creeks are likely to include species that are tolerant of poor habitat quality. Tolerant species dominated the biological communities at the majority of the 2010 sample locations, which is consistent with the poor habitat quality that was observed.

- The section "Segment A" of Otter Creek that is downstream (North) of Millard Avenue differed from the other stream reaches of Otter Creek, the Duck Creek segments, and the urban comparison streams Grassy Creek and Amlosch Ditch. The observed differences in the lowest reach of Otter Creek include: reductions in the survival and growth of midge larvae in the sediment toxicity test; the presence of elevated PAH concentrations in sediment pore waters; the frequent observation of petroleum odor and sheen during field sampling; and the presence of elevated hydrocarbon concentrations in sediment core samples (0-48 inches) relative to surface (0-6 inches) grab samples.

- The 2010 data do not indicate there are sediment contamination or toxicity issues within Duck Creek or the upper segments of Otter Creek.

Recommendations

- Further evaluate potential remedies for Segment A of Otter Creek in a subsequent phase of the project;

- Further evaluate the combined 2007 and 2010 data sets for the remaining stream sections in a subsequent phase of the project.

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Chapter 1

Introduction

Duck and Otter Creeks are located within the Maumee River Area of Concern (AOC). An AOC is an area where there are known beneficial use impairments (BUIs) of water bodies located within the watershed(s). A full discussion of the Maumee AOC is located in the Maumee River Remedial Action Plan (RAP) [Maumee RAP, TMACOG and OEPA, 2006]. The Maumee AOC is approximately 775 square miles and includes Swan Creek, Ottawa River (Ten Mile Creek), Duck Creek, Otter Creek, Grassy Creek, Cedar Creek, and Crane Creek. In 1992, this area was extended to the east to include Turtle Creek, Packer Creek, and the Toussaint River (Maumee RAP, TMACOG and OEPA 2006).

In the late Nineteenth Century, these streams and others in the region were modified when the Great Black Swamp was drained. They have had a complex history of urban, industrial, oil production and residential land uses. Previous investigations determined that several chemical constituents are present in the sediments of these streams at concentrations that exceed conservative benchmarks for the protection of aquatic life. The biological communities of Duck and Otter Creeks have been identified as impaired. For the Duck and Otter Creek watersheds, the beneficial use impairments include the loss of habitat and adverse impacts to fish, wildlife, benthic invertebrates and overall aesthetics of the watershed (Maumee RAP, TMACOG and OEPA 2006).

Although several previous studies had been conducted on the Duck and Otter Creeks, crucial information necessary to understand the degree of impairment and potential causes of the impairment was not available. These data gaps needed to be filled to support future environmental decisions. The Duck and Otter Creek Industrial Partners (DOCIP) and the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) identified several data gaps for these creeks and entered into a Project Agreement under the Great Lakes Legacy Act (GLLA) to conduct an investigation to address the data gaps.

1.1 Objectives

One of the purposes of a GLLA project is to determine, based on the degree and possible sources of impacts, if sediment and/or habitat management is warranted. Specific Project Objectives relating to this purpose were identified in the Project Agreement. These objectives are inputs that are needed to address data gaps that have been identified by GLNPO and the DOCIP, and will allow decisions to be made for these streams. The project objectives identified for the GLLA investigation include:

- Determining the extent of contamination in both surface and subsurface sediments;
- Verifying sediment toxicity and identify cause(s), to the extent practicable within the constraints of this data gap investigation;
- Evaluating whether sediment contaminants are bioaccumulating in benthic invertebrates and fish at levels likely to contribute significantly to the degradation of benthos and fish populations;

- Evaluating habitat resources; and
- Collecting data to support development of a feasibility study (evaluation of remedial and restoration options to protect human health and the environment and to advance progress toward delisting of beneficial use impairments), if one is determined to be necessary.

1.2 Conceptual Model

The biological communities of Duck and Otter Creeks exhibit impairment as reflected by low biological criteria scores, as identified in the Maumee River AOC. The source of these impairments has been unclear because there are multiple physical and chemical stressors. Because the sediments of these streams contain concentrations of chemicals that exceed benchmarks used for screening level sediment quality assessments, this investigation was conducted to determine if sediment contamination may be contributing to the impaired state of the aquatic communities.

1.2.1 Physical Environment of Streams and Watersheds

Duck and Otter Creeks flow through an urban and industrial area that was historically within the Great Black Swamp on the western end of Lake Erie. Streams that flowed through the Great Black Swamp were channelized in the late Nineteenth Century to enhance drainage and support agricultural, urban and industrial land uses. Both streams remain highly-modified drainage ditches with numerous utility crossings. Portions of each stream flow through subsurface culverts. During previous investigations, SulTRAC divided each stream into five sections for sampling in 2007 (Figure 1-1 and Tables 1-1 and 1-2). These segments designations are a useful tool to summarize and evaluate data and were retained for the purpose of this report.

1.2.2 Physical Stressors

Historically, the watersheds of Duck and Otter Creeks were included in a large forested wetland that European settlers called the Great Black Swamp because the tree canopy was so complete that the interior of the forest was shaded even during the day. The Great Black Swamp was clear-cut and drained to support agricultural and industrial land uses during the late Nineteenth Century. There are no obvious remnants of the historic habitat in the watershed of Duck and Otter Creeks. Duck and Otter Creeks, like most streams within the former Great Black Swamp, were converted to storm water utilities more than a century ago and the quality of the streams as aquatic habitat is generally poor: Both streams lack the riffle-pool sequences of natural streams; meanders have been removed as channels have been straightened to improve drainage; and riparian canopy is limited.

- Duck Creek is about 3.6 miles (19,000 feet) long, with approximately 1,000 feet of (Hecklinger) pond, 3,000 feet of emergent wetland[1] (Ravine Park,) and 3,000 feet of meandering channel with partial riparian forest (Table 1-1).
- The main channel of Otter Creek is about 9.5 miles (50,300 feet) long. Approximately 16,000 feet of meandering channel has a partial riparian forest. At least 2,100 feet (4%) of Otter Creek flows through underground culverts (Table 1-2).

[1] An emergent wetland is characterized by erect, rooted herbaceous wetland hydrophytes, usually perennials, that are generally present for most of the growing season.

Stream ecosystems have common structural features that perform essential functions. Many of these structural features are rare in Duck and Otter Creeks, the absence of which is likely contributing to the impairment of aquatic communities because the essential ecological functions are not being provided. A very brief overview of common stream features is provided below:

The stream channel is the area that transmits water and provides living space for aquatic species during “normal” flow periods. Flowing waters represent kinetic energy that affects the landscape, and natural stream channels have common features to which stream communities are adapted, including:

- **Riffles** are areas where the water flows quickly over a rough (rocky) stream bed. Riffles add oxygen to the water, and the spaces beneath and between rocks are important living spaces for invertebrates. Benthic macroinvertebrate community indices such as the Index of Community Integrity (ICI) are largely influenced by the diverse communities of invertebrates that inhabit riffle areas. Riffles are rare in Duck and Otter Creeks and may not have been common historically because the area was a large forested wetland (swamp).
- **Glides** (sometimes called “Runs”) areas within a stream where the water flows quickly, but smoothly. The stream bed may be smooth; or, if the water depth is sufficient, fast-moving water can flow smoothly over a rough bottom. Glides are usually located between riffles and pools, and inhabited by organisms that are adapted to currents, or seek refuge downstream of structures that provide shelter from the force of flowing water. **Pools** are areas of deeper, slower moving water. Pools provide refuge from currents, and living space for fish. Sediment also deposits in pools where it is available for burrowing invertebrates. Fish community indices such as the Index of Biological Integrity (IBI) are largely influenced by the diverse fish communities that inhabit pools and glides/runs which are intermediate between riffles and pools. Stream pools are rare in Duck and Otter Creeks, but may have been more common when the area was a swamp.
- **Meanders** are areas where stream channels curve as sediments are eroded and deposited over time. The concave sides of meanders provide rough substrates that are used for breeding by some aquatic species. The convex sides of meanders provide refuge from currents, and allow suspended sediments to settle. Meanders are rare in Duck and Otter Creeks, but were likely common when the area was a swamp.
- The **floodplain** is the land area between the stream channel and the “bank” that occurs along the high water mark. Floodplains function as a secondary stream channel that transmits high flows, or floods. Floodplains also provide ecological linkages between the stream and the watershed; for example, plant communities on the floodplain stabilize the soils and prevent erosion during floods. Important floodplain features include:
- In a forested area, the **riparian** (streamside) **canopy** shades the stream which allows the water to contain more oxygen. Warm water is stressful for many aquatic species so stream segments without trees can have impaired aquatic communities. Headwater stream ecosystems are adapted to the leaves that are deposited into the stream in the fall, so some invertebrates species that shred leaves are absent in streams without riparian forests, which will decrease overall diversity and can result in lower ICI and IBI scores. Riparian forests occur in about one-third of Duck and Otter Creeks, but likely were very common historically. Emergent wetlands or

marshes, which provide some of the functions as riparian forests exist along some portions of Duck and Otter Creeks.

- **Oxbows** are sections of historic stream channels that remain after the channel moves. Oxbows that contain open water are often important breeding and nursery habitats for fish, amphibians and burrowing invertebrates. Oxbows that contain wetlands are often important habitats for invertebrates and wildlife such as birds. Oxbows are very rare in Duck and Otter Creeks; however, some reaches of the streams have wetlands along the edges of the stream channel and along the floodplain.

The stream channels and floodplains of Duck and Otter Creeks were modified a century ago. The channels were straightened, the riparian trees were removed and structures were built on the floodplains. These land use modifications likely are contributing to low biological community scores in Duck and Otter Creeks.

1.2.3 Chemical Stressors

In addition to the physical habitat modifications of Duck and Otter Creeks, extensive industrial and urban development has resulted in chemical contamination of the creek sediments. Also, some of the chemicals in creek sediments are a natural component of soil and sediment due to weathering of materials that comprise the Earth’s crust (i.e., naturally-occurring background) and as the result of human activities such as the combustion of fossil fuels and use of pesticides (i.e., anthropogenic background). Excessive concentrations of chemicals in surface water and/or sediments can stress aquatic life and result in impaired biological communities. Sediment contamination has been the focus of several previous investigations of Duck and Otter Creeks, as well as other streams within the Maumee River AOC. Previous investigations have measured a variety of chemicals in bulk sediment samples and determined that concentrations of some chemicals exceed conservative benchmarks that are used for assessing sediment quality.

However, potential adverse affects posed to benthic macroinvertebrates in Duck and Otter Creeks may not be predicted solely on the basis of the bulk sediment chemistry data. Many contaminants bind to particulate matter that is suspended in the water column and settle into sediments when the particles are deposited. Some of those chemical contaminants persist in the sediments, and it is only when present in a bioavailable form, that these chemicals may adversely affect aquatic life. Therefore, evaluation of the bulk chemistry data alone may not be sufficient to identify key chemical stressors, if any, that may be contributing to generally poor benthic community structure. In addition, evaluation of the bulk chemistry data without weighing the potential contribution of physical modifications of the steam habitat to potential degradation of the benthic community may lead to an incorrect identification of a causative factor.

Sediment toxicity tests were conducted by SulTRAC in 2007 and survival of midge larvae was impaired in some samples from Duck Creek and most samples from Otter Creek. However, a relationship between contaminant concentrations measured in the sediments and the mortalities observed during the 2007 toxicity tests could not be developed from the data. The lack of a relationship between chemical concentrations and toxicity limited inferences regarding the potential for chemicals at other locations within the streams to adversely affect aquatic communities.

Previous investigations of sediment chemistry have focused on the surface layer of sediments. The surface layer is the layer that is inhabited by benthic organisms, so evaluation of chemical contamination in the surface layer is important for understanding if and how chemical stressors in sediments are affecting biological communities. Because there was about a century of wastewater discharge to the streams prior to the Clean Water Act, there may be chemical contamination in the subsurface sediments as well. Chemicals in subsurface sediments could be exposed and/or transported downstream if erosion occurs in the stream or may move during flood events and sieches; therefore the lack of subsurface sediment data represented a data gap.

Table 1-1 Summary Description of Duck Creek.

Name	Length (a)	Landmarks	Description
Headwaters	Approximately 479 feet from aerial photos	Ravine Park on southwest side of I-280; long basin adjacent to Seaman Road	All that remains of this segment is a narrow basin with no identified connection to downstream. The upstream end of the culvert entering Hecklinger Pond is not visible.
DC-E	Approximately 1,000 feet (length of Hecklinger Pond)	Culvert beneath I-280 to shore of Hecklinger Pond at Burger Street.	An improvement project was undertaken in Hecklinger Pond in July 2007. The water was pumped out; abandoned cars bicycles, tires and other trash were removed; fish were removed and new fish were stocked.
DC-D	4,710 feet	Ravine Park; Toledo water treatment impoundment on East bank. Burger Street to Consaul Street.	Approx. 3,000 ft of cattail wetland; former Consaul landfill cover soil placement in April 2007 approx 1,500 feet of residential property on West bank
DC-C	2,804 feet	Golf Course and Toledo water plant to East. Consaul Street to York Street.	Ditch with several large culverts through a golf course.
DC-B	4,385 feet	Former Refinery, railroad tracks, and landfills. York Street to Millard Avenue.	Channelized, with riparian vegetation
DC-A	5,631 feet	Millard Ave overpass to mouth at Maumee River; Port of Toledo.	Approx. 3,131 feet has meanders and riparian wetlands, and approx. 2,500 feet is a ditch along the East side of Port Authority access road. Lacustrine area influenced by seiches.

(a) SulTRAC 2007 Duck and Otter Creeks Sediment Sampling Report

Table 1-2 Summary Description of Otter Creek.

Name	Length (a)	Landmarks	Description
Headwaters	7,800 feet	Walbridge Road to Wales Road	Ditch along the west side of Tracy Road. Agricultural and industrial land uses on watershed.
OC-E	10,255 feet	Tracy & Wales Roads to Oakdale Ave.; large storm culvert enters at Oakdale Ave.; Railroad crossings (2), Pilkington former plant site ; WMI landfill south of Wales Road	Underground culverts – RR between Tracy RD and Broadway RD.; Broadway RD. to N. of RR ; open ditch south half; mix of undeveloped land and meander creek in north half; tributary from large commercial area joins from southeast.
OC-D	6,188 feet	Woodville Road crossing –Cemetery – Sunoco Refinery	Flows through underground culverts: approx 575 ft from Woodville Rd to Maginnis Road; approximately 1,500 feet beneath Sunoco Refinery; ditch through commercial area from Sunoco Refinery to I-280
OC-C	10,648 feet	I-280 –to Consaul Street/ Corduroy Road.	Stream flows through an underground culvert under I-280; primarily residential land use with some meanders and areas with riparian vegetation.
OC-B	4,693 feet	Toledo Water Plant impoundments; closed Landfills; former Chevron Refinery; Buckeye Pipeline	Linear ditch with steep banks; and some riparian vegetation
OC-A	10,722 feet	Millard Ave overpass to mouth at Maumee Bay; CSX rail yard on West Bank and to east (setback approx. 400 feet); BP Husky Refinery east of CSX rail yard and Otter Creek Road.	Channelized area with riparian vegetation. Lacustrine area influenced by seiches.

(a) SulTRAC 2007 Duck and Otter Creeks Sediment Sampling Report; headwaters length estimated from aerial photographs

1.3 Technical Approach to GLLA Data Gap Investigation

Five specific objectives were identified in the Statement of Work for Great Lakes Legacy Act Data Gap Investigation for Duck and Otter creeks in the Maumee River Area of Concern, Ohio. These objectives formed the basis of the technical approach for this Data Gap Investigation (DGI).

1.3.1 Determining the extent of contamination in both surface and subsurface sediments

Sediment core samples were collected from selected locations and chemical analyses were conducted on 0 to 24-inch, 24 to 48-inch and 48 to 60-inch intervals, depending on availability of depositional material. Surficial sediment chemistry from previous investigations and sediment probing information was used to guide the selection of locations. Some cores were archived for potential future fine sectioning and/or additional chemical analyses.

The list of chemical analyses for subsurface sediments is summarized in Table 1-3, and includes: metals; semivolatile organic compounds (SVOCs); PCBs (i.e., Aroclors); total petroleum hydrocarbons in the gasoline range (C_8-C_{12}), diesel range (C_{10}-C_{28}), and residual range (C_{25}-C_{36}) organics (GRO/DRO/RRO); total organic carbon (TOC); and moisture.

Table 1-3 Summary of Chemical Analyses for Subsurface Sediment Samples.

Analysis	Method	Rationale
Metals	ILM05.4 with Hg, Ca, Mg	Metals exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
SVOCs	SOM01.2	SVOCs exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
Aroclors	SOM01.2	PCBs exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
TPH GRO/DRO/RRO	SW846-8015	Oil and grease have been measured in surface samples; hydrocarbon data are needed to determine vertical extent of contamination.
TOC	SW846 9060	TOC binds organic contaminants; data are used to “normalize” contaminant concentrations.
Moisture		Data are needed to compare these results with other studies.

Surface grab samples were collected from selected locations for chemical analysis. Sample locations were selected based on data from previous investigations to fill identified data gaps. The list of chemical analyses for surface sediments is summarized in Table 1-4, and includes: metals; SVOCs; the 16 priority pollutant Polycyclic Aromatic Hydrocarbons plus 18 alkylated homologues (PAH_{34}); PCBs (Aroclors); GRO/DRO/RRO; acid-volatile sulfide/simultaneously extracted metals (AVS-SEM/foc); TOC; particle size; and moisture. The suite of chemical analyses for the surface sediment grab samples was closely matched with the chemical analyses for the Sediment Quality Triad samples so that relationships developed from the Triad data set can be applied to additional reaches of Duck and Otter Creeks.

Table1-4 Summary of Chemical Analyses for Surficial Sediment Samples from Duck and Otter Creeks.

Analysis	Method	Rationale
Metals	ILM05.4 with Hg, Ca, Mg	Metals exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
AVS/SEM	SW846 9071B	This is the bioavailable fraction of divalent metals in sediments; data are needed to apply toxicity test results to additional samples.
SVOCs	SOM01.2	SVOCs exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
PAH_{34}	1734.2	PAH concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to apply toxicity test results to additional samples.
Aroclors	SOM01.2	PCBs exceed conservative benchmarks in surface samples; data are needed to determine vertical extent of contamination.
TPH GRO/DRO/RRO	SW846-8015	Oil and grease have been measured in surface samples; hydrocarbon data are needed to determine vertical extent of contamination.
TOC	sw846 9060	TOC binds organic contaminants; data are used to “normalize” contaminant concentrations.
Particle size	ASTM D421/D422	TOC binds organic molecules in sediments; data are needed to apply toxicity test results to additional samples.
Moisture		Data are needed to compare these results with other studies.

1.3.2 Verifying sediment toxicity and identify cause(s), to the extent practicable within the constraints of this data gap investigation

The Sediment Quality Triad (Triad) concept was used as a general framework for the technical approach to verifying toxicity and identifying potential causes of toxicity. The traditional elements of the Triad are sediment chemistry, toxicity, and benthic macroinvertebrate community structure. These combined lines of evidence are used to evaluate the relationship, if any, between chemical stressors, adverse effects in a controlled setting (toxicity), and the quality of the biological communities in the field setting. Bioavailability assessments and habitat quality are also lines of evidence that can be included in a Triad approach. All available lines of evidence are evaluated jointly to determine whether sediment management is likely to improve the biological communities and make progress toward restoring beneficial uses.

For the ‘toxicity’ line of evidence, laboratory bioassays were conducted to determine whether contaminants in sediments from Duck and Otter Creeks are toxic to a standard laboratory test organism. Ten-day exposures with *Chironomus dilutus* were conducted on bulk sediments to determine if exposure affected survival or growth of the organisms. *C. dilutus* is a standard test organism that was sensitive to some sediment samples from Duck and Otter Creeks in the SulTRAC 2007 study.

In addition, for the ‘chemistry’ line of evidence, selected chemicals and physical parameters were measured in bulk sediments and/or pore water extracted from sediments at all toxicity test locations. The list of chemical analyses for surface sediments (where aquatic communities would be exposed to sediments) at Triad locations is summarized in Table 1-6 and includes: metals;

SVOCs; PAH_{34}; PCBs (Aroclors); GRO/DRO/RRO; AVS/SEM; TOC; dissolved organic carbon (DOC); particle size; and moisture.

Based on the lack of a discernable relationship between bulk sediment chemistry and toxicity test results in the SulTRAC 2007 study (Tetra Tech EMI 2008b), analyses of ammonia (in pore water) and pyrethroid pesticides (in bulk sediment) were conducted in the 2010 investigation. If present at sufficient concentrations in sediment, either of these classes of compounds can result in toxicity. Recently, pyrethroid pesticides have been found to be responsible for toxicity of sediments in non-industrialized urban and suburban water bodies around the country (Weston et al. 2005; Amweg et al. 2006; Holmes et al. 2008), and it was plausible that these pesticides might be responsible for toxicity in Duck and/or Otter Creeks.

Analyses of both bulk sediments and pore water were needed for the following reasons:

- Bulk sediment chemistry – As discussed in the Conceptual Site Model (CSM), contaminants that have been discharged into water bodies often bind to suspended particles and are deposited onto the sediments. If sufficient quantities of bioavailable contaminants are present, aquatic life can be harmed, and removal of contaminated sediments may contribute to improvements in biological communities. Bulk sediments have been characterized chemically in previous studies, but significant correlations with toxicity were not found.
- Pore water chemistry - Sediment is a complex matrix that can effectively bind contaminants. Bulk sediment chemistry analyses do not separate the labile component (i.e., the fraction of the chemical in pore water) that can harm biological organisms from the component of contaminants that is not available to cause harm. The labile component of sediment contaminants can be measured by extracting and analyzing pore water from sediment samples. Measurement of contaminant concentrations in pore water represents one of the best possible methods for establishing a relationship between chemical concentrations and adverse effects to aquatic life that can be used for interpretation and decision-making. Water quality criteria for the protection of aquatic life can be used as a screening tool to evaluate pore water chemistry for many contaminants, which may assist in identification of the contaminants, if any, that are contributing to adverse effects.

Representing the 'benthic community' line of evidence in the Triad, biological community metrics were used to evaluate the quality of the benthic macroinvertebrate communities. Macroinvertebrate community quality was evaluated using tolerance and diversity metrics that are applied in the USEPA Rapid Bioassessment Protocol (RBP). The macroinvertebrate community sampling methods applied in this data gap investigation were based on the qualitative OEPA methods (OEPA 2010a); but multiple transects and consistent sampling efforts for each transect were used to provide a more quantitative assessment than is typically conducted with kick nets and D-nets.

Table 1-5 Summary Table of Surface Sample Chemical Analyses for Sediment Quality Triad Locations.

Analysis	Bulk sediment	Pore water	Rationale
Metals	√	√	Metals concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to interpret toxicity test results. Bulk sediment analyses are needed to apply Sediment Quality Triad results to sample locations where only bulk sediment chemistry has been measured.
AVS/SEM	√	-	This is the bioavailable fraction of divalent metals in sediments; data are critical for toxicity test interpretation (USEPA 2005).
SVOCs	√	-	SVOC concentrations in sediments exceed conservative screening benchmarks (ChemRisk 1999). SVOC results will be interpreted using equilibrium partitioning methods (USEPA 2008).
PAH_{34}	√	√	PAH concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to interpret toxicity test results (USEPA 2003, Hawthorne et al. 2005). Bulk sediment analyses are needed to apply Sediment Quality Triad results to sample locations where only bulk sediment chemistry has been measured.
Aroclors	√	-	PCB concentrations in sediments exceed conservative screening benchmarks; data are needed to interpret toxicity test results. Aroclor results will be interpreted using equilibrium partitioning methods (Fuchsman et al. 2006, USEPA 2008).
GRO/DRO/RRO	√	-	More informative for source identification than “Oil and Grease” analyses conducted in previous investigations. Information from USEPA may be useful for interpreting toxicity results (Mount et al. 2009)
TOC	√	-	TOC binds organic molecules in sediments; data are needed to interpret toxicity test results.
DOC	-	√	DOC binds metals and some organics in pore water; data are needed to interpret toxicity test results.
Hardness	-	√	Hardness competes with metals for uptake channels in gills; data are needed to interpret toxicity test results.
pH	-	√	pH controls metals solubility and precipitation and ammonia ionization; data are needed to interpret toxicity tests
Ammonia	-	√	Ammonia can be a source of toxicity in sediments; data are needed to interpret toxicity test results.
Particle size	√	-	Particle size can affect contaminant bioavailability and invertebrate survival; data needed for toxicity test interpretation.
Moisture	√	-	Used to compare data on a dry weight basis. Moisture can also be used interpret the bioavailability of less-hydrophobic organic compounds such as methylphenols (Fuchsman 2003, USEPA 2008).
Pyrethroid pesticides	√	-	Pyrethroid pesticides have been identified as a significant sediment toxicant in urban areas (Holmes et al. 2008).

1.3.3 Evaluating whether sediment contaminants are bioaccumulating in benthic invertebrates and fish at levels likely to contribute significantly to the degradation of benthos and fish populations

As a direct measure of bioaccumulation, chemical analyses of whole fish and benthic macroinvertebrates were conducted to quantify the bioaccumulation of contaminants in the aquatic biota of Duck and Otter Creeks. These tissue data were needed to verify the validity of the 2008 Tetra Tech Ecological Risk Assessment (2008b) which used sediment-to-biota accumulation factors (BSAFs) from other studies to estimate the concentrations of chemicals in the biota of Duck and Otter Creeks. Site-specific tissue data are necessary for a more accurate evaluation of the potential for contaminants to adversely affect the organisms or their predators. Fish and benthic macroinvertebrates were collected from selected locations in Duck and Otter Creeks and analyzed for: metals, PCBs (Aroclors), PAH_{34} and lipid content (Table 1-6).

Because not all contaminants that may affect biota accumulate in tissue, it is important that assessments of effects on biota consider bioavailability in addition to bioaccumulation. Contaminant bioavailability was estimated using chemical extractions of sediments (e.g. pore water, SEM/AVS) that may provide better estimates of biological dose than either tissue chemistry or bulk sediment chemistry. As discussed above in the Triad section, pore water is considered to be the primary route of toxicological exposure for several classes of chemical stressors, including: metals (Di Toro et al. 2005), PAH_{34} (Di Toro et al. 2000a; USEPA 2003; Hawthorne et al. 2005), SVOCs (Di Toro et al. 2000b; USEPA 2004), and pyrethroid pesticides (Holmes et al. 2008). Therefore, the concentration of chemicals in sediment pore water may be a better surrogate of the concentration at the site of action (i.e., the dose to which the organism is exposed).

Table 1-6 Summary of Chemical Analyses for biota tissue samples that will be used to determine site-specific bioaccumulation.

Analysis	Method	Rationale
Metals	ILM05.4 - with Hg	Some metals in sediments can be accumulated by biota Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
PAH_{34}	1734.2	PAHs are organic molecules that can be accumulated and metabolized by aquatic life. Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
Aroclors	SOM01.2	PCBs are persistent organic compounds that can biomagnify in aquatic ecosystems. Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
Lipid content	Gravimetric	Organic molecules tend to partition into, and can be transferred through the food web with lipids. Lipid content can also be useful for estimating accumulation factors for other species or stream areas.

Arsenic was identified as a risk driver by Tetra Tech EMI (2008) for adult and child exposure to sediments in both Duck and Otter Creeks, based on an assumption that 100% of the arsenic in the sediment was bioavailable. However, bioavailability of arsenic from incidentally ingested sediment is highly dependent upon the solid matrix and, therefore can vary widely from site to site. An accurate evaluation of the sediment ingestion pathway requires a determination of how much of the contaminants are available for absorption from the human gastrointestinal tract into systemic circulation (e.g., blood). Traditionally, this absorption has been achieved using an *in vivo* method such as a swine feeding trial. However, an *in-vitro* method using simulated gastrointestinal fluids (IVG) has been developed to estimate the potentially bioavailable arsenic by quantifying the fraction of the ingested arsenic released from the environmental matrix that is available for absorption in the human gastrointestinal (GI) tract (i.e., the fraction defined as 'bioaccessible"). The IVG analysis (Rodriguez et al 1999) is analogous to the evaluation that will be conducted to estimate the contaminants that are available to biological organisms in which the pore water concentrations of contaminants are used to estimate the labile component of contaminants that may cause adverse effects to aquatic life.

1.3.4 Evaluating habitat resources

As discussed in the CSM, Duck and Otter Creeks were greatly modified a century ago by the conversion to ditches to drain the Great Black Swamp. Habitat quality has been evaluated at two scales of analysis:

- In-stream habitat quality was evaluated at each of the Triad sampling locations using measurements and metrics consistent with the Ohio Qualitative Habitat Evaluation Index (QHEI) methodology.
- Watershed quality was evaluated by reviewing land cover and land use information, surface permeability, the presence of storm water outfalls, aerial photo review, field notes and other sources of information.

1.3.5 Collecting data to support development of a feasibility study (evaluation of remedial and restoration options to protect human health and the environment), if one is found to be necessary, and to advance progress toward delisting of beneficial use impairments.

- The Triad (chemistry, toxicity, community structure) and QHEI data were collected at the same locations to facilitate the evaluation of whether sediment contamination and/or habitat modification are key factors that contribute to impaired aquatic communities.
- Comparisons regarding the structure of biological communities, chemical concentrations in sediment and pore water, and habitat quality were made between study streams and urban comparison streams. These comparisons provide supplemental information for evaluating impacts of urban conditions in the area. The process that was used to select Amlosch Ditch and Grassy Creek as the urban comparison streams for this study is recorded in Appendix A.
- Measures of the bioavailability (e.g. AVS/SEM/foc, pore water, equilibrium partitioning, tissue chemistry, IVG, etc.) were used to identify which contaminants are biologically available.
- Arsenic bioaccessibility measurements were used to support evaluation of exposure pathways, if any, for local residents, in the event that remedial approaches are evaluated that involve leaving sediments in place.
- Supplemental core samples were collected from several of the DGI locations and have been archived for possible additional future analyses.

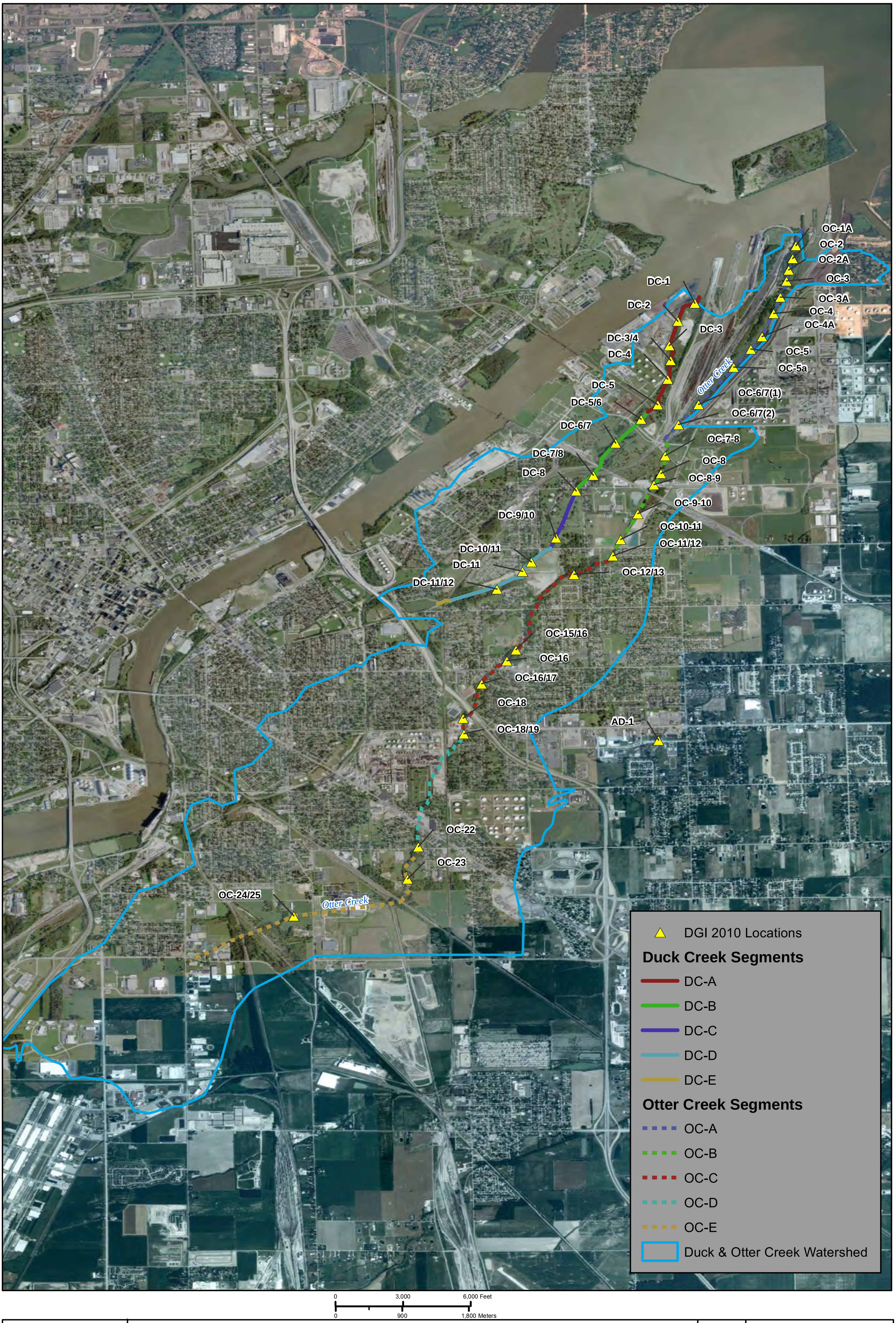

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Figure 1-1 Duck and Otter Creeks Study Area

Duck and Otter Creek
Lucas County, Ohio

Image:Bing
2011 Aerial

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Coordinate System:
GCS WGS 1984

Date: 09/10/2010 Rev. Date: 09/10/2010 PM: JK GIS Analyst: AJB Map Document: DOC_Sampling_overview_20110728_1_ajb.mxd Project Number: 72606001.00 2000 PDF Document: DOC_Sampling_overview_20110728_1_ajb.pdf Plot Size: 11 x 17

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Figure 1-2 Duck Creek Segment A

Duck & Otter Creek
Lucas County, Ohio

N

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Figure 1-3 Duck Creek Segment B

Duck & Otter Creek
Lucas County, Ohio

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Figure 1-4 Duck Creek Segment C

Duck & Otter Creek
Lucas County, Ohio

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Figure 1-5 Duck Creek Segment D & E

Duck & Otter Creek
Lucas County, Ohio

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Figure 1-6 Otter Creek Segment A

Duck & Otter Creek
Lucas County, Ohio

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Figure 1-7 Otter Creek Segment B

Duck & Otter Creek
Lucas County, Ohio

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Figure 1-8 Otter Creek Segment C

Duck & Otter Creek
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Figure 1-9 Otter Creek Segment D

Duck & Otter Creek
Lucas County, Ohio

N

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2011 Aerial

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Figure 1-10 Otter Creek Segment E

Duck & Otter Creek
Lucas County, Ohio

Image:Bing
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Chapter 2

Methods

A complete description of the methods for this DGI is presented in the *Quality Assurance Project Plan, Duck & Otter Creeks 2010 Data Gap Investigation, Wood and Lucas Counties, Ohio* (Weston Solutions 2010). Summaries of the main elements of the DGI are presented in this section.

2.1 Sample Locations

A summary of the 2010 data gap investigation sample locations and analyses for Duck and Otter Creeks and the urban comparison streams is presented in Table 2-1.

2.2 Sediment Sample Collection

Sediment core samples were collected using Lexan tubing, driven to the depth of refusal or five feet (whichever was encountered first) by delivering surface blows. Sampling was conducted from downstream to upstream. Samples were collected within the clear plastic tube liners, retrieved, and capped with plastic end caps. The field procedure was as follows:

- Sample points were located with the GPS and the water depth was measured using an echo-sounder or specialized measuring tape.
- A sediment probe was used to determine the depth of penetrable sediments.
- Sediment samples were collected at intervals stated in the plan, when the available sediment thickness permitted.
- Sediment cores were processed and sub-sampled in accordance with the sampling and analysis program outlined in Sections 2 and 7 of the Field Sampling Plan (Weston 2010). Qualitative sediment information such as sediment type, color, etc. was recorded on the appropriate field log. Sediments from the cores were transferred to a stainless steel pan, homogenized, and transferred to the appropriate sample jar. Homogenizing samples by hand mixing was accomplished by dividing the sample into quarters, mixing opposite quarters, and then mixing the remaining halves.
- Excess sediment was returned to the water body at the point of collection.
- All reusable sampling equipment was decontaminated between each sample in accordance with procedures outlined in Subsection 3.4.
- Duplicate samples were collected at a 10% frequency following the procedures outlined in Section 4.1 and Section 4.2. of the Quality Assurance Project Plan (QAPP) (Weston 2010).
- All samples were placed immediately in a cooler on wet ice (frozen water).

Table 2-1. Summary of sampling program for 2010 Data Gap Investigation

					Sediment Quality Triad Analyses										
river segment	river mile	**2010 DGI Sample Location**	x coord	y coord	QHEI	sediment toxicity	benthic invertebrate community	pore water chemistry	(SEM-AVS)/foc	chemistry on surface sediment "grab" sample	invertebrate tissue chemistry	fish tissue chemistry	As bioaccessibility	particle size distribution	chemistry on sediment core samples
DC-A	0.07	**DC-1**	-83.466109	41.688459											X
DC-A	0.30	**DC-2**	-83.468171	41.686288									X		X
DC-A	0.51	**DC-3**	-83.469238	41.683313	X	X	X	X	X	X		X		X	X
DC-A	0.66	**DC-3/4**	-83.469064	41.681534					X	X				X	X
DC-A	0.85	**DC-4**	-83.469430	41.679240					X	X				X	X
DC-A	1.09	**DC-5**	-83.470627	41.676134	X	X	X	X	X	X	X			X	X
DC-B	1.27	**DC-5/6**	-83.472656	41.674362					X	X				X	
DC-B	1.63	**DC-6/7**	-83.475763	41.671482	X	X	X	X	X	X				X	
DC-B	1.97	**DC-7/8**	-83.478443	41.667542					X	X				X	
DC-C	2.14	**DC-8**	-83.480536	41.665667											X
DC-C	2.53	**DC-9/10**	-83.483001	41.659964					X	X				X	
DC-D	2.85	**DC-10/11**	-83.485999	41.657027					X	X				X	
DC-D	2.97	**DC-11**	-83.487066	41.655887								X	X		X
DC-D	3.23	**DC-11/12**	-83.490185	41.653709		X		X	X	X	X			X	
OC-A	0.15	**OC-1A**	-83.453813	41.695493					X	X				X	X
OC-A	0.21	**OC-2**	-83.454218	41.693934									X		X
OC-A	0.38	**OC-2A**	-83.454716	41.692516					X	X				X	X
OC-A	0.42	**OC-3**	-83.454962	41.691196											X
OC-A	0.57	**OC-3A**	-83.455704	41.689224					X	X				X	X
OC-A	0.73	**OC-4**	-83.456536	41.687237	X	X	X	X	X	X	X	X		X	X
OC-A	1.00	**OC-4A**	-83.457932	41.684414					X	X				X	X
OC-A	1.15	**OC-5**	-83.459289	41.682876											X
OC-A	1.35	**OC-5A**	-83.461392	41.680692		X	X	X	X	X	X			X	X
OC-A	1.80	**OC-6/7(1)**	-83.465650	41.676172					X	X				X	X
OC-A	2.04	**OC-6/7(2)**	-83.468122	41.673738	X	X	X	X	X	X				X	X
OC-B	2.44	**OC-7-8**	-83.469713	41.669945					X	X				X	
OC-B	2.55	**OC-8**	-83.470243	41.667770											X
OC-B	2.66	**OC-8-9**	-83.471089	41.666426					X	X				X	
OC-B	2.96	**OC-9-10**	-83.473031	41.662890	X	X	X	X	X	X				X	
OC-B	3.22	**OC-10-11**	-83.475116	41.659771					X	X				X	
OC-C	3.37	**OC-11/12**	-83.476080	41.657779					X	X				X	
OC-C	3.76	**OC-12/13**	-83.480800	41.655507	X	X	X	X	X	X	X			X	
OC-C	4.57	**OC-15/16**	-83.487861	41.646351					X	X		X	X	X	
OC-C	4.69	**OC-16**	-83.488978	41.645025	X	X	X	X	X	X	X		X	X	
OC-C	4.96	**OC-16/17**	-83.492021	41.642215					X	X				X	
OC-C	5.34	**OC-18**	-83.494297	41.638041											X
OC-D	5.44	**OC-18/19**	-83.494194	41.636138					X	X				X	
OC-D	6.60	**OC-22**	-83.499739	41.622397	X	X	X	X	X	X			X	X	
OC-E	6.90	**OC-23**	-83.501048	41.618468											X
OC-E	7.82	**OC-24/25**	-83.514857	41.613992	X	X	X	X	X	X			X	X	
Amlosch	5.00	**AD-1**	-83.470517	41.635336	X	X	X	X	X	X	X			X	
Grassy	8.20	**GC-1**	-83.621853	41.552728	X	X	X	X	X	X	X			X	

2.3 Sediment Pore Water Generation

Sediment pore water was collected for chemical analysis on a subset of the sediment samples (see Section 2.2 above for sampling methods) as part of the Sediment Quality Triad. A total of 14 samples were collected (see Tables 2-1 through 2-3) as sediment, centrifuged at the laboratory, and analyzed for metals, 34 PAH (following alum treatment to precipitate colloids and adsorption onto a solid-phase microextraction (SPME) column), DOC, hardness, pH, and ammonia.

2.4 Benthic Macroinvertebrate Community Structure

To allow verification and future monitoring studies, the coordinates of each cross-creek transect were recorded at the West bank of the creek (unless otherwise noted) using a Trimble ProXRS, sub-meter accurate GPS.

Qualitative sampling

Qualitative sampling was used to develop a general understanding of the invertebrate community that exists within the vicinity of each of the 13 stations. Qualitative sampling was conducted utilizing methods described in the USEPA's Rapid Bioassessment Protocols. Using the USEPA's Multi-habitat Approach, benthic macroinvertebrates were collected by an aquatic entomologist from all available instream habitats along a 50 meter sampling reach, by "kicking" or "jabbing" the substrate with a pole mounted D-frame dip net (12" wide; 500µ mesh).

Semi-quantitative Sampling

Semi-quantitative sampling was used to develop specific benthic metric data of the invertebrate community that exists at each of the 13 sample stations. At each of the 13 sampling sites (see Tables 2-1 through 2-3), collection of the invertebrates was conducted at 4 cross-creek transects located at 5 meter intervals, with one transect approximately coinciding with the location of the sediment sampling site. The combination of 4 transverse and one longitudinal sampling transects ensured that all available instream habitat features were represented, and that aggregated data from these 5 transects accurately represented the benthic macroinvertebrate community.

Collection Sorting

After collection, the benthic macroinvertebrate samples were "sorted" to remove debris and sediments. Sorting of the collected samples was performed by an aquatic technician under the direct supervision of an aquatic entomologist. The sorted sample was transferred to a clean sample container and preserved in a sufficient amount of 95% ethanol to cover the sample. Sample containers were labeled (with labels both inside and outside) to provide sample identification code number, date, stream name, sampling location, collector name, and the words "preserved in 95% ethanol."

Benthic Macroinvertebrate Identification

The aquatic entomologist performed the identification of the collected benthic macroinvertebrates to taxonomic levels in accordance with recognized protocols and consistent with selected Ohio EPA published metrics. The minimum levels of taxonomic identification for the collected benthic macroinvertebrates are summarized in Table 2-2.

Table 2-2 Taxonomic resolution used to characterize the benthic macroinvertebrate communities in Duck Otter and Grassy Creeks and Amlosch Ditch.

Phylum	Class	Order	Family	Genus
Arthropoda	Insecta	Ephemeroptera	X	X
		Trichoptera	X	
		Plecoptera	X	
		Coleoptera	X	
		Diptera	X	
		Odonata	X	
		Hemiptera	X	
		Megaloptera	X	
	Crustacea	Decapoda		
		Amphipoda		
		Isopoda		
Annelida	Oligochaeta			
Mollusca	Gastropoda			
	Pelecypoda			

Taxonomic identification of the collected invertebrates was performed utilizing dissecting and compound microscopes, as well as recognized taxonomic "keys". Each taxon found in the samples was recorded and enumerated in a laboratory bench notebook and then transcribed to the laboratory bench sheet for subsequent reports. Labels with specific taxa names (initialed by the taxonomist) were added to the vials of specimens by the taxonomist. The identity and number of organisms were recorded on the Laboratory Bench Sheet. Either a tally counter or "slash" marks on the bench sheet were used to keep track of the cumulative count. Also, the life stage of the organisms, the taxonomist's initials, and the Taxonomic Certainty Rating (TCR) as a measure of confidence were recorded.

For archiving samples, specimen vials (grouped by sampling station and date) were placed in jars with a small amount of denatured 70% ethanol and tightly capped. The ethanol level in these jars was examined periodically and replenished as needed. A stick-on label was placed on the outside of the jar indicating sample identifier, date, and preservative (denatured 70% ethanol).

Quality Control Specimen Vouchers

In accordance with USEPA's *Rapid Bioassessment Protocols*, a *voucher collection of all samples and subsamples* were *maintained. These specimens* have been *labeled, preserved, and stored in the laboratory for future reference.*

2.5 Habitat Quality

For the in-stream evaluation of aquatic habitats, Cardno ENTRIX field biologists utilized the OEPA QHEI procedure (OEPA 2006) to determine habitat quality scores at three locations on Duck Creek, seven locations on Otter Creek and one locations on each local urban comparison stream (Amlosch Ditch and Grassy Creek) located in non-industrial areas. Specifically, QHEI scoring was performed at each location where the sediment quality triad assessment (benthic invertebrate community assessment, sediment toxicity testing and sediment chemistry analyses) was conducted pursuant to the GLLA Data Gap Investigation Work Plan (Weston 2010).

The standardized QHEI procedure (OEPA 2006) was used to ensure that habitat evaluations were consistent among sample stations. A single team of experienced stream ecologists conducted all of the QHEI assessments to avoid differences in the application of the procedure, and ensure consistency among the sample stations.

The QHEI is composed of 6 principal metrics, each of which is described below. The maximum possible QHEI score for a station is 100. Each of the metrics is scored individually and then the scores for all metrics are summed to provide the total QHEI station score. Standardized definitions for pool, run, and riffle habitats, for which a variety of existing definitions and perceptions exist, was essential for accurately using the QHEI. For consistency, pool, run, and riffle definitions were each taken from Platts et al. (1983). When accessible, the assessment was conducted over a 200 meter reach of stream. At two stations, access to the stream channel was limited, so shorter reaches (195 m and 125 m) were evaluated. The QHEI assessments were conducted from September 27, 2010 through September 30, 2010. The six metrics evaluated in the QHEI include:

- Metric 1 Substrate: This metric has three components, including: substrate type, substrate origin, and substrate quality;
- Metric 2 Instream Cover: This metric evaluates the presence of instream cover types and amount of overall cover within the stream channel for use by fish and aquatic macroinvertebrate species;
- Metric 3 Channel Morphology: This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (i.e. the degree to which the stream meanders), channel development, channelization, and channel stability;
- Metric 4 Bank Erosion and Riparian Zone: This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This metric includes riparian zone width, floodplain quality, and the extent of bank erosion;
- Metric 5 Pool/Glide and Riffle/Run Quality: This metric emphasizes the quality of the pool, glide and/or riffle/run. The following are definitions for "pool," "glide," "riffle," and "run" taken from Platts et al. (1983). This also includes maximum pool depth, overall diversity of current velocities (in pools and riffles), channel width, riffle-run depth, riffle-run substrate quality, and riffle-run substrate embeddedness.

- Pool: an area of a stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.
- Glide: this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero.
- Riffle: areas of a stream with fast current velocity and shallow depth; the water surface is visibly broken.
- Run: areas of a stream that have a rapid, non-turbulent flow; runs are deeper than riffles with a faster current velocity than pools and are generally located downstream from riffles where the stream narrows; the stream bed is often flat beneath a run and the water surface is not visibly broken.

▪ Metric 6 Map Gradient and Drainage Area: Local or map gradient is calculated from United States Geological Survey (USGS) 7.5 minute topographic maps by measuring the elevation drop through the sampling area. This gradient calculation is conducted by measuring the stream length between the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the height of the contour interval.

General narrative ranges were assigned to final QHEI scores consistent with OEPA guidance (OEPA 2006). Ranges vary slightly in headwater streams (< 20 sq mi) as compared with larger streams and rivers (Table 2-3). The streams evaluated in the GLLA data gap investigation were all headwater streams with small watersheds, so the headwater scores apply to this document.

Table 2-3 Range of possible QHEI scores and associated narrative descriptions.

Narrative Description of Stream Habitat Quality	Headwater Stream Scores	Larger Stream Scores
Excellent	≥ 70	≥ 75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	≤ 29	≤ 29

In addition to the in-stream habitat evaluation, Cardno ENTRIX conducted a geographic analysis of the riparian zones and watershed of Duck and Otter Creeks. The watershed analysis was conducted using a geographic information system (GIS), and included an evaluation of three categories of spatial data:

▪ Stormwater utility information was obtained from the City of Oregon, Ohio to determine the locations of stormwater outfalls to Duck and Otter Creeks. Stormwater outfalls have the potential to transport contaminants from sources that are somewhat remote from the riparian zone. Stormwater outfalls can also deliver large volumes of water that dramatically alter the hydrology of the stream and affect the quality of the stream habitat, sediments and biological communities.

- The National Land Cover (NCLD) Dataset from 2006 was acquired for Lucas and Wood Counties. Land use in the riparian zone was tabulated at three different scales: 5 meters, 100 meters, and 250 meters to evaluate land uses adjacent to the stream banks. Land use was also tabulated for the combined topographic watershed of Duck and Otter Creeks. Land use affects stream ecology by affecting nutrient inputs, hydrology and thermal regimens. Some land uses also can contribute eroded soils and chemical contaminants to streams.
- The amount of impervious surface was provided by the 2006 NCLD. The USGS developed the imperviousness algorithms in 2001 using imperviousness threshold values of: developed open space (imperviousness < 20%); low-intensity developed (imperviousness from 20 - 49%); medium intensity developed (imperviousness from 50 -79%); and, high-intensity developed (imperviousness > 79%), and re-tested the national map with the NCLD 2006 dataset. The amount of impervious surface on the watershed and within the riparian zone can dramatically affect stream hydrology. Large amounts of impervious surface will decrease infiltration and can decrease base flows in the stream. During rain events, impervious surfaces transmit water to streams, especially in landscapes such as Lucas and Wood Counties where stormwater drains are abundant, and increase peak flows, which can result in erosion, scouring and displacement of aquatic biota.

2.6 Benthic Macroinvertebrate Tissue Sample Collection

A total of eight benthic macroinvertebrate samples (four from Otter Creek, two from Duck Creek, and one from each comparison stream) were collected for the project. The specific species that were collected for tissue analysis was not recorded. However, the list of species that were identified at each station as part of the (separate) benthic invertebrate community analysis is documented in Appendix B. Chemical analyses of tissues (summarized above in Table 1-6) were conducted to determine if and how much of the sediment contaminants in Duck and Otter Creek are present in the aquatic organisms that live in these streams.

2.7 Fish Tissue Sample Collection

Fish tissue sample data collected by U.S. Fish and Wildlife Service on Duck and Otter Creeks was provided to the GLNPO and the Industrial Partners for use in evaluating bioaccumulation of contaminants. The Industrial Partners also split fish tissue samples and obtained their own fish tissue data. The fish collection effort and the selection of samples for chemical analyses were documented in a memorandum (Kubitz and Matousek 2010, Appendix N) and are summarized as follows. Fish were collected August 24-25, 2010 from Duck and Otter Creeks by the USFWS and Cardno ENTRIX using boat electroshocking and trap nets through entire stream segments (see Figures 1-1 through 1-10). Fish were sorted by species and size to obtain the most consistent samples possible. Four samples of small whole fish were selected by Cardno ENTRIX for tissue analyses. Small fish tend to have smaller home ranges than large fish, which gives them greater fidelity for a particular location. This high site fidelity of small fish was desirable for assessing the uptake of contaminants from sediments such as metals, PCBs, and PAHs. The four fish tissue samples selected for the DGI were:

- A composite sample of whole log perch (FWS1626-OCA-LP1-C) from Otter Creek segment A;
- A composite sample of whole log perch (FWS1632-DCA-LP-1-C93) from Duck Creek segment A;
- A composite sample of whole creek chubs (FWS1626-OCC-CCH2-C8) from Otter Creek segment C; and
- A composite sample of whole creek chubs (FWS1590-DCD-CCH1-C) from Duck Creek segment D.

2.8 Sediment Toxicity Tests

Sediment samples collected as part of the Sediment Quality Triad were also subjected to 10-day bulk sediment toxicity testing using *Chironomus dilutus*. The U.S. Army Corp of Engineers (USACE) Engineering Research and Development Center (ERDC) located in Vicksburg, Mississippi performed the 10-day whole sediment toxicity testing using Method 100.4 and 100.2 as detailed in *Methods for Measuring Toxicity and Bioaccumulation of Associated Contaminants in Freshwater Invertebrates* (USEPA 2000).

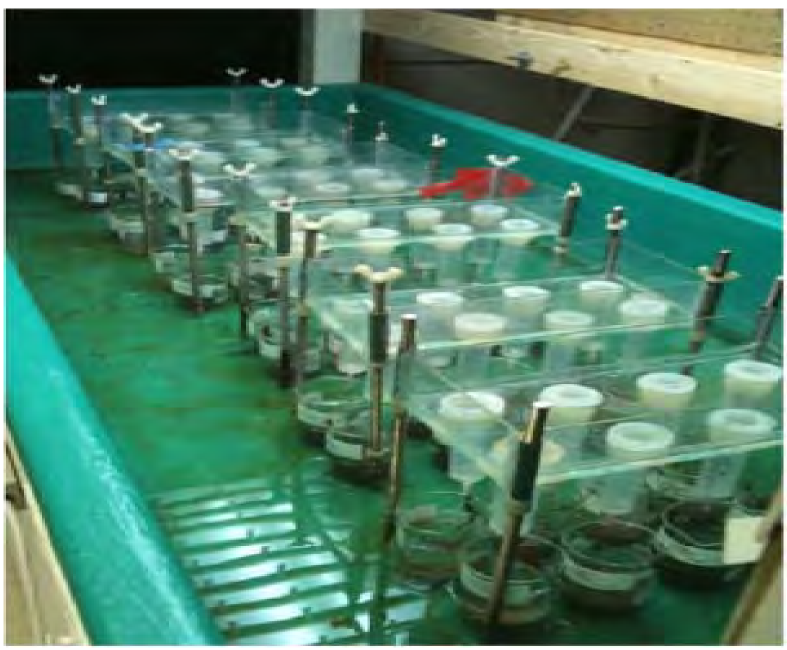

Figure 2-1 Sediment Toxicity Test Exposure System at ERDC Laboratory.

2.9 Chemical Analyses

The chemical analyses that were employed for the Sediment Quality Triad are summarized in Table 2-4 along with the rationale for each measurement.

Table 2-4 Chemical analyses for surface sediment samples and the rationale for each measurement used in support of the Sediment Quality Triad evaluation for Duck and Otter Creeks.

Type	Analysis	Method	Rationale
Surface Sediment	Metals	C200.7	Metals concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to apply toxicity test results to additional samples.
Surface Sediment	AVS/SEM	SW846-6010	This is the bioavailable fraction of divalent metals in sediments; data are needed to apply toxicity test results to additional samples.
Surface Sediment	SVOCs	SOM01.2	SVOC concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to apply toxicity test results to additional samples.
Surface Sediment	PAH_{34}	1734.2	PAH concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to apply toxicity test results to additional samples.
Surface Sediment	Aroclors	SOM01.2	PCB concentrations in sediments exceed conservative screening benchmarks; data are needed to apply toxicity test results to additional samples.
Surface Sediment	GRO/DRO/ORO	SW846-8015	More informative for source identification than "Oil and Grease" analyses conducted in previous investigations.
Surface Sediment	TOC	Lloyd Khan	TOC binds organic molecules in sediments; data are needed to apply toxicity test results to additional samples.
Surface Sediment	Particle size distribution	ASTM D421/D422	TOC binds organic molecules in sediments; data are needed to apply toxicity test results to additional samples.
Surface Sediment	Moisture	E160.3	Data are needed to compare these results with other studies.
Surface Sediment	Pyrethroid Pesticides	GC-MS/MS NCI SIM	Pyrethroid pesticides have been identified as a significant sediment toxicant in urban areas (Holmes et al. 2008).
Surface Sediment	10-day Bulk Sediment Toxicity Testing	Method 100.4 and 100.2 (U.S. EPA 200)	C. dilutus is a standard test organism that has been sensitive to some sediment samples from Duck and Otter Creeks in the SulTRAC 2007 study.
Pore Water	Metals	Method C200.7	Metals concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to interpret toxicity test results. Bulk sediment analyses are needed to apply Sediment Quality Triad results to sample locations where only bulk sediment chemistry has been measured.
Pore Water	34 PAHs	ASTM D 7363-07; Hawthorne et. al. 2005; SPME	PAH concentrations in sediments exceed conservative screening benchmarks; data, especially in pore water, are needed to interpret toxicity test results (USEPA 2003, Hawthorne et al. 2005). Bulk sediment analyses are needed to apply Sediment Quality Triad results to sample locations where only bulk sediment chemistry has been measured.
Pore Water	DOC	9060A/5310C	DOC binds metals and some organics in pore water; data are needed to interpret toxicity test results.
Pore Water	Hardness	2340C	Hardness competes with metals for uptake channels in gills; data are needed to interpret toxicity test results.
Pore Water	pH	150	pH controls metals solubility and precipitation and ammonia ionization; data are needed to interpret toxicity tests

Table 2-4 Chemical analyses for surface sediment samples and the rationale for each measurement used in support of the Sediment Quality Triad evaluation for Duck and Otter Creeks.

Type	Analysis	Method	Rationale
Pore Water	Ammonia	350.1	Ammonia can be a source of toxicity in sediments; data are needed to interpret toxicity test results.
Sediment	Arsenic bioavailability	OSU IVG 2007	Arsenic concentrations in soil/sediment were previously identified as a concern. Analyses conducted for a subset of stations.

In addition to the analyses conducted by the GLNPO contractors, the Duck and Otter Creek Industrial Partners received split samples of four fish tissues from the USFWS and contracted Columbia Analytical Services (CAS) to conduct the following chemical analyses: PCBs and PCB congeners by Method SW846-8082; PAHs by Method Sw846-8270SIM; metals by Method SW846-6020; lipids and moisture content.

2.10 Data Validation

All data generated in field and laboratory activities were reduced, reviewed and validated prior to reporting. No data were disseminated by the laboratory until they have been subjected to the procedures, which are summarized below.

Data Reduction and Review

Raw data from any field measurements and sample collection activities were appropriately recorded in the site logbook. If the data were used in the project reports, they were reduced and summarized, and the method of reduction were documented in the report. Laboratory data reduction procedures were in accordance with the requirements of the CLP SOM01.2 for SVOCs, sediment PAHs (extended list), and PCBs; and ILM05.4 for metals.

Laboratory data reduction procedures were in accordance with the requirements of the appropriate laboratory Standard Operating Procedures (SOPs) for PAHs (extended list and standard), PCBs, DRO/ORO/GRO, TOC, AVS/SEM, pyrethroid pesticides, ammonia, pH, hardness, DOC, lipids, toxicity, and grain size. For each of the laboratory methods, the Laboratory Project Manager completed a thorough inspection of all reports prior to release of the data. Following review and approval of the preliminary report by the Laboratory Project Manager, final reports were generated and signed by the Laboratory Project Manager.

Data Validation

Weston completed the data validation for all the analyses conducted by the Contract Laboratory Program (CLP) (sediment SVOCs, extended list PAHs, PCBs, and metals). Weston also completed data validation for all of the analysis conducted by the WESTON - procured subcontractor laboratories. Completeness was evaluated by auditing the data package for:

- Chain-of-Custody records.
- Technical holding times.

- Required analytical methods.
- Reporting limits.
- Reporting format.
- Laboratory and field Quality Control (QC) reporting forms (blanks, surrogates, laboratory control samples (LCSs), duplicates, matrix spikes (MSs), etc., as appropriate).
- Appropriate supporting data.
- Case narrative.
- Completeness of results.
- Data usability [compliance with project Data Quality Objectives (DQOs)].

Details of any missing, incomplete or incorrect parts of the data packages were stamped "Resubmitted on [date]", attached to the original data package, and returned to the analytical laboratory.

Validation and Verification Methods

Upon receipt of the CLP data, Weston conducted a compliance check to ensure that all quality control components (field quality control samples, etc) were properly evaluated and that the data met the project DQOs. Data were received in one of several acceptable electronic formats. In addition, a CLP-like data package (hardcopy or complete PDF) was received with each electronic data set (EDD). Data that were received from a subcontracted laboratory in a CLP-like data package (complete package with raw data, narrative, and quality control data), with the EDD were manually validated by Weston, independently of the Weston Project Manager. Weston completed the QA/QC checklist for each parameter, and prepared an overall data narrative summary that described any laboratory quality control, data usability , completeness, and any other issues pertaining to the project DQOs. Weston performed a manual data review of 5% of data packages for the CLP parameters.

Validation for data usability was accomplished by comparing the contents of the data packages and Quality Assurance/Quality Control (QA/QC) results to the requirements contained in the QAPP, the respective methods, and the laboratory SOPs.

General guidelines for data validation are presented in:

- National Functional Guidelines for Superfund Organics Method Data Review, U.S. EPA, June 2008
- National Functional Guidelines for Superfund Inorganics Method Data Review, U.S. EPA, January 2010
- National Functional Guidelines for Inorganic Data Review, U.S. EPA, October 2004

- Data that were not covered in the functional guidelines were compared against the applicable analytical methods, the laboratory SOPs, and the accuracy/precision limits described in the QAPP (WESTON 2010).

Weston performed a cursory review of the geotechnical parameters (grain size distribution). The data were compared against the applicable ASTM methods. Findings or QC concerns were included in the data narrative that Weston provided to GLNPO. Examples of USEPA data qualifier definitions are included in Appendix K.

The fish tissue data were validated by Laboratory Data Consultants, Inc. (LDC). LDC conducted a level IV validation of the four fish tissue samples. No issues were identified during data validation and no validation qualifiers were assigned by LDC. Data qualifiers assigned by CAS are included in Appendix L.

Chapter 3

Study Results

3.1 Field Observations and Physical Sediment Parameters

The sediment sampling crew recorded observations regarding the depth to which sediment cores were recovered, and visual and olfactory observations of the sediment and water during sampling. These observations are summarized in Table 3-1.

Sediment depths, as recorded by core recovery, varied from 6 to 62 inches throughout the DGI sampling locations. In general, sediment depths were shallow in the headwater areas: 6 inches in Amlosch Ditch; 8 inches in Grassy Creek; 10 inches in Duck Creek Segment D; however, in Otter Creek Segment E, (OC-23), the sediment depth was 27 inches. Most of the sediment samples collected from the middle reaches of Duck and Otter Creeks were collected with grab samplers for the DGI because sediment thickness was commonly about one foot during the 2007 SulTRAC investigation (Tetra Tech EMI 2008b). The recorded sediment depths for Duck Creek segment C and Otter Creek segments C and B ranged from 8 to 24 inches. Sediment thicknesses were greatest in the lacustuarine segments of Duck and Otter Creeks. Sediment thickness in segment A of Duck Creek ranged from 24 to 52 inches. Sediment thickness ranged from 12 to 62 inches in segment A of Otter Creek, with 9 of 12 DGI core samples in that reach exceeding a depth of 40 inches (Table 3-1).

Field observations described the majority of sediments as silt; clay, sand, gravel, and peat were also recorded somewhat frequently. Sediment colors included grey, brown and black; some sediments contained shells or fragments of shells, presumably from mussels. A few of the deeper sediments were described as “native”. The field observations in Table 3-1 are consistent with the particle size data from sieve and hydrometer tests that are included in Appendix E. Silt was present in all sediments, and was the dominant component of the in 18 of 32 (56.3%) sample locations. Sand was the dominant component in 12 of 32 (37.5%) locations, and gravel was the dominant component in sediments at two locations (OC-8-9 and OC-9-10). In general, silt and clay were the dominant particle sizes in the lacustuarine reaches (A segments) of Duck and Otter Creeks (Appendix E).

The sediment sampling team recorded the observance of sheen following disturbance of the sediments at several sampling locations in Otter Creek and one location in Duck Creek. No sheens were reported for Grassy Creek or Amlosch Ditch. Within Otter Creek, sheens were recorded in 7 of the 12 DGI locations in segment A, with the most frequent reports in the stretch between locations OC-3 and OC-5A, and again at OC6/7(2) near Millard Avenue. Sheens were also reported at single locations in segments C (OC-11/12), D (OC-22), and E (OC-24/25) of Otter Creek (Table 3-1).

Table 3-1. Summary of Field Observations During Sediment Sample Collection.

Segment	Otter Creek A												Otter Creek B		Urban Comparison Streams
Location	**OC-1A**	**OC-2**	**OC-2A**	**OC-3**	**OC-3A**	**OC-4**	**OC-4A**	**OC-5**	**OC-5A**	**OC-6**	**OC-6/7 (1)**	**OC-6/7(2)**	**OC-7/8**	**OC-8**	
Water Depth	3.9 feet	12 inches	6-12 inches	2.5 feet	2.5 feet	3 feet	3 feet	2.5 feet	2.5 feet	2.5 feet	2.5 feet	1 foot 5 inches	6 inches	12 inches	
Surface Grab	SILT, black wet, strong petroleum odor	As bio only:	SILT, with clay, black/grey, wet, some peat layering, moderate petroleum odor	SILT, sheen on water, mod-strong petroleum odor	SILT, sheen on water, moderate petroleum odor	SILT, sheen on water, strong petroleum odor	SILT and cobbles/gravel, sheen on water	NA	SANDY SILT, fn-med sand/grit, wet, sheen, petroleum odor	NA	SAND and GRAVEL, md-cr, wet, slight petroleum odor	SILT and iron pellets - harder substrate	Dark grey sediment, slight petroleum odor	NA	
Core Length Retreived	48 inches	39 inches	62 inches	30 inches	46 inches	42 inches	41 inches	47 inches	46 inches	41 inches	45.5 inches	12 inches	NA	24 inches	
0-24	SILT, black, wet, strong petroleum odor	SILT, with clay, trace fn sand, black/grey, wet, moderate-strong petroleum odor	SILT, with clay, black/grey, wet, some peat layering, moderate petroleum odor	SILT, with clay, trace fine sand, grey/brown, wet, mod-strong petroleum odor	SILT, with clay (muck), black/grey, wet, trace fn sand, moderate petroleum odor	SILT, trace fn sand, grey/black, sheen on water, moderate petroleum odor	SILT, with clay (muck), wet, black/grey, moderate petroleum odor (large cobble with md-cr gravel at surface)	SILT with clay, wet , black/grey, mod-strong petroleum odor, angular md-cr gravel at surface, trace fine sand - sheen on water when retrieving core	CLAYEY SILT, grey/black, wet, trace fn sand, moderate-strong petroleum odor	SILT, with clay, black/grey, some fine sand and md cobbles, wet, moderate petroleum odor	SILT, with clay, grey/black, with some fn sand and lg gravel, moderate petroleum odor	SILT, with fn sand and gravel, some iron pellets, sheen on water, mod-strong petroleum odor	NA	SILT, dark grey/black, slight odor	
24-48	SILT, with clay, some peat layering, trace fin sand/gravel, strong petroleum odor	SAA, some peat layering; 36-39 inches is fn-md gravel (rounded/subangular) and clay	SAA, layering of fine sand, layering of organic/roots/peat, strong petroleum odor	CLAY (silty), moist, some white shell fragments, no odor (26-30 inches is native)	SAA; 40-46 inches: CLAY, with silt, brown, moist, some white shell fragments, no odor (native)	SILT, with clay, brown organic layer/woody debris (clayey with trace white shell fragments), slight-moderate petroleum odor	SAA, brown woody debris layering, sl-mod petroleum odor	SAA, no gravel, increasing clay content	SAA, wet moist; (43-36 inches is native SILTY CLAY, brown, with fine sand and small white shell fragments)	SAA; (38-41 inches is CLAY, with lg cobbles, grey/brown, moist, no odor)	SAA; higher clay content, layering of brown moist clay with roots/organic near terminus	NA	NA	NA	
48-72	NA	NA	SILTY CLAY (native), brown, moist, organic/roots/peat, no odor, trace white shell fragments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Segment	Otter Creek B				Otter Creek C						Otter Creek D		Otter Creek E		Grassy Creek
Location	**OC-8/9**	**OC-9**	**OC-9/10**	**OC-10/11**	**OC-11/12**	**OC-12/13**	**OC-15/16**	**OC-16**	**OC-16/17**	**OC-18**	**OC-18/19**	**OC-22**	**OC-23**	**OC-24/25**	**GC-1**
Water Depth	1.5 feet	6 inches	1 foot 5 inches	1 foot	~1 foot	1 foot 3 inches	~1.5 feet	1 foot	1 foot	1 foot	1 foot	1 foot	1 foot	1.5 feet	8 inches
Surface Grab	SILT, grey, slight odor	NA	SILT, grey/black, slight odor	CLAYEY SILT, light grey/grety, no odor	SILT, black, visible sheen, strong petroleum odor	SAND, cr, dark grey-dark brown, no odor/sheen, moderately solid creek bed	no sheen, no odor	SAND, cr, dark brown, no odor, moderate solid creek be with hard brown clay along shorelines	SAND/GRAVEL, no sheen, no odor	NA	No sheen, no odor	slight sheen, no odor	NA	Slight sheen, no odor	Dark grey sediment and sand, no odor
Core Length Retreived	NA	8 inches	NA	NA	NA	NA	NA	NA	NA	21 inches	NA	NA	27 inches	NA	NA
0-24	NA	0-3 inches: SAND, md-cr brown, with md subangular gravel, wet, no odor; 3-8 inches: CLAY, grey, dry-moist, sticky	NA	NA	NA	NA	NA	NA	NA	SILTY SAND, black, wet, moderate petroleum odor	NA	NA	SILT, some clay, grey wet, layering of gravel, md-cr, subangular-rounded, with cr sand	NA	NA
24-48	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	GRAVEL, with silt, md rounded-subangular gravel, wet	NA	NA
48-72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Segment	Duck Creek A						Duck Creek B			Duck Creek C		Duck Creek D			Amlosch Ditch
Location	**DC-1**	**DC-2**	**DC-3**	**DC-3/4**	**DC-4**	**DC-5**	**DC-5/6**	**DC-6/7**	**DC-7/8**	**DC-8**	**DC-9/10**	**DC-10/11**	**DC-11**	**DC-11/12**	**AD-1**
Water Depth	3 feet	8 inches	6 inches	6 inches	6 inches	1 foot	2 feet	2 feet	1 foot	1.5 feet	1 foot	1 foot	2 feet		6 inches
Surface Grab	NA	As bio only	SILT/CLAY, black	SILT/CLAY, black/grey	SILT/CLAY, black/grey	SILT, moderate-strong petroleum odor	SILT, black with vegetation		SILT/CLAY, dark grey, some vegetation	NA	SILT, dark grey, with vegetation, no odor	No sheen/odor	NA		Dark grey sediment, leaves, no odor
Core Length Retreived	36 inches	42.5 inches	24 inches	24 inches	24 inches	52 inches	NA		NA	20 inches	NA	NA	10 inches		NA
0-24	SILT/CLAY, black/grey, no odor	SILT/CLAY, black/grey, some roots, slight odor	SILT/CLAY, black/grey	SILT/CLAY, black/grey	SILT/CLAY, black/grey	SILT, some clay, grey/black, wet, moderate-strong petroleum odor	NA		NA	CLAYEY SILT, grey/black, wet, with fn sand, no odor; (17-20 inches is CLAY, grey/brown, trace cr rounded gravel, dry-moist, no odor	NA	NA	CLAYEY SILT, some fn sand, grey/black, wet, no odor, some whole white shells		NA
24-48	SILT/CLAY, black/grey, some grey sand, slight odor	SILT/CLAY, black/grey, slight odor	NA	NA	NA	SILTY CLAY, grey, with fn black sand layering, moist-wet, moderate-strong petroleum odor	NA		NA	NA	NA	NA	NA		NA
48-72	NA	NA	NA	NA	NA	SILTY CLAY, brown/grey, with md gravel (rounded), moist, no odor, sticky	NA		NA	NA	NA	NA	NA		NA

The sediment sampling team recorded that "odors" and "petroleum odors" were observed at several sampling locations in Otter and Duck Creeks. No odors were reported in Grassy Creek or Amlosch Ditch. Odors were recorded in only segment A of Duck Creek, and the odor was identified as "petroleum" in one location (DC/5), with "slight odors" at two of the other 6 locations in that segment. In Otter Creek, odors were recorded in segments C, B and A, but not D or E; in most cases the odor was identified as "petroleum." In segment C of Otter Creek, odors were reported in 2 of 6 DGI locations, described as "strong" or "moderate", and identified as "petroleum" in both cases. In segment B of Otter Creek, odors were recorded for 4 of 6 DGI locations, and all were described as "slight", and identified as "petroleum" in one location. In segment A of Otter Creek, "petroleum" odors were reported in all 12 DGI locations, and described as "moderate" or "strong" (Table 3-1).

3.2 Benthic Macroinvertebrate Community Structure

The structure of the benthic macroinvertebrate community is one component of the Sediment Quality Triad approach for assessing sediment quality. If sediment contaminants are present at concentrations that are sufficient to adversely affect biological life, the community of organisms that inhabit those sediments could be altered, or even completely absent. Aquatic communities can be affected by habitat modifications (physical stressors) or invasive species (biological stressors). Because the landscape of Lucas and Wood counties has been drained and developed during the last century, the benthic communities of two urban comparison streams were assessed along with Duck and Otter Creeks to obtain information about the general steam community conditions that are present in urban, non-industrial streams in the area. The complete benthic macroinvertebrate data set is included as Appendix B of this report; a summary is included as Table 3-2.

The benthic macroinvertebrate community summary is based on selected metrics, which included the following:

- Taxa Richness; the total number of taxa observed at the consistent effort described in Table 2.2., which can be viewed as a measure for biodiversity. Greater taxa richness indicates a more robust biological community;
- Abundance; the total number of individual organisms observed. Greater abundance can be indicative of a robust biological community unless the community is dominated by pollution-tolerant organisms;
- Abundance of Sensitive Taxa; four groups of benthic (bottom-dwelling) organisms are generally considered to be indicative of high-quality biological communities because they have been found to be relatively sensitive to habitat conditions such as nutrient enrichment, altered thermal regimens, and siltation. When these sensitive taxa are abundant (relative to other taxa) the water body is generally considered to have high quality. Conversely, the absence of sensitive taxa is generally considered to be evidence of an impaired water body. Images of sensitive taxa are shown in Figure 3-4. The sensitive taxa include:
    - Percent Ephemeroptera; this taxon includes the mayflies, which generally require high dissolved oxygen concentrations and are therefore sensitive to nutrient pollution. Some mayflies burrow into sediments and could be exposed to (and affected by) sediment-related contaminants. Lake Erie is famous for large "hatches" of the large mayfly

Hexagenia limbata, and the decreases in abundance of this species during the 1960s contributed to the environmental movement of that time;

- Percent Plecoptera; this taxon includes the stoneflies, which also generally require high dissolved oxygen conditions and are generally sensitive to nutrient pollution and warm water temperatures. The leaf-shredding stoneflies flourish in streams with forested riparian zones and are sensitive to changes in watershed land use as well. The predatory stoneflies prefer gravel and cobble substrates where prey items are abundant, and are sensitive to siltation. No stoneflies were observed in the data gap investigation, so they do not appear in Appendix B or Table 3-2;
- Percent Trichoptera; this taxon includes the caddisflies, which build cases from sand, plant material or other items. The caddisflies also prefer high dissolved oxygen temperatures, and cold, flowing waters; and
- Percent Amphipoda; this taxon includes the “scuds” or “sideswimmers”, which are small crustaceans that have been observed to be sensitive to contaminants in laboratory toxicity tests. The amphipod *Hyalella azteca* is a standard sediment toxicity testing organism.

▪ Abundance of Tolerant Taxa; two groups of benthic organisms are considered to be generally tolerant of low oxygen concentrations, and will often flourish in nutrient-enriched water bodies. Water bodies are frequently considered to be impaired when tolerant species dominate the benthic macroinvertebrate community; images of tolerant taxa are shown in Figure 3-5.

  - Percent Chironomidae; this taxon is a family of true flies (insects); the larvae are aquatic and are commonly called “bloodworms” that are red in color because their circulatory systems contain hemoglobin, which carries oxygen and allows them to survive in aquatic systems that have low dissolved oxygen concentrations. The adults are commonly known as “midges”. Chironomids are naturally abundant in many aquatic ecosystems, and a few species are used as sediment toxicity testing organisms, including *Chironomus dilutus* that was used in this study;
  - Percent Oligochaeta; this taxon includes the aquatic species of segmented worms. Some species of oligochetes thrive in silty, organic-rich sediments, and have been observed to be extremely abundant in water bodies that had received substantial inputs of untreated municipal wastewater, which earned the label “sludge worms” for these taxa. The oligochete *Lumbriculus sp*. is used in laboratory experiments to study the uptake of contaminants from sediments because they are large in size, burrow relatively deeply into sediments, and tolerate high densities so scientists have sufficient tissue mass for chemical analysis.

The study design for this data gap investigation used a system of five transects for benthic macroinvertebrate collection to ensure that all microhabitat features were sampled. Four transects were sampled across the width of the stream (transverse transects), and one (longitudinal) transect was sampled down the length of the stream channel. Arithmetic mean values for each macroinvertebrate community metric were calculated for these five transects (4 transverse, 1 longitudinal) for each of the selected locations Duck and Otter Creeks as well as the urban comparison streams, and those data are presented in Table 3-2.

Table 3-2 Summary of benthic macroinvertebrate data for Amlosch Ditch and Duck, Otter and Grassy Creeks.

Sample Location	Taxa Richness	Total Abundance	Abundance of Sensitive Taxa			Abundance of Tolerant Taxa	
			% Ephemeroptera	% Trichoptera	% Amphipoda	% Chironomidae	% Oligochaeta
Amlosch Ditch 1	8	419	0.00%	0.00%	46.78%	11.93%	13.60%
Amlosch Ditch 2	10	1140	0.00%	0.00%	41.87%	30.39%	16.10%
Amlosch Ditch 3	5	462	0.00%	0.00%	65.58%	0.65%	30.52%
Amlosch Ditch 4	6	265	0.00%	0.00%	89.43%	0.38%	4.15%
Amlosch Ditch Longitudinal	8	745	0.00%	0.00%	63.09%	9.40%	0.67%
Mean	7	606	0.00%	0.00%	61.35%	10.55%	13.01%
Standard Deviation	2	345	0.00%	0.00%	18.72%	12.23%	11.70%
DC3-1	5	110	0.00%	0.00%	34.55%	5.45%	29.09%
DC3-2	8	167	0.00%	0.00%	14.97%	18.56%	26.95%
DC3-3	12	734	0.27%	0.00%	4.36%	7.77%	65.67%
DC3-4	7	478	0.00%	0.00%	10.46%	5.44%	39.75%
DC3-Longitudinal	8	1204	0.00%	0.00%	25.58%	4.65%	13.62%
Mean	8	539	0.05%	0.00%	17.98%	8.37%	35.01%
Standard Deviation	3	449	0.12%	0.00%	12.08%	5.81%	19.49%
DC5-1	8	282	3.90%	0.35%	0.35%	84.75%	4.96%
DC5-2	9	586	14.85%	0.00%	0.00%	45.90%	37.37%
DC5-3	8	280	39.29%	0.36%	0.00%	28.57%	26.79%
DC5-4	6	50	0.00%	0.00%	2.00%	50.00%	32.00%
DC5-Longitudinal	7	540	20.74%	0.00%	1.48%	51.11%	8.15%
Mean	8	348	15.75%	0.14%	0.77%	52.07%	21.85%
Standard Deviation	1	219	15.56%	0.19%	0.92%	20.39%	14.50%

Table 3-2 Summary of benthic macroinvertebrate data for Amlosch Ditch and Duck, Otter and Grassy Creeks.

Sample Location	Taxa Richness	Total Abundance	Abundance of Sensitive Taxa			Abundance of Tolerant Taxa	
			% Ephemeroptera	% Trichoptera	% Amphipoda	% Chironomidae	% Oligochaeta
DC6/7-1	11	280	30.36%	1.43%	5.71%	45.36%	3.21%
DC6/7-2	6	215	13.02%	0.00%	0.00%	32.09%	50.70%
DC6/7-3	5	133	8.27%	0.00%	0.00%	37.59%	51.88%
DC6/7-4	6	49	32.65%	0.00%	0.00%	34.69%	14.29%
DC6/7-Longitudinal	7	344	1.16%	0.00%	0.00%	67.44%	15.12%
Mean	7	204	17.09%	0.29%	1.14%	43.44%	27.04%
Standard Deviation	2	117	13.84%	0.64%	2.56%	14.31%	22.63%
Grassy Creek 1	11	2662	0.00%	0.00%	0.00%	0.68%	92.82%
Grassy Creek 2	8	1355	0.00%	0.00%	0.00%	0.66%	89.23%
Grassy Creek 3	10	505	0.00%	0.00%	0.00%	0.59%	84.75%
Grassy Creek 4	6	307	0.00%	0.00%	0.00%	1.41%	70.42%
Grassy Creek Longitudinal	9	1520	0.00%	0.00%	0.00%	3.29%	62.17%
Mean	9	1270	0.00%	0.00%	0.00%	1.33%	79.88%
Standard Deviation	2	938	0.00%	0.00%	0.00%	1.15%	13.05%
OC4-1	4	155	0.00%	0.00%	0.00%	14.19%	66.45%
OC4-2	4	409	0.00%	0.00%	0.00%	9.05%	80.20%
OC4-3	4	280	0.00%	0.00%	0.00%	11.43%	83.93%
OC4-4	5	257	0.00%	0.00%	0.00%	21.01%	51.36%
OC4-Longitudinal	4	370	0.00%	0.00%	0.00%	20.27%	28.38%
Mean	4	294	0.00%	0.00%	0.00%	15.19%	62.06%

Table 3-2 Summary of benthic macroinvertebrate data for Amlosch Ditch and Duck, Otter and Grassy Creeks.

Sample Location	Taxa Richness	Total Abundance	Abundance of Sensitive Taxa			Abundance of Tolerant Taxa	
			% Ephemeroptera	% Trichoptera	% Amphipoda	% Chironomidae	% Oligochaeta
Standard Deviation	0	100	0.00%	0.00%	0.00%	5.31%	22.78%
OC5A-1	5	622	0.00%	0.00%	0.00%	12.38%	81.67%
OC5A-2	5	623	0.00%	0.00%	0.00%	6.26%	87.64%
OC5A-3	4	234	0.00%	0.00%	0.00%	5.13%	85.04%
OC5A-4	5	186	0.00%	0.00%	0.00%	5.38%	91.40%
OC5A-Longitudinal	4	120	0.00%	0.00%	0.00%	12.50%	66.67%
Mean	5	357	0.00%	0.00%	0.00%	8.33%	82.48%
Standard Deviation	1	246	0.00%	0.00%	0.00%	3.78%	9.53%
OC6/7(2)-1	1	3	0.00%	0.00%	0.00%	100.00%	0.00%
OC6/7(2)-2	2	10	0.00%	0.00%	0.00%	10.00%	90.00%
OC6/7(2)-3	2	61	0.00%	0.00%	0.00%	3.28%	96.72%
OC6/7(2)-4	3	36	0.00%	0.00%	0.00%	5.56%	91.67%
OC6/7(2)-Longitudinal	3	25	0.00%	0.00%	0.00%	40.00%	40.00%
Mean	2	27	0.00%	0.00%	0.00%	31.77%	63.68%
Standard Deviation	1	23	0.00%	0.00%	0.00%	40.91%	42.38%
OC9/10-1	3	19	0.00%	0.00%	0.00%	68.42%	26.32%
OC9/10-2	4	40	0.00%	0.00%	0.00%	25.00%	37.50%
OC9/10-3	6	19	0.00%	5.26%	0.00%	52.63%	15.79%
OC9/10-4	5	67	1.49%	0.00%	0.00%	5.97%	76.12%
OC9/10-Longitudinal	5	140	0.00%	0.00%	0.00%	31.43%	42.86%

Table 3-2 Summary of benthic macroinvertebrate data for Amlosch Ditch and Duck, Otter and Grassy Creeks.

Sample Location	Taxa Richness	Total Abundance	Abundance of Sensitive Taxa			Abundance of Tolerant Taxa	
			% Ephemeroptera	% Trichoptera	% Amphipoda	% Chironomidae	% Oligochaeta
Mean	5	57	0.30%	1.05%	0.00%	36.69%	39.72%
Standard Deviation	1	50	0.67%	2.35%	0.00%	24.34%	22.87%
OC12/13-1	4	21	0.00%	0.00%	0.00%	47.62%	23.81%
OC12/13-2	8	119	0.00%	0.00%	0.00%	11.76%	69.75%
OC12/13-3	4	51	0.00%	0.00%	0.00%	11.76%	82.35%
OC12/13-4	5	45	0.00%	0.00%	0.00%	2.22%	80.00%
OC12/13-Longitudinal	2	44	0.00%	0.00%	0.00%	27.27%	0.00%
Mean	5	56	0.00%	0.00%	0.00%	20.13%	51.18%
Standard Deviation	2	37	0.00%	0.00%	0.00%	17.80%	37.13%
OC16-1	3	28	0.00%	0.00%	0.00%	21.43%	60.71%
OC16-2	8	68	0.00%	1.47%	0.00%	67.65%	11.76%
OC16-3	5	43	0.00%	0.00%	0.00%	23.26%	69.77%
OC16-4	4	29	0.00%	0.00%	0.00%	27.59%	58.62%
OC16-Longitudinal	4	60	0.00%	0.00%	0.00%	20.00%	53.33%
Mean	5	46	0.00%	0.29%	0.00%	31.98%	50.84%
Standard Deviation	2	18	0.00%	0.66%	0.00%	20.14%	22.64%
OC22-1	4	76	0.00%	0.00%	0.00%	2.63%	88.16%
OC22-2	4	28	0.00%	0.00%	0.00%	17.86%	50.00%
OC22-3	8	187	3.21%	0.00%	0.00%	6.95%	74.87%
OC22-4	5	134	0.00%	0.00%	0.00%	5.22%	91.04%

Table 3-2 Summary of benthic macroinvertebrate data for Amlosch Ditch and Duck, Otter and Grassy Creeks.

Sample Location	Taxa Richness	Total Abundance	Abundance of Sensitive Taxa			Abundance of Tolerant Taxa	
			% Ephemeroptera	% Trichoptera	% Amphipoda	% Chironomidae	% Oligochaeta
OC22-Longitudinal	9	299	1.34%	0.00%	0.00%	8.03%	71.91%
Mean	6	145	0.91%	0.00%	0.00%	8.14%	75.20%
Standard Deviation	2	105	1.41%	0.00%	0.00%	5.80%	16.32%
OC24/25-1	15	421	5.94%	0.00%	0.00%	4.75%	8.08%
OC24/25-2	14	319	3.76%	0.00%	0.00%	10.34%	10.03%
OC24/25-3	10	497	0.00%	0.00%	0.00%	3.82%	16.90%
OC24/25-4	13	146	4.11%	0.00%	0.00%	3.42%	32.19%
OC24/25-Longitudinal	10	595	0.84%	0.00%	0.00%	2.52%	3.36%
Mean	12	396	2.93%	0.00%	0.00%	4.97%	14.11%
Standard Deviation	2	172	2.45%	0.00%	0.00%	3.11%	11.22%
Percentages do not necessarily sum to 100% because some benthic taxa are not designated as either sensitive or tolerant.							

Regarding taxa richness, Duck and Grassy Creeks along with Amlosch Ditch generally exhibited more taxa than Otter Creek (Figure 3-1). The most taxa observed at a single location, however, were recorded at OC-24/25.

Sensitive taxa were relatively abundant in Amlosch Ditch (Figure 3-2) location, which was dominated by Amphipoda. Stoneflies (Plecoptera) were absent in all locations, and mayflies (Ephemeroptera) were relatively abundant in Duck Creek. Caddisflies (Trichoptera) were rare to absent in all sample locations. Sensitive taxa were rare in Grassy and Otter Creeks.

Tolerant taxa, represented by Oligochaeta and Chironomidae, were relatively abundant in all streams with the least relative abundance of tolerant taxa in Amlosch Ditch (Figure 3-3). Specific locations with the lowest abundance of tolerant taxa were OC-24/25 and DC-3.

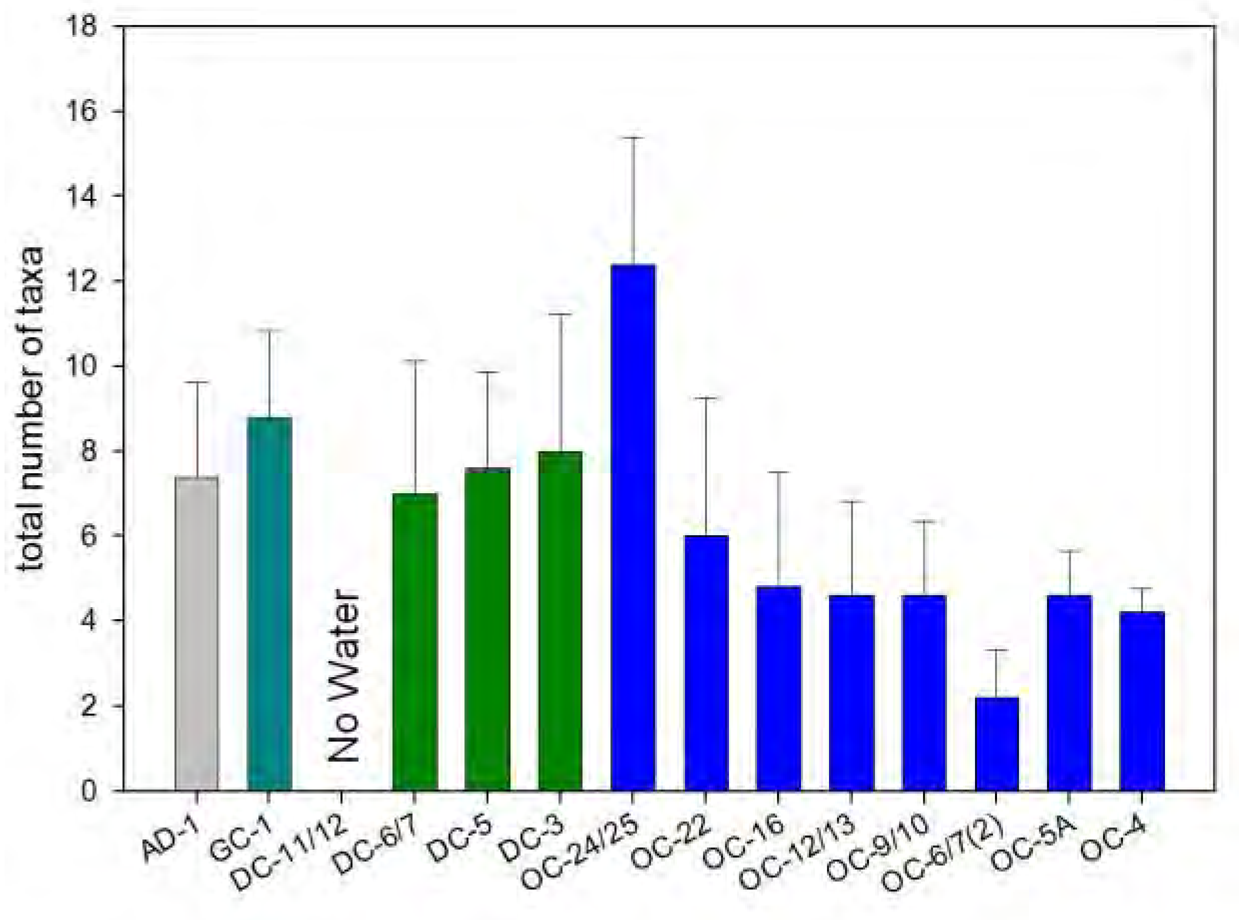

Figure 3-1 **Summary of the total number of taxa in Duck, Otter and Grassy Creeks and Amlosch Ditch.**

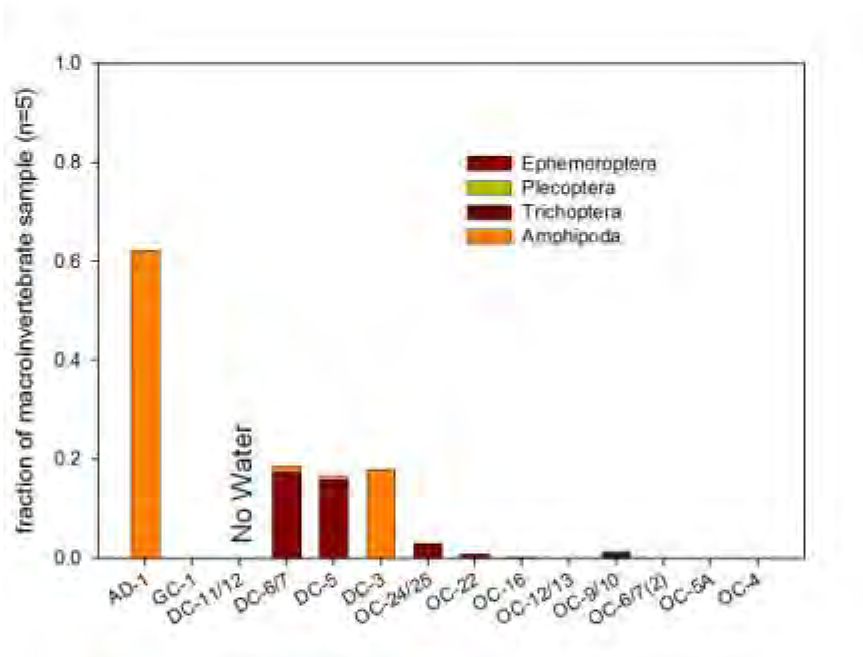

Figure 3-2 Summary of the relative abundance of sensitive benthic macroinvertebrate taxa in Duck, Otter and Grassy Creeks and Amlosch Ditch.

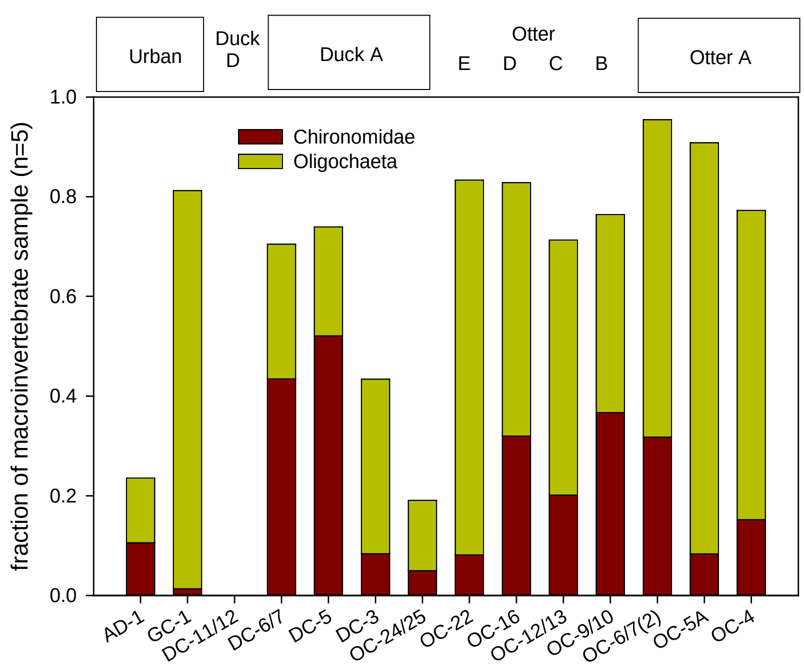

Figure 3-3 Summary of the relative abundance of tolerant benthic macroinvertebrate taxa in Duck, Otter and Grassy Creeks and Amlosch Ditch.

Gammarus **(amphipods)**

Ephemeroptera (mayfly larvae and adult), genus *Hexagenia*

Trichoptera (caddisfly adult), family *Limnephilidae*

Figure 3-4 Images of sensitive taxa of benthic macroinvertebrates.

Chironomidae (midge) larvae **Chironomidae (midge) adult**

Oligochaeta (aquatic worm) and *Gammarus* (amphipod)

Figure 3-5 Images of tolerant taxa of benthic macroinvertebrates (except *Gammarus* which is sensitive).

3.3 Habitat Quality

Habitat quality was evaluated within the stream channels using the Ohio EPA Quantitative Habitat Evaluation Index and Use Assessment Field Sheets (QHEI), and outside of the stream channels using GIS-based approaches. The QHEI data sheets and a complete set of field photos are included in Appendix C. Maps of stormwater outfalls are included in Appendix D. Physical characteristics of sediment (particle size distribution, solids content and organic carbon content) are included in Appendix E. A detailed summary of riparian and watershed land use, as well as an accounting of the relative percent of impervious surface categories are included in Appendix F.

3.3.1 In-stream (channel) Habitat Quality

The QHEI assessment started on September 27, 2010 and was finished on September 30, 2010. Due to a rain event on September 28, 2010 some of the stream conditions such as water depth and current velocity may have varied slightly throughout the course of conducting the QHEI assessment, but it is unlikely that alterations in flow regimens were sufficient to change the OHEI scores.

In-stream channel habitat ranged from very poor to poor throughout the study area, including the two urban comparison streams. Low scores were observed for Amlosch Ditch on all metrics (Table 3-3), with the lowest scoring metrics including: Substrate, Instream Cover and Pool/Glide and Riffle/Run Quality. The Substrate contained heavy silt with extensive embeddedness and the Instream Cover was nearly absent. One of the positive habitat characteristic observed in Amlosch Ditch was the absence of bank erosion (Figure 3-6), which contributed to a rating of 6 for channel morphology at that location.

For Grassy Creek, the lowest metrics were Substrate and Pool/Glide and Riffle/Run Quality. The Substrate was composed of silt and detritus and was moderately embedded. There was no riffle in this sample station and the stream was shallow with slow moving water (Figure 3-7). Highlights of Grassy Creek included: moderate sinuosity, a recovering channel, and moderate channel stability. Little to no erosion was observed in Grassy Creek; the stream also exhibited a narrow but present forested riparian zone in a residential area. These features contributed to a score of 9 for QHEI Metric 4 (Bank Erosion and Riparian Zone).

Table 3-3 Summary of habitat quality for the local urban comparison streams.

Category	Max value	Amlosch Ditch*	Grassy Creek
River Mile	N/A	5.0	8.2
Substrate	20	2.5	4.5
Instream Cover	20	2	6
Channel Morphology	20	6	9
Bank Erosion and Riparian Zone	10	3.5	6
Pool/Glide and Riffle/Run Quality	20	3	3
Map Gradient	10	6	4
Total QHEI Score	100	23	32.5
Narrative Description		Very Poor	Poor

* Due to roads and culverts the sample station for Amlosch Ditch was limited to 195 meters.

Figure 3-6 Sample station in Amlosch Ditch (AD-1), depicting little to no bank erosion, high channel stability and little to no instream cover.

Figure 3-7 Sample station in Grassy Creek (GC-1), depicting good quality floodplain, no riffle and shallow slow moving water.

The QHEI scores for the three sample stations in Duck Creek ranged from 23.5 to 40 (Table 3-4); which correspond to OEPA narrative ratings of "Very Poor" to "Poor" stream habitat. All 3 sample stations on Duck Creek demonstrated low scores in the Substrate category, which indicates the substrate is poor habitat for colonization of "sensitive" macroinvertebrate taxa. Lower Duck Creek (segment A) scored poorly in the Pool/Glide and Riffle/Run Quality category, which is reflective of low channel variation and slow water velocities (Figure 3-8).

Station 6/7 in Duck Creek (segment B) scored relatively well in the category of Pool/Glide and Riffle/Run with 8 out of a possible score of 20. Duck Creek stations DC-5 and DC-6/7 scored 13 out of 20 for instream cover, which reflects the presence of logs and other woody debris (Figure 3-9) which provide habitat for invertebrate and fish populations.

The QHEI scores for Otter Creek ranged from 31 to 42 (Table 3-5), which correspond to narrative ratings of "poor". All 7 sample stations on Otter Creek demonstrated low scores in the Substrate category, which was representative of a silt substrate that was extensively embedded (see Figure 3-10). Scores Channel Morphology and Pool/Glide and Riffle/Run Quality metrics in Otter Creek were varied. Lower scores were observed in the channelized upper (segment E) and lower (segment A) reaches (see Figure 3-11), but higher in the meandering middle reaches (segments D-B) (see also Figure 3-12).

The riffle (fast-flowing water) pool (deep slow water) sequence at OC-9-10 was a major contribution to the relatively high overall QHEI score at that location. Even though the riffle-pool sequence constituted only 15% of the observed stream segment, it was sufficient to increase the habitat diversity of the location.

Table 3-4 Summary of habitat quality for the Duck Creek stations.

		Segment B	Segment A	
Category	**Max value**	**DC6-7**	**DC-5**	**DC-3**
River Mile	N/A	2	1.5	1
Substrate	20	4	2.5	2.5
Instream Cover	20	13	13	5
Channel Morphology	20	6	9	6
Bank Erosion and Riparian Zone	10	6	6	5
Pool/Glide and Riffle/Run Quality	20	8	4	2
Map Gradient	10	3	3	3
Total QHEI Score	100	40	37.5	23.5
Narrative Description		Poor	Poor	Very Poor

Figure 3-8 Sample station DC-3, depicting stable stream bank conditions and straightened stream channel.

Figure 3-9 Sample station DC-5, representing moderate riparian width and relatively good instream cover.

Table 3-5 Summary of habitat quality for the Otter Creek stations.

Stream segments		E	D	C		B	A	
Category	**Max value**	**OC24-25**	**OC22***	**OC16**	**OC12-13**	**OC9-10**	**OC6-7(2)**	**OC4**
River Mile	N/A	7.3	6	4.25	3.4	2.6	1.8	0.7
Substrate	20	3	2.5	2.5	2.5	2.5	4.5	2.5
Instream Cover	20	13	7	6	5	7	12	10
Channel Morphology	20	6	6	8	6	10	6	6
Bank Erosion and Riparian Zone	10	4	6	6.5	7.5	5.5	4	3.5
Pool/Glide and Riffle/Run Quality	20	3	6	4	6	11	4	6
Map Gradient	10	6	6	6	6	6	3	3
Total QHEI Score	100	35	33.5	33	33	42	33.5	31
Narrative Description		Poor	Poor	Poor	Poor	Poor	Poor	Poor

* Due to lack of access to private property the sample station for OC22 was limited to 125 meters.

Figure 3-10 Sample station OC9-10, depicting a silt substrate that is extensively embedded.

Figure 3-11 Sample station OC-4, representing stream channelization and low to no sinuosity.

Figure 3-12 Sample station OC9-10, representing riffle, pool and glide characteristics.

The QHEI scores for the stream stations that were evaluated for the GLLA data gap investigation were relatively low, and ranged from 23 at the Amlosch Ditch urban comparison stream location to 40 in the middle reach of Otter Creek (sample station OC9-10). The narrative QHEI descriptions for stream habitat quality scores range from “very poor” to “poor”. The results of the in-stream habitat assessments indicate that the urban comparison streams, which flow through non-industrial watersheds, exhibit physical habitat conditions that are similar to Duck and Otter Creeks study streams (Table 3-6).

Table 3-6 Summary of habitat quality for the Duck and Otter Creek stations and the urban comparison stream stations.

Category	Max possible value	Amlosch Ditch*	Grassy Creek	Range for Duck & Otter Creeks
Substrate	20	2.5	4.5	2.5 to 4.5
Instream Cover	20	2	6	5 to 13
Channel Morphology	20	6	9	6 to 10
Bank Erosion and Riparian Zone	10	3.5	6	3.5 to 7.5
Pool/Glide and Riffle/Run Quality	20	3	3	2 to 11
Map Gradient	10	6	4	3 to 6
Total QHEI Score	100	23	32.5	23.5 to 42
Narrative Description		Very Poor	Poor	Very Poor to Poor

*Due to roads and culverts the sample station for Amlosch Ditch was limited to 195 meters.

The generally low QHEI scores for all stream locations suggest that habitat quality may be contributing to the impaired biological communities of these northwest Ohio streams. Restoration of beneficial uses within Duck and Otter Creeks would benefit from, and possibly require, enhancement of the stream habitats even in cases where other stream restoration measures are warranted. The individual metrics of the QHEI scores provide additional information regarding which habitat enhancements may be considered for implementation in the channelized streams in this urbanized watershed, as discussed below:

- Metric 1: Substrate scores for the stream stations evaluated for the GLLA data gap investigation were uniformly low. The values ranged from 2.5 to 4.5 out of a maximum value of 20. The reason for the consistently low substrate scores across all of the streams is the prevalence of silty sediments that were likely deposited after the last ice age when the study area was covered by the Great Black Swamp. Gravel substrates are present, but are embedded in silt so the pore spaces are not available for aquatic life. Given the historic swamp sediments and the mobility of silt during periods of high flow, it is likely that placement of larger-sized substrates to create riffles may be only partly successful in terms of stream habitat enhancement because those riffles could become embedded by the transport of silt from upstream areas, or during seiches;
- Metric 2: Instream Cover scores for the stream stations in this study ranged from 2 to 13 out of a maximum value of 20: The instream cover values for the local urban comparison streams

were low, with 2 for Amlosch Ditch and 6 for Grassy Creek. The low instream cover scores for many of the stream stations evaluated for the GLLA data gap investigation indicate that habitat quality in some stream reaches in the area could be improved or enhanced by the addition of woody debris that would add cover and habitat for aquatic species;

- Metric 3: Channel Morphology scores for the stream stations in this study ranged from 6 to 9 out of a maximum value of 20. The generally low scores for channel morphology are likely the result of historic channelization. However, scores of 10 are on the high end of the range for scores typically observed at ditches and streams located within urbanized watersheds. Given the prevalence of private property and the highly-developed nature of the watersheds, some limitations or challenges may exist in these watersheds for adding meanders to improve stream habitat; however, some projects have been and could potentially be developed to incorporate meanders into some reaches of Duck and Otter Creeks;
- Metric 4: Bank Erosion and Riparian Zone scores for the stream stations in the study area ranged from 3.5 to 7.5 out of a maximum value of 10. The stream banks for Amlosch Ditch, Duck, Otter and Grassy Creeks and Amlosch are generally stable, and erosion is not an obvious problem within the study area. To ensure continued stability of stream banks, it would be helpful to protect the current riparian zones and potentially expand riparian width in areas with low scores for this QHEI metric. There may be opportunities for enhancement of the riparian buffer zone; however, most of the land appears to be privately owned, so management of riparian vegetation would need to be acceptable to the landowners. Given the prevalence of invasive vegetation such as *Phragmites* and honeysuckle along the stream banks in the "A" segments of both streams, portions of the floodplain and/or riparian corridor quality may be improved by increasing the floral diversity with native plants, which would enhance wildlife use and aesthetics of the stream corridors;
- Metric 5: Pool/Glide and Riffle/Run Quality scores for the stream stations in the study area ranged from 2 to 11 out of a maximum value of 20. Both urban comparison streams exhibited metric 5 scores of 3. Most stream stations had scores for this metric in the range of 3 to 6. The greatest pool/glide riffle/run score (11) in this study was observed for station OC9-10 on Otter Creek. The presence of at least one station with a much greater riffle/run and pool/glide score than most sample stations suggests there could be opportunities to enhance the stream microhabitats through in-channel projects; and
- Metric 6: Map Gradient scores in the stations evaluated for the GLLA data gap investigation ranged from 3 to 6 out of a maximum value of 10. The map gradients for all Duck Creek locations had scores of 3; Otter Creek gradients had scores of 6 in the upstream areas and scores of 3 in the lower reach (Table 3-4). The Amlosch Ditch station exhibited a gradient score of 6, while the Grassy Creek station had a gradient score of 4. Map gradients are determined by the topography of the landscape, so there are few, if any, opportunities to enhance stream gradients through in-stream projects.

The habitat quality information was incorporated into the DGI to supplement the sediment quality triad approach for these streams because they have a history of substantial modifications to the stream channels and watersheds. The QHEI metrics and scores were evaluated at a similar scale of effort, namely 12 independent observations across a variety of stream conditions, as was invested in the benthic community structure data (13 independent observations across the same stream conditions). The land use evaluation described in Section 3.3.3. was conducted at the watershed scale of aggregation (not on the basis of individual locations or stream segments), which does not provide equal precision for the following statistical evaluations. Consequently, land use data are not included in Tables 3-7or 3-8, or the corresponding discussion.

Table 3-7 Summary of selected benthic community metrics and stream channel habitat quality (QHEI metrics and scores from the DGI data set.

Sample location	Median taxa richness[1]	Median sensitive taxa abundance	Median tolerant taxa abundance	Total QHEI Score[1]	Substrate	Instream Cover[1]	Channel Morphology	Bank Erosion and Riparian Zone[1]	Pool/Glide and Riffle/Run Quality	Map Gradient
Amlosch Ditch	8	63.1%	25.5%	23	2.5	2	6	3.5	3	6
Grassy Creek	9	0%	85.3%	32.5	4.5	6	9	6	3	4
DC-11/12	-	-	-	-	-	-	-	-	-	-
DC-6/7	6	13.0%	82.6%	40	4	13	6	6	8	3
DC-5	8	14.8%	82.0%	37.5	2.5	13	9	6	4	3
DC-3	8	15.0%	45.2%	23.5	2.5	5	6	5	2	3
OC-24/25	13	3.76%	20.4%	35	3	13	6	4	3	6
OC-22	5	0%	81.8%	33.5	2.5	7	6	6	6	6
OC-16	4	0%	82.1%	33	2.5	6	8	6.5	4	6
OC-12/13	4	0%	81.5%	33	2.5	5	6	7.5	6	6
OC-9-10	5	0%	74.3%	42	2.5	7	10	5.5	11	6
OC-6/7(2)	2	0%	100%	33.5	4.5	12	6	4	4	3
OC-5A-01	5	0%	93.9%	-	-	-	-	-	-	-
OC-4	4	0%	80.6%	31	2.5	10	6	3.5	6	3

[1]The data for these valuables are normally-distributed; but others were not so the nonparametric Spearman Rank Order test was used for correlation analysis. Median (middle) values were used instead of mean (average) values to represent the (statistical) central tendency because most data sets were not normally distributed.

The QHEI and benthic community data provide an opportunity to assess how biological communities within an urbanized landscape are responding to stream metrics. Conversely, these data allow decision makers to investigate which stream channel features appear to have the greatest influence on the biological communities in the urban streams sampled in this investigation. The combined summary of QHEI and benthic community data for correlation analysis is presented in Table 3- 7. Statistical analyses are presented in full in Appendix N, and the significant correlations are summarized in Table 3-8. Five trends are suggested by the correlations among the habitat quality and benthic community quality variables:

- The correlation analysis revealed that the total QHEI scores for the DGI were influenced the most by *Instream Cover,* and *Pool/Glide and Riffle/Run Quality* metrics. These two metrics exhibited greater variation than the others, and these results suggest there is a presently a range of conditions regarding instream cover and riffle-pool sequences within the urbanized streams sampled in this investigation;

- The presence of sensitive taxa contributes to the overall taxa richness; or, stated another way, more diverse benthic communities tend to have more sensitive taxa than the less diverse benthic communities;

- The abundance of Senstive and Tolerant taxa were negatively correlated, which suggests these organisms are somewhat exclusive in their habitat preferences and/or distribution;

- Tolerant taxa were more abundant in locations that have higher substrate scores. This relationship is unusual, but appears to be the result of three unusual factors in this DGI data set. First, the substrate scores are generally low among all the stations; second, the tolerant taxa were generally abundant throughout the study; and third, the two stations with slightly higher substrate scores also had the greatest abundance of tolerant taxa; and

- In the DGI data set, *Taxa Richness* was negatively correlated with *Pool/Glide and Riffle/Run Quality*. This relationship is also unusual, but may also have resulted from three other unusual features of the DGI. First, the headwater sections of Otter & Grassy Creeks, and Amlosch Ditch had relatively diverse benthic communities, but lacked riffle-pool sequences; second the lacustuarine reach of Duck Creek contained diverse taxa, including mayflies that inhabit nearshore environments that are typically not assessed using the QHEI method; and third, location OC-9-10 had the only true riffle-pool sequence in the DGI data set, but had a moderate taxa richness.

The first three observed correlations are consistent with stream quality assessment principles, but the last two are not. The inconsistent correlations may have resulted from unusual circumstances in this specific data set, and/or there could be additional factors in the field to which the biological communities are responding in the streams sampled in this investigation that are not measured by these habitat metrics.

Table 3-8 Summary of significant Spearman Rank Order Correlation Coefficients between stream channel habitat quality (QHEI metrics and scores) and benthic community quality from the DGI data set..

Significant Correlations[1]	5% level of significance	10% level of significance
Total QHEI Score and **Instream Cover**	0.737	0.737
Total QHEI Score and **Pool/Glide and Riffle/Run Quality**	0.602	0.602
Taxa Richness and **Abundance of Sensitive Taxa**	0.637	0.637
Abundance of Sensitive Taxa and **Abundance of Tolerant Taxa**	-	-0.479
Abundance of Tolerant Taxa and **Substrate**	-	0.538
Taxa Richness and **Pool Glide and Riffle/Run Quality**	-	-0.563

[1]All correlations are reported in Appendix N

Correlations that are significant at the 5% level are also significant at the 10% level and have been repeated in this table.

3.3.2 Sediment Characteristics

The physical characteristics of the sediment samples that were collected during the GLLA Data gap investigation are consistent with the QHEI observations and those documented by the sediment sampling crew (Table 3-1). Silt was present at all locations, and typically was the most abundant particle size (Appendix E). Sand was present in many locations, and gravel was abundant at locations: DC-11/12; DC-5/6; OC-9/10 and OC-8/9. The organic carbon content of surface sediment samples ranged from 1.62% to 22.9%. Duck Creek sediments were generally in the range of 5% to 8% TOC, while most of the Otter Creek sediments contained from 3% to 4% TOC. Because TOC contains ligands that are important for binding many classes of sediment contaminants, the relatively large values in the DGI locations indicate that these streams have the ability to adsorb sediment contaminants and protect the resident aquatic life from harm. The least value was observed at OC-12-13, and the greatest TOC value was observed at DC-11/12. Sediment characteristics at DC-11/12, having 22.9% TOC, 12.2% solids, and 20% gravel, were atypical of sediments in this investigation, and may reflect this location being a heavily vegetated wetland area where a defined stream channel is difficult to identify and the sediment has extensive vegetation debris.

3.3.3 Watershed Quality

Land use is quite variable through the watersheds and riparian zones of Duck and Otter Creeks. In some areas, by example a portion of segment A of Duck Creek, the stream channels have meander through forested areas with gently-sloping banks (Figure 3-19). In contrast, Segment A of Otter Creek has industrial land use very near to the stream banks (Figure 3-14).

Figure 3-13 Riparian zone in Segment A of Duck Creek.

Figure 3-14 Riparian zone in Segment A of Otter Creek.

Even in watershed areas dominated by industrial land uses there are relicts of the wetlands that were historically abundant. By example, the mixed emergent and forested wetland shown in Figure 3-15 lies adjacent to the industrial area shown in Figure 3-14.

Figure 3-15 Wetland near Segment A of Otter Creek.

The headwaters of Otter and Grassy Creeks, and Amlosch Ditch are ditches with little to no riparian forest; Figure 3-16 is typical for the watershed conditions of these streams. The current headwaters of Duck Creek is Hecklinger Pond; however, the surface topography and watershed boundary (Figure 3-17) along with ah historic topographic map (see Appendix A) indicate that Duck Creek historically originated to the west of Highway I-280. Photographs of the Sediment Quality Triad sample locations (see Table 2-1) are included in Appendix B.

The field photographs represent only portions of the diverse riparian zones and watershed of Duck and Otter Creeks. A more comprehensive summary of land use was gleaned from the National Land Cover Dataset (USGS 2006). Detailed information regarding the land use within the riparian buffer zones of each stream segment is included in Appendix F; a summary is presented in the text of this report.

Eleven categories of land use are present in the Duck and Otter Creeks watershed (Table 3-9). Much of the watershed is developed, as shown in Figure 3-17. The most prevalent land use in the watershed is the “developed” (urban) category, and the combination of low, medium and high intensity development represents about 70% of land use for the entire watershed. There is a trend of less intense land use in the riparian zones, where open space, wetlands, and forest comprise between 43% and 53% of the land surface. These less intense land uses represent only 20% of the watershed land surface. Agricultural land uses are relatively minor, representing 10% or less of the land surface in the watershed.

Figure 3-16 Headwaters of Amlosch Ditch.

Table 3-9 Land cover and watershed of Duck and Otter Creeks.

Land Use Category	5 m Riparian buffer	100 m Riparian buffer	Watershed
Open water	0.11%	0.67%	0.20%
Developed, Open Space	24.76%	25.07%	15.65%
Developed, Low Intensity	25.59%	28.73%	35.28%
Developed, Med Intensity	9.34%	12.21%	23.34%
Developed, High Intensity	8.42%	11.46%	10.90%
Barren Land	0.00%	0.15%	0.33%
Deciduous Forest	5.04%	3.96%	2.01%
Grassland/Herbaceous	0.00%	0.28%	0.58%
Pasture Hay	0.00%	0.00%	0.48%
Cultivated Crops	3.43%	3.30%	9.26%
Emergent Herbaceous Wetlands	23.32%	14.17%	1.96%

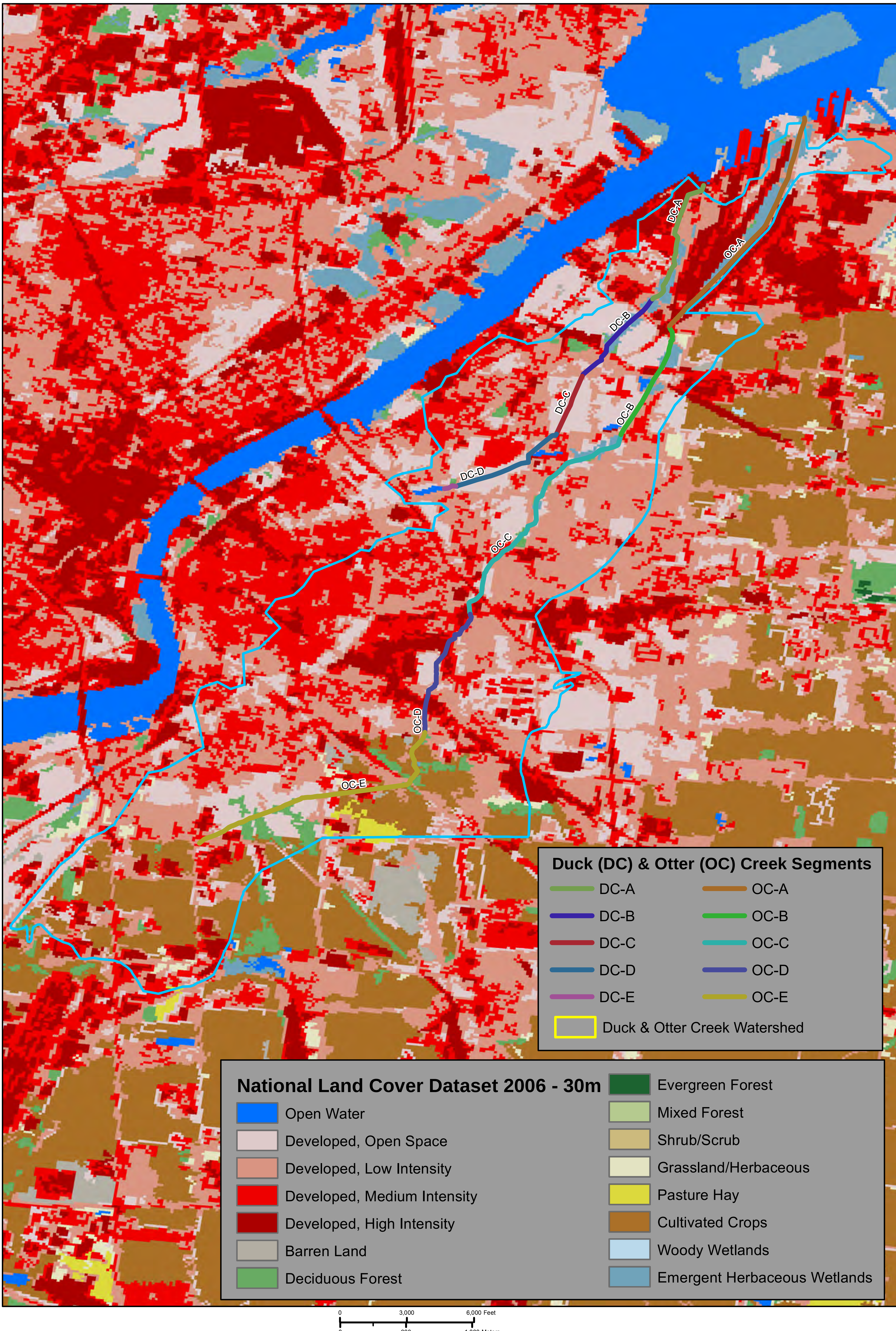

Figure 3-17 - NLCD 2006 Land Cover

Duck and Otter Creek
Lucas County, Ohio

N

Cardno ENTRIX
4295 Okemos Road Ste 101
Okemos MI 48864
ph. 517.381.1434
fx. 517.381.1435
www.entrix.com

Coordinate System:
Albers Conical Equal Area
NAD 1983

Date: 07/18/2011 Rev. Date: XX/XX/XXXX PM: SR GIS Analyst: AJB Map Document: LC_IMP_sampling_overview_20110726_ajb.mxd Project Number: 72606001.00 2000 PDF Document: LC_IMP_sampling_overview_20110726_ajb.mxdf Plot Size: 11 x 17

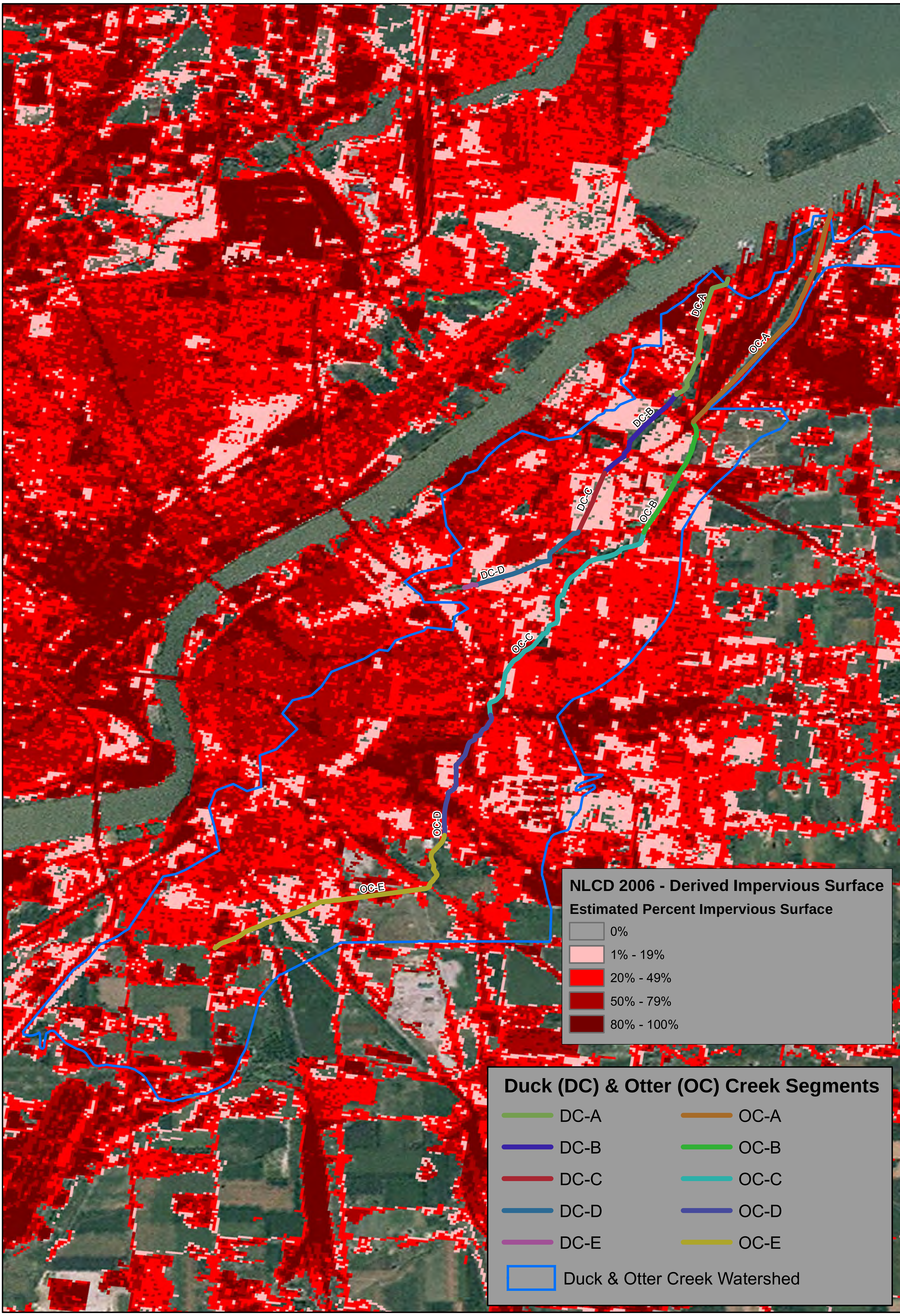

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Figure 3-18 - NLCD 2006 Impervious Surfaces

Duck and Otter Creek
Lucas County, Ohio

N

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Coordinate System:
Albers Conical Equal Area
NAD 1983

Date: 07/18/2011 Rev. Date: XX/XX/XXXX PM: SR GIS Analyst: AJB Map Document: IMP_LC_sampling_overview_20110726_ajb.mxd Project Number: 72606001.00 2000 PDF Document: IMP_LC_sampling_overview_20110726_ajb.mxdf Plot Size: 11 x 17

The relative percentages of impervious surface follow trends that are consistent with the land use categories (Figure 3-18). The least impervious categories is greatest in the narrow (5 m) riparian zone, where wetlands, forest and developed open space are most common (Table 3-10). At the watershed scale, about 70% of the land surface has more than 19% percent impervious surface, which increases surface runoff and diminishes groundwater recharge that is available for base flow during dry periods. Overall, the watershed land use suggests that flow regimens for Duck and Otter Creek are more variable in the present developed condition than they were historically.

Table 3-10 Impervious surface data for riparian zones and watersheds of Duck and Otter Creeks.

Impervious Surface Category	5 m Riparian buffer	100 m Riparian buffer	Watershed
0% to 19%	57%	47%	30%
20% to 49%	26%	30%	35%
50% to 79%	9%	13%	24%
80% to 100%	8%	10%	11%

The relatively level topography of the Duck and Otter Creek watershed, in combination with a relatively large proportion of impervious surface suggests that area could be susceptible to flooding if heavy precipitation is not managed effectively. Several large stormwater conveyances were observed during field sampling activities, as shown in Figures 3-19 and 3-20. These large stormwater management systems almost certainly transport large volumes of water to Duck and Otter Creek during precipitation events, so the biological communities are periodically exposed to high flow and velocity conditions. The hydraulic regimens of Duck and Otter Creek appear to be variable, with periods of shallow water and low velocities interspersed with periods of deep water that flow at greater velocity.

A review of utility maps for the City of Oregon, Ohio revealed that numerous stormwater sewers enter Otter Creek, with more than 50 outfalls in segments D and C (Table 3-11). The locations of the known stormwater outfalls for each stream segment are included in Appendix D. The presence of so many stormwater sewers in portions of Otter Creek suggests that the influence of stormwater will be more pronounced in some areas than in others. Of particular interest to a GLLA project is the potential for storm sewers to transport contaminants from sources located some distance from the riparian zone to the streams.

Table 3-11 Number of stormwater outfalls and approximate length of each stream segment of Duck and Otter Creeks.

Stream Segment	Duck Creek	Otter Creek
A	2 in 5,631 feet	0 in 10,722 feet
B	3 in 4,385 feet	5 in 4,693 feet
C	2 in 2,804 feet	29 in 10,648 feet
D	1 in 4,710 feet	22 in 6,188 feet
E	0 in 1,000 feet	0 in 10,255 feet

Figure 3-19 **Three large culverts are located immediately upstream of the Amlosch Ditch sampling location (AD-1). The center culvert transmits upstream flow beneath Dustin Road.**

Figure 3-20 **A large stormwater outfall enters Otter Creek from the east bank near OC-22 in Segment D.**

3.3.4 Previously-Identified Habitat Restoration Projects in Relation to GLLA Sampling

A previous investigation on behalf of the Duck and Otter Creeks Partnership, Inc., one of the stakeholders for these streams, has identified potential wetlands restoration projects within the Duck and Otter Creek watershed (Mannik & Smith et al 2003). Summary information of candidate wetlands restoration sites that are in proximity to GLLA sample locations is included here to provide context for other stakeholder activities in the watershed. At most candidate sites, the Ohio Rapid Assessment Method (ORAM) has been used to characterize and categorize the quality of the wetland. The ORAM in a method used develop scores for wetlands, in a manner similar to the QHEI. The overall ORAM score is used to categorize a wetland as low, medium, or high quality (categories 1, 2, and 3, respectively).

Duck Creek 1 - Hecklinger Pond & Lutheran Home Wetland

Duck Creek Site 1 consists of two sites: Hecklinger Pond and a large emergent wetland located adjacent for the Lutheran Home of Toledo. Because a defined stream channel is not present in either site, a Qualitative Habitat Evaluation Index (QHEI) was not conducted at this combined enhancement area. This site is near Ravine Park, where the GLLA data gap investigation collected samples at location DC-11/12 in segment D of Duck Creek.

An Ohio Rapid Assessment Method (ORAM) was completed on the Lutheran Home wetland, producing a score of 42.5. This score placed the wetland in the intermediate or ‘gray’ zone between Category 1 (poor quality) and 2 (medium quality). The wetland’s size, moderate buffer zones, consistent hydrology, and moderate habitat development contribute to the ORAM score. The wetland’s relative lack of heterogeneity and strong persistence of invasive species decreased the ORAM score. Duck Creek 1 has changed following restoration efforts in the pond in 2007 and the information from 2003 may no longer be accurate.

Duck Creek 2 - Collins Park Golf Course

The QHEI score for the segment of Duck Creek through the golf course between York and Consaul Streets was 32 (poor). The lack of diversity in substrate material, the heavy silt loading, the channelization of the stream, and a very low gradient contributed to the low score. Currently no wetlands exist on the site; thus, no ORAM was needed. This site corresponds with a portion of Duck Creek Segment C, and DGI sample DC-9/10 was located in this vicinity.

Duck Creek 3 - North of York Street

A QHEI score of 24 (very poor) was obtained for this section of Duck Creek. The low score was a result of a lack of riffle/run/pool development, heavy siltation, lack of floodplain on the west bank and limited in-stream habitat.

An ORAM scoring form was completed. The wetland scored 18, which places the wetland in Category 1 (poor quality) of Ohio’s Wetland Water Quality Standards (OAC 3745-1-54). The low score is due primarily to the small size of the wetland, the predominance of invasive plant species and presence of only one vegetation class (emergent community dominated by *Phragmites australis*). The GLLA data gap investigation location DC-7/8 was located between sites 2 and 3 on Duck Creek.

Duck Creek 4 – Chevron [now Port of Toledo] Property

The wetland area achieved an ORAM score of 36.5, which corresponds to a Modified Category 2 (moderate quality) wetland. Because of the site's elevation (below 575'), its hydrologic connection to Duck Creek and its proximity to Lake Erie, the site may automatically be classified by Ohio EPA as a Category 3 (high quality) wetland under ORAM. However, Mannik and Smith et al (2006) suggested that the predominance of invasive species merits reconsideration and possible lowering of this classification. Other factors that contributed to the score were channelization of the creek, lack of protective buffer and low diversity in the plant community. The QHEI score for Duck Creek adjacent to the wetlands was 35.5 (poor). The lack of diverse in-stream substrate, heavy silt loading, channelization, and low gradient contributed to a low score. Cardno ENTRIX assessed GLLA location DC 6-7 via the QHEI and assigned the location a score of 40 (Poor). Duck Creek 4 has been modified for development since 2003 and the information provided above might no longer be accurate.

Otter Creek 2 - Oakdale and Mahala Streets

A QHEI score of 28 (poor) was obtained for this section of Otter Creek. The low score was the result of a lack of riffle/run/pool development, moderate siltation, lack of floodplain on the west bank and limited in-stream habitat. Cardno ENTRIX assessed GLLA location OC-22 in this vicinity via the QHEI and assigned the location a score of 33.5 (Poor).

The emergent wetland attained an ORAM score of 24, which places the wetland in Category 1 of Ohio's Wetland Water Quality Standards (OAC3745-1-54). The low score was achieved due to the small size of the wetland, presence of only one vegetation community, and a predominance of the invasive reed canary grass (*Phalaris arundinacea*).

Otter Creek 4 - Starr Ave. to Earlwood St.

The section of Otter Creek within the project area was scored using the Qualitative Habitat Evaluation Index (QHEI) on July 16, 2003. A score of 40.5 (poor) was obtained for this section of Otter Creek, which indicates that the sample zone is lacking some of the characteristics needed for warm water habitat. The low score resulted from a lack of riffle/run/pool development, moderate siltation, lack of floodplain on the left bank, marginal habitat value on either floodplain, and a limited amount of in-stream habitat. Cardno ENTRIX assessed a nearby DGI site OC-16/17using the QHEI and assigned the location a score of 33 (Poor).

Because no wetlands were present, neither the Ohio Rapid Assessment Method nor the WET assessment were conducted.

Otter Creek 5 - Toledo Water Treatment Plant

The south wetland attained an ORAM score of 32.5, which falls within the gray zone between Categories 1 and 2. Factors that contributed to this score included the high intensity of surrounding land use, the lack of water and protective buffers, very low diversity and the high degree of past disturbance. The north wetland attained an ORAM score of 29, which equates to a Category 1 wetland. Factors that influenced this low score were the same as for the south wetland, as well as significantly greater coverage by invasive species.

The QHEI score for Otter Creek adjacent to the wetland was 45.75. The lack of diversity in substrate, the channelization of the creek, and the lack of gradient contributed to a lower score. Cardno ENTRIX assessed OC 9-10 for the DGI near the upstream end of this area via the QHEI and assigned the location a score of 42 (Poor). The GLLA sample location OC-8/9 was located near the downstream end of this site.

3.4 Sediment Toxicity Test

Sediment toxicity was assessed using the 10-day whole-sediment bioassay method with the midge *Chironomus dilutus.* The sediment toxicity tests were conducted by the US Army Corps of Engineers Engineering Research and Development Laboratory (ERDC). The full report is presented in Appendix G, and a summary is presented below. Control survival was acceptable for all tests; however, indigenous organisms (the flatworm *Planaria*) in the sediment samples adversely affected the survival of test organisms in several exposures. Data from test chambers that were affected by *Planaria* have not been included in the statistical analyses presented in Appendix G, or the summary included below.

Survival of the midge *C. dilutus* was significantly less than the test controls in one sample location, OC-4, which is located in segment A of Otter Creek (Figure 3-21). The presence of *Planaria* or other indigenous organisms was not mentioned in the 2007 study.

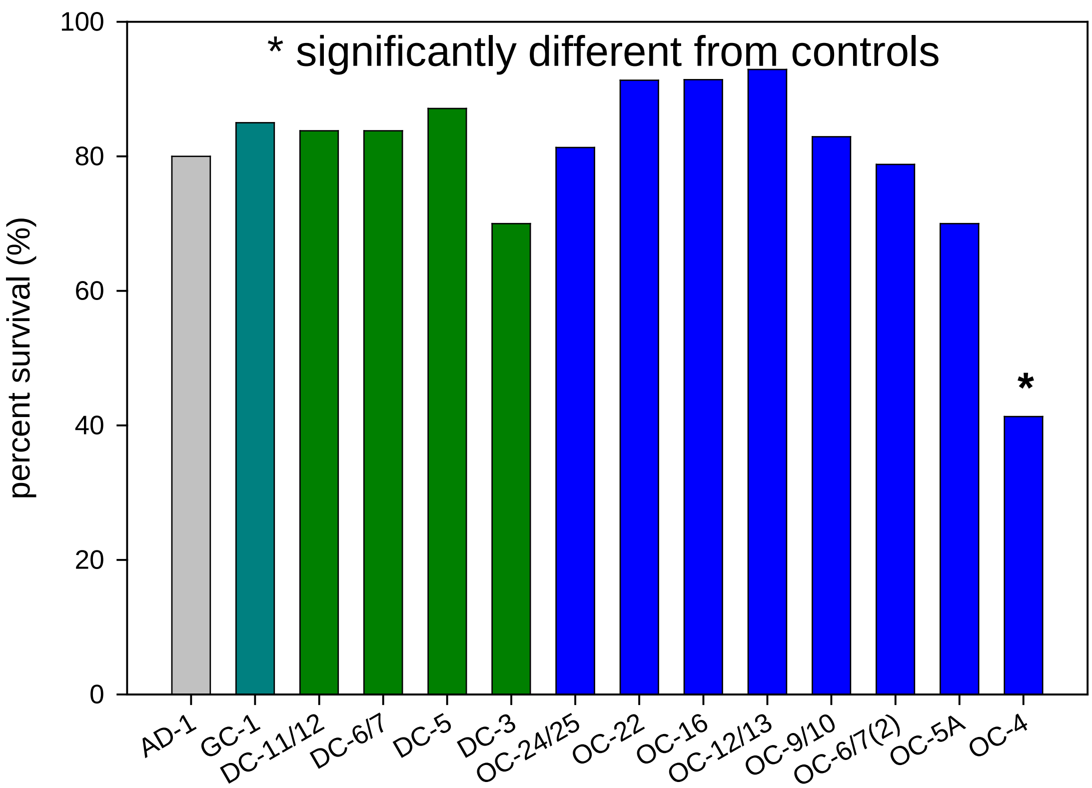

Figure 3-21 Survival of the Midge *C. dilutus* in sediments from Duck, Otter and Grassy Creeks and Amlosch Ditch.

Growth of the midge *C. dilutus*, expressed as ash-free biomass per initial organism was significantly less in sediments from three locations in Otter Creek than growth in laboratory control sediments (Figure 3-22). Ash-free biomass was used as the measure of growth to remove the potential influence of gut contents (ash) that could influence test interpretation. Biomass per initial organism was used (Table 3-12) instead of average weight to remove the potential influence of compensatory growth, which means that if food were limiting, individual larvae might grow larger in beakers where fewer individuals survived. Biomass is also relevant because in incorporated survival and weight gain. Because larger egg-laying animals tend to product more eggs and larger eggs that are more viable, size and survival of adults can affect reproductive success.

Table 3-12 Growth of midge larvae, as ash-free biomass per initial organism for toxicity tests with sediments from Duck, Otter and Grassy Creeks and Amlosch Ditch.

	A	B	C	D	E	F	G	H
Test 1 - mean control biomass per initial organism = 1.348 mg								
OC-4*	0.159	0.091	0.040	0.130	P	0.123	0.100	0.162
OC-5A-01*	0.315	0.112	0.563	0.290	0.060	0.303	0.311	0.162
OC-6/7	1.192	P	1.294	1.219	0.855	1.253	1.532	0.927
OC-9-10	0.620	0.803	0.709	0.762	0.804	P	0.617	0.326
DC-3	1.368	1.584	1.463	0.766	0.539	1.205	P	1.537
Test 2 - mean control biomass per initial organism = 1.412 mg								
AD-1	P	1.540	0.956	P	0.747	P	P	P
GC-1	0.271	1.139	P	P	0.710	P	0.847	P
OC-12/13	1.447	1.270	1.211	P	1.374	1.178	1.131	1.221
OC-16	1.195	0.866	1.174	1.072	1.008	1.339	1.660	P
DC-5	1.078	0.952	0.997	0.903	1.144	1.345	P	1.347
Test 3 - mean ash-free control biomass per initial organism = 2.840 mg								
OC-22	1.870	3.174	3.266	1.352	2.343	2.320	2.405	2.699
OC-24/25	2.144	2.891	3.519	2.998	0.567	1.813	1.976	2.436
DC-6/7	1.952	1.974	1.532	2.168	1.960	1.513	2.997	1.578
DC-11/12	0.897	2.044	1.417	2.093	1.259	1.446	1.405	1.754
Test 4 - mean as-free control biomass per initial organism = 1.130 mg								
AD-1	1.314	1.410	P	0.997	P	P	P	1.751
GC-1	P	1.170	P	1.098	0.952	1.379	0.794	1.444

Letters in header row indicate individual test replicates
P means indigenous organisms affected test outcome;
* mean significantly less than control biomass ($p < 0.05$) as reported by ERDC (see Appendix G)

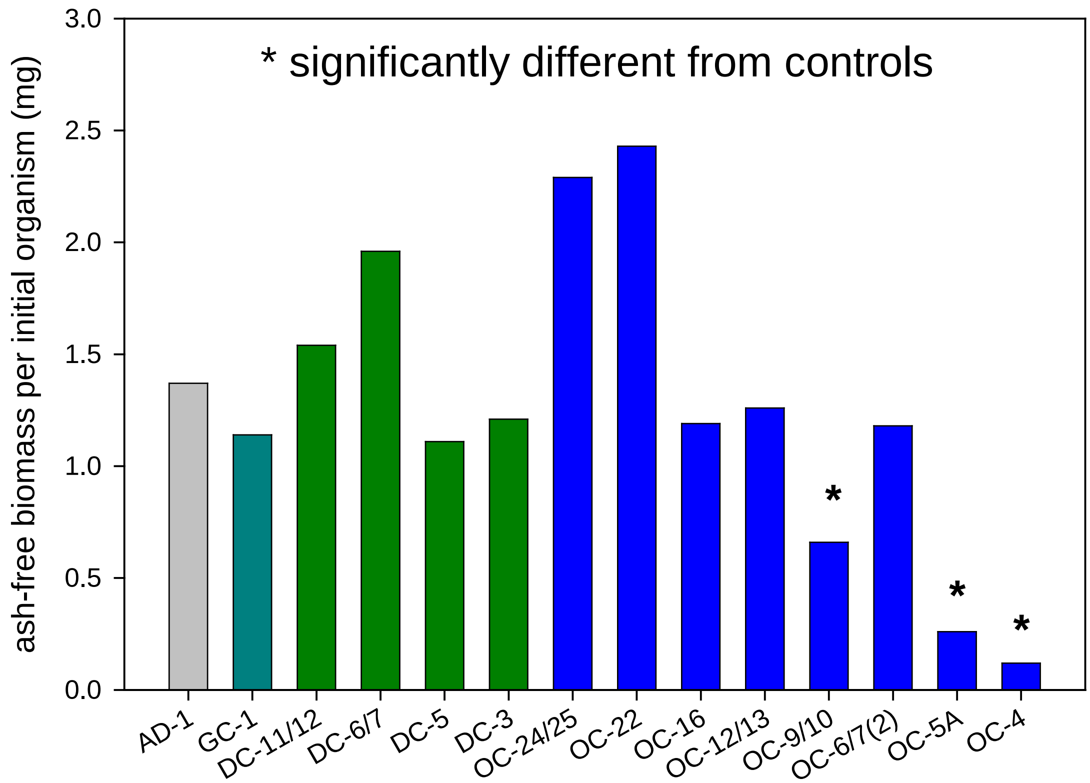

Figure 3-22 Growth (biomass) of the midge *C. dilutus* was significantly less in sediments three locations in Otter Creek than in laboratory control sediments.

Midge growth (biomass) was also tested for significance among all locations within the GLLA Data Gap Investigation study area. Midge growth, expressed as ash-free biomass, was scaled to the biomass of the control organisms (Table 3-13) to remove the influence of the test organisms in Test 3 being much larger than in the other tests. Control-scaled biomass was significantly different (less) at two locations, OC-5A and OC-4 (Figure 3-23).

Table 3-13 Growth (ash-free biomass) of midge larvae, scaled to control biomass to allow inter-test comparisons, for toxicity tests with sediments from Duck, Otter and Grassy Creeks and Amlosch Ditch.

	A	B	C	D	E	F	G	H
Test 1								
OC-4*	0.118	0.068	0.029	0.097	P	0.091	0.074	0.120
OC-5A-01*	0.233	0.083	0.418	0.215	0.044	0.225	0.231	0.120
OC-6/7	0.884	P	0.960	0.905	0.635	0.930	1.137	0.688
OC-9-10	0.460	0.596	0.526	0.566	0.597	P	0.458	0.242
DC-3	1.015	1.176	1.085	0.568	0.400	0.894	P	1.140
Test 2								
AD-1	P	1.090	0.677	P	0.529	P	P	P
GC-1	0.192	0.807	P	P	0.503	P	0.600	P
OC-12/13	1.025	0.899	0.857	P	0.973	0.834	0.801	0.865
OC-16	0.846	0.613	0.831	0.759	0.714	0.948	1.175	P
DC-5	0.763	0.674	0.706	0.639	0.810	0.952	P	0.954
Test 3								
OC-22	0.658	1.117	1.150	0.476	0.825	0.817	0.847	0.950
OC-24/25	0.755	1.018	1.239	1.055	0.200	0.638	0.696	0.858
DC-6/7	0.687	0.695	0.539	0.763	0.690	0.533	1.055	0.556
DC-11/12	0.316	0.719	0.499	0.737	0.443	0.509	0.495	0.617
Test 4								
AD-1	1.162	1.247	P	0.882	P	P	P	1.549
GC-1	P	1.035	P	0.971	0.842	1.220	0.703	1.278

Letters in header row indicate individual test replicates

P means indigenous organisms affected test outcome;

* mean significantly less than control biomass ($p < 0.05$) as determined by Analysis of Variance on Ranks and Dunns Pairwise Comparisons Test (Appendix N)

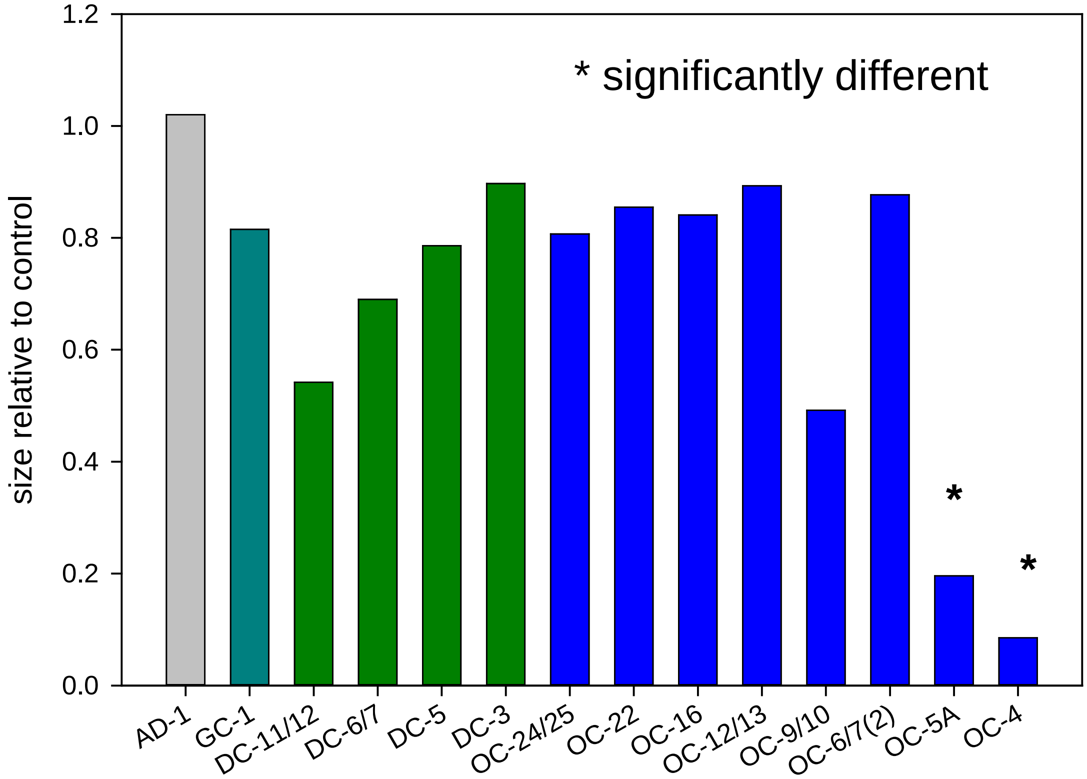

Figure 3-23 Growth (mean biomass) of the midge *C. dilutus* was significantly different among two locations within the GLLA Data Gap Investigation study area.

The sediment toxicity test results are a component of the Sediment Quality Triad approach for assessing sediment. In the Triad approach, benthic community structure, sediment toxicity and sediment chemistry are evaluated together to evaluate cause-effect relationships among these endpoints (see Table 3-14). The two biological metrics of sediment quality were generally in agreement: more growth in the laboratory corresponded with greater abundance of sensitive taxa in the field; less growth in the laboratory corresponded with a greater abundance of tolerant taxa in the field. However, a comparison of total taxa, abundance of sensitive taxa, and abundance of tolerant taxa, did not yield significant correlations with midge growth or midge survival (Appendix N), which suggests that sediment toxicity is not the sole factor affecting the benthic communities of Duck and Otter Creeks.

Table 3-14 Summary of aggregated benthic community structure and sediment toxicity test results for correlation analysis in support of sediment quality triad evaluations.

Sample location	Median taxa richness	Median sensitive taxa abundance	Median tolerant taxa abundance	Mean midge survival	Mean scaled biomass
Amlosch Ditch	8	63.1%	25.5%	75.7%	1.02
Grassy Creek	9	0%	85.3%	66.0%	0.815
DC-11/12	-	-	-	83.8%	0.542
DC-6/7	6	13.0%	82.6%	83.8%	0.690
DC-5	8	14.8%	82.0%	87.1%	0.786
DC-3	8	15.0%	45.2%	70.0%	0.897
OC-24/25	13	3.76%	20.4%	81.3%	0.807
OC-22	5	0%	81.8%	91.3%	0.855
OC-16	4	0%	82.1%	91.4%	0.841
OC-12/13	4	0%	81.5%	92.9%	0.893
OC-9-10	5	0%	74.3%	82.9%	0.492
OC-6/7(2)	2	0%	100%	78.8%	0.877
OC-5A-01	5	0%	93.9%	70.0%	0.196
OC-4	4	0%	80.6%	41.3%	0.085

Aggregated benthic community data were normally-distributed, so medians were used for statistical testing of these variables

Aggregated sediment toxicity test data were normally-distributed so mean values were used for statistical testing

3.5 GLLA Chemistry Data

The third component of the Sediment Quality Triad is an evaluation of sediment chemistry. The GLLA Data Gap Investigation employed several measurements of sediment chemistry, with a focused effort on evaluation of the biologically-available dose to aquatic organisms. These chemical measurements are evaluated by chemical classes that act through similar modes of action and have comparable measurements of the biologically-available dose. The following data evaluations are organized in a tiered approach.

- In the first tier, chemical concentrations in bulk sediment are compared against benchmarks to determine if additional evaluation is warranted, prior to evaluating site-specific bioavailability.

- In the second tier, the bioavailable fraction of each chemical class was assessed using calculations that are based on the processes by which chemicals can become available for uptake by aquatic organisms. Specifically, the organic carbon in sediments can bind organic compounds and some metals, and decrease the dissolution in water and uptake by biological organisms. Some metals form very insoluble salts with sulfide that also decrease uptake by biological organisms. The DGI analyses included measures of total organic carbon and acid-volatile sulfides so the partitioning of contaminants in sediments could be estimated. In addition, the “bioaccessible” fraction of arsenic that can be dissolved in simulated stomach fluids was measured at selected locations. For organic compounds equilibrium partitioning (EqP) calculations were used to calculate sediment pore water concentrations that were potentially available to aquatic organisms;

- The third tier of DGI chemistry assessment was to measure the concentrations of selected classes of contaminants in sediment pore water because pore water is generally accepted as the primary route of exposure for sediment-dwelling organisms; and

- The fourth tier of the chemistry assessment involved the measurement of tissue concentrations of aquatic organisms that were collected from Duck and Otter Creeks and the urban comparison streams.

This multi-tiered approach to chemistry interpretation involves multiple lines of evidence regarding the potential for sediment-associated chemicals to adversely affect aquatic life.

The chemistry data tables are somewhat complex and large, and are included in Appendix H to enhance the readability of the report. Summary charts of the chemical constituents that were identified as potentially important in previous investigations are included in the body of the report, and summary tables are presented as supplements to the figures and Appendix tables.

3.5.1 Metals and Ammonia

Metals were measured in sediments collected from Duck, Otter and Grassy Creeks and Amlosch Ditch. Total metals concentrations in sediment on a dry weight basis are presented in Tables H-1 and H-2 of Appendix H, along with the Probable Effects Concentrations (PECs), which are chemical-specific bulk sediment benchmarks that have been developed using databases of chemistry and biological endpoints for freshwater systems, including data from the Great Lakes region (MacDonald et al., 2000). The PECs are estimates of sediment concentrations above which adverse effects on exposed organisms often occurred in the MacDonald et al. (2000) database. PECs are used here as a first-tier evaluation of bulk sediment chemistry data.

Tier 1 - The PEC for lead was exceeded in one sediment sample from Duck Creek (Figure 3-24). Bulk sediment concentrations exceeded the PEC for arsenic in several samples from Duck Creek (Table H-1 and figure 3-26). In Otter Creek, the PECs for arsenic (Figure 3-27), chromium, copper, lead (figure 3-25) and mercury were exceeded in at least one sample location (Table H-2).

Of the metals, lead, arsenic and chromium most frequently exceeded its respective bulk sediment benchmark. Lead concentrations exceeded the bulk sediment benchmark in at least one surface sample in segment A of Duck Creek, and segments C, and B of Otter Creek. For subsurface sediments, lead concentration exceeded the benchmark in one sample from segment A in Otter Creek. Arsenic concentrations exceeded the bulk sediment benchmark in at least one surface sample in segments D, and A of Duck Creek, and segment E of Otter Creek. For subsurface sediments, the arsenic concentration exceeded the benchmark in one sample from segment E of Otter Creek. Chromium exceeded the sediment benchmark in at least one surface sediment sample in segments C, B and A of Otter Creek, and in at least one subsurface sediment sample in segment A of Otter Creek. The evaluation of metals in Duck and Otter Creeks proceeded to the second tier.

Figure 3-24 **Summary of lead concentrations in sediments of Duck, Grassy Creeks and Amlosch Ditch.**

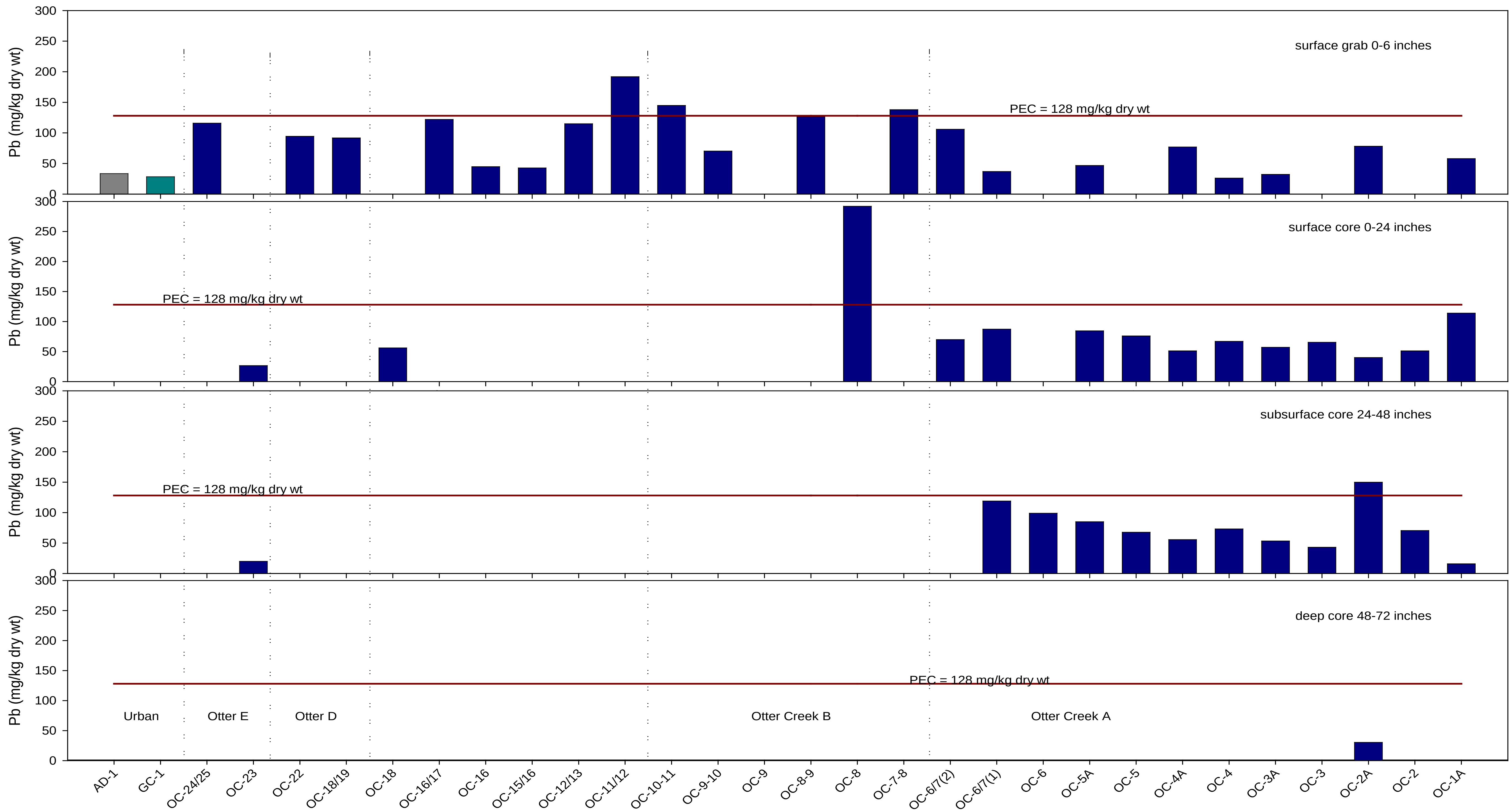

Figure 3-25 **Summary of lead concentrations in sediments from Otter, Grassy Creeks and Amlosch Ditch.**

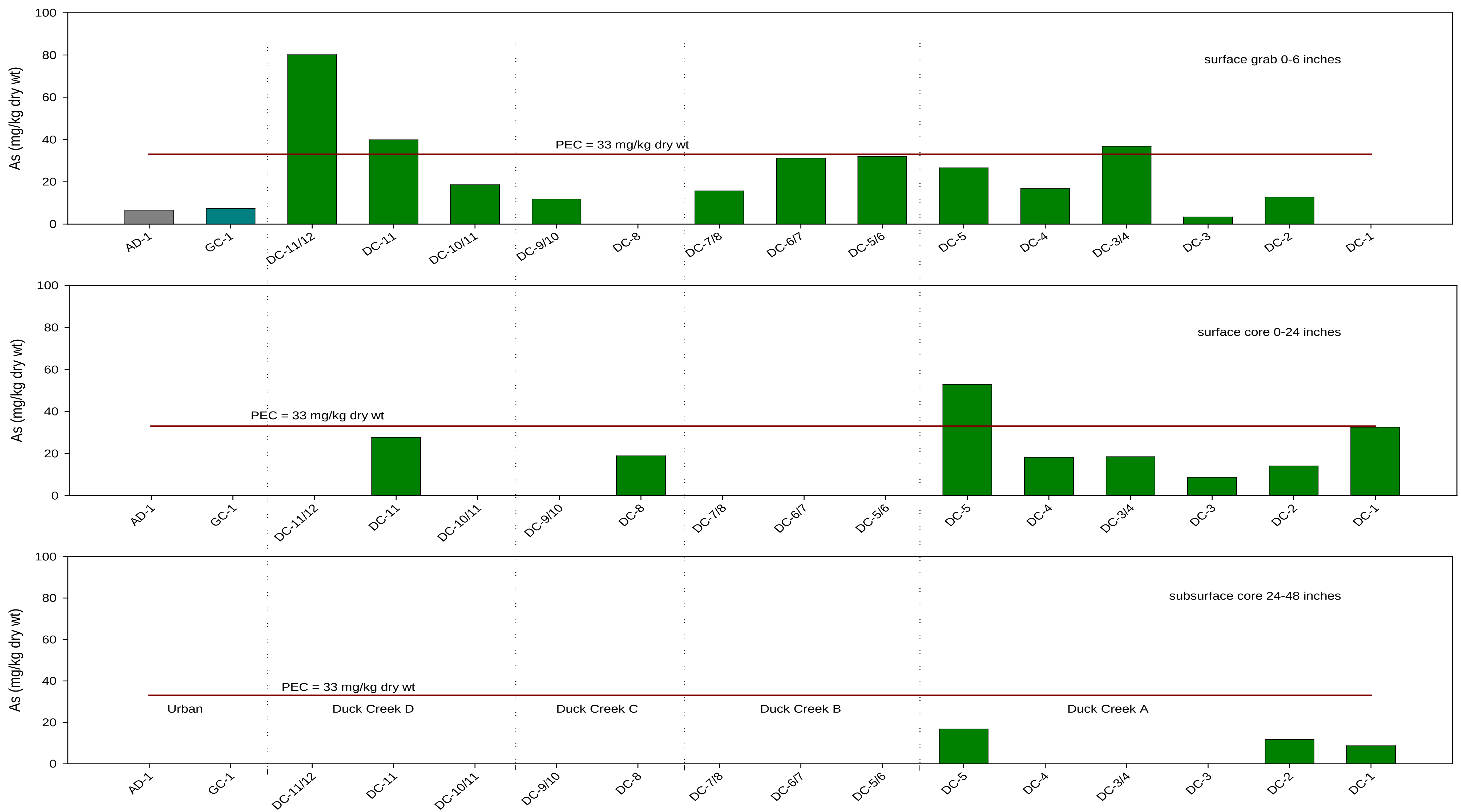

Figure 3-26 **Summary of arsenic concentrations in sediments of Duck and Grassy Creeks and Amlosch Ditch.**

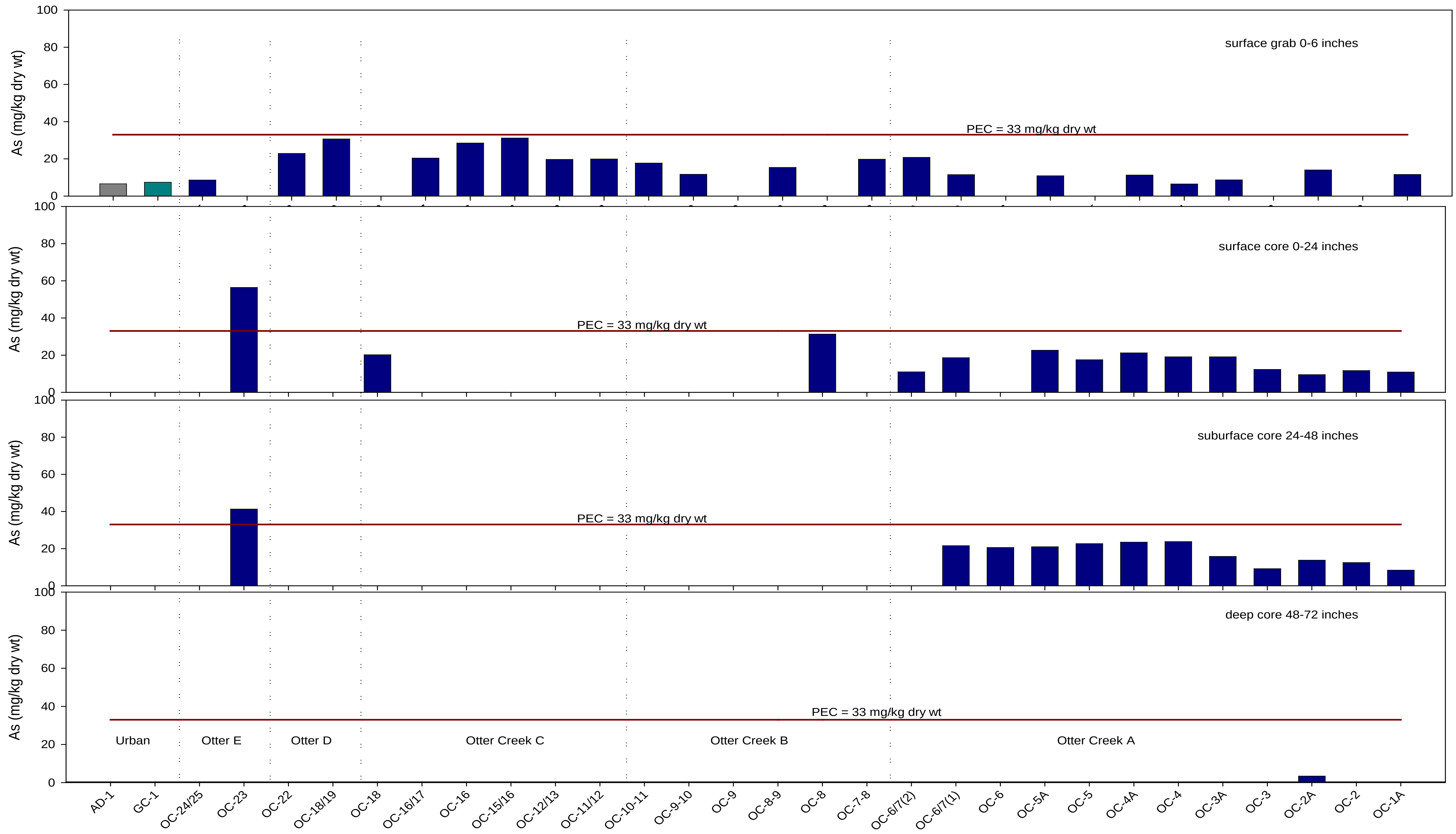

Figure 3-27 **Summary of arsenic concentrations in sediments from Otter and Grassy Creeks and Amlosch Ditch.**

Tier 2 - The second tier of the evaluation of metals in Duck and Otter Creek sediments was based on the chemical interaction of metals with sulfides. Under reducing conditions (about -100 mV), sulfate is microbially reduced to sulfide, which forms extremely insoluble salts with divalent metal ions. Environmental conditions that are favorable for metal-sulfide reactions are common in aquatic sediments, especially in water bodies with silty sediments and fertile watersheds or other nutrient sources. The ratio of acid volatile sulfide (AVS) , that fraction that can be extracted by cold HCl with the molar concentrations of cadmium, copper, lead, nickel, silver and zinc that are extracted simultaneously (SEM) can be used to determine if there is sufficient excess metal present to bind with the organic carbon content of sediments. If the ratio of excess SEM (e.g. SEM-AVS on a molar basis) to the fraction of organic carbon in the sediment (SEM-AVS/foc) is greater than 130 µmole/gOC, then divalent metals are potentially available for to aquatic organisms (USEPA 2005, OEPA 2010b). The SEM-AVS/foc analysis indicated that sediments from Duck and Otter Creek contained sufficient sulfide and organic carbon to bind the simultaneously extracted metals in all DGI locations (Tables H-3 and H-4 in Appendix H). In fact, for most sediment samples the AVS content was much greater than the SEM, and the SEM-AVS/foc values were negative numbers (Tables 3-15 and 3-16). These data indicate that the metals cadmium, copper, lead nickel silver and zinc are not bioavailable in the sediments of Duck, Otter and Grassy Creeks or Amlosch Ditch.

Table 3-15 Summary of SEM-AVS/foc data from the urban comparison streams and Duck Creek..

Sample location	ΣSEM (µmole/g dry weight)	AVS (µmole/g dry weight)	foc (g OC/g dry weight)	(ΣSEM-AVS)/foc (µmole/gOC)
Amlosch Ditch	1.1446	38.1	0.0507	-729
Grassy Creek	0.7664	20.7	0.0212	-940
DC-11/12	0.4510	8.06	0.229	-33
DC-10/11	1.3609	49.6	0.0679	-710
DC-9/10	1.1611	25.6	0.0537	-455
DC-7/8	0.8459	37.1	0.0629	-576
DC-6/7	5.0811	111	0.0755	-1403
DC-5/6	7.9690	209	0.0836	-2405
DC-5	3.7763	97	0.0499	-1868
DC-4	1.6133	13.7	0.0618	-196
DC-3/4	0.9755	29.8	0.0476	-606
DC-3	0.5382	13.8	0.0797	-166

Benchmark concentration for (ΣSEM-AVS/foc) is 130 µmole/gOC (USEPA 2005, OEPA 2010b)
Includes: cadmium, copper, lead, nickel, silver and zinc

Table 3-16 Summary of SEM-AVS/foc data from Otter Creek.

Sample location	ΣSEM (µmole/g dry weight)	AVS (µmole/g dry weight)	foc (g OC/g dry weight)	(ΣSEM-AVS)/foc (µmole/gOC)
OC-24/25	0.4260	14	0.0174	-780
OC-22	1.2840	41.6	0.0379	-1064
OC-18/19	1.4482	1.03	0.0326	13
OC-16/17	0.8916	1.19	0.0302	-10
OC-16	0.5944	2.02	0.0356	-40
OC-15/16	0.6841	0.74	0.0326	-2
OC-12/13	1.2670	13	0.0162	-724
OC-11/12	4.6856	77	0.0891	-812
OC-10-11	1.6264	0.408	0.0371	33
OC-9-10	2.6128	30.5	0.0468	-596
OC-8-9	2.5326	6.11	0.0305	-117
OC-7-8	1.6576	5.5	0.0334	-115
OC-6/7(2)-01	2.3870	12.8	0.0392	-266
OC-6/7(1)-01	0.6805	0.45	0.0196	12
OC-5A-01	1.8593	2.7	0.0317	-27
OC-4A-01	1.6223	1.32	0.0339	9
OC-4-01	1.5929	21.3	0.0495	-398
OC-3A-01	1.5456	5.4	0.0221	-174
OC-2A-	1.0139	19	0.0397	-453
OC-1A	1.4072	7.2	0.0381	-152
Benchmark concentration for (ΣSEM-AVS/foc) is 130 µmole/gOC (USEPA 2005, OEPA 2010b) Includes: cadmium, copper, lead, nickel, silver and zinc				

Tier 3 - The third tier evaluation was based on a comparison of the measured concentrations of metals (and ammonia) in sediment pore water with concentrations of metals that are known to be protective of aquatic life, namely, the State of Ohio's chronic ambient water quality criteria (AWQC) under Ohio Administrative Code (OAC) Rule 3745-1-07. The average values for outside the mixing zone (OMZA) were used for the calculations in Tables H-5 and H-6 of Appendix H. Several of the chronic OMZA criteria are based on the hardness of the water, with a maximum allowable value of 400 mg/L hardness (as mg $CaCO_3$/L). The specific equations for total recoverable (TR) metals in Rule 3745-1-07 are:

- Beryllium TR OMZA (µg/L) = $e^{(1.609 [\ln Hardness] - 5.017}$;
- Cadmium TR OMZA (µg/L) = $e^{(0.7852 [\ln Hardness] - 2.715}$;

- Chromium TR OMZA (µg/L) = $e^{(0.819 [\ln Hardness] + 0.6848}$;
- Copper TR OMZA (µg/L) = $e^{(0.8545 [\ln Hardness] - 1.702}$;
- Lead TR OMZA (µg/L) = $e^{(1.273 [\ln Hardness] - 4.003}$;
- Nickel TR OMZA (µg/L) = $e^{(0.846 [\ln Hardness] + 0.584}$;
- Zinc TR OMZA (µg/L) = $e^{(0.8473 [\ln Hardness] + 0.884}$;

Trace concentrations of several metals were measured in sediment pore water samples; however no pore water concentrations exceeded its applicable Tier 1 chronic AWQC. In one sample (DC-11/12) the barium concentration in pore water exceeded the Tier II standard (Table 3-17). The maximum pore water concentrations of lead and arsenic, which were identified as potentially important metals in previous investigations, were much less than the respective AWQCs lead and arsenic (see Figures 29 and 30). Except for barium, the maximum pore water concentration observed in the DGI was much less than the respective AWQCs (Table 3-17). The State of Michigan has a hardness-based standard for barium[2], which yields a sample-specific chronic standard for DC-11/12 of 1911µg/L, which is much greater than the measured pore water concentration. Neither midge survival nor growth were significantly decreased at sample location DC-11/12, which indicates that barium did not adversely affect sediment-dwelling organisms at the maximum concentration observed in the DGI. Aquatic organisms that could potentially be exposed to water above the sediments would be protected further by diffusion and dilution of pore water that might be released from sediments into the water column.

[2] Michigan Rule 57 standard for barium final chronic value (µg/L) = $e^{1.0629 [\ln Hardness] + 1.1869}$. At the maximum hardness used by the OEPA, the barium standard for DC-11/12 is 1911 µg/L.

Table 3-17 Summary of the maximum measured concentration for each metal and the Ohio surface water standards.

Constituent	Tier I Aquatic Life Standard (µg/L)	Tier II Aquatic Life Standard (µg/L)	Maximum detected pore water concentration (µg/L)	Sample location for maximum concentration
Antimony	Not available	190	1.81	OC-9-10
Arsenic	150	Not applicable	48.7	OC-22
Barium	Not available	220	329	DC-11/12
Beryllium[H]	Not available	28 to 102	0.025	DC-11/12
Cadmium[H]	3.9 to 7.3	Not applicable	0.054	OC-22
Chromium[H]	187 to 268	Not applicable	8.56	OC-4
Cobalt	Not available	24	2.51	DC-11/12
Copper[H]	21 to 30	Not applicable	1.56	OC-24/25
Lead[H]	21 to 37	Not applicable	1.12	OC-9-10
Mercury	0.91	Not applicable	<0.2	Not detected
Nickel[H]	85 to 169	Not applicable	9.31	OC-4
Selenium	5.0	Not applicable	3.7	DC-11/12
Silver	1.3	Not applicable	0.008	Grassy Creek
Thallium	Not available	17	0.076	Grassy Creek
Vanadium	Not available	44	5.02	OC-4
Zinc[H]	267 to 388	Not applicable	13.4	DC-5
H = water quality standard is based on the hardness of the water (up to a maximum value of 400 mg/L as $CaCO_3$) and the range of sample-specific values from the DGI is presented here.).				

Ammonia concentrations were greater than the AWQC in the sediment pore waters from several sediment samples, including the Amlosch Ditch urban comparison stream (see B-1 in Appendix G and Tables H-5 and H-6 in Appendix H). The AWQC is a protective value, so exposures at greater concentrations do not necessarily translate to adverse effects. Moreover, ammonia did not reach problematic concentrations in the overlying water during the sediment toxicity test (see tables B-2 through B-4 in Appendix G). The available site-specific data suggest that sediment-associated ammonia is not affecting the benthic community structure or contributing to sediment toxicity in the laboratory.

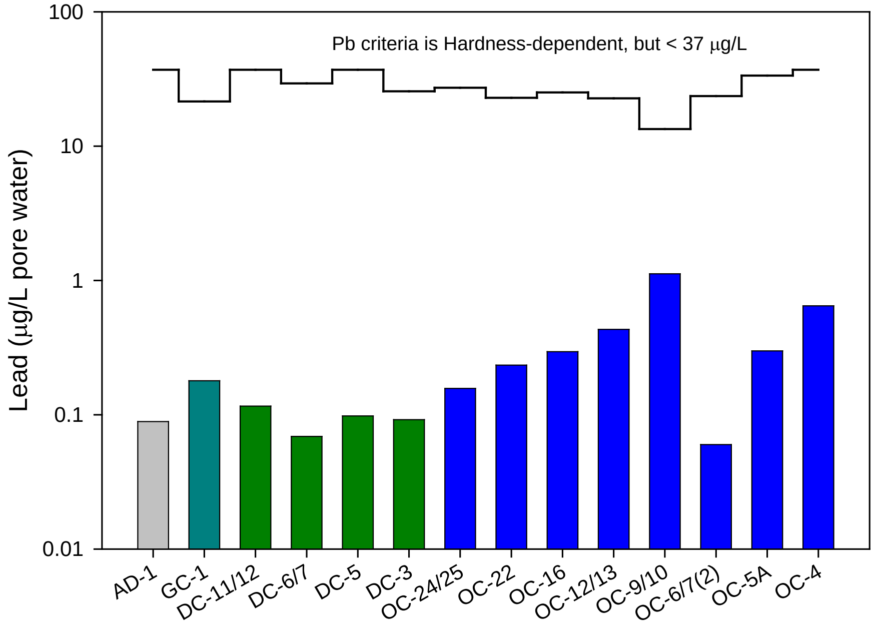

Figure 3-28 **Summary of lead concentrations in sediment pore waters from Amlosch Ditch and Grassy, Duck and Otter Creeks. Note the logarithmic scale on the Y axis.**

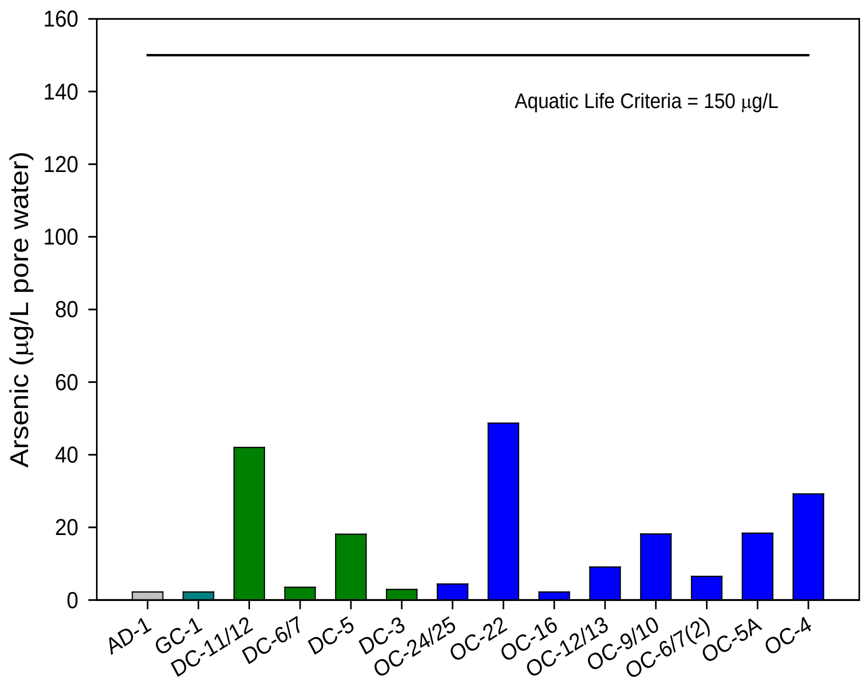

Figure 3-29 **Summary of arsenic concentrations in sediment pore waters from Amlosch Ditch and Grassy, Duck and Otter Creeks.**

Tier 4 - The third tier of assessment for metals, the evaluation of tissue data is difficult because there are no well-defined tissue residue-based benchmarks for adverse effects. A comprehensive study of tissue residues was undertaken by Jarvinen and Ankley at the USEPA Research Lab in Duluth, Minnesota in 1999; however they noted that the uptake rate of metals appeared to be more important than body residues for assessing toxicity. Many metals are essential micronutrients that are carefully regulated by metabolic processes. Some have specific modes of action, and whole-body residues are seldom reliable surrogates of the dose that is received in the target organs or site of toxicological action (Meador et al, 2010). The exception is selenium, for which the USEPA has drafted a whole-body tissue concentration of 7.91 mg/kg dry weight for protection of fish reproduction (USEPA 2004). The metals concentrations measured in invertebrate tissues are reported in Table H-7; the detected selenium concentrations ranged from 0.56 to 1.1 mg/kg dry weight. The fish tissue metals data are reported in Table H-8; selenium concentrations in fish from Duck and Otter Creeks ranged from 1.79 to 3.2 mg/kg dry weight.

The tissue data also provided information for evaluating site-specific bioaccumulation of metals, for example, lead (Table 3-18) and arsenic (Table 3-19). The site-specific DGI data show that neither lead nor arsenic are bioaccumulating in the aquatic food webs of Duck, Otter and Grassy Creeks, or Amlosch Ditch. The concentrations of both metals are greatest in sediments, relative to benthic macroinvertebrate tissues and fish. In general, lead and arsenic concentrations decrease about one order of magnitude between sediments and benthic invertebrate tissues, on a dry weight basis (Tables 3-19 and 3-20). The relationships between invertebrate and fish tissue concentrations vary among stream reach. In some cases the concentrations of these two metals decreases from invertebrates (prey) to fish (predator); in some cases the concentrations are about equal. Neither lead nor arsenic exhibited an increased concentration between invertebrates and fish. The tissue data are consistent with the SEM/AVS and sediment pore water evaluations in that all Tier 2, 3 and 4 evaluations in this DGI demonstrate that metals in the sediments of Duck, Otter and Grassy Creeks and Amlosch Ditch are bound to ligands, have very low bioavailability, and are not bioacccumulating.

Table 3-18 Summary of lead concentrations in sediments, benthic macroinvertebrates and fish from the DGI data set.

<table>
<tr><th>Stream Segment</th><th>Sample Location</th><th>Sediment Lead (mg/kg dry wt)</th><th>Invertebrate Tissue Lead (mg/kg dry wt)</th><th>Fish Tissue Lead (mg/kg dry wt)</th></tr>
<tr><td rowspan="2">Urban Comparison</td><td>Amlosch Ditch</td><td>33.5</td><td>3.6</td><td>No sample</td></tr>
<tr><td>Grassy Creek</td><td>28.4</td><td>1.2</td><td>No sample</td></tr>
<tr><td>Duck Creek D</td><td>DC-11/12</td><td>66.1</td><td>0.48</td><td>0.194</td></tr>
<tr><td>Duck Creek A</td><td>DC-5</td><td>67.3</td><td>1.8</td><td>0.278</td></tr>
<tr><td rowspan="2">Otter Creek C</td><td>OC-16</td><td>44.8</td><td>4.7</td><td rowspan="2">0.627</td></tr>
<tr><td>OC-12/13</td><td>115</td><td>3.6</td></tr>
<tr><td rowspan="2">Otter Creek A</td><td>OC-5A</td><td>46.8</td><td>0.78</td><td rowspan="2">0.394</td></tr>
<tr><td>OC-4</td><td>26.1</td><td>1.4</td></tr>
<tr><td colspan="5">Fish were collected within stream reaches and are generally more mobile than invertebrates so they are reported on a reach basis here</td></tr>
</table>

Table 3-19 Summary of arsenic concentrations in sediments, benthic macroinvertebrates and fish from the DGI data set..

Stream Segment	Sample Location	Sediment Arsenic (mg/kg dry wt)	Invertebrate Arsenic (mg/kg dry wt)	Fish Tissue Arsenic (mg/kg dry wt)
Urban Comparison	Amlosch Ditch	6.6	1.3	No sample
	Grassy Creek	7.4	0.62	No sample
Duck Creek D	DC-11/12	80.1	2.6	0.42
Duck Creek A	DC-5	26.6	1.1	0.93
Otter Creek C	OC-16	28.5	2.1	0.69
	OC-12/13	19.7	1.8	
Otter Creek A	OC-5A	10.9	0.66	0.80
	OC-4	6.5	1.1	
Fish were collected within stream reaches and are generally more mobile than invertebrates so they are reported on a reach basis here				

Supplemental assessment – Protection of human health protection is a component of any environmental decision, including those based primarily on protection of aquatic communities. The lack of site-specific bioavailability of arsenic in sediments of streams that have residential riparian land use was a data gap that was identified and addressed in this DGI. The arsenic bioaccessibility may be useful to decision makers in a subsequent process, and has been included in this report. Arsenic bioaccessibility was measured using the in-vitro gastrointestinal (IVG) method. The full report from that study is included as Appendix I. Bioaccessible arsenic that was extracted by simulated digestive liquids represented from 29.8% to 57.6% of the total arsenic present in sediments from Duck and Otter Creek (Appendix I). A summary comparison of bioaccessible arsenic with total arsenic is presented in Figure 3-30.

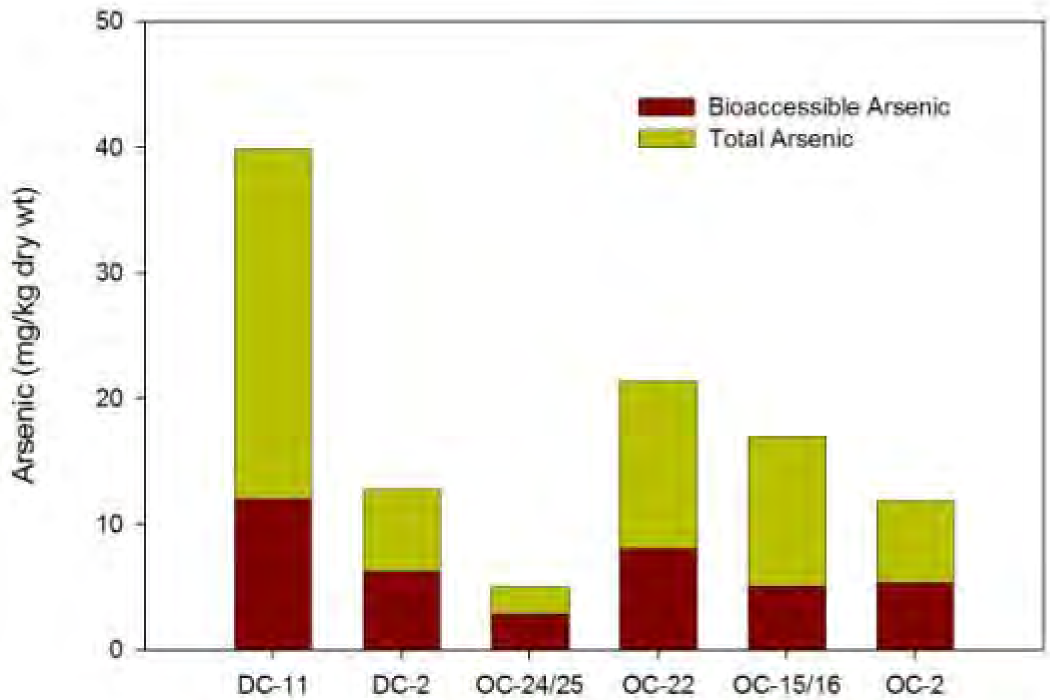

Figure 3-30 **Summary of in-vitro arsenic bioaccessibility in surface (0-6 inch) sediments from Duck and Otter Creeks.**

3.5.2 Pyrethroid Pesticides

Tier 1 – Only three of 12 pyrethroid pesticides, Bifenthrin, L-Cyhalothrin and Permethrin, were detected in DGI sediment samples (Tables H-9 and H-10).

- Bifenthrin was detected in 9 of 14 DGI locations: Amlosch Ditch; Grassy Creek; one location in Duck Creek (DC-6/7); and in six of the eight locations in Otter Creek;
- L-Cyhalothrin was detected only once in the DGI, at location OC-9-10 in Otter Creek;
- Permethrin was detected in two DGI locations, Amlosch Ditch and OC-22 in Otter Creek.

No bulk sediment benchmark concentrations are available for these compounds, so the assessment proceeded directly to Tier 2.

Tier 2 – None of the detected pyrethroid pesticides that were detected in DGI sediments exceeded the associated benchmark concentrations. The available benchmarks for pyrethroid pesticides (Maund et al. 2002, Amweg et al. 2005, Starner et al. 2006), are based on equilibrium partitioning calculations between the sediment organic carbon and sediment pore water. The EqP equation is:

Sediment benchmark = surface water benchmark *Koc * foc* 1kg/1000g

Where:

> The surface water benchmark is concentration associated with an endpoint, for pyethroid pesticides, the water benchmarks are median lethal concentrations (µg/L) from 10-day toxicity tests with the amphipod *Hyalella azteca*;
>
> Koc is the water-organic carbon partitioning coefficient (L/kg OC);
>
> foc is the organic carbon fraction of the sediments (kg OC/kg sediment);
>
> 1kg/1000g is a conversion factor; and
>
> The sediment benchmark units are µg/g OC.

In summary, the Tier 2 DGI pyrethroid pesticide evaluation includes:

- Detected Bifenthrin concentrations ranged from 0.0137 to 0.205 µg/g OC, which were all less than the benchmark concentration of 0.52 µg/g OC.
- The detected concentration of L-Cyhalothrin was 0.0571 µg/g OC, which was less than the benchmark of 0.45 µg/g OC.
- The detected concentrations of Permethrin ranged from 0.300 to 0.522 µg/g OC, which was less than the benchmark concentration of 10.83 µg/g OC.

No Tier 3 or 4 assessments were conducted for pyrethroid pesticides.

The greatest concentrations of the pyrethroids Bifenthrin and Permethrin were measured in the Amlosch Ditch sample; however, the concentrations were much less than the EqP-based benchmarks, and no sediment toxicity was observed at that location. It is interesting to note that the pyrethroid benchmarks are based on LC50 values from toxicity tests with amphipods, and amphipods were abundant in Amlosch Ditch. The results from the DGI indicate that pyrethroid pesticide concentrations were not present at quantities that would cause lethality to a sensitive species of amphipod in the fall of 2010. The DGI data do not indicate that pyrethroid pesticides were adversely affecting the biological communities of Duck, Otter, and Grassy Creeks, or Amlosch Ditch.

3.5.3 Polychlorinated Biphenyls (Aroclors)

Tier 1 - Trace concentrations of PCBs were detected in some sediment samples from Duck, Otter and Grassy Creeks, and Amlosch Ditch (Figures 3-31 and 3-32). Only two of nine Aroclor mixtures, 1248 and 1254, were detected in the DGI sediment samples. The greatest PCB concentrations (290 µg/kg dry weight Aroclor 1248 and 300 µg/kg dry weight Aroclor 1254) were measured in sediment from Grassy Creek. (Tables H-11 and H-12). All PCB concentrations, including the sum of both Aroclors in Grassy Creek (590 µg/kg dry weight) were less than the PEC of 676 µg/kg dry weight.

Tier 2 – The maximum PCB concentrations observed in the DGI samples were compared with EqP-based benchmarks using the method of Fuchsman et al 2006, and is summarized in Appendix A.

- The maximum Aroclor 1248 concentration (Grassy Creek) was 13.7 µg/g OC, which was much less than the EqP benchmark of 490 µg/g OC.

- The maximum Aroclor 1254 concentration (Grassy Creek) was 14.2 µg/g OC, which was much less than the EqP benchmark of 1500 µg/g OC.

The Tier 2 results indicate that concentrations of PCBs in the urban comparison stream do not exceed the binding capacity of those sediments and are not likely to harm aquatic life.

No Tier 3 evaluations were conducted for PCBs in the DGI.

Tier 4 - Some PCBs were also detected in invertebrate (Table H-13) and fish (table H-14) tissue samples. All of the detected Aroclors, as well as the sum of detected PCB congeners or Aroclors were much less than tissue benchmark concentration for larval fish from Monosson (2000). Specifically:

- The maximum Aroclor 1254 concentration observed in fish was 260 µg/kg wet weight in the log perch sample from Otter Creek segment A. The larval fish benchmark for Aroclor 1254 is 5000 µg/kg wet weight (Monosson 2000).

- The maximum Aroclor 1254 concentration observed for invertebrate tissues was 81 µg/kg wet weight at location OC-4, which is also much less than the available benchmark for fish tissue.

- The fish larvae benchmark for PCB 77 is 1300 µg/kg wet weight (Monosson 2000). PCB 77 was not detected in any of the fish tissue samples from the DGI, and the detection limits for PCB congeners were approximately 2 orders of magnitude less than the benchmark.

A comparison of Aroclor 1254, which was the most frequently-detected PCB mixture, data in sediments, benthic macroinvertebrates and fish demonstrated evidence of biomagnification from invertebrates to fish (Table 3-20). There was no clear evidence of biomagnification from sediments because benthic invertebrate tissue concentrations were generally less than sediment concentrations. The fish tissue concentration was nearly equal to the sediment concentration in Otter Creek Segment A, but was less than the sediment concentration in Duck Creek Segment A. The DGI data suggest that PCBs are not present at concentrations that are sufficient to adversely affect the biological communities of Duck, Otter and Grassy Creeks, or Amlosch Ditch.

Table 3-20 Summary of PCB (Aroclor 1254) concentrations in sediments, benthic macroinvertebrates and fish from the DGI data set.

Stream Segment	Sample Location	Sediment Aroclor 1254 (µg/kg dry wt)	Invertebrate Aroclor 1254 (µg/kg wet wt)	Fish Tissue Aroclor 1254 (µg/kg wet wt)
Urban Comparison	Amlosch Ditch	Not detected	Not detected	No sample
	Grassy Creek	300	16	No sample
Duck Creek D	DC-11/12	Not detected	5.8	Not detected
Duck Creek A	DC-5	170	24	99
Otter Creek C	OC-16	Not detected	21	150
	OC-12/13	Not detected	25	
Otter Creek A	OC-5A	Not detected	36	260
	OC-4	240	81	
Fish were collected within stream reaches and are generally more mobile than invertebrates so they are reported on a reach basis here				

3.5.4 Semivolatile Organic Compounds (SVOCs)

Tier 1 – Most of the SVOCs were not detected in any DGI sediment samples. The most frequently-detected SVOCS were the PAHs, which are evaluated in the following section. The non-PAH SVOC data are included in Tables H-17 through H-23 of Appendix H. PEC values are not available for the non-PAH SVOCs, so bulk sediment benchmark concentrations that are based on equilibrium partitioning (see equation in section 3.5.2) and the assumption that sediments contain 1% total organic carbon are presented in Table 3-21.

Tier 2 – None of the non-PAH SVOCs that were detected in sediments from the urban comparison streams exceeded the equilibrium partitioning-based benchmark concentrations that assume a sediment organic content of 1%. Sediments from the urban comparison streams contained between 1.62% and 22.9% TOC (Appendix E), so the sediments have more binding capacity than is assumed for the benchmark values.

The maximum measured values of three SVOCs (carbazole, diethyl phthalate, and phenol) were greater than the EqP-based benchmarks that assumed 1% TOC (Table 3-21). Sample-specific evaluations using the measured TOC were conducted to determine if the greater sediment organic carbon that is typical of these streams provided a different interpretation.

- For 4-methyl phenol, the sediment sample that contained the maximum concentration (DC-08-02), which is a subsurface sample, had an organic carbon content of 5.417%, which is 54.1 g OC/kg dry sediment. The 4-methyl phenol concentration in the sediment sample from DC-08-02 (420 µg/kg) converts to 7.76 µg/ g OC. The 4-methyl phenol benchmark at 1% TOC (10 g OC/kg sediment) converts to 26.6 µg/g OC. The carbon-based sample concentration was less than the carbon-based benchmark (e. g. 7.76 µg/g OC < 26.6 µg/g OC). A sample-specific evaluation of 4-methyl phenol indicated the maximum observed concentration of this SVOC was unlikely to adversely affect sediment-dwelling organisms.

- For carbazole, the sediment sample that contained the maximum concentration (Amlosch Ditch) had an organic carbon content of 5.07%, which is 50.7 g OC/kg dry sediment. The carbazole concentration in the sediment sample from Amlosch Ditch (1900 µg/kg) converts to 37.5 µg/ g OC. The carbazole benchmark at 1% TOC (10 g OC/kg sediment) converts to 18.6 µg/g OC. The carbon-based sample concentrations remained greater than the carbon-based benchmark (e. g. 37.5 µg/g OC > 18.6 µg/g OC); however, the sediment at this location did not affect midge survival. Midge lavae exhibited the maximum growth (in terms of biomass scaled to control organisms) at this location, and benthic community was dominated by sensitive taxa. The DGI data indicate that the maximum concentration of carbazole detected in sediments did not adversely affect aquatic life.

- For diethyl phthalate, the sediment sample that contained the maximum concentration (DC-11/12) had an organic carbon content of 22.9%, which is 229 g OC/kg dry sediment. The diethyl phthalate concentration in that sediment sample (410 µg/kg) converted to 1.79 µg/ g OC. The diethyl phthalate benchmark at 1% TOC (10 g OC/kg sediment) converted to 15.2 µg/g OC. The carbon-based sample concentration in DC-11/12 was much less than the carbon-based benchmark (e. g. 1.79 µg/g OC 15.2 µg/g OC), so a sample-specific evaluation of diethyl phthalate indicated the maximum observed concentration of this SVOC was unlikely to adversely affect sediment-dwelling organisms. The TOC content at DC-11/12 was unusually high compared with other DGI samples, and may have been caused by the presence of detritus from the abundant emergent plant community at that location. The remaining sample data were scanned to assess the overall situation with diethyl phthalate. This compound was detected in one additional sample (DC-6/7) at a concentration of 260 µg/kg. The organic carbon content of that sample was 7.55% (75.5 µg/g OC). The carbon –based concentration of diethyl phthalate in DC-6/7 was 3.44 µg/g OC, which is also less than the 15.2 µg/g OC screening benchmark. Sample-specific evaluations of diethyl phthalate indicate that this SVOC was unlikely to adversely affect sediment-dwelling organisms.

- For n-nitrosodiphenylamine, the sediment sample that contained the maximum concentration (OC-18-02, which is a subsurface sample) had an organic carbon content of 5.41%, which is 54.1 g OC/kg dry sediment. The n-nitrosodiphenylamine concentration in that sediment sample (570 µg/kg) converted to 7.09 µg/ g OC. The phenol benchmark at 1% TOC (10 g OC/kg sediment) converted to 24.0 µg/g OC, which was greater than the sample concentration. A sample-specific evaluation of n-nitrosodiphenylamine l indicated the maximum observed concentration of this SVOC was unlikely to adversely affect sediment-dwelling organisms.

No Tier 3 or 4 assessments were conducted for non-PAH SVOCs.

In summary, most of the non-PAH SVOCs were rarely detected in the DGI sediment samples. When detected, the SVOC concentrations were almost always less than EqP-based benchmarks; the exception was carbazole at the Amlosch Ditch sample location, which produced the largest midge larvae relative to controls, and had a benthic community that was dominated by sensitive taxa. In general, non-PAH SVOCs are unlikely to harm aquatic life in the DGI streams.

Table 3-21 Sediment benchmark concentrations for SVOCs (µg/kg dry weight) that were detected in DGI sediment samples. Benchmarks are based on 1% TOC.

Name of detected SVOC	Water benchmark (µg/L)	Benchmark Source	log Koc	Sediment Benchmark Concentration (µg/kg dry weight)	Maximum concentration detected in a DGI sample (µg/kg dry weight)
4-methylphenol	53	Ohio OMZAstandard [a]	2.70	266	420 (DC-8-02)
Acetophenone	ID	Van Leeuwen et al 1992	N/A	977[b]	270 (DC-8-02)
Benzaldehyde	14000	Illinois chronic standard [c]	1.514	4572	270 (OC-5A-02)
Bis(2-ethylhexyl)phthalate	8.4	Ohio OMZA standard [a]	4.94	7316	1500 (OC-4A-02)
Benzyl butyl phthalate	23	Ohio OMZA standard [a]	3.72	1207	570 (OC-11/12)
Carbazole	7.4	Illinois chronic standard [c]	3.40	186	1900 (Amlosch Ditch)
Diethyl phthalate	220	Ohio OMZA standard [a]	1.84	152	410 (DC-11/12)
N-Nitrosodiphenylamine	58.5	USEPA Region IV[d]	2,613	240	570 (OC-18-02)
Phenol	400	Ohio OMZA standard [a]	1.90	318	180 (DC-8-02)

a equilibrium partitioning-based concentration, assumes 1% TOC and uses Ohio chronic (outside mixing zone average) water quality criterion from Chapter 3745-1 of Ohio Administrative Code for Lake Erie tributaries

b equilibrium partitioning-based No Effect Level from Van Leeuwen et al 1992

c equilibrium partitioning-based concentration, assumes 1% TOC and uses Illinois general use water quality criterion

d equilibrium partitioning-based benchmark from USEPA IV freshwater screening value, assumes 1% TOC

log Koc data from EpiSuite (experimental data when available, log Kow-derived values used when experimental data were not available

ID = Ohio has determined there are insufficient data to develop a water quality standard

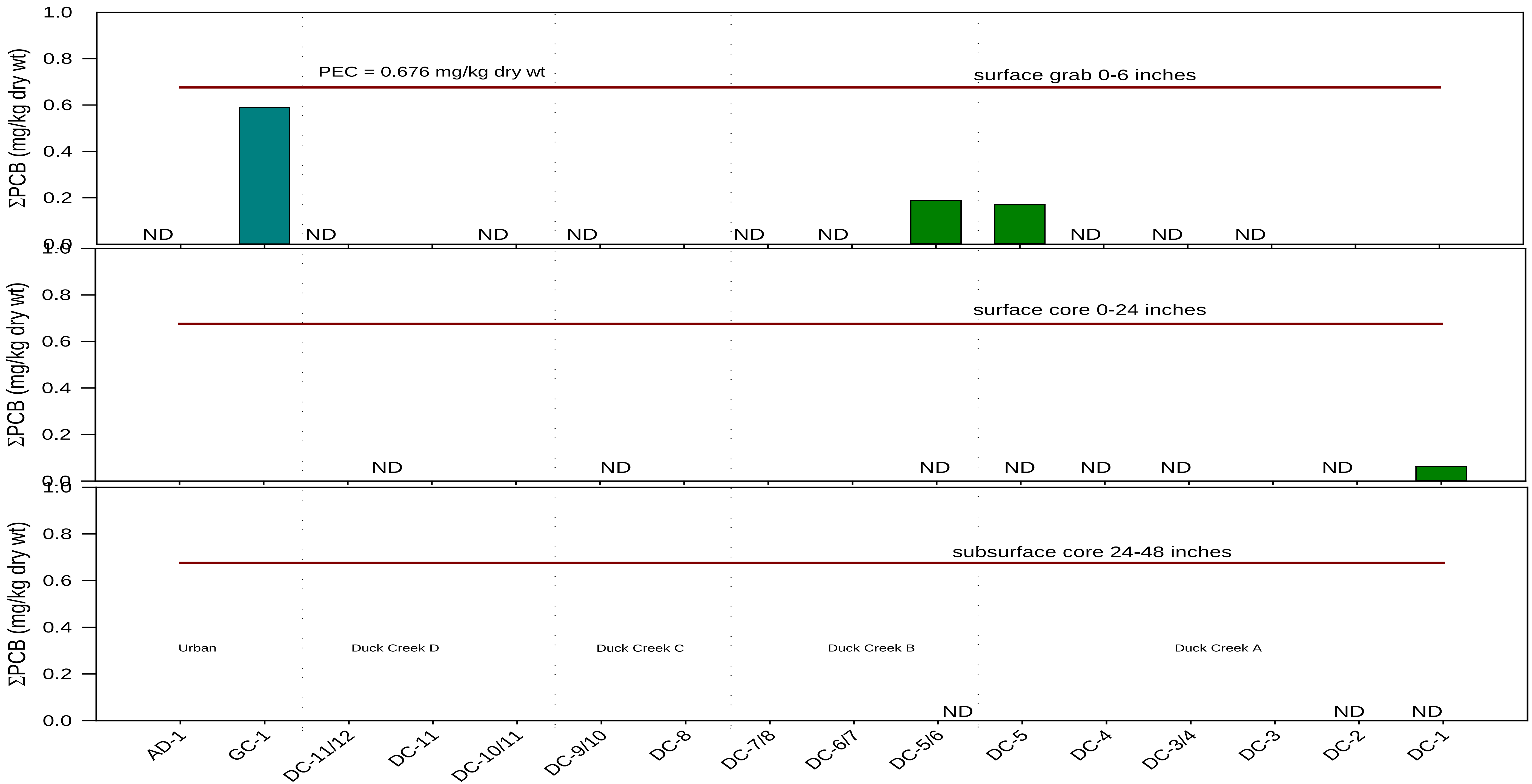

Figure 3-31 Summary of PCB concentrations in sediments from Duck and Grassy Creeks and Amlosch Ditch.

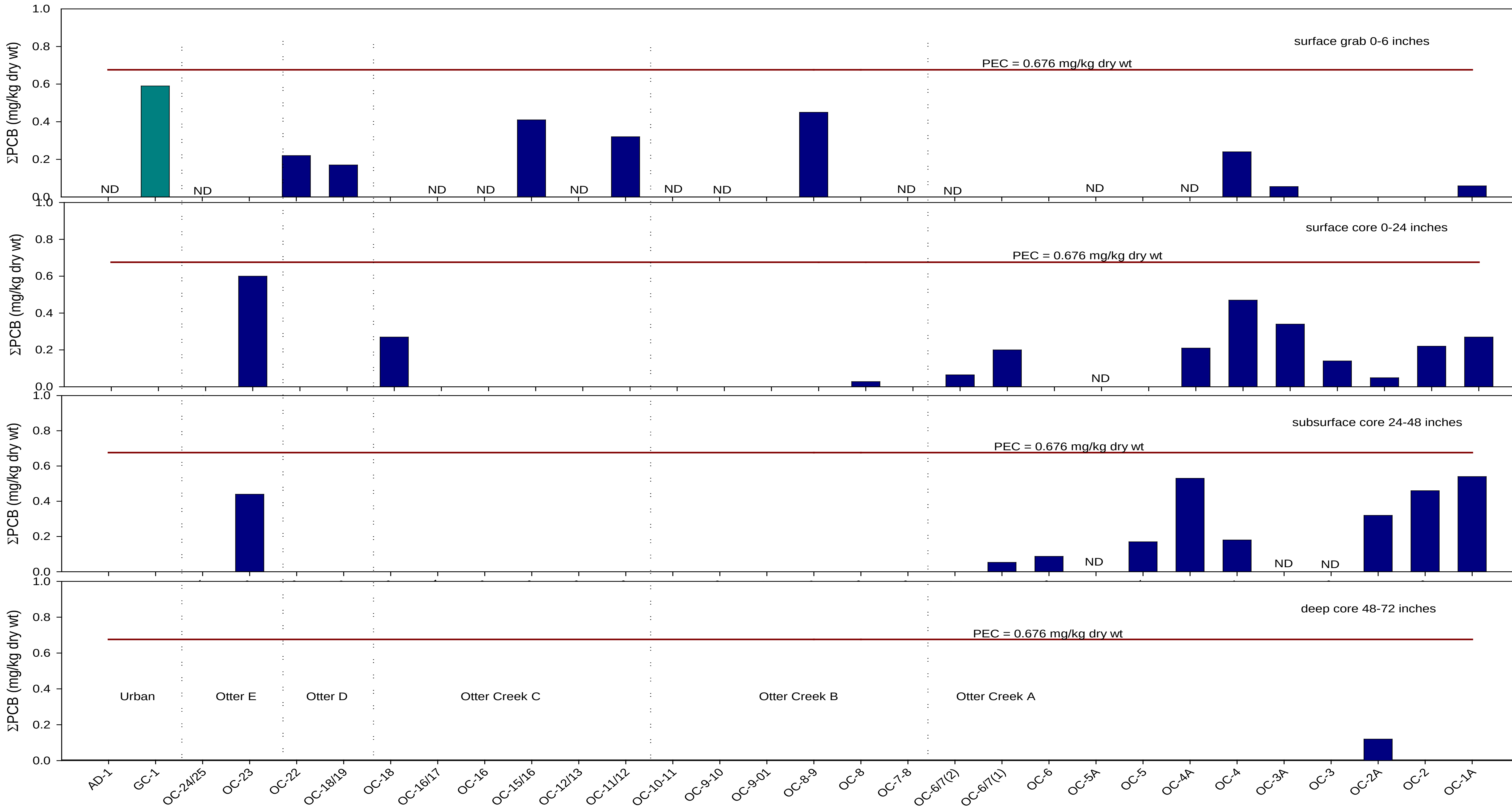

Figure 3-32 **Summary of PCB concentrations in sediments from Otter and Grassy Creeks and Amlosch Ditch.**

3.5.5 Total Petroleum Hydrocarbons

Tier 1 - Total petroleum hydrocarbons (TPH) concentrations were measured in the gasoline (C_8-C_{12}), diesel (C_{10}-C_{28}) and residual (C_{25} to C_{36}) ranges. Gasoline-range hydrocarbons were absent from most samples (Tables H-15 and H-16); the greatest concentrations were measured in surface core samples collected near the mouth of Otter Creek (Figures 3-33 and 3-34). Diesel- and residual-range hydrocarbons were generally comparable; however, the concentrations in Otter Creek (Figure 3-34) tended to be greater than those measured in Duck Creek (Figure 3-33). The presence of elevated TPH concentrations in several locations indicated that additional tiers of evaluation were warranted.

Tier 2 – The available benchmarks for TPH ranges (Battelle 2007) are based on equilibrium partitioning; however, the values are based on carbon ranges of alkanes and aromatic compounds, and appropriate application of the values requires that the analytical data be available in the same fractions as the benchmarks,

- Aliphatic Hydrocarbons which are saturated structures that contain 2 hydrogen atoms per carbon, in four different size fractions: C_5 to C_8; C_9 to C_{12}; C_{13} to C_{18} and C_{19} to C_{36}.

- Aromatic Hydrocarbons which are unsaturated ring structures that contain double bonds, also in four different size fractions: C_6 to C_8; C_9 to C_{12}; C_{13} to C_{15} and C_{16} to C_{24}.

The TPH analyses conducted for the DGI did not separate alkane and aromatic compounds; moreover, it is not possible to estimate the 8 TPH fractions from the 3 ranges of mixed alkanes and aromatics that were reported in this study, so the DGI TPH data cannot be readily interpreted using the available benchmarks.

No Tier 2, 3 or 4 evaluations were conducted for TPH. The evaluation of petroleum hydrocarbon proceeded to assessment of PAHs, which are generally accepted as the main cause for petroleum hydrocarbon toxicity, and this group of compounds is quantitatively addressed in the next subsection. Other petroleum components may also contribute to petroleum toxicity, but quantitative methods have not been developed to assess them.

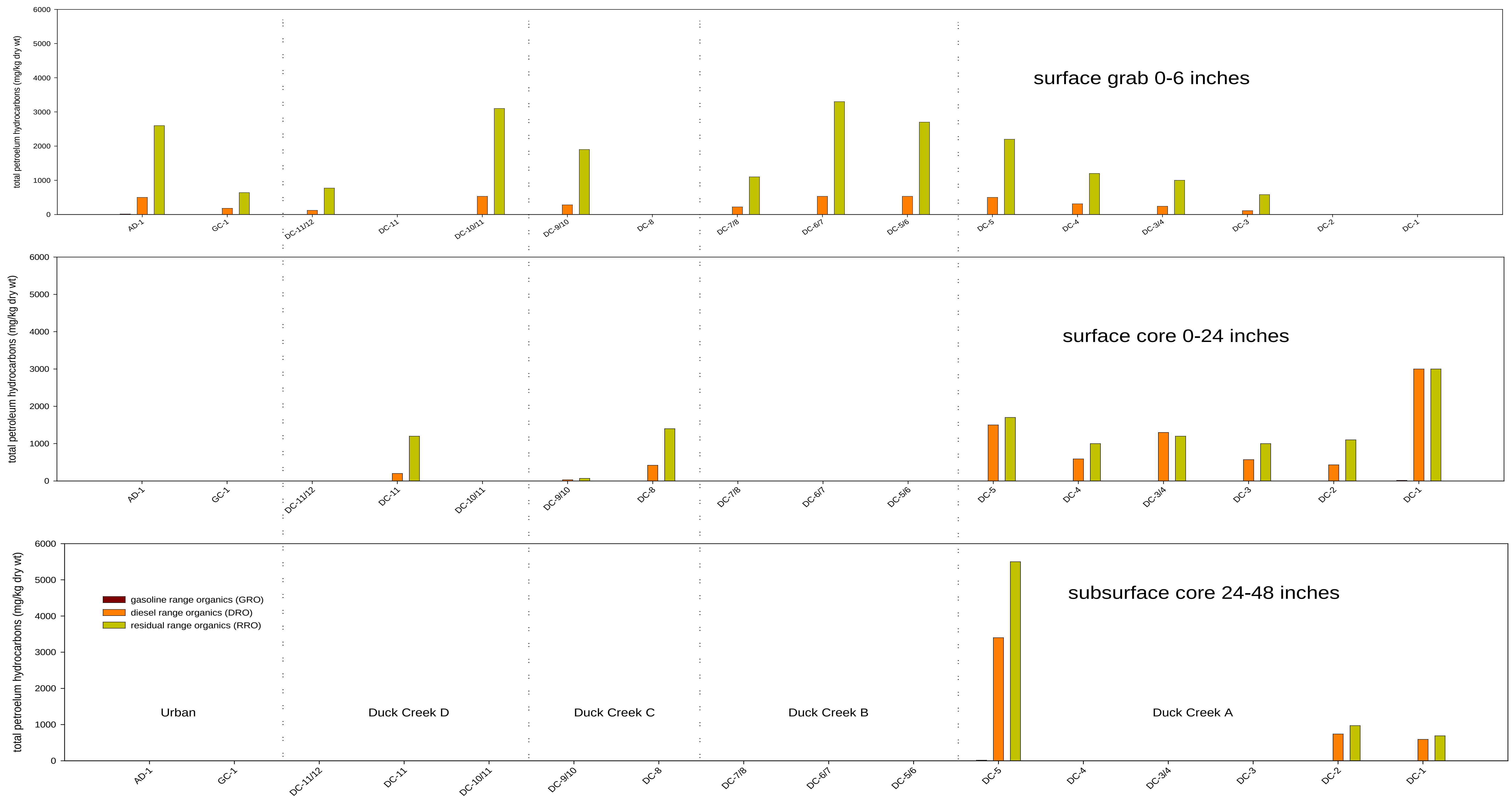

Figure 3-33 Summary of TPH concentrations with sediment depth in Duck Creek.

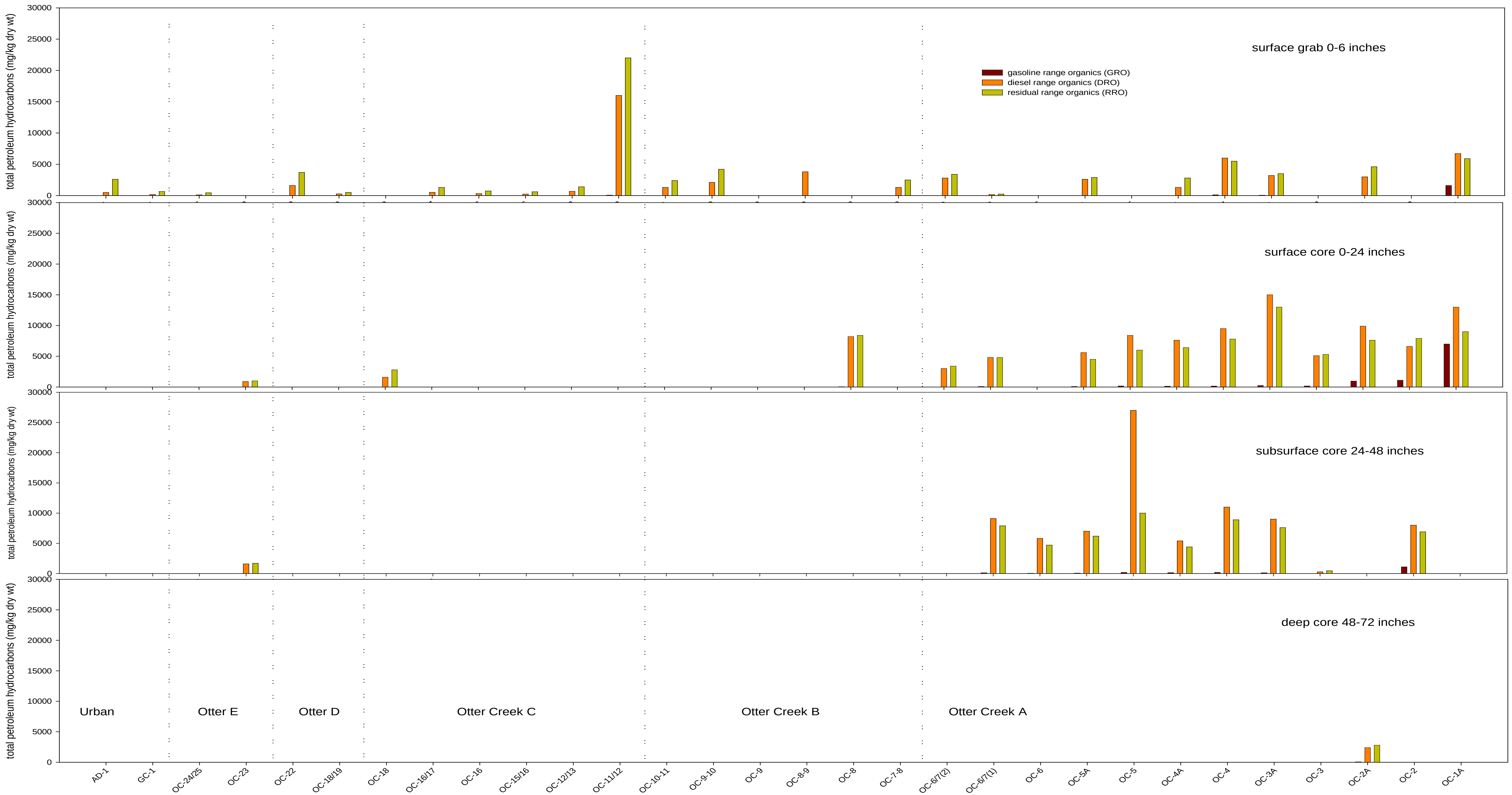

Figure 3-34 Summary of TPH concentrations with sediment depth in Otter Creek.

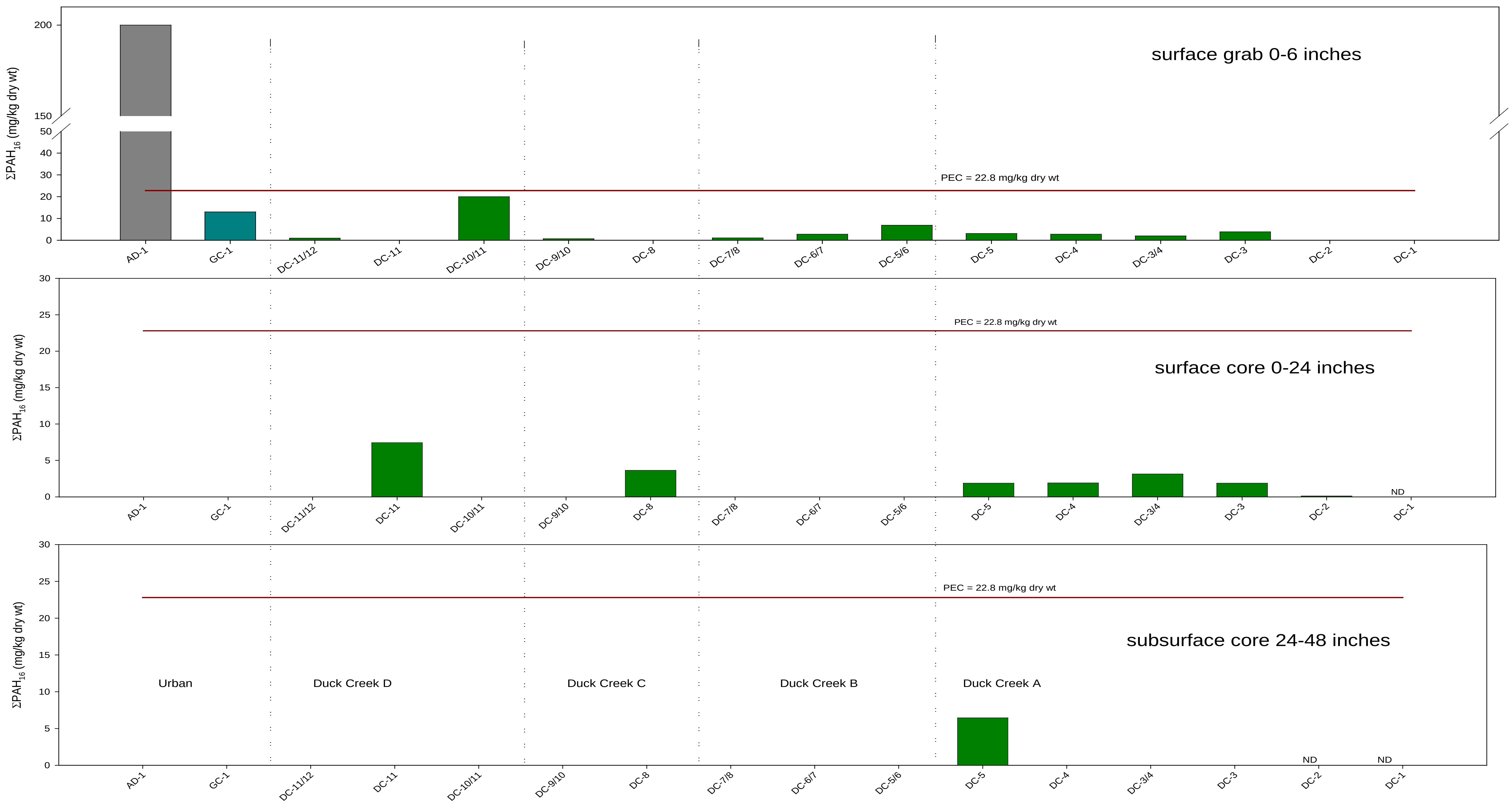

Figure 3-35 Summary of PAH16 Concentrations with depth for Duck Creek sediments.

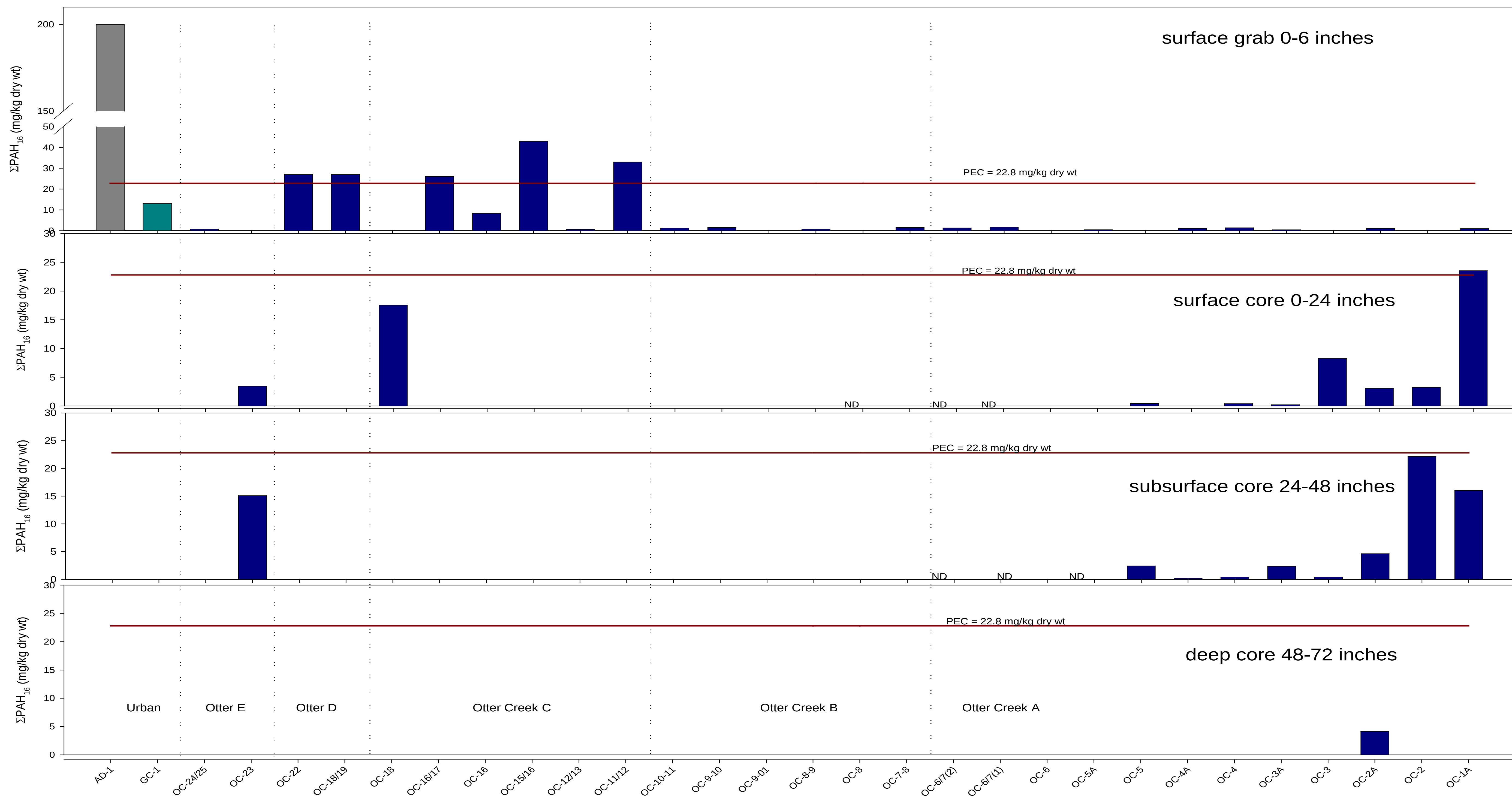

Figure 3-36 Summary of PAH16 Concentrations at sediment depths in Otter Creek

3.5.6 Polycyclic Aromatic Petroleum Hydrocarbons

The toxicity of petroleum mixtures can be readily interpreted with existing mechanistic interpretive tools that utilize polycyclic aromatic hydrocarbon (PAH) data. The PAHs are generally more bioavailable than alkanes, and the USEPA (2003) has developed an Ecological Screening Benchmark (ESB) method based on the interpretation of PAHs to assess petroleum toxicity in aquatic environments, and the OEPA (2010) has adopted them.

Tier 1 - The summed concentration of the 16 priority pollutant PAHs (PAH_{16}) in sediment samples were greater than the bulk sediment PEC_{16} for PAH_{16} in several samples in Duck and Otter Creek (Tables H-24 and H-25), with the greatest concentration in Amlosch Ditch (Figures 3-35 and 3-36). The PEC_{16} benchmarks that are based on dry weight were used for the first tier assessment of PAHs in this DGI. PEC_{16} values that account for binding to sediment organic carbon are available, and the TOC-rich silty sediments in these streams would decrease the number and magnitude of exceedences in the DGI data set.

Tier 2 **–** Because pore water concentrations of priority pollutant PAHs and their alkylated homologues (i. e. PAH_{34}) were measured directly, the DGI interpretation proceeded directly to a Tier 3 evaluation. Some studies have observed that the standard partitioning coefficients that are included in the ESB document do not accurately predict sediment pore water concentrations in all sediments types, or with sediments that have organic carbon from different origins (Hawthorne et al, 2006). The investment in measured pore water PAH_{34} concentrations allowed this DGI to conduct a site-specific evaluation of PAHs.

Tier 3 - Concentrations of PAH_{34} in pore water samples were elevated, relative to the final chronic value (FCV) benchmarks proposed by USEPA (2003) guidance (Tables H-26 and H-27). The ratios of pore water concentrations to FCV benchmarks were summed to calculate a summed toxic unit approach for interpretation of the PAH_{34} pore water data. In terms of toxic unit contributions (e.g. PAH_i concentration in pore water/$FCV_i = TU_i$), the alkylated naphthalenes contributed the greatest proportion of the total toxic units in segment A of Otter Creek. The alkylated anthrancenes, phenanthrenes and fluorenes were also prominent, relative to the other PAHs in pore water (Table 3-22). There was a negative relationship between the summed toxic units of PAHs in sediment pore water ($PAH_{34}\ \Sigma TU_{FCV}$) and growth (scaled biomass) of the midge *C. dilutus* (see Figure 3-37). The relationship was not linear, and the correlation was not statistically significant (see also Appendix N); however, the two samples that contained 6.7 or more summed toxic units of PAHs in sediment pore water ($PAH_{34}\ \Sigma TU_{FCV} \geq 6.7$) co-occurred with significant inhibition of midge growth, and the sample in which $PAH_{34}\ \Sigma TU_{FCV} = 18.2$ co-occurred with significant mortality in midge larvae (Figure 3-37).

Table 3-22 Summary of PAH_{34} ΣTU_{FCV} in sediment pore water samples from segment A of Otter Creek.

Individual PAH (PAH_i)	OC-6/7-01 Pore Water PAH Toxic Units (TU_i)	OC-5A-01 Pore Water PAH Toxic Units (TU_i)	OC-4-01 Pore Water PAH Toxic Units (TU_i)
Naphthalene	0.00052	0.00393	0.00450
1-Methylnaphthalene	0.00066	0.00876	0.03980
2-Methylnaphthalene	0.00069	0.00180	0.01192
C2- Naphthalenes	0.00496	0.11111	0.42626
C3- Naphthalenes	0.06667	0.71982	2.93964
C4 Naphthalenes	0.57312	1.23271	6.35375
Acenaphthylene	0.00065	0.00065	0.00072
Acenaphthene	0.00179	0.00179	0.00645
Fluorene	0.00102	0.00153	0.00560
C1- Fluorenes	0.00786	0.01930	0.08363
C2- Fluorenes	0.07917	0.10556	0.36192
C3- Fluorenes	0.49061	0.53758	1.26305
Phenanthrene	0.00523	0.00523	0.01202
Anthracene	0.00241	0.00241	0.00338
C1-Phenanthrenes/Anthracenes	0.00807	0.05648	0.15196
C2- Phenanthrenes/Anthracenes	0.17818	0.45639	0.93467
C3- Phenanthrenes/Anthracenes	0.81210	1.08280	1.97452
C4- Phenanthrenes/Anthracenes	1.64462	2.05577	3.25349
Flouranthene	0.00703	0.00141	0.00141
Pyrene	0.00890	0.00791	0.01187
C1-Fluoranthenes/Pyrenes	0.02865	0.03274	0.06139
Chrysene	0.00988	0.00494	0.00988
C1 Chrysenes	0.01169	0.01169	0.02337
C2 Chrysenes	0.02072	0.02072	0.02072
C3 Chrysenes	0.05970	0.05970	0.05970
C4 Chrysenes	0.14160	0.14160	0.14160
Perylene	0.00444	0.00444	0.00444
Benzo[A]Anthracene	0.00449	0.00000	0.00000
Benzo[B+K]Fluoranthene	0.00779	0.00779	0.00779
Benzo[A]Pyrene	0.00836	0.00836	0.00836
Benzo[E]Pyrene	0.00555	0.00555	0.00555
Dibenzo[A,H]Anthracene	0.00708	0.00708	0.00708

Table 3-22 Summary of PAH_{34} ΣTU_{FCV} in sediment pore water samples from segment A of Otter Creek.

Individual PAH (PAH_i)	OC-6/7-01 Pore Water PAH Toxic Units (TU_i)	OC-5A-01 Pore Water PAH Toxic Units (TU_i)	OC-4-01 Pore Water PAH Toxic Units (TU_i)
Indeno[1,2,3-CD]Pyrene	0.00364	0.00364	0.00364
Benzo[G,H,I]Perylene	0.00228	0.00228	0.00228
PAH_{34} ΣTU_{FCV}	4.21013	6.72347	18.19634
Pore water PAH_{34} ΣTU_{FCV} calculated by dividing the measured pore water concentration by the final chronic value water criterion and summing the quotients (ISEPA 2003).			

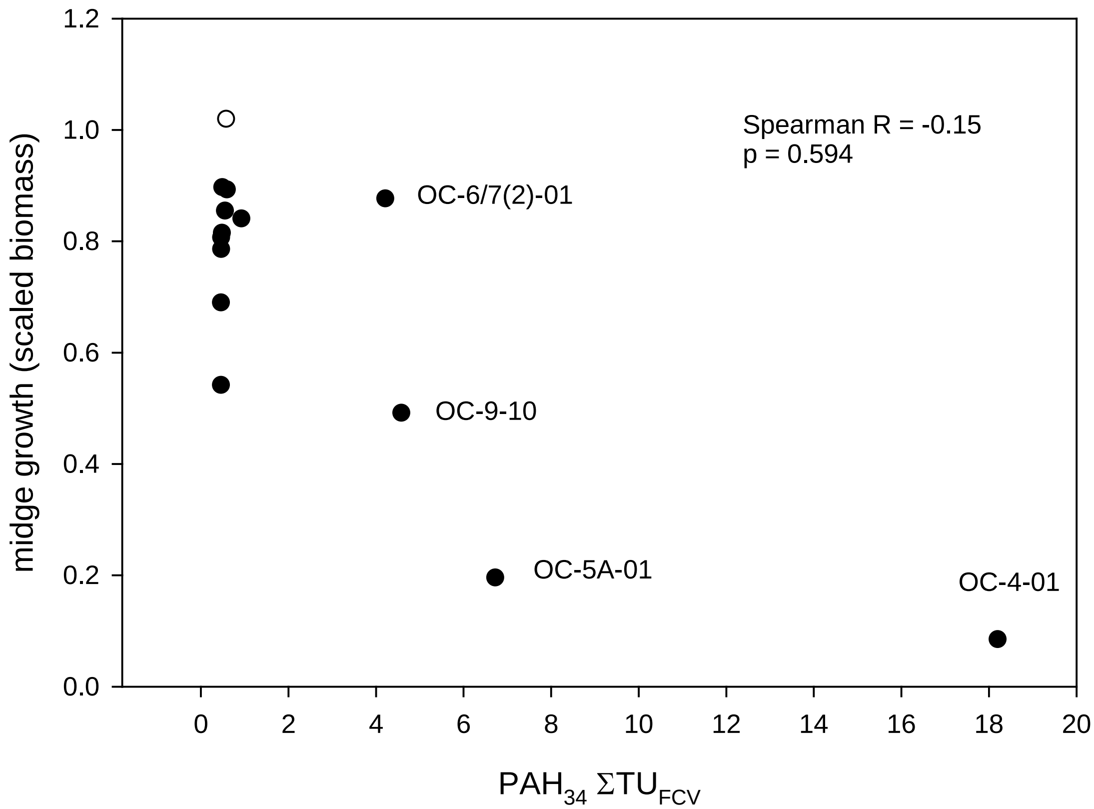

Figure 3-37 The relationship between the summed final chronic value toxic units for PAH_{34} in sediment pore water (PAH_{34} ΣTU_{FCV}) and growth of the midge *C. dilutus* is not linear.

Tier 4 – The PAH_{34} concentrations in tissues of benthic invertebrates and fish that were collected from Duck, Otter and Grassy Creeks did not exceed the lipid-normalized tissue residue benchmark (2.24 µmole/g lipid) upon which the ESB method is based (Tables H-28 and H-29). In summary, benthic invertebrate tissue concentrations ranged from 0.025 to 0.763 µmoles/g lipid in Duck and Otter Creeks, and 1.09 µmoles/g lipid in Grassy Creek. In contrast, the PAH_{34} tissue concentration in the benthic macroinvertebrate sample from Amlosch Ditch (17.3 µmoles/g lipid) did exceed the tissue benchmark concentration. The invertebrate tissue data from Amlosch Ditch appear to contradict the sediment pore water data from that stream; however, the two PAHs (fluoranthene and pyrene) that were reported at elevated concentrations in the invertebrate sample are also prominent in the sediment sample. This correlation suggests that sediment may have been present in the Amlosch Ditch invertebrate tissue sample, either within the digestive tracts of the animals, or possibly, adhered to the cuticle. The PAH_{34} concentrations in tissues of fish that were collected from Duck and Otter Creeks ranged from 0.00243 to 0.157 µmoles/g lipid which were one to three orders of magnitude less than the lipid-normalized tissue residue benchmark of 2.24 µmole/g lipid.

Data to support an evaluation of PAH_{34} bioaccumulation in the DGI streams is summarized in Table 3-23. There is no consistent relationship among the stream segments, or between compartments of the aquatic food web. The DGI data reveal that simplistic, empirical approaches will likely be inadequate for addressing PAH_{34} bioaccumulation or lack thereof. The chemical and physical properties of individual PAHs vary, which affects the binding coefficients, bioavailability, bioaccumulation and metabolism of the individual components. The tissue data from the DGI indicate that PAHs are not bioaccumulating in aquatic organisms in Duck and Otter Creeks.

Table 3-23 Summary of PAH_{34} concentrations in sediments, pore water, benthic macroinvertebrates and fish from the DGI data set.

Stream Segment	Sample Location	Sediment PAH_{34} (µg/kg dry wt)	Pore Water PAH_{34} (µg/L)	Invertebrate PAH_{25} (µg/kg wet wt)	Fish Tissue PAH_{34} (µg/kg wet wt)
Urban Comparison	Amlosch Ditch	260000	2.321	22594	No sample
	Grassy Creek	17000	1.546	1632	No sample
Duck Creek D	DC-11/12	1700	1.393	35.59	45.93
Duck Creek A	DC-5	9700	1.413	191.6	624.4
Otter Creek C	OC-16	12000	2.721	2606	216.0
	OC-12/13	980	2.081	690.9	
Otter Creek A	OC-5A	3200	24.976	127.1	1729
	OC-4	3100	91.526	163.5	

Only 25 PAHs were reported for benthic macroinvertebrate tissue samples, and several of those were not detected; non-detect concentrations were treated as 0 in these calculations.

Fish were collected within stream reaches and are generally more mobile than invertebrates so they are reported on a reach basis here

Chapter 4

Discussion

The discussion of this report is structured around the five specific objectives of the Statement of Work for the Duck and Otter Creeks Data Gap Investigation.

4.1 Determining the extent of contamination in both surface and subsurface sediments

The extent of contamination can be evaluated at two tiers; the first tier involves the bulk sediment chemistry, which provides information about the presence and locations of contaminants. Bulk sediment chemistry data provide information about the locations and magnitude of contaminant concentrations, but does not provide information about the availability of those contaminants to aquatic life. The second tier of the evaluation of sediment chemistry contaminants addresses the bioavailable fraction of the contaminants and provides information about which contaminants could potentially be adversely affecting aquatic organisms. Bulk sediment chemistry data help to identify "what" and "where" aspects of contaminant presence, but pore water data give the most useful information regarding the potential for contaminants to cause adverse effects. The pore water data provide the important link to biology that informs decisions regarding where the management of sediment contaminants has the greatest potential to produce positive improvements in the biological communities, which is an important connection for restoring beneficial use impairments that could be associated with sediment contamination.

The two categories of sediment contaminants that exceeded bulk sediment benchmarks were metals, and petroleum hydrocarbons. The pyrethroid pesticides and PCBs did not exceed sediment benchmarks in any sample. Of the metals, lead, arsenic and chromium most frequently exceeded the respective bulk sediment benchmarks. Surface samples had elevated concentrations (relative to benchmarks) of metals in segments D and A of Duck Creek, and segments E, C, B and A of Otter Creek. Subsurface sediments had elevated concentrations of metals in at least one sample from segments E and A of Otter Creek. Gasoline-range organic carbons (C_8-C_{12}) were infrequently detected, except at the mouth of Otter Creek, while hydrocarbons in diesel (C_{10}-C_{25}) and residual (C_{25}-C_{36}) ranges were present at measureable concentrations in nearly all surface sediment samples, including both urban comparison streams. Hydrocarbon concentrations were elevated in surface sediments of Otter Creek, relative to Duck and Grassy Creeks and Amlosch Ditch. PAH_{16} concentrations were greatest in Amlosch Ditch, and also exceeded sediment benchmarks in segments D, C and a single sample in segment A of Otter Creek. PAH_{16} concentrations were detected in most subsurface sediment samples, but did not exceed sediment benchmarks in either Duck or Otter Creek.

Regarding the extent of the bioavailable sediment contaminants, only two classes of sediment contaminants were present in pore water at concentrations that were sufficient to potentially affect sediment-dwelling organisms: ammonia and PAH_{34} (see Table 4-1). Ammonia concentrations were not elevated in the overlying water of the sediment toxicity test chambers, and ammonia was not correlated with midge survival, midge growth, or any of the benthic community metrics. Thus, the available site-specific data suggest that sediment-associated ammonia is not affecting the benthic community structure or contributing to sediment toxicity in the laboratory.

Sediment toxicity, as expressed by reduced biomass (growth) was observed in two surface sediments of Otter Creek Segment A, and PAHs were elevated in the sediment pore water at both of those locations. Moreover, PAH_{34} concentrations in sediment pore water were significantly correlated with growth of the midge in the sediment toxicity test (Figure 3-38). Sediment cores (0-4 feet) also contained measureable concentrations of PAHs (Figure 3-36), in the downstream portion of Otter Creek segment A. Elevated concentrations of TPH DRO and RRO were also observed in sediment to a depth of approximately four feet in segment A of Otter Creek (Figure 3-34).

Pore water PAH concentrations and reduced midge growth were also elevated in OC-9/10; however the sediment thickness in this area was only 6 inches, and the sample contained much more gravel than most others (Table E-2), which could also have affected midge growth. The presence of the only riffle-pool sequence that was observed during the habitat evaluation at sample location OC-9/10 indicates that spot is not representative of segment B, or Otter Creek in general, but is unique.

Table 4-1 Summary Table of the Chemical Analyses of Sediment Samples.

Analysis	Bulk sediment	Pore water	Summary of Results
Metals	√	√	Metals concentrations in sediments exceed conservative screening benchmarks; however, SEM- AVS/foc data indicated that metals were not bioavailable, and in only one sample did a metal concentration in pore water exceed a chronic surface water quality criterion. That pore water concentration did not exceed a hardness-based chronic water quality criterion from an adjacent state. Metals (selenium) concentrations in benthic invertebrate and fish tissues did not exceed available benchmarks, and no evidence of biomagnification was observed.
SVOCs	√	-	Most of the SVOCs, with the exception of the PAHs, were seldom detected. The maximum detected non-PAH SVOC concentrations exceeded the associated benchmark concentrations in only one (urban comparison stream) sample, but no toxicity occurred in that sample
PAH_{16} and PAH_{34}	√	√	PAH_{16} concentrations in some sediments exceed conservative screening benchmarks; PAH_{34} concentrations were elevated in sediment pore waters at the locations were growth of midge larvae was reduced. PAH_{34} concentrations in biological tissues did not exceed benchmark concentrations with the exception of one benthic macroinvertebrate sample from Amlosch Ditch that may have contained sediment.
Aroclors	√	-	PCB concentrations were rarely detected in sediments and biological tissues, and did not exceed screening benchmarks in either sediments or tissues.
GRO/DRO/RRO	√	-	TPH DRO and RRO concentrations in sediments were elevated in Otter Creek relative to other streams. TPH DRO and RRO concentrations were elevated in sediment cores relative to surface sediment grabs in segment A of Otter Creek. TPH GRO concentrations were elevated in some sediment core samples in segment A of Otter Creek
Ammonia	-	√	Ammonia concentrations in pore water exceeded surface water criteria in several sample locations; however ammonia was not elevated in the overlying water in sediment toxicity test

Table 4-1 Summary Table of the Chemical Analyses of Sediment Samples.

			chambers. Ammonia concentrations are not correlated with midge survival or growth, or the benthic community metrics.
Pyrethroid pesticides	√	-	Some of the pyrethroid pesticides were detected in some sediment samples, but did not exceed screening benchmarks.

4.2 Verifying sediment toxicity and identify cause(s), to the extent practicable within the constraints of this data gap investigation

The Sediment Quality Triad, as supplemented by a habitat evaluation, reveals that Duck and Otter Creeks are complex streams that have generally poor habitat quality because of modification of both the stream channels and watersheds. Given the physical conditions of these streams, the resident benthic communities are expected to be comprised of species that are tolerant of silty sediments, low base flows and very high discharges during precipitation events.

Sediment toxicity has been verified for three locations within Otter Creek by this study. In the DGI sediment toxicity tests, a careful examination of the exposure chambers at the end of the test revealed that indigenous sediment predators severely affected the survival of test organisms in the majority (9 of 14) sample locations in this study. These predatory flatworms (*Planaria*) were not mentioned in the 2007 study report. The statistical tests for this DGI were conducted in way that the presence of indigenous organisms did not affect the data interpretation (i.e., affected replicate test chambers were excluded from the analysis).

The presence of multiple physical (poor habitat), biological (predator) and chemical stressors in this small data set make data interpretation a challenge, but a summary of the Sediment Quality Triad, with the supplemental habitat quality information is presented in Table 4-2. As discussed above, the strongest relationship between sediment contamination and the biological endpoints has been observed for PAH_{34} in the sediment pore waters of segment A in Otter Creek. Metals, PCBs, Pyrethroid pesticides, and non-PAH SVOCs can be ruled out as sources of toxicity in the DGI data set because these classes of contaminants are not generally elevated in sediments, or are not bioavailable. Ammonia concentrations in pore water were elevated in several sediment samples; however there was no relationship with biological endpoints.

Table 4-2 Interpretations of the Sediment Quality Triad plus Habitat Quality for the Duck and Otter Creek Data Gap Investigation

Sample Location	Invertebrate Community Structure	Habitat Quality	Sediment Toxicity	Chemistry	Interpretation
Amlosch Ditch (AD-1)	7 taxa 61% sensitive 24% tolerant	QHEI 23 (very poor) Stormwater	No *Planaria*[a]	PAH_{34} in invertebrate sample	Sensitive biological community co-occurs with very poor habitat quality ; PAH_{34} suspected to be sediment in gut or adhered to cuticle.
Grassy Creek (GC-1)	9 taxa 1% sensitive 80% tolerant	QHEI 32.5 (poor)	No *Planaria*	No bioavailability	Tolerant biological community co-occurs with poor habitat.
DC-11/12	No water	No water	No	No bioavailability	Extremely low base flow is limited the biological community during the DGI.
DC-6/7	7 taxa 1% sensitive 70% tolerant	QHEI 40 (poor)	No *Planaria*	No bioavailability	Tolerant biological community co-occurs with poor habitat.
DC-5	8 taxa 17% sensitive 73% tolerant	QHEI 37.5 (poor)	No *Planaria*	No bioavailability	Tolerant biological community co-occurs with poor habitat.
DC-3	8 taxa 18% sensitive 43% tolerant	QHEI 23.5 (very poor)	No *Planaria*	No bioavailability	Biological community with relatively fewer tolerant taxa co-occurs with very poor habitat.
OC-24/25	12 taxa 3% sensitive 19% tolerant	QHEI 35 (poor)	No	No bioavailability	Diverse biological community co-occurs with poor habitat.
OC-22	6 taxa 1% sensitive 83% tolerant	QHEI 33.5 (poor) Stormwater	No	No bioavailability	Tolerant biological community co-occurs with poor habitat.
OC-16	5 taxa 0.3% sensitive 83% tolerant	QHEI 33 (poor) Stormwater	No	No bioavailability	Tolerant biological community co-occurs with poor habitat.
OC-12/13	5 taxa 0% sensitive 72% tolerant	QHEI 33 (poor) Stormwater	No *Planaria*	No bioavailability	Tolerant biological community co-occurs with poor habitat.
OC-9/10	5 taxa 1% sensitive 77% tolerant	QHEI 42 (poor)	Growth *Planaria*	Pore water PAH_{34}	Tolerant biological community co-occurs with poor habitat, sediment contamination and toxicity.
OC-6/7(2)	2 taxa 0% sensitive	QHEI 33.5 (poor)	No *Planaria*	Pore water PAH_{34}	Tolerant biological community co-occurs with poor habitat: sediment contamination present

Table 4-2 Interpretations of the Sediment Quality Triad plus Habitat Quality for the Duck and Otter Creek Data Gap Investigation

Sample Location	Invertebrate Community Structure	Habitat Quality	Sediment Toxicity	Chemistry	Interpretation
	96% tolerant				without toxicity
OC-5A	5 taxa 0% sensitive 100% tolerant	No safe bank access	Growth	Pore water PAH_{34}	Tolerant biological community co-occurs with sediment contamination and toxicity.
OC-4	4 taxa 0% sensitive 77% tolerant	QHEI 31 (poor)	Survival Growth *Planaria*	Pore water PAH_{34}	Tolerant biological community co-occurs with poor habitat, sediment contamination and toxicity.

a the flatworm Planaria was present in some test chambers and adversely affected the midge larvae; to remove the influence of predation by indigenous sediment organisms, test replicates that included flatworms were not included in statistical analyses.

4.3 Evaluating whether sediment contaminants are bioaccumulating in benthic invertebrates and fish at levels likely to contribute significantly to the degradation of benthos and fish populations

The available benthic invertebrate and forage fish tissue data do not indicate that bioaccumulation of sediment contaminants is significant in Duck or Otter Creeks. PCB concentrations did not exceed benchmark concentrations for tissues in fish or benthic macroinvertebrates collected for the DGI. PAH_{34} concentrations did not exceed tissue benchmarks for aquatic species in fish or invertebrate samples from Duck, Otter or Grassy Creeks; however the PAH_{34} benchmark was exceeded in the benthic macroinvertebrate tissue sample from Amlosch ditch. Many metals are essential micronutrients, and are carefully modulated by living organisms. Whole body tissue concentrations for metals are not typically the best predictors of adverse effects (Meador et al 2010, Jarvenin and Ankley 1999) so only a benchmark for selenium is available (USEPA 2004)), which was not exceeded in any sample. A cursory review of the metals data for tissues does not suggest that metals are accumulating in aquatic life, which is consistent with the very low sediment pore water concentrations that have been observed in this study.

4.4 Evaluating habitat resources

More than a century of urbanization and industrial land use has modified the stream channels and watersheds in the streams sampled in this investigation. Instream aquatic habitat is generally poor, because of silty sediments, lack of in-stream structures, removal of meanders and riparian vegetation, and shallow water depths. About 70% of the watershed surface has more than 19% impervious surface, which inhibits infiltration and lessens base flow. During precipitation events, water moves rapidly into the stream via many subsurface storm sewers, and greatly increases flow volume and velocity. This combination of habitat conditions limits the biological communities to those species that can tolerate these hydraulic disturbances, and are adapted to silty sediments.

4.5 Collecting data to support development of a feasibility study (evaluation of remedial and restoration options to protect human health and the environment), if one is found to be necessary, and to advance progress toward delisting of beneficial use impairments.

Data collected through the QHEI and the Sediment Quality Triad (chemistry, toxicity, community structure) were key to understanding how a potential Feasibility Study for the Creeks may be focused toward key factors adversely affecting the Creeks within each segment. For example, as evidenced by the overall poor scores observed during the QHEI, the habitat quality information has applications for advancing progress toward delisting the beneficial use impairments regarding impaired benthic communities. The poor quality of the stream channels, combined with the transient nature of large volumes of stormwater influent, has implications for restoring the aquatic communities. In addition, the information obtained through the comparison between study streams and urban comparison streams regarding the structure of biological communities, chemical concentrations in sediment and pore water, and habitat quality were used to assess distinctive aspects of Duck and Otter Creek that may suggest particular, or combinations of, remediation approaches. Although, the physical constraints of Duck, Otter and the urban comparison streams are sufficient to preclude the establishment of more sensitive aquatic species, in-stream enhancements such as adding woody structures would likely be productive for restoring beneficial use impairments. Stormwater retention might also be advised, in cases where such modifications are acceptable to the landowners on the watershed.

Other remediation approaches may be considered at discrete locations within the Creeks, where data suggests that addressing sediments in areas where there is an apparent correlation between sediment toxicity and chemical concentrations in sediment and/or pore water, which may improve aquatic communities. In this case, data delineating the spatial extent of chemicals of concern is available to assist in supporting the evaluation of potential action.

4.6 Conclusions

The elevated PAH_{34} concentrations in sediment pore waters occurred at the same locations where the growth of the midge *C. dilutus* was inhibited in the sediment toxicity test (Figure 3-37). The data from this study suggest that PAHs in sediment pore water could be contributing to the observed sediment toxicity in lower Otter Creek. The poor benthic community structure in lower Otter Creek is generally consistent with the results of the sediment toxicity test.

PCBs, metals, pyrethroid pesticides, and non-PAH SVOCs can be ruled out as sources of toxicity in the 2010 Data Gap Investigation data set because these classes of contaminants generally are not elevated in sediments (Section 3.5.2 and 3.5.3), or are not bioavailable (Sections 3.5.1 and 3.5.4). Ammonia concentrations were at levels of concern in the pore water of several sediment samples; however, sediments at many of those locations were not toxic to midge larvae so the role of ammonia as a toxic agent, if any, is not known.

The in-stream habitat quality ranged from very poor to poor (Section 3.3.1.), which implies the biological communities in these creeks are likely to include species that are tolerant of poor habitat quality. Tolerant species dominated the biological communities at the majority of the

2010 sample locations (Figure 3-3), which is consistent with the poor habitat quality that was observed.

The section "Segment A" of Otter Creek that is downstream (North) of Millard Avenue differed from the other stream reaches of Otter Creek, the Duck Creek segments, and the urban comparison streams Grassy Creek and Amlosch Ditch. The observed differences in the lowest reach of Otter Creek include: reductions in the survival and growth of midge larvae in the sediment toxicity test (Section 3.4); the presence of elevated PAH concentrations in sediment pore waters (Table 3-20); the frequent observation of sheen and petroleum odor during field sampling (Table 3-1); and the presence of elevated hydrocarbon concentrations in sediment core samples (0-48 inches) relative to surface (0-6 inches) grab samples (Figures 3-34 and 3-36).

The 2010 data do not indicate there are sediment contamination or toxicity issues within Duck Creek or the upper segments of Otter Creek..

4.7 Recommendations

Further evaluate potential remedies for Segment A of Otter Creek in a subsequent phase of the project.

Further evaluate the combined 2007 and 2010 data sets for the remaining stream sections in a subsequent phase of the project.

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Chapter 5
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Chapter 6

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Appendix A

Urban Comparison Stream Selection and Summary

Urban Comparison Stream Selection and Summary
Duck & Otter Creeks Data Gap Investigation (DGI)

The purpose for sampling local urban comparison streams in the Duck and Otter Creeks data gap investigation Great Lakes Legacy Act (GLLA) project was to provide supplemental information relevant to evaluating what the biological communities in Duck and Otter Creeks would be in the absence of inputs from surrounding industrial land use, as well as to provide points of comparison for sediment chemistry and toxicity test results. Standard practice for environmental investigations relies on use of comparative data to determine to the extent possible environmental effects which are outside of the particular impacts being investigated – in this case inputs from historic industrial operations. In this study two urban comparison locations, one on each of two streams in the nearby areas of Duck and Otter Creeks were investigated for this purpose.

There have been significant changes in land use throughout the watersheds of the Maumee River and western Lake Erie during the past two centuries. The historical forested wetland that was called the Great Black Swamp has been drained to facilitate agriculture, and some of the landscape has been urbanized. A habitat assessment was conducted in the Data Gap Investigation (DGI) to evaluate the quality of the channelized streams because information was needed to understand how additional modifications and inputs associated with the surrounding urban land use may have contributed to the impairment of the biological communities of Duck and Otter Creeks. The eventual restoration of beneficial uses and ecological services of Duck and Otter Creeks will be challenging because of the extensive habitat modifications that have occurred within the historic boundaries of the Great Black Swamp. Channelization has shortened the path of water and removed meanders that allowed the energy of high flow events to dissipate. During urbanization, a significant portion of the watersheds have been sealed with pavement, concrete, buildings and other impervious surfaces, which has changed the hydrology. Water that historically would have been stored and released slowly by wetlands is now diverted into storm water drains, ditches and straightened stream channels to be delivered as rapidly as possible to Maumee Bay and Lake Erie. These increased storm water flows scour the modified channels as the hydraulic energy transmitted with the flowing water attempts to recreate meanders. In response to these erosive forces, stream channels have been armored with a variety of recycled concrete, stone and other construction materials, which further alters the remaining habitat. By redirecting surface waters to the streams, historic ground water sources that would have sustained stream flows during periods of lesser precipitation are diminished, relative to historic conditions. The current streams have much more variable water flow regimens than were present historically. Water temperatures are also less stable because surface runoff is warmed by the urban environment, there is lesser cool groundwater input, and much of the riparian corridor that shaded the stream has been removed and direct sunlight can reach the stream channel and warm it. Oxygen is less soluble in warm water than it is in cold water, which limits the fauna to species that are adapted to low concentrations of dissolved oxygen, and also warm, turbid conditions and variable flow conditions.

Removal of contaminated sediments has been a focus of many GLLA projects, and several million cubic yards of material have been dredged from Great Lakes waterways and placed into disposal facilities. Like other GLLA projects, sediment contamination has been observed in Duck and Otter Creeks. Decisions regarding the amount, location and effective methods for sediment management are forthcoming, and this GLLA data gap investigation (DGI) was conducted to inform those decisions. Because of the extensive habitat modifications that have occurred in Duck and Otter Creeks, sediment management alone might not be sufficient to restore the beneficial use impairments (BUIs) in these streams. Restoration of BUIs is becoming a greater priority in the Great Lakes Area of Concern (AOC) program and one component of this DGI is to provide information about what the conditions in Duck and Otter Creek would be in the absence of the levels of sediment contamination that can be associated with historic industrial inputs. If BUIs are to be restored in Duck and Otter Creeks, it will be important to have an understanding of how much progress can reasonably be expected from sediment removal alone. Data from regional streams with similar amounts of channelization, storm water inputs and urbanizations are will be useful for understanding the conditions that could potentially be achieved by sediment management.

The OEPA has developed biological criteria that are used to determine when streams are meeting designated uses. These criteria have been developed for ecoregions and are based on reference streams. The OEPA reference stream information will be important for tracking restoration and making decisions about removal of BUIs and delisting of the Maumee AOC. The data from the urban comparison streams that are proposed here can be used to understand the current conditions in Duck and Otter Creeks with the historic industrial inputs as compared to the conditions that represent the urban, non-industrial setting. The reference stream information can be used to compare to streams that are fully restored and are meeting all designated uses, and, presumably, are providing all beneficial uses and the associated ecological services.

The selection of suitable urban comparison streams was conducted through a three-step process: 1) urban comparison stream characteristics were identified in June 21, 2010 draft document that included the conceptual site model and data quality objectives; 2) Local candidate streams were evaluated using criteria developed from the DQO characteristics in a July 16, 2010 Draft document. From that evaluation, Amlosch Ditch and portions of Grassy Creek were identified as potentially suitable urban comparison streams; and, 3) Several locations of two candidate local urban comparison streams within the same Level IV Ecoregion, (57a Maumee Lake Plain) were inspected on July 29, 2010 by Mike Darr (BP) and Jody Kubitz (Cardno ENTRIX), and representatives of the US Fish and Wildlife Service to provide additional information about specific locations.

Recommendations:

- Grassy Creek just downstream of Elm Street in Perrysburg, Ohio was suitable for use as an urban comparison stream for the upstream reaches of Duck and Otter Creeks and was included in the GLLA data gap investigation. Photographs of Otter Creek near Taylor Road are included for comparison with the Grassy Creek Elm Street location. Further downstream of Elm Street in Perrysburg, Grassy Creek becomes a meandering stream surrounded by low-density residential development, parks and a country club, and is not representative of Duck and Otter Creeks. The Elm Street location of Grassy Creek represents residential components of urban land uses;

- Amlosch Ditch downstream of Dustin Road in Oregon, Ohio was a suitable urban comparison stream location for the middle reaches of Duck and Otter Creeks that are influenced by large storm water outfalls. When combined with the Elm Street location of Grassy Creek, these two locations represent an “urban comparison envelope” for the non-lacustrine reaches of Duck and Otter Creeks. Amlosch Ditch receives urban runoff from two large culverts at Dustin Road, which is similar to the large storm drain that enters Otter Creek at Oakdale Avenue. The Dustin Road location of Amlosch Ditch represents urban comparison conditions for commercial components of urban land uses and was included in the DGI; and

- No suitable urban comparison stream was identified for the lacustrine reaches of Duck and Otter Creeks. Grassy Creek downstream of Colony Road in Rossford, Ohio was the best available urban comparison stream for the downstream lacustrine reaches of Duck and Otter Creeks. However, the channel of Grassy Creek is much wider and more sinuous than the lacustrine reaches of Duck and Otter Creeks, and the landscape is much more forested. In comparison, paved surfaces cover a much larger percentage of the Duck and Otter Creek watersheds than are found on Grassy Creek.

Summary of Step 1 (from the CSM/DQO document).

Because of the complexity of modern landscapes, it is unlikely that a single stream would be a suitable match for all of the desired attributes. To increase the likelihood of representing general urban comparison conditions for Duck and Otter Creeks, this draft plan proposes to use two urban comparison streams. Specific characteristics of the urban comparison streams for this GLLA investigation include:

- Urban comparison streams should be in the same Level III Ecoregion (Omernik 1987), which is the Huron/Erie Lake Plain Ecoregion (57). Ideally, the urban comparison streams would be in Ecoregion 57a, the Maumee Lake Plains Ecoregion, which is described by Woods et al as: "The Maumee Lake Plains ecoregion is poorly-drained and contains clayey lake deposits, water-worked glacial till, and fertile soils. Elm-ash swamp forests and beech forests once were extensive; marshes and bogs occurred along the coast. They have been replaced by productive, drained farmland. Sluggish, low gradient rivers wind through Ecoregion 57a and have high suspended sediment loads of clayey silts that endanger biota."
- Urban comparison streams should have stream channel modifications similar to those in Duck and Otter Creeks such as a combination of low gradient with a large amount of channelization, installation of culverts, If available, QHEI scores may be reviewed as part of the selection process;
- Urban comparison streams should have similar watershed characteristics as Duck and Otter Creeks such as generally low relief, a reduced riparian canopy, filling of portions of the floodplain, numerous rail and street crossings, and storm sewers;
- Urban comparison streams should have similar proportions of urban land uses on the watershed as are present in along Duck and Otter Creeks. Some industrial land use of the urban comparison stream watersheds may be appropriate; however, it is desirable to avoid streams with the same or greater levels of industrial inputs that are being studied in Duck and Otter Creeks. When possible, existing sediment chemistry data from candidate urban comparison streams should be evaluated as part of the selection process. Agricultural land use is uncommon in the Duck and Otter Creek watersheds, and is should be limited in the watersheds of the urban comparison streams.
- By selecting for these characteristics, the biological communities of the urban comparison streams can reasonably be expected to be similar to those in Duck and Otter Creeks.

Summary of Step 2 (document review)

The primary considerations in reviewing candidate urban comparison streams were:

- Flow through the same (57a - Maumee Lake Plains) Ecoregion as Duck and Otter Creeks (see Figure 2);
- Close proximity to Oregon, Ohio was preferred over more distant locations because of less demanding logistics and greater similarity in geology and ecology;
- Channelization, urban, and residential use should exist in urban comparison streams, but sources of industrial contaminants should be minimal; and,
- Streams, or stream segments, with primarily agricultural land use are not preferred.

Existing information about candidate urban comparison streams was obtained from the recent Ohio Environmental Protection Agency (OEPA) document: *Biological and Water Quality Study of the Portage River Basin, Select Lake Erie Tributaries, and Select Maumee River Tributaries, 2006 – 2008.* Additional information was obtained from the OEPA web-based application that allows a search of biological monitoring data: http://wwwapp.epa.ohio.gov/dsw/gis/bio/index.php. Aerial photography from Google Earth (Figure 1) and Bing Maps was also useful for reviewing riparian land use and stream channelization.

In addition to the review of OEPA habitat data and aerial mapping information OEPA was contacted for information on candidate comparison streams. Initially Mills and Pipe Creeks were identified as candidates by OEPA; however, agricultural land use dominates the watersheds of the upstream reaches of Mills and Pipe Creeks. Upon further review, Mills Creek has significant issues from sewage effluent that make it unsuitable as an urban comparison for this GLLA project. Pipe Creek has an urbanized lacustrine stream reach; however, it is over 50 miles away from Duck & Otter Creeks, and located in Ecoregion 57d, Marblehead Drift/Limestone Plain. The Marblehead Drift/Limestone Plain Ecoregion "has areas of thin glacial drift and limestone-dolomite ridges and islands. Streams often flow on carbonate bedrock; their character is different from the clayey channels of Ecoregions 57a and 57c." (Griffith and Omernik 2008). The different geology of Pipe Creek is likely to result in different ecological communities than are typical of the Maumee Lake Plain (57a) Ecoregion. Pipe Creek is also a considerable distance from the study site, which makes it undesirable in terms of travel costs.

Wolf , Henry, Cedar, and Dry Creeks are in the vicinity of Duck and Otter Creeks, but the watersheds of those streams are dominated by agricultural land use, and channelization may less or different in these creeks. Big and Johlin Ditches are nearby, but their watersheds are dominated by agriculture and rural residential land use. Also, Johlin Ditch has a small watershed and is often dry. Big Ditch recently underwent improvement project that involved culvert placement and relocation of a portion of the stream channel. These construction activities and the predominant agricultural land use result in stream conditions that are not suitable for comparison to Duck and Otter Creeks.

Detwiler Ditch was mentioned as a potential candidate stream with a lacustuary reach. However, a review of aerial photographs and the Maumee AOC documents raised some concerns about the suitability of that stream because there are at least 5 impoundments in the lacustuary section that flows through a large golf course. There is very little tree canopy along Detwiler Ditch, which is in contrast to Duck and Otter Creeks. The mouth of Detwiler Ditch appears to be enclosed in a culvert; it is unknown if the stream has normal hydrology, or if there is engineering in place to protect the golf course from flooding during seiches. There are features that suggest that storm water impoundments may have been constructed along Detwiler Ditch. The Maumee RAP mentions three former brownfields in the Manhattan Blvd area, and migration of vinyl chloride from the Libby Plant 57 site to Detwiler Ditch is discussed. In short, there are several concerns regarding habitat similarity, hydrology and historic land uses that precluded Detwiler Ditch from selection as an urban comparison stream in the DGI.

Upon further review, the upstream reaches of Amlosch Ditch have primarily urban (residential and commercial) land use that is similar to Otter Creek. Agricultural land use occurs along the middle reaches of Amlosch Ditch, and it was possible to avoid those areas during urban comparison stream sampling. A summary of the published information for the candidate urban comparison streams that was available during the selection process is presented in the following three tables. OEPA and stakeholders were engaged in the selection process, however, since the DGI urban comparison approach was not one that OEPA typically employed the final selection of urban comparison locations was left to the DGI project consultant.

Table 1. Summary of watershed characteristics for Duck and Otter Creeks and each of the candidate urban comparison streams.

Stream name	Level IV Ecoregion	Lacustrine present?	watershed land uses present			
			agriculture	residential	Urban	industrial
Amlosch Ditch	57a	No	yes	Yes	Yes	No[1]
Big Ditch	57a	No	yes	Yes	No	No
Detwiler Ditch	57a	Yes	No	Yes	Yes	Yes
Duck Creek	57a	Yes	No	Yes	Yes	Yes
Grassy Creek	57a	Yes	No	Yes	Yes	No
Johlin Ditch	57a	No	Yes	Yes	No	No
Mills Creek	57d	Yes	Yes	Yes	Yes	Yes
Otter Creek	57a	Yes	Yes	Yes	Yes	Yes
Pipe Creek	57d	Yes	Yes	Yes	Yes	No
Wolf Creek	57a	No	Yes	Yes	Yes	No
1 Land use in Driftmeyer Ditch, which is downstream of Amlosch Ditch, is industrial, but industrial land use is not present in the upstream reaches of Amlosch Ditch.						

Table 2. Summary of the biological scores available for Duck and Otter Creeks and each of the candidate urban comparison streams.

Stream name	OEPA Station	Drainage Area miles^2	OEPA Scores					
			QHEI	IBI	MIWB	ICI	Taxa	EPT
Amlosch Ditch	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Big Ditch	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Detwiler Ditch	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Duck Creek	York St	0.8	22	12	n/a	n/a	22	1
Duck Creek	Consaul Rd	0.6	30	12	n/a	n/a	23	1
Grassy Creek	Buck Road	8.4	59.5	24	n/a	n/a	33	7
Johlin Ditch	none	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mills Creek	Perkins Ave	41.0	46.5	16, 22	4.33, 5.38	18	n/a	n/a
Otter Creek	Near mouth	7.4	35	33, 35	7.93, 8.15	n/a	32	0
Otter Creek	Millard Rd	6.6	30	28	n/a	n/a	13	1
Otter Creek	Consaul Rd	5.9	25.5	18	n/a	n/a	18	1
Otter Creek	Oakdale Ave	2.8	23	16	n/a	n/a	15	2
Pipe Creek	Columbus Ave	22.8	41.5	22, 24	3.69, 5.47	22	n/a	n/a

Stream name	OEPA Station	Drainage Area miles^2	OEPA Scores					
			QHEI	IBI	MIWB	ICI	Taxa	EPT
Wolf Creek	Stadium Rd	7.8	34.5	34	n/a	n/a	32	1
Wolf Creek	Yondata Rd	7.6	31	40	8.84	n/a	n/a	n/a

Table 3. Summary of available Impairment information for Duck and Otter Creeks and the candidate urban comparison streams.

Stream name	OEPA Station	Impairments		
		Identified	Sources	Causes
Amlosch Ditch	none	n/a	n/a	n/a
Big Ditch	None	n/a	n/a	n/a
Detwiler Ditch	None	n/a	n/a	n/a
Duck Creek	York St	Yes	A, B	1
Duck Creek	Consaul Road	Yes	A, B	1
Grassy Creek	Buck Road	Yes	A, B	1
Johlin Ditch	None	n/a	n/a	n/a
Mills Creek	Perkins Ave	Yes	B, C, D	1, 3, 4, 5
Otter Creek	Near mouth	Yes	A, E, F, G	1, 6
Otter Creek	Millard Rd	Yes	A, E, F, G	1, 6
Otter Creek	Consaul Rd	Yes	A, E, F, G	1, 6, 7
Otter Creek	Oakdale Ave	Yes	A, E, F, G	1, 6, 7, 8
Pipe Creek	Columbus Ave	Yes	B	1, 2
Wolf Creek	Stadium Rd	Yes	A, H	1, 4
Wolf Creek	Yondata Rd	No	n/a	n/a
A Channelization B Urban Runoff/Storm Sewers C Combined Sewer Overflows D Municipal Point Source Discharges E Commercial Districts (Industrial Parks) F. Landfills G. Sediment resuspension H. Onsite Treatment systems (Septic Systems and Similar Decentralized Systems)				
1 Sedimentation/Siltation 2 Other flow regime alterations 3 Phosphorus (total) 4 Organic Enrichment (Sewage) Biological Indicators 5 Nutrient/Eutrophication Biological Indicators 6. Sediment screening values (exceeded) 7 Arsenic 8. Polycyclic aromatic hydrocarbons (PAHs) (Aquatic Ecosystems)				

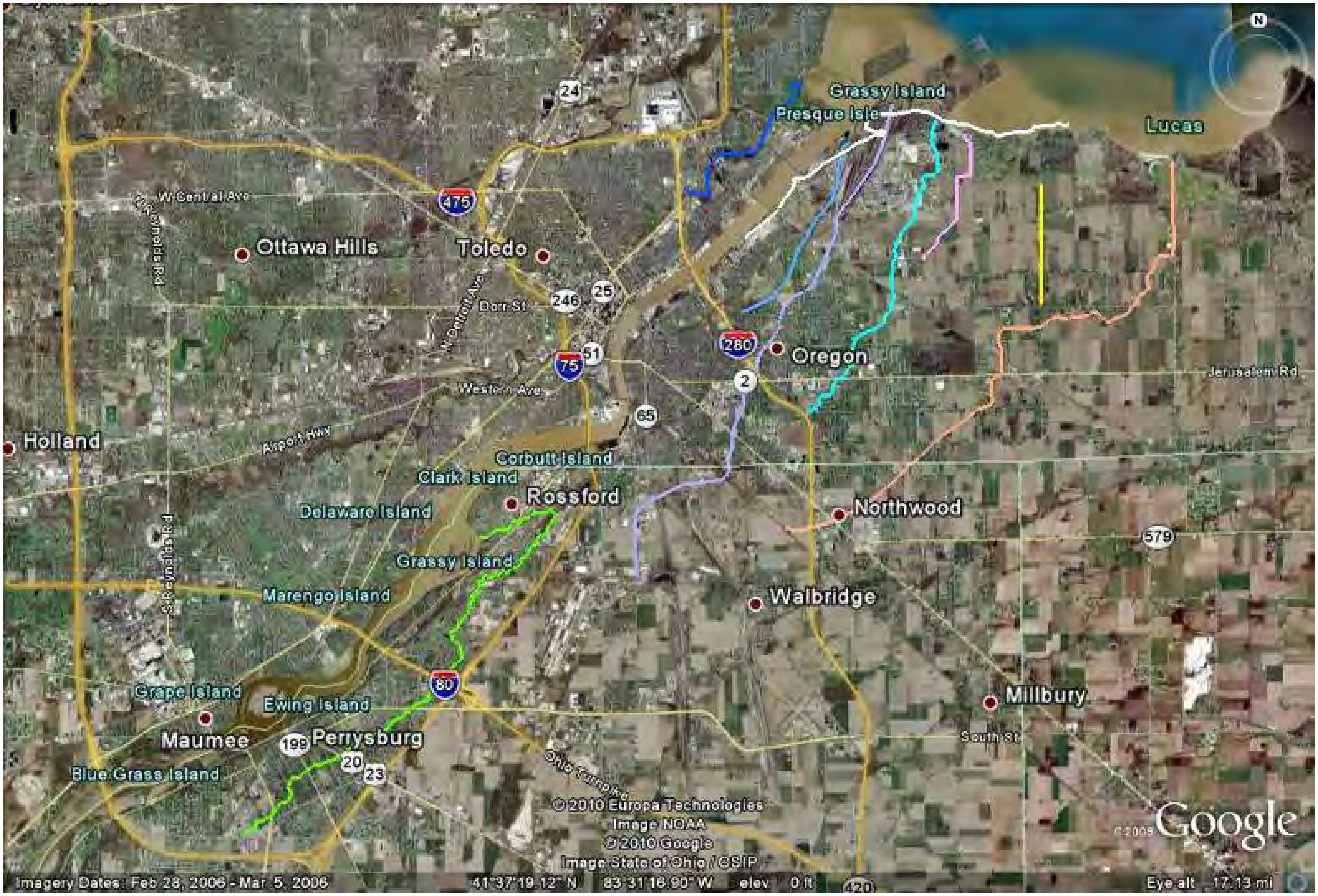

Figure 1. Aerial photograph showing (left to right) Detwiler Ditch in royal blue, Grassy Creek in lime, Duck Creek in blue, Otter Creek in lavender, Amlosch Ditch in teal, Johlin Ditch in pink, Big Creek in yellow and Wolf Creek in orange. Selected locations that are featured in this document are indicated with blue flags. The shoreline in 1900 is shown in white.

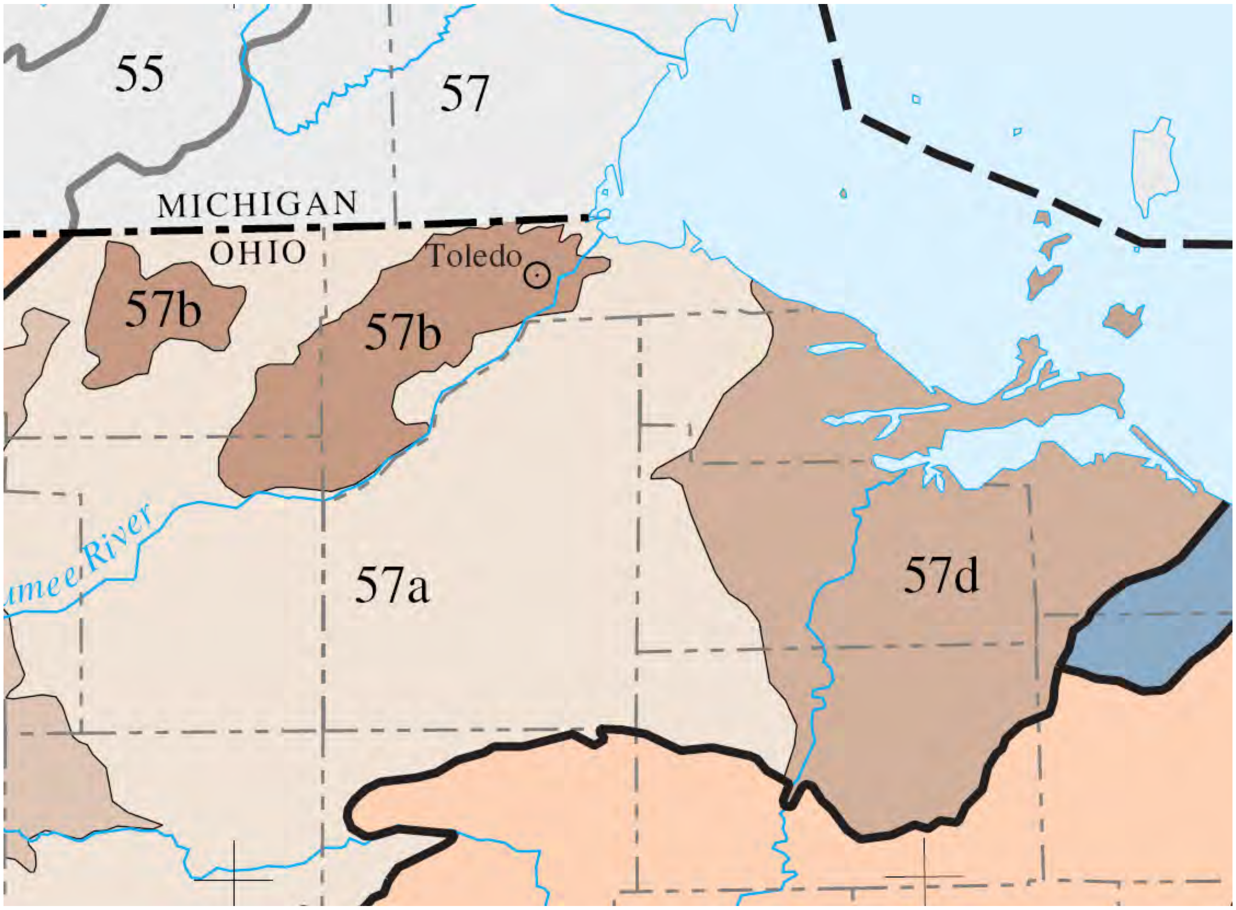

Figure 2. Selected portion of the map of Level IV Ecoregions of Indiana and Ohio.

Very little existing chemistry data for candidate urban comparison streams were available during the selection process. The most comprehensive data set for a candidate urban comparison stream was generated by BP in 2002 for a background investigation of semivolatile organic compounds in sediment samples from Amlosch Ditch. The Amlosch ditch samples determined that polycyclic aromatic hydrocarbons (PAHs) were elevated relative to the upstream location in a sample collected downstream (North) of Dustin Road.

The July 29, 2010 site visit determined that two large storm sewers enter Amlosch Ditch immediately north of Dustin Road, in addition to the culvert beneath Dustin Road (Figure 15). The drainage areas served by these presumed storm sewers are not presently known. Urban runoff has been identified as a source of metals, petroleum constituents (including PAHs), glycols, pesticides, nitrogen, salinity and sediment. Urban runoff also increases stream temperatures and alters flow regimes, which contributes to erosion (Maumee RAP et al. 2006). A pipeline right-of-way also traverses the area between the two sample locations on Amlosch Ditch; however, a review of release information provided by the OEPA did not include any pipeline releases in that vicinity. Downstream of Dustin Road, the sediment PAH concentrations decreased rapidly, but remained at detectable levels through urban and agricultural areas. The available data suggested that the chemical concentrations that were measured in Amlosch Ditch in 2002 may reflect regional urban runoff inputs, which makes the urbanized but non-industrial Dustin Road location suitable for use as an urban comparison for Duck and Otter Creeks.

Summary of Step 3 (July 29, 2010 field observations)

Following step 2, Grassy Creek and the upstream, urbanized section of Amlosch Ditch were identified as the most suitable of the available urban comparison streams for the GLLA project. Mike Darr (BP) and Jody Kubitz (Cardno ENTRIX) along with Kevin Tloczynski and David Henry (U S Fish and Wildlife Service), viewed several locations on Amlosch Ditch and Grassy and Otter Creeks. Photographs of the locations on Grassy Creek and Amlosch Ditch that most closely matched Otter Creek are presented below. Photographs of potential urban comparison stream locations are paired with stream locations from Otter Creek to facilitate comparisons. The sequence of photographs is from upstream to downstream. The recommended urban comparison stream locations (and DGI locations on Duck and Otter Creeks) were sampled using the sediment quality triad approach, which includes sediment chemistry; 10-day sediment toxicity testing with larvae of the freshwater midge *Chironomus dilutus*, evaluation of the benthic community structure; and habitat assessment using the OEPA Qualitative Habitat Evaluation Index (QHEI).

Grassy Creek at Westbrook Drive in Perrysburg, Ohio (Figures 3 & 5) is near commercial areas and has steep banks like many reaches of Duck and Otter Creeks; however, the stream substrate appears to be cobble, which is uncommon in the study streams. Otter Creek near Eastmoreland Drive in Oregon, Ohio is presented in Figures 4 & 6 for comparison. At Eastmoreland Drive, Otter Creek has a gravel substrate with woody debris and leaf packs.

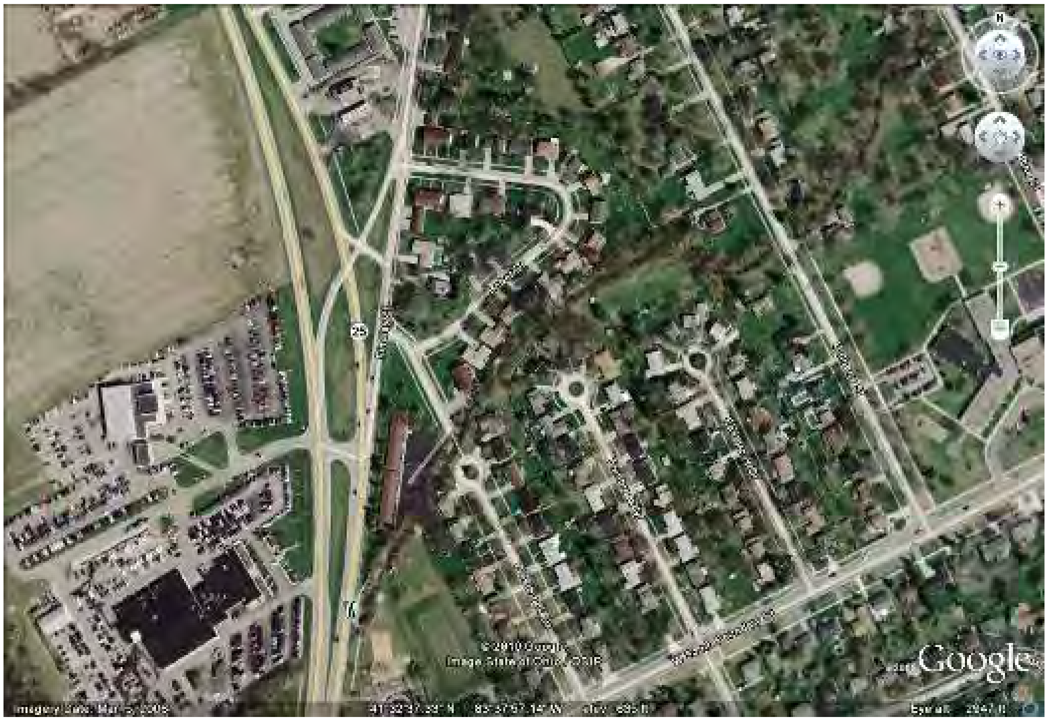

Figure 3. Aerial photograph of Grassy Creek near Westbrook Drive in Perrysburg, Ohio. Flow is from left/bottom to right/top.

Figure 4. Aerial photograph of Otter Creek near Eastmoreland Drive in Oregon, Ohio. Flow is from left/bottom to right/top. DGI sample OC16-17 was collected in this area.

Figure 5. Grassy Creek channel near Westbrook Drive in Perrysburg, Ohio.

Figure 6. Otter Creek channel near Eastmoreland Drive in Oregon, Ohio. DGI sample OC16-17 was collected near this area.

Grassy Creek at Elm Street in Perrysburg, Ohio was 1.5 to 2 m wide, about 10 cm deep and had a flow velocity of approximately 15 cm/sec at the time of the site visit. There is a school and public park on the downstream (NE) side of Elm St that provides access. The substrate is silty, with some large woody debris. The stream channel has been modified, but is not completely straight. The banks are forested, with full canopy and understory vegetation. Upstream land use is residential, with some commercial property. At ground level, this stream point is similar to Otter Creek near Taylor Road in Oregon, Ohio. Both locations have silty-gravelly sediments, somewhat undeveloped floodplains, and mature trees with full canopy.

Figure 7. Aerial view of Grassy Creek at Elm Street in Perrysburg, Ohio. Flow direction is to the right. DGI sample GC-1 was collected in this area.

Figure 8. Aerial view of Otter Creek at Taylor Road in Oregon, Ohio. Flow direction is to the right. Sample OC-12 was collected in this area

Figure 9. Grassy Creek downstream of Elm Street in Perrysburg, Ohio. DGI sample GC-1 was collected in this area.

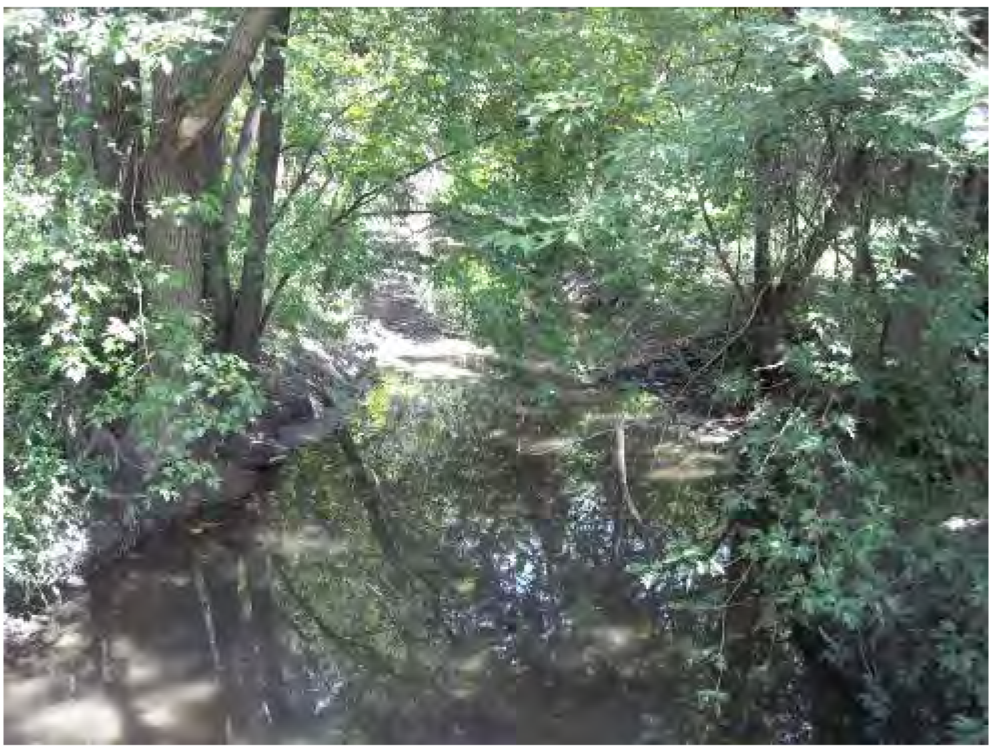

Figure 10. Otter Creek near Taylor Road in Oregon, Ohio. Sample OC-12 was collected near this area.

Amlosch Ditch at Dustin Road is similar to Otter Creek at Oakdale Avenue because of the channelization and influx of a large storm sewer. The riparian vegetation at these two locations is different, with Amlosch having no canopy while Otter Creek is forested at Oakdale Avenue. However, many other sections of Duck and Otter Creeks have no tree canopy, so the mowed riparian vegetation at Dustin Avenue is representative of several reaches of Duck and Otter Creeks.

Figure 11. Aerial view of Amlosch Ditch at Dustin and Coy Roads, and Navarre Avenue. Land use is commercial; flow is from bottom to top of photograph. DGI sample AD-1 was collected in this area.

Figure 12. Aerial view of Otter Creek near Oakdale Avenue. Stream flow is from bottom to top. DGI sample OC-22 was collected in this area.

Figure 13. Amlosch Ditch receives storm water from large underground pipes at Dustin Road on Oregon, Ohio. DGI sample AD-1 was collected near this area.

Figure 14. Otter Creek receives storm water from a large underground pipe at Oakdale Road in Oregon, Ohio. DGI sample OC-22 was collected near this area.

Figure 15, Amlosch Ditch downstream of Dustin Road, flow is toward the background. DGI sample AD-1 was collected in this area.

Figure 16. Amlosch Ditch upstream of Dustin Road and the storm water drains is much smaller relative to the downstream reach.

There is a large storm water drain on Grassy Creek along White Road in Perrysburg, Ohio. However, the low-density residential land use along Grassy Creek is not representative of the Duck and Otter Creek watersheds. Grassy Creek also has a cobble substrate through this reach, which is not representative of Duck and Otter Creeks.

Figure 17. Grassy Creek at storm sewer outfall along White Road in Perrysburg, Ohio. Land use is low-density residential.

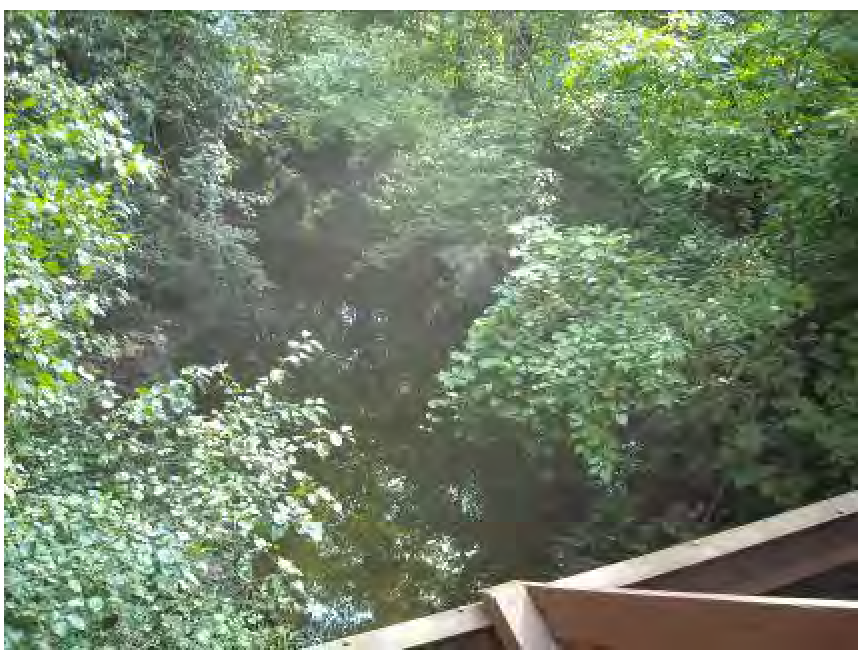

Figure 18. Grassy Creek near White Road in Perrysburg, Ohio also receives storm water from a large culvert.

Grassy Creek downstream of Colony Road in Rossford, Ohio is the only lacustrine stream reach that was identified in Ecoregion 57a. However, it has sinuous, wide channel that does not have the rip-rapped banks that are present in Duck and Otter Creeks. The riparian corridor of Grassy Creek is also much wider than the riparian corridors of either Duck or Otter Creeks. A review of the attached historical topographical maps reveals that the mouth of Duck Creek was wetlands in 1900, and the stream channel has been extended through fill to create the present condition. Historically, the lacustrine portion of Otter Creek flowed west into the Maumee River south of Presque Isle. Otter Creek has been re-routed through a filled area and presently enters Maumee Bay about half a mile north of the original mouth. In summary, the lacustrine reach of Grassy Creek does not have the extensive habitat modification that is representative of Duck and Otter Creeks, which precluded it from being selected as an urban comparison stream location for the DGI.

Figure 19. Aerial photograph of about 0.4 miles of lacustrine portion of Grassy Creek, which is downstream of Colony Road in Rossford, Ohio. Flow is from right to left in the photograph.

Figure 20. Aerial view of about 0.4 miles of the lacustrine section of Otter Creek, which is downstream of the CSX bridge in Toledo, Ohio. Flow is from bottom to top.

Figure 21. View of the lacustrine reach of Grassy Creek from the Colony Road bridge in Rossford, Ohio.

Figure 22. View of the lacustrine reach of Otter Creek.

A few observations regarding invasive species were made during the July 29, 2010 field visit. Honeysuckle shrubs and vines (*Lonicera sp*.) were abundant along the upstream banks of Duck, Otter and Grassy Creeks. No invasive species were observed at the Grassy Creek or Amlosch Ditch locations that were not present in Duck and Otter Creeks.

Potential Urban Comparison Stream Data Uses

The term "urban comparison" as used in this document is intended to describe the general stream channelization and conversion of the watershed to urban land uses. Biological samples and habitat evaluations are intended to be used to inform decision makers about the biological communities that are being supported by channelized urban streams/ditches that have not had industrial activity on their watersheds. OEPA has a distinct definition of "reference" stream that is associated with determining the minimum benchmarks that streams in each ecoregion need to achieve in order to support designated uses. The urban comparison stream information in this DGI is intended for a different purpose.

The urban comparison stream data collection effort for the DGI was limited in scope to only two locations, and, as such, the data are most suitable for use as a line of evidence to be considered together with other appropriate information. The urban comparison stream data are not intended to serve as the sole basis for any sediment management decisions. Specific examples of how the DGI data could potentially be used to inform management decisions for Duck and Otter Creek include:

- If sediments from both of the urban comparison stream locations are uncontaminated, the biological community metrics from urban comparison locations can provide information about the level of biological quality that could potentially be achieved in comparable (upstream, free-flowing) reaches of Duck and Otter Creeks if the contaminated sediments were removed. That information may be important for understanding how sediment management may or may not result in restoration of beneficial use impairments in an urban setting;

- If the sediments of one or both of the urban comparison locations contain sediment contaminants, those concentrations may be representative of general urban conditions;
- Sediments from neither of the urban comparison locations caused lethality or growth inhibition to *C. dilutus* in the laboratory; consequently they provide information about the biologically available (lack thereof) concentrations of contaminants.

Concentration-response relationships may be an interpretive tool for the combination of urban comparison and study data. By example, adverse biological responses such as lethality and loss of diversity tend to increase with increasing exposure to stressors, including contaminants. The data from the urban comparison stream can be used in combination with data that span the range of chemical concentrations in Duck and Otter Creek sediments to investigate concentration-response relationships that can be used to identify thresholds for biological effects. If relationships can be drawn from these DGI data, it may be possible to apply those concentration-response models to older data sets.

Discussion

The “reference envelope” concept is useful for describing streams with a history of channel modification and urban/commercial land uses in the vicinity of Duck and Otter Creeks. The two urban comparison stream locations that were sampled for the DGI represent a range of conditions that are present in urban/commercial landscapes within the Maumee River watershed and former Great Black Swamp. In this complex landscape, there are differences in habitat quality, benthic macroinvertebrate communities and sediment toxicity and sediment contamination among streams. These differences may not be statistically significant at the level of effort conducted during the DGI, but they do inform decision makers that urban stream quality varies within a range of conditions.

- Habitat quality in the urban comparison streams is generally poor, with specific limitations related to: silt-dominated substrates, lack of instream cover, straightened channel morphology, and lack of pool/glide and riffle/run sequences. These observations are consistent with the historic land use changes and the conditions observed in Duck and Otter Creeks (Section 3.3 of the DGI Report). The former Great Black Swamp was drained to facilitate agricultural, urban and industrial development of the landscape more than a century ago, and the stream channels were modified to become ditches to transport storm water into the Maumee River and Bay.
- Benthic macroinvertebrate communities are dominated by taxa that are adapted to silty sediments: chironomids were universally abundant. Amphipods, a sensitive taxon, dominated the invertebrate community of the Amlosch Ditch urban comparison stream location, and oligocheates, a tolerant taxon, dominated the invertebrate community of the Grassy Creek urban comparison stream location as well as many locations in Duck and Otter Creeks (Section 3.2 of the DGI Report). In general the benthic communities of the urban comparison streams were similar to those in the upstream locations of Duck and Otter Creeks.
- Sediments from both of the urban comparison stream locations, and all DGI locations in Duck Creek, did not affect survival or growth of midge larvae in the DGI toxicity test. Midge survival was decreased at one DGI location in Otter Creek; and midge growth was decreased at three DGI locations in Otter Creek. Indigenous organisms, predatory flatworms, were present in several DGI sediment samples, including both urban comparison streams and affected midge survival. However, data from the test chambers that contained these flatworms were not were not included in statistical analyses so that the interpretation of the toxicity test results was focused on contamination and was not influenced by predation (Section 3.4 of the DGI Report).
- Contaminants were present, in some cases at concentrations that exceed bulk sediment benchmarks that are used for first-tier screening assessments of sediment quality. However, the contaminants in the urban comparison stream locations and most locations within Duck and Otter Creeks are bound within the sediment matrix; most sediment contaminants are not available to be

taken up by aquatic species and cause harm (Section 3.5 of the DGI Report). Sediment contaminants in the two urban comparison streams were consistent with inputs from their urban, non-industrial watersheds.

The urban comparison streams from the DGI provide information about the physical, chemical, biological and toxicological conditions within the former Great Black Swamp that have not received industrial discharges. Data from the urban comparison streams informs decision makers about the conditions that can be achieved by managing industrial inputs to Duck and Otter Creeks. Grassy Creek and Amlosch are neither pristine, nor are they grossly impacted by contaminant concentrations associated with urbanization. The silty sediments in these streams limit the biological communities to species that are adapted to fine particles; the silt also contains organic carbon, which is binds contaminants and protects those species by limiting exposure to chemical constituents. The urban comparison streams have generally poor habitat quality, but still support somewhat diverse and even sensitive biological assemblages.

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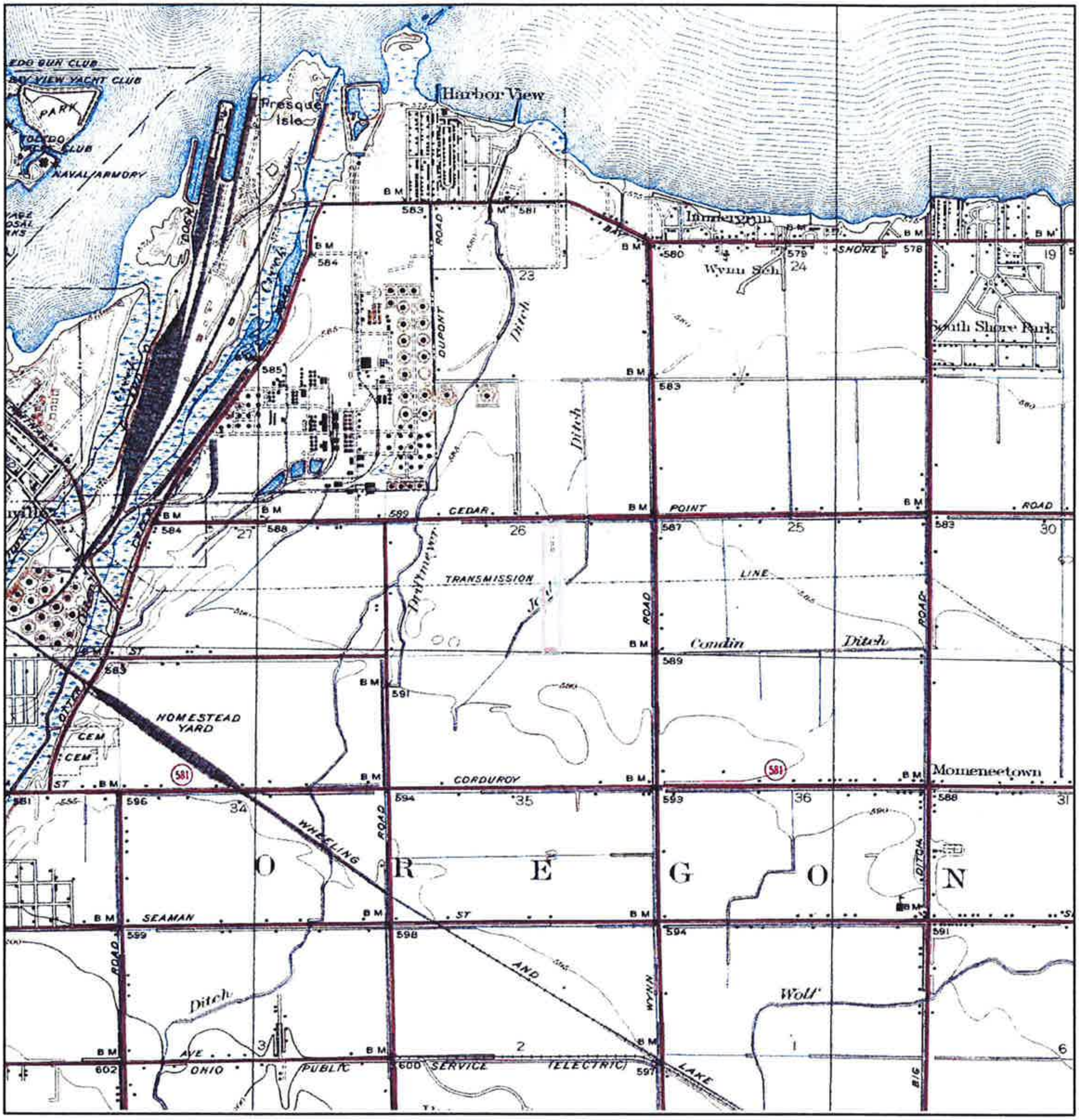
Historical Topographic Map



N ↑	TARGET QUAD NAME: POINT PLACE MAP YEAR: 1938 SERIES: 7.5 SCALE: 1:31680	SITE NAME: [illegible] ADDRESS: [illegible] Oregon, OH 43616 LAT/LONG: 41.6714 / -83.4373	CLIENT: [illegible] CONTACT: [illegible] INQUIRY#: 2804173.4 RESEARCH DATE: 06/28/2010

Historical Topographic Map

N	TARGET QUAD NAME: MAUMEE BAY MAP YEAR: 1900 SERIES: 15 SCALE: 1:62500	SITE NAME: ADDRESS: Oregon, OH 43616 LAT/LONG: 41.6714 / -83.4373	CLIENT: CONTACT: INQUIRY#: 2804173.4 RESEARCH DATE: 06/28/2010

Appendix B

Benthic Macroinvertebrate Community Data

Location	Cross Transect	Collection Date	CLASS	ORDER	FAMILY	SUBFAMILY/TRIBE	GENUS	NUMBER LIVE	NOTES
Amlosch Ditch	1	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	196	range of sizes (1-8 mm)
Amlosch Ditch	1	9/27/2010	Hirudinea					26	
Amlosch Ditch	1	9/27/2010	Turbellaria					50	
Amlosch Ditch	1	9/27/2010	Pelecypoda					29	all small (≤ 5 mm)
Amlosch Ditch	1	9/27/2010	Gastropoda					0	Both tiny
Amlosch Ditch	1	9/27/2010	Insecta	Diptera	Chironomidae			50	Variety of species and sizes; some orange
Amlosch Ditch	1	9/27/2010	Oligochaeta					57	variety of species and sizes
Amlosch Ditch	1	9/27/2010	Insecta	Odonata	Coenagrionidae			7	range of sizes (3-15 mm)
Amlosch Ditch	1	9/27/2010	Insecta	Odonata	Libellulidae		Orthemis	4	tentative - genus necessary to confirm family ID
Amlosch Ditch	3	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	303	variety of sizes
Amlosch Ditch	3	9/27/2010	Oligochaeta					141	variety of species and sizes
Amlosch Ditch	3	9/27/2010	Hirudinea					1	tiny leach
Amlosch Ditch	3	9/27/2010	Insecta	Diptera	Chironomidae			3	
Amlosch Ditch	3	9/27/2010	Gastropoda					0	
Amlosch Ditch	3	9/27/2010	Pelecypoda					14	fingernail clams, all tiny (< 3 mm)
Amlosch Ditch	4	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	237	variety of sizes
Amlosch Ditch	4	9/27/2010	Insecta	Diptera	Chironomidae			12	variety of species and sizes
Amlosch Ditch	4	9/27/2010	Insecta	Odonata	Coenagrionidae			1	
Amlosch Ditch	4	9/27/2010	Pelecypoda					11	all small (≤ 5 mm)
Amlosch Ditch	4	9/27/2010	Turbellaria					3	all small (≤ 5 mm)
Amlosch Ditch	4	9/27/2010	Hirudinea					1	small (~5 mm)
Amlosch Ditch	2	9/27/2010	Insecta	Diptera	Chironomidae			117	Jar 2 of 2; variety of species and sizes, includes 1 pupa
Amlosch Ditch	2	9/27/2010	Insecta	Diptera	Ceratopogonidae			8	Jar 2 of 2
Amlosch Ditch	2	9/27/2010	Oligochaeta					84	Jar 2 of 2; variety of species and sizes
Amlosch Ditch	2	9/27/2010	Turbellaria					17	Jar 2 of 2
Amlosch Ditch	2	9/27/2010	Hirudinea					15	Jar 2 of 2 (all tiny ≤ 6 mm)
Amlosch Ditch	2	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	157	Jar 2 of 2; range of sizes
Amlosch Ditch	2	9/27/2010	Insecta	Odonata	Coenagrionidae			1	Jar 2 of 2
Amlosch Ditch	2	9/27/2010	Insecta	Odonata	Libellulidae			1	Jar 2 of 2
Amlosch Ditch	2	9/27/2010	Gastropoda					0	Jar 2 of 2; all empty shells
Amlosch Ditch	2	9/27/2010	Pelecypoda					43	Jar 2 of 2; mostly intact, all tiny (≤ 6 mm)
Amlosch Ditch	2	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	320	Jar 1 of 2 subsampled (23.1%); range of sizes
Amlosch Ditch	2	9/27/2010	Gastropoda					4	Jar 1 of 2 subsampled (23.1%)
Amlosch Ditch	2	9/27/2010	Insecta	Odonata	Coenagrionidae			13	Jar 1 of 2 subsampled (23.1%)
Amlosch Ditch	2	9/27/2010	Insecta	Odonata	Libellulidae			4	Jar 1 of 2 subsampled (23.1%); large nymph
Amlosch Ditch	2	9/27/2010	Turbellaria					9	Jar 1 of 2 subsampled (23.1%)
Amlosch Ditch	2	9/27/2010	Hirudinea					17	Jar 1 of 2 subsampled (23.1%); all tiny < 6 mm
Amlosch Ditch	2	9/27/2010	Insecta	Diptera	Chironomidae			229	Jar 1 of 2 subsampled (23.1%); variety of species and sizes; includes some orange-red
Amlosch Ditch	2	9/27/2010	Oligochaeta					100	Jar 1 of 2 subsampled (23.1%); variety of species and sizes
Amlosch Ditch	Longitudinal	9/27/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	470	Transect subsampled (20%); range of sizes; many look transparent, damaged

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Amlosch Ditch	Longitudinal	9/27/2010	Hirudinea					165	Transect subsampled (20%); appear to be contained within some type of cocoons; may be more than one species
Amlosch Ditch	Longitudinal	9/27/2010	Insecta	Odonata	Coenagrionidae			5	Transect subsampled (20%); specimen is damaged
Amlosch Ditch	Longitudinal	9/27/2010	Insecta	Odonata	Libellulidae			5	Transect subsampled (20%); specimen broken in half
Amlosch Ditch	Longitudinal	9/27/2010	Pelecypoda					20	Transect subsampled (20%); all tiny, all intact
Amlosch Ditch	Longitudinal	9/27/2010	Insecta	Diptera	Chironomidae			70	Transect subsampled (20%); variety of species and sizes
Amlosch Ditch	Longitudinal	9/27/2010	Oligochaeta					5	Transect subsampled (20%); variety of species and sizes; some are stringy
Amlosch Ditch	Longitudinal	9/27/2010	Insecta	Diptera	Ceratopogonidae			5	Transect subsampled (20%)
DC-3	Longitudinal	9/28/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	308	Transect subsampled (25%); many are transparent (damaged?); range of sizes
DC-3	Longitudinal	9/28/2010	Crustacea	Isopoda	Asellidae			532	Transect subsampled (25%); some are damaged
DC-3	Longitudinal	9/28/2010	Hirudinea					104	Transect subsampled (25%); several species
DC-3	Longitudinal	9/28/2010	Insecta	Diptera	Chironomidae			56	Transect subsampled (25%); variety of species and sizes
DC-3	Longitudinal	9/28/2010	Oligochaeta					164	Transect subsampled (25%); variety of species and sizes; some are stringy
DC-3	Longitudinal	9/28/2010	Turbellaria					4	Transect subsampled (25%)
DC-3	Longitudinal	9/28/2010	Gastropoda					8	Transect subsampled (25%); almost all are empty shells; some broken; several species
DC-3	Longitudinal	9/28/2010	Pelecypoda					28	Transect subsampled (25%); almost all are empty shells; many broken
DC-3	3	9/28/2010	Insecta	Odonata	Libellulidae			1	
DC-3	3	9/28/2010	Insecta	Odonata	Coenagrionidae			2	
DC-3	3	9/28/2010	Insecta	Ephemeroptera	Caenidae		Caenis	1	
DC-3	3	9/28/2010	Insecta	Ephemeroptera	Ephemeridae		Hexagenia	1	
DC-3	3	9/28/2010	Hirudinea					19	all tiny (8 mm or less) except for one ~10 mm
DC-3	3	9/28/2010	Turbellaria					7	
DC-3	3	9/28/2010	Pelecypoda					3	3 intact, 2 empty 1/2 shells
DC-3	3	9/28/2010	Gastropoda					0	almost all empty shells
DC-3	3	9/28/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	32	range of sizes
DC-3	3	9/28/2010	Crustacea	Isopoda	Asellidae			127	range of sizes
DC-3	3	9/28/2010	Insecta	Diptera	Chironomidae			57	variety of species and sizes, some reddish-orange
DC-3	3	9/28/2010	Oligochaeta					482	
DC-3	3	9/28/2010	Insecta	Diptera	Ceratopogonidae			2	
DC-3	1	9/28/2010	Crustacea	Isopoda	Asellidae			27	range of sizes
DC-3	1	9/28/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	38	range of sizes
DC-3	1	9/28/2010	Hirudinea					7	all tiny; 1 looks different from the rest
DC-3	1	9/28/2010	Pelecypoda					0	tiny, empty 1/2 shell
DC-3	1	9/28/2010	Insecta	Diptera	Chironomidae			6	variety of species and sizes

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DC-3	1	9/28/2010	Oligochaeta					32	variety of species and sizes
DC-3	4	9/28/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	50	range of sizes
DC-3	4	9/28/2010	Crustacea	Isopoda	Asellidae			193	range of sizes
DC-3	4	9/28/2010	Insecta	Diptera	Chironomidae			26	variety of species and sizes; some orange-red
DC-3	4	9/28/2010	Oligochaeta					190	variety of species and sizes
DC-3	4	9/28/2010	Turbellaria					9	
DC-3	4	9/28/2010	Hirudinea					8	all tiny (< 7-8 mm)
DC-3	4	9/28/2010	Gastropoda					0	mostly empty shells; variety of species and sizes
DC-3	4	9/28/2010	Pelecypoda					2	mostly empty shells; a few intact
DC-3	2	9/29/2010	Crustacea	Amphipoda	Gammaridae		Gammarus	25	range of sizes
DC-3	2	9/29/2010	Crustacea	Isopoda	Asellidae			19	range of sizes
DC-3	2	9/29/2010	Turbellaria					1	
DC-3	2	9/29/2010	Hirudinea					12	most are tiny, 1 is longer and more slender
DC-3	2	9/29/2010	Insecta	Odonata	Libellulidae			5	
DC-3	2	9/29/2010	Gastropoda					0	30 empty shells and 1 large 20 mm long; several species including 1 freshwater limpet
DC-3	2	9/29/2010	Pelecypoda					29	approximately 1/2 are intact; 1/2 are empty shells; variety of species and sizes
DC-3	2	9/29/2010	Insecta	Diptera	Chironomidae			31	
DC-3	2	9/29/2010	Oligochaeta					45	
DC-5	1	9/28/2010	Insecta	Diptera	Chironomidae			239	Appears to be a variety of species
DC-5	1	9/28/2010	Insecta	Diptera	Ceratopogonidae			13	
DC-5	1	9/28/2010	Oligochaeta					14	Variety of sizes
DC-5	1	9/28/2010	Insecta	Ephemeroptera	Caenidae		Caenis	11	all small (≤ 3mm)
DC-5	1	9/28/2010	Crustacea	Amphipoda	Talitridae			1	Small <3 mm Hyallela azteca
DC-5	1	9/28/2010	Insecta	Trichoptera	Hydroptilidae			1	Small <3 mm Hyallela azteca
DC-5	1	9/28/2010	Insecta	Odonata	Coenagrionidae			2	Small <3 mm Hyallela azteca
DC-5	1	9/28/2010	Insecta	Coleoptera	Haliplidae			1	Larva
DC-5	3	9/28/2010	Insecta	Ephemeroptera	Caenidae		Caenis	110	all small (< 3mm)
DC-5	3	9/28/2010	Insecta	Diptera	Chironomidae			80	looks like a variety of species and sizes
DC-5	3	9/28/2010	Oligochaeta					75	looks like a variety of species and sizes
DC-5	3	9/28/2010	Insecta	Odonata	Coenagrionidae			5	2 larger specimens (~1 cm); 3 small (<3 mm)
DC-5	3	9/28/2010	Insecta	Diptera	Ceratopogonidae			2	
DC-5	3	9/28/2010	Pelecypoda		Sphaeriidae			1	Fingernail clam, ~3 mm
DC-5	3	9/28/2010	Crustacea	Copepoda				6	
DC-5	3	9/28/2010	Insecta	Trichoptera	Hydroptilidae			1	tiny (~1 mm)
DC-5	2	9/28/2010	Insecta	Ephemeroptera	Caenidae		Caenis	86	range of sizes; all tiny
DC-5	2	9/28/2010	Insecta	Ephemeroptera	Baetidae		Cloeon	1	
DC-5	2	9/28/2010	Insecta	Odonata	Coenagrionidae			3	Range of sizes
DC-5	2	9/28/2010	Crustacea	Copepoda				2	
DC-5	2	9/28/2010	Crustacea	Cladocera				1	
DC-5	2	9/28/2010	Pelecypoda					0	empty half-shell
DC-5	2	9/28/2010	Gastropoda					0	almost all empty shells; many broken fragments

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DC-5	2	9/28/2010	Insecta	Diptera	Chironomidae			269	variety of species and sizes; includes 1 pupa
DC-5	2	9/28/2010	Insecta	Diptera	Ceratopogonidae			4	
DC-5	2	9/28/2010	Insecta	Coleoptera	Haliplidae		Haliplus	1	different genus than seen before
DC-5	2	9/28/2010	Oligochaeta					219	variety of species and sizes
DC-5	4	9/28/2010	Insecta	Diptera	Chironomidae			25	variety of species and sizes
DC-5	4	9/28/2010	Insecta	Diptera	Ceratopogonidae			2	
DC-5	4	9/28/2010	Insecta	Odonata	Coenagrionidae			5	range of sizes
DC-5	4	9/28/2010	Crustacea	Amphipoda	Talitridae		Hyallella	1	tiny
DC-5	4	9/28/2010	Gastropoda					1	
DC-5	4	9/28/2010	Oligochaeta					16	variety of species and sizes
DC-5	Longitudinal	9/28/2010	Insecta	Ephemeroptera	Caenidae		Caenis	112	Transect subsampled (25%); range of sizes
DC-5	Longitudinal	9/28/2010	Insecta	Odonata	Coenagrionidae			80	Transect subsampled (25%); range of sizes
DC-5	Longitudinal	9/28/2010	Insecta	Odonata	Libellulidae			4	Transect subsampled (25%); looks like a different genus than seen previously
DC-5	Longitudinal	9/28/2010	Crustacea	Amphipoda	Talitridae		Hyalella	8	Transect subsampled (25%)
DC-5	Longitudinal	9/28/2010	Gastropoda					0	Transect subsampled (25%); 2 species, all empty shells
DC-5	Longitudinal	9/28/2010	Pelecypoda					0	Transect subsampled (25%); empty half-shell
DC-5	Longitudinal	9/28/2010	Insecta	Diptera	Ceratopogonidae			16	Transect subsampled (25%)
DC-5	Longitudinal	9/28/2010	Insecta	Diptera	Chironomidae			276	Transect subsampled (25%)variety of species and sizes; some are bright green
DC-5	Longitudinal	9/28/2010	Oligochaeta					44	Transect subsampled (25%); a few are green
DC-6/7	1	9/29/2010	Insecta	Odonata	Coenagrionidae			28	range of sizes
DC-6/7	1	9/29/2010	Insecta	Odonata	Libellulidae			2	very small nymphs (< 5 mm)
DC-6/7	1	9/29/2010	Insecta	Hemiptera	Corixidae			2	both nymphs
DC-6/7	1	9/29/2010	Insecta	Ephemeroptera	Caenidae		Caenis	85	
DC-6/7	1	9/29/2010	Insecta	Trichoptera	Limnephilidae			4	tiny larvae without cases
DC-6/7	1	9/29/2010	Crustacea	Amphipoda	Talitridae		Hyalella	16	range of sizes
DC-6/7	1	9/29/2010	Gastropoda					2	2 species, both small
DC-6/7	1	9/29/2010	Pelecypoda					0	empty half-shell
DC-6/7	1	9/29/2010	Hirudinea					1	tiny, striped
DC-6/7	1	9/29/2010	Insecta	Diptera	Ceratopogonidae			4	
DC-6/7	1	9/29/2010	Insecta	Diptera	Chironomidae			127	variety of species and sizes
DC-6/7	1	9/29/2010	Oligochaeta					9	
DC-6/7	3	9/29/2010	Insecta	Ephemeroptera	Caenidae		Caenis	11	
DC-6/7	3	9/29/2010	Insecta	Odonata	Coenagrionidae			1	
DC-6/7	3	9/29/2010	Insecta	Hemiptera	Corixidae			2	Both nymphs
DC-6/7	3	9/29/2010	Gastropoda					0	All empty shells; all same species
DC-6/7	3	9/29/2010	Insecta	Diptera	Chironomidae			50	Includes 1 pupa; variety of species and sizes
DC-6/7	3	9/29/2010	Oligochaeta					69	Variety of species and sizes
DC-6/7	2	9/29/2010	Insecta	Hemiptera	Corixidae			5	all nymphs; all tiny
DC-6/7	2	9/29/2010	Insecta	Odonata	Coenagrionidae			2	
DC-6/7	2	9/29/2010	Insecta	Ephemeroptera	Caenidae		Caenis	28	
DC-6/7	2	9/29/2010	Gastropoda					0	all empty shells
DC-6/7	2	9/29/2010	Insecta	Diptera	Chironomidae			69	variety of species and sizes
DC-6/7	2	9/29/2010	Insecta	Diptera	Ceratopogonidae			2	

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DC-6/7	2	9/29/2010	Oligochaeta					109	variety of species and sizes
DC-6/7	Longitudinal	9/29/2010	Insecta	Ephemeroptera	Caenidae		Caenis	20	Transect subsampled (25%); 2 are "dyed" bright green
DC-6/7	Longitudinal	9/29/2010	Insecta	Odonata	Coenagrionidae			4	Transect subsampled (25%)
DC-6/7	Longitudinal	9/29/2010	Insecta	Hemiptera	Corixidae			12	Transect subsampled (25%); all nymphs
DC-6/7	Longitudinal	9/29/2010	Insecta	Ephemeroptera	Baetidae			4	Transect subsampled (25%); tiny nymph, specimen damaged, missing parts
DC-6/7	Longitudinal	9/29/2010	Insecta	Diptera	Ceratopogonidae			20	Transect subsampled (25%); 1 large and 4 small
DC-6/7	Longitudinal	9/29/2010	Insecta	Diptera	Chironomidae			232	Transect subsampled (25%); includes 1 pupa; several larvae "dyed" bright green
DC-6/7	Longitudinal	9/29/2010	Oligochaeta					52	Transect subsampled (25%); some "dyed" bright green
DC-6/7	4	9/29/2010	Insecta	Hemiptera	Corixidae			3	all nymphs
DC-6/7	4	9/29/2010	Insecta	Odonata	Coenagrionidae			4	
DC-6/7	4	9/29/2010	Insecta	Ephemeroptera	Caenidae		Caenis	16	All tiny
DC-6/7	4	9/29/2010	Gastropoda					2	2 species
DC-6/7	4	9/29/2010	Insecta	Diptera	Chironomidae			17	Includes 1 pupa; variety of species and sizes
DC-6/7	4	9/29/2010	Oligochaeta					7	
Grassy Creek	2	9/27/2010	Hirudinea					109	all small (≤ 5 mm)
Grassy Creek	2	9/27/2010	Turbellaria					14	
Grassy Creek	2	9/27/2010	Pelecypoda					6	all small (≤ 5 mm)
Grassy Creek	2	9/27/2010	Gastropoda					1	all small (≤ 5 mm)
Grassy Creek	2	9/27/2010	Insecta	Odonata	Coenagrionidae			4	
Grassy Creek	2	9/27/2010	Insecta	Odonata	Libellulidae		Orthemis	3	1 large, 1 medium, 1 small
Grassy Creek	2	9/27/2010	Oligochaeta					1209	variety of species and sizes
Grassy Creek	2	9/27/2010	Insecta	Diptera	Chironomidae			9	variety of species and sizes
Grassy Creek	3	9/27/2010	Hirudinea					38	all small < 5 mm
Grassy Creek	3	9/27/2010	Turbellaria					6	all small < 5 mm
Grassy Creek	3	9/27/2010	Pelecypoda					5	all small < 5 mm
Grassy Creek	3	9/27/2010	Gastropoda					2	Several species; one large ~ 20 mm, rest are tiny
Grassy Creek	3	9/27/2010	Insecta	Hemiptera	Corixidae			15	both nymphs and adults present
Grassy Creek	3	9/27/2010	Insecta	Odonata	Libellulidae		Orthemis	4	all ~10 mm long - tentative genus
Grassy Creek	3	9/27/2010	Crustacea	Isopoda	Asellidae			1	
Grassy Creek	3	9/27/2010	Insecta	Odonata	Coenagrionidae			3	
Grassy Creek	3	9/27/2010	Oligochaeta					428	variety of sizes and species
Grassy Creek	3	9/27/2010	Insecta	Diptera	Chironomidae			3	Transect subsampled (25%); All tiny
Grassy Creek	4	9/27/2010	Gastropoda					9	Transect subsampled (23.1%); both large 20 and 25 mm
Grassy Creek	4	9/27/2010	Pelecypoda					0	Transect subsampled (23.1%); empty half shell
Grassy Creek	4	9/27/2010	Crustacea	Isopoda	Asellidae			4	Transect subsampled (23.1%)
Grassy Creek	4	9/27/2010	Insecta	Odonata	Libellulidae			4	Transect subsampled (23.1%)
Grassy Creek	4	9/27/2010	Hirudinea					69	Transect subsampled (23.1%); all tiny (< 6 mm)
Grassy Creek	4	9/27/2010	Insecta	Diptera	Chironomidae			4	Transect subsampled (23.1%)

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Grassy Creek	4	9/27/2010	Oligochaeta					216	Transect subsampled (23.1%); many are stringy and sickly looking; variety of species and sizes
Grassy Creek	Longitudinal	9/27/2010	Insecta	Hemiptera	Corixidae			20	Transect subsampled (20%); 3 adults, 1 nymph
Grassy Creek	Longitudinal	9/27/2010	Insecta	Odonata	Coenagrionidae			45	Transect subsampled (20%); range of sizes
Grassy Creek	Longitudinal	9/27/2010	Insecta	Odonata	Libellulidae			10	Transect subsampled (20%)
Grassy Creek	Longitudinal	9/27/2010	Crustacea	Isopoda	Asellidae			10	Transect subsampled (20%)
Grassy Creek	Longitudinal	9/27/2010	Gastropoda					0	Transect subsampled (20%); all empty shells, several species
Grassy Creek	Longitudinal	9/27/2010	Pelecypoda					20	Transect subsampled (20%); 4 intact, rest are empty half shells
Grassy Creek	Longitudinal	9/27/2010	Turbellaria					30	Transect subsampled (20%)
Grassy Creek	Longitudinal	9/27/2010	Hirudinea					390	Transect subsampled (20%); some are purple-grey
Grassy Creek	Longitudinal	9/27/2010	Insecta	Diptera	Chironomidae			50	Transect subsampled (20%); variety of species and sizes
Grassy Creek	Longitudinal	9/27/2010	Oligochaeta					945	Transect subsampled (20%); variety of species and sizes; some are stringy
Grassy Creek	1	9/27/2010	Hirudinea					99	all tiny (≤ 5 mm)
Grassy Creek	1	9/27/2010	Turbellaria					29	
Grassy Creek	1	9/27/2010	Insecta	Hemiptera	Veliidae			2	both nymphs
Grassy Creek	1	9/27/2010	Insecta	Odonata	Coenagrionidae			1	
Grassy Creek	1	9/27/2010	Insecta	Odonata	Libellulidae			5	
Grassy Creek	1	9/27/2010	Gastropoda					5	most intact, some broken, empty shells
Grassy Creek	1	9/27/2010	Pelecypoda					13	some intact but many empty and broken
Grassy Creek	1	9/27/2010	Insecta	Diptera	Chironomidae			18	variety of species and sizes
Grassy Creek	1	9/27/2010	Insecta	Diptera	Ceratopogonidae			18	range of sizes
Grassy Creek	1	9/27/2010	Oligochaeta					2471	variety of species and sizes
Grassy Creek	1	9/27/2010	Crustacea	Copepoda				1	
OC-12/13	4	9/23/2010	Insecta	Diptera	Chironomidae			1	
OC-12/13	4	9/23/2010	Oligochaeta					36	Variety of Species and Sizes
OC-12/13	4	9/23/2010	Crustacea	Isopoda	Asellidae			4	Range of sizes
OC-12/13	4	9/23/2010	Pelecypoda					3	Mostly empty; 1/2 shells but some intact
OC-12/13	4	9/23/2010	Gastropoda					1	Freshwater limpet, intact
OC-12/13	1	9/23/2010	Insecta	Diptera	Chironomidae			10	Variety of Species and Sizes
OC-12/13	1	9/23/2010	Oligochaeta					5	
OC-12/13	1	9/23/2010	Crustacea	Isopoda	Asellidae			4	2 have eggs underneath
OC-12/13	1	9/23/2010	Gastropoda					0	
OC-12/13	1	9/23/2010	Pelecypoda					2	Mostly broken or empty shell halves but some complete
OC-12/13	2	9/23/2010	Insecta	Diptera	Chironomidae			14	Variety of Species and Sizes
OC-12/13	2	9/23/2010	Oligochaeta					83	Variety of Species and Sizes
OC-12/13	2	9/23/2010	Insecta	Odonata	Coenagrionidae			1	
OC-12/13	2	9/23/2010	Crustacea	Isopoda				9	Range of sizes
OC-12/13	2	9/23/2010	Hirudinea		Asellidae			4	Tiny ~3 mm
OC-12/13	2	9/23/2010	Gastropoda					1	Mostly broken shells but includes 1 intact freshwater limpet
OC-12/13	2	9/23/2010	Pelecypoda					6	Mostly broken 1/2 shells but some are intact

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OC-12/13	2	9/23/2010	Insecta	Coleoptera	Haliplidae			1	
OC-12/13	3	9/23/2010	Insecta	Diptera	Chironomidae			6	
OC-12/13	3	9/23/2010	Oligochaeta					42	Variety of Species and Sizes
OC-12/13	3	9/23/2010	Pelecypoda					2	mostly broken empty 1/2 shells but 2 are complete
OC-12/13	3	9/23/2010	Gastropoda					0	some broken shells
OC-12/13	3	9/23/2010	Hirudinea					1	tiny
OC-12/13	Longitudinal	9/23/2010	Insecta	Diptera	Chironomidae			12	Transect subsampled (25%)
OC-12/13	Longitudinal	9/23/2010	Gastropoda					0	Transect subsampled (25%); all empty, broken shells
OC-12/13	Longitudinal	9/23/2010	Pelecypoda					32	Transect subsampled (25%); 8 are intact; rest are empty 1/2 shells
OC-16	1	9/23/2010	Oligochaeta					17	Variety of Species and Sizes
OC-16	1	9/23/2010	Insecta	Diptera	Chironomidae			6	5 larvae, 1 pupa
OC-16	1	9/23/2010	Pelecypoda					5	5 tiny (1-2 mm) ; 1 larger half-shell (8 mm)
OC-16	1	9/23/2010	Gastropoda					0	Tiny (1-2 mm)
OC-16	2	9/23/2010	Insecta	Diptera	Chironomidae			46	Variety of Species and Sizes
OC-16	2	9/23/2010	Oligochaeta					8	Variety of Species and Sizes
OC-16	2	9/23/2010	Turbellaria					1	
OC-16	2	9/23/2010	Hirudinea					1	
OC-16	2	9/23/2010	Crustacea	Isopoda	Asellidae			8	Range of sizes
OC-16	2	9/23/2010	Insecta	Trichoptera	Hydropsychidae			1	
OC-16	2	9/23/2010	Insecta	Odonata	Coenagrionidae			2	~15 mm each
OC-16	2	9/23/2010	Gastropoda					0	Range of sizes; some just broken shells
OC-16	2	9/23/2010	Pelecypoda					1	1 complete, 2 empty half-shells, 1 larger (~8 mm)
OC-16	3	9/23/2010	Insecta	Diptera	Chironomidae			10	Variety of Species and Sizes
OC-16	3	9/23/2010	Oligochaeta					30	Variety of Species and Sizes
OC-16	3	9/23/2010	Gastropoda					0	1 freshwater limpet included (empty shell)
OC-16	3	9/23/2010	Pelecypoda					1	all but 1 are empty half shells 2-10 mm
OC-16	3	9/23/2010	Crustacea	Isopoda	Asellidae			1	Tiny ~1 mm
OC-16	3	9/23/2010	Insecta	Odonata	Libellulidae			1	May or may not be Orthemis
OC-16	3	9/23/2010	Insecta	Diptera					ID very tentative - very odd pupa
OC-16	4	9/23/2010	Insecta	Diptera	Chironomidae			8	several species and sizes
OC-16	4	9/23/2010	Oligochaeta					17	several species and sizes
OC-16	4	9/23/2010	Gastropoda					1	tiny ~2 mm
OC-16	4	9/23/2010	Crustacea	Isopoda	Asellidae			3	
OC-16	Longitudinal	9/23/2010	Crustacea	Isopoda	Asellidae			4	Transect subsampled (25%); tiny
OC-16	Longitudinal	9/23/2010	Insecta	Diptera	Chironomidae			12	Transect subsampled (25%)
OC-16	Longitudinal	9/23/2010	Oligochaeta					32	Transect subsampled (25%); about 1/2 are stringy looking
OC-16	Longitudinal	9/23/2010	Gastropoda					0	Transect subsampled (25%); empty shell
OC-16	Longitudinal	9/23/2010	Pelecypoda					12	Transect subsampled (25%); 3 intact, 2 empty 1/2 shells
OC-22	1	9/21/2010	Insecta	Diptera	Chironomidae			2	
OC-22	1	9/21/2010	Oligochaeta					67	Variety of Species and Sizes
OC-22	1	9/21/2010	Crustacea	Isopoda	Asellidae			4	
OC-22	1	9/21/2010	Gastropoda					3	all small (1-3 mm)
OC-22	2	9/21/2010	Insecta	Diptera	Chironomidae			5	several species and sizes

Location	Cross Transect	Collection Date	CLASS	ORDER	FAMILY	SUBFAMILY/TRIBE	GENUS	NUMBER LIVE	NOTES
OC-22	2	9/21/2010	Oligochaeta					14	mostly in silt tuber
OC-22	2	9/21/2010	Crustacea	Isopoda	Asellidae			5	range of sizes
OC-22	2	9/21/2010	Insecta	Odonata	Coenagrionidae			4	1 large (~12 mm); 3 tiny
OC-22	3	9/21/2010	Insecta	Diptera	Chironomidae			13	Variety of Species and Sizes; including 1 pupa
OC-22	3	9/21/2010	Oligochaeta					140	Variety of Species and Sizes; including 1 pupa
OC-22	3	9/21/2010	Insecta	Diptera	Empididae			1	tiny larva
OC-22	3	9/21/2010	Insecta	Odonata	Coenagrionidae			7	range of sizes
OC-22	3	9/21/2010	Insecta	Ephemeroptera	Caenidae		Caenis	6	range of sizes
OC-22	3	9/21/2010	Crustacea	Isopoda	Asellidae			14	range of sizes
OC-22	3	9/21/2010	Gastropoda					1	many broken empty shells; range of sizes, several species
OC-22	3	9/21/2010	Pelecypoda					5	many broken empty shells; but some complete; range of sizes, some 10 mm
OC-22	4	9/21/2010	Insecta	Diptera	Chironomidae			7	variety of species and sizes
OC-22	4	9/21/2010	Oligochaeta					122	variety of species and sizes
OC-22	4	9/21/2010	Insecta	Odonata	Coenagrionidae			1	
OC-22	4	9/21/2010	Crustacea	Isopoda	Asellidae			3	
OC-22	4	9/21/2010	Gastropoda					0	2 species including 1 freshwater limpet
OC-22	4	9/21/2010	Pelecypoda					1	
OC-22	Longitudinal	9/21/2010	Insecta	Ephemeroptera	Caenidae		Caenis	4	Transect subsampled (25%)
OC-22	Longitudinal	9/21/2010	Insecta	Odonata	Coenagrionidae			12	Transect subsampled (25%)
OC-22	Longitudinal	9/21/2010	Insecta	Hemiptera	Corixidae			4	Transect subsampled (25%); nymph
OC-22	Longitudinal	9/21/2010	Crustacea	Isopoda	Asellidae			20	Transect subsampled (25%)
OC-22	Longitudinal	9/21/2010	Insecta	Diptera	Ceratopogonidae			8	Transect subsampled (25%)
OC-22	Longitudinal	9/21/2010	Insecta	Diptera	Chironomidae			24	Transect subsampled (25%)
OC-22	Longitudinal	9/21/2010	Oligochaeta					215	Transect subsampled (25%); many are stringy
OC-22	Longitudinal	9/21/2010	Hirudinea					8	Transect subsampled (25%); ~10 mm long, slender
OC-22	Longitudinal	9/21/2010	Gastropoda					0	Transect subsampled (25%); several species; all empty shells
OC-22	Longitudinal	9/21/2010	Pelecypoda					4	Transect subsampled (25%); only 1 intact, rest are empty/broken 1/2 shells
OC-24/25	1	9/22/2010	Insecta	Diptera	Ceratopogonidae			82	range of sizes
OC-24/25	1	9/22/2010	Insecta	Diptera	Chironomidae			20	variety of species and sizes
OC-24/25	1	9/22/2010	Oligochaeta					34	variety of species and sizes
OC-24/25	1	9/22/2010	Turbellaria					11	
OC-24/25	1	9/22/2010	Hirudinea					2	2 different species
OC-24/25	1	9/22/2010	Insecta	Odonata	Libellulidae			2	
OC-24/25	1	9/22/2010	Insecta	Odonata	Coenagrionidae			7	range of sizes
OC-24/25	1	9/22/2010	Insecta	Coleoptera	Haliplidae			16	adult (1) rest are larvae
OC-24/25	1	9/22/2010	Insecta	Ephemeroptera	Baetidae		Cloeon	25	range of sizes
OC-24/25	1	9/22/2010	Crustacea	Isopoda	Asellidae			2	
OC-24/25	1	9/22/2010	Insecta	Collembola	Isotomidae			1	Dark stripe down each side
OC-24/25	1	9/22/2010	Crustacea	Copepoda				9	2 have attached egg sacks
OC-24/25	1	9/22/2010	Crustacea	Cladocera				4	
OC-24/25	1	9/22/2010	Gastropoda					45	some empty/broken but most are intact
OC-24/25	1	9/22/2010	Pelecypoda					161	mostly instact, all tiny ($\leq$ 4 mm)

Location	Cross Transect	Collection Date	CLASS	ORDER	FAMILY	SUBFAMILY/TRIBE	GENUS	NUMBER LIVE	NOTES
OC-24/25	3	9/22/2010	Insecta	Diptera	Ceratopogonidae			112	
OC-24/25	3	9/22/2010	Insecta	Diptera	Chironomidae			19	Variety of species and sizes
OC-24/25	3	9/22/2010	Oligochaeta					84	variety of species and sizes
OC-24/25	3	9/22/2010	Turbellaria					7	
OC-24/25	3	9/22/2010	Insecta	Odonata	Coenagrionidae			3	
OC-24/25	3	9/22/2010	Insecta	Odonata	Libellulidae			1	
OC-24/25	3	9/22/2010	Crustacea	Isopoda	Asellidae			4	
OC-24/25	3	9/22/2010	Gastropoda					15	
OC-24/25	3	9/22/2010	Pelecypoda					228	some empty 1/2 shells but most are intact, tiny
OC-24/25	3	9/22/2010	Insecta	Coleoptera	Haliplidae			24	all larvae
OC-24/25	4	9/22/2010	Insecta	Diptera	Ceratopogonidae			38	
OC-24/25	4	9/22/2010	Insecta	Diptera	Chironomidae			5	
OC-24/25	4	9/22/2010	Oligochaeta					47	variety of species and sizes
OC-24/25	4	9/22/2010	Hirudinea					2	
OC-24/25	4	9/22/2010	Turbellaria					11	
OC-24/25	4	9/22/2010	Crustacea	Isopoda	Asellidae			6	range of sizes, 1 large with eggs
OC-24/25	4	9/22/2010	Insecta	Collembola	Isotomidae			1	dark stripe down sides of body
OC-24/25	4	9/22/2010	Insecta	Hemiptera	Corixidae			2	both nymphs
OC-24/25	4	9/22/2010	Insecta	Odonata	Coenagrionidae			1	
OC-24/25	4	9/22/2010	Insecta	Ephemeroptera	Caenidae		Caenis	2	
OC-24/25	4	9/22/2010	Insecta	Ephemeroptera	Baetidae		Cloeon	4	1 large (~8 mm), 3 tiny (~3 mm) ;
OC-24/25	4	9/22/2010	Gastropoda					0	
OC-24/25	4	9/22/2010	Pelecypoda					19	About half are empty 1/2 shells, half are complete
OC-24/25	4	9/22/2010	Insecta	Coleoptera	Haliplidae			8	all larvae
OC-24/25	2	9/22/2010	Insecta	Diptera	Ceratopogonidae			101	range of sizes
OC-24/25	2	9/22/2010	Insecta	Diptera	Culicidae			1	
OC-24/25	2	9/22/2010	Insecta	Diptera	Chironomidae			33	variety of species and sizes
OC-24/25	2	9/22/2010	Oligochaeta					32	variety of species and sizes
OC-24/25	2	9/22/2010	Insecta	Coleoptera	Haliplidae			19	4 adults, rest are larvae
OC-24/25	2	9/22/2010	Insecta	Odonata	Coenagrionidae			3	
OC-24/25	2	9/22/2010	Insecta	Ephemeroptera	Caenidae		Caenis	1	
OC-24/25	2	9/22/2010	Insecta	Ephemeroptera	Baetidae		Cloeon	11	range of sizes
OC-24/25	2	9/22/2010	Crustacea	Isopoda	Asellidae			2	
OC-24/25	2	9/22/2010	Turbellaria					16	
OC-24/25	2	9/22/2010	Hirudinea					1	tiny (~5 mm)
OC-24/25	2	9/22/2010	Crustacea	Cladocera				2	
OC-24/25	2	9/22/2010	Gastropoda					5	2 species
OC-24/25	2	9/22/2010	Pelecypoda					92	All tiny ($\leq$ 5 mm)
OC-24/25	Longitudinal	9/22/2010	Insecta	Coleoptera	Haliplidae		Peltodytes	70	Transect subsampled (20%); 7 adults, 7 larvae
OC-24/25	Longitudinal	9/22/2010	Insecta	Ephemeroptera	Caenidae		Caenis	5	Transect subsampled (20%)
OC-24/25	Longitudinal	9/22/2010	Insecta	Hemiptera	Corixidae			5	Transect subsampled (20%); tiny nymph
OC-24/25	Longitudinal	9/22/2010	Turbellaria					25	Transect subsampled (20%)
OC-24/25	Longitudinal	9/22/2010	Oligochaeta					20	Transect subsampled (20%)
OC-24/25	Longitudinal	9/22/2010	Pelecypoda					395	Transect subsampled (20%); majority are intact
OC-24/25	Longitudinal	9/22/2010	Insecta	Diptera	Ceratopogonidae			10	Transect subsampled (20%)
OC-24/25	Longitudinal	9/22/2010	Insecta	Diptera	Chironomidae			15	Transect subsampled (20%)

Location	Cross Transect	Collection Date	CLASS	ORDER	FAMILY	SUBFAMILY/TRIBE	GENUS	NUMBER LIVE	NOTES
OC-24/25	Longitudinal	9/22/2010	Hirudinea					10	Transect subsampled (20%); tiny
OC-24/25	Longitudinal	9/22/2010	Gastropoda					40	Transect subsampled (20%); mostly intact
OC-4	2	9/30/2010	Pelecypoda					3	3 intact, rest are empty 1/2 shells
OC-4	2	9/30/2010	Gastropoda					41	variety of species and sizes, mostly intact
OC-4	2	9/30/2010	Insecta	Diptera	Chironomidae			37	variety of species and sizes
OC-4	2	9/30/2010	Oligochaeta					328	variety of species and sizes
OC-4	1	9/30/2010	Insecta	Diptera	Chironomidae			22	variety of species and sizes
OC-4	1	9/30/2010	Oligochaeta					103	variety of species and sizes
OC-4	1	9/30/2010	Pelecypoda					2	both tiny (2-3 mm) and intact
OC-4	1	9/30/2010	Gastropoda					28	almost all intact
OC-4	4	9/30/2010	Insecta	Odonata	Coenagrionidae			1	
OC-4	4	9/30/2010	Pelecypoda					10	mostly intact and tiny <5 mm
OC-4	4	9/30/2010	Gastropoda					60	almost all intact and all tiny < 5 mm
OC-4	4	9/30/2010	Insecta	Diptera	Chironomidae			54	variety of species and sizes
OC-4	4	9/30/2010	Oligochaeta					132	variety of species and sizes
OC-4	3	9/30/2010	Pelecypoda					2	both tiny (≤ 5 mm)
OC-4	3	9/30/2010	Gastropoda					11	Mostly small ≤ 5 mm, mostly intact
OC-4	3	9/30/2010	Insecta	Diptera	Chironomidae			32	variety of species and sizes
OC-4	3	9/30/2010	Oligochaeta					235	variety of species and sizes; mostly healthy, a few stringy
OC-4	Longitudinal	9/30/2010	Insecta	Diptera	Chironomidae			75	Transect subsampled (20%); variety of species and sizes
OC-4	Longitudinal	9/30/2010	Oligochaeta					105	Transect subsampled (20%); variety of species and sizes; many are stringy
OC-4	Longitudinal	9/30/2010	Gastropoda					140	Transect subsampled (20%); mostly intact, at least 2 species
OC-4	Longitudinal	9/30/2010	Pelecypoda					50	Transect subsampled (20%); 1 large (~60 mm), 1 medium (~10 mm), rest are tiny(< 5 mm)
OC-5A	1	9/30/2010	Oligochaeta					508	Variety of Species and Sizes
OC-5A	1	9/30/2010	Insecta	Diptera	Chironomidae			77	Variety of Species and Sizes
OC-5A	1	9/30/2010	Gastropoda					20	several species
OC-5A	1	9/30/2010	Pelecypoda					16	all small (< 5mm)
OC-5A	1	9/30/2010	Insecta	Odonata	Coenagrionidae			1	Tiny
OC-5A	1	9/30/2010	Insecta	Trichoptera				0	case without larva
OC-5A	2	9/30/2010	Oligochaeta					546	looks like a variety of species and sizes
OC-5A	2	9/30/2010	Insecta	Diptera	Chironomidae			39	looks like a variety of species and sizes
OC-5A	2	9/30/2010	Gastropoda					19	looks like a variety of species and sizes
OC-5A	2	9/30/2010	Pelecypoda					18	All tiny (≤ 5 mm)
OC-5A	2	9/30/2010	Insecta	Odonata	Coenagrionidae			1	
OC-5A	3	9/30/2010	Oligochaeta					199	variety of species and sizes; look stringy and stressed
OC-5A	3	9/30/2010	Insecta	Diptera	Chironomidae			12	variety of species and sizes
OC-5A	3	9/30/2010	Pelecypoda					4	4 intact, 2 empty half shells
OC-5A	3	9/30/2010	Gastropoda					19	
OC-5A	Longitudinal	9/30/2010	Gastropoda					20	Transect subsampled (20%); 4 intact, 1 empty shell
OC-5A	Longitudinal	9/30/2010	Pelecypoda					5	Transect subsampled (20%); 1 intact, 1 empty 1/2 shell
OC-5A	Longitudinal	9/30/2010	Insecta	Diptera	Chironomidae			15	Transect subsampled (20%)

Location	Cross Transect	Collection Date	CLASS	ORDER	FAMILY	SUBFAMILY/TRIBE	GENUS	NUMBER LIVE	NOTES
OC-5A	Longitudinal	9/30/2010	Oligochaeta					80	Transect subsampled (20%); some look stringy
OC-5A	4	9/30/2010	Oligochaeta					170	variety of species and sizes; some sickly?
OC-5A	4	9/30/2010	Insecta	Diptera	Chironomidae			10	variety of species and sizes
OC-5A	4	9/30/2010	Pelecypoda					1	large, 30 mm long
OC-5A	4	9/30/2010	Gastropoda					4	all small ≤ 6 mm
OC-5A	4	9/30/2010	Insecta	Diptera	Simuliidae?			1	Adult - ID questionable
OC-6/7(2)	Longitudinal	9/29/2010	Crustacea	Decapoda	Cambaridae			5	Transect subsampled (20%); large 34 mm with abdomen curled under
OC-6/7(2)	Longitudinal	9/29/2010	Insecta	Diptera	Chironomidae			10	Transect subsampled (20%)
OC-6/7(2)	Longitudinal	9/29/2010	Oligochaeta					10	Transect subsampled (20%)
OC-6/7(2)	2	9/29/2010	Oligochaeta					9	somewhat stringy looking
OC-6/7(2)	2	9/29/2010	Insecta	Diptera	Chironomidae			1	tiny
OC-6/7(2)	2	9/29/2010	Gastropoda					0	both tiny, empty shells
OC-6/7(2)	3	9/29/2010	Gastropoda					0	empty shell
OC-6/7(2)	3	9/29/2010	Insecta	Diptera	Chironomidae			2	
OC-6/7(2)	3	9/29/2010	Oligochaeta					59	
OC-6/7(2)	1	9/29/2010	Insecta	Diptera	Chironomidae			3	all tiny
OC-6/7(2)	4	9/29/2010	Insecta	Diptera	Chironomidae			2	
OC-6/7(2)	4	9/29/2010	Oligochaeta					33	
OC-6/7(2)	4	9/29/2010	Gastropoda					1	tiny ~2 mm
OC-9/10	Longitudinal	9/27/2010	Hirudinea					16	Transect subsampled (25%)
OC-9/10	Longitudinal	9/27/2010	Crustacea	Isopoda	Asellidae			16	Transect subsampled (25%)
OC-9/10	Longitudinal	9/27/2010	Insecta	Odonata	Coenagrionidae			4	Transect subsampled (25%)
OC-9/10	Longitudinal	9/27/2010	Insecta	Diptera	Chironomidae			44	Transect subsampled (25%); variety of species and sizes
OC-9/10	Longitudinal	9/27/2010	Oligochaeta					60	Transect subsampled (25%); many are stringy looking
OC-9/10	4	9/27/2010	Crustacea	Isopoda	Asellidae			9	
OC-9/10	4	9/27/2010	Insecta	Ephemeroptera	Caenidae		Caenis	1	
OC-9/10	4	9/27/2010	Hirudinea					2	Tiny < 5 mm and one larger, more slender
OC-9/10	4	9/27/2010	Insecta	Diptera	Chironomidae			4	includes 2 pupae and 2 larvae
OC-9/10	4	9/27/2010	Oligochaeta					51	variety of species and sizes
OC-9/10	1	9/27/2010	Insecta	Diptera	Chironomidae			13	variety of species and sizes
OC-9/10	1	9/27/2010	Oligochaeta					5	variety of species and sizes
OC-9/10	1	9/27/2010	Crustacea	Isopoda	Asellidae			1	
OC-9/10	3	9/27/2010	Insecta	Odonata	Coenagrionidae			1	
OC-9/10	3	9/27/2010	Insecta	Trichoptera	Hydropsychidae			1	
OC-9/10	3	9/27/2010	Insecta	Diptera	Chironomidae			10	variety of species and sizes
OC-9/10	3	9/27/2010	Oligochaeta					3	
OC-9/10	3	9/27/2010	Gastropoda					0	both empty shells
OC-9/10	3	9/27/2010	Crustacea	Isopoda	Asellidae			3	ranges of sizes
OC-9/10	3	9/27/2010	Crustacea	Decapoda	Cambaridae			1	~25 mm long with abdomen curled up
OC-9/10	2	9/27/2010	Crustacea	Isopoda	Asellidae			10	Transect subsampled (20%)
OC-9/10	2	9/27/2010	Gastropoda					0	Transect subsampled (20%); empty, broken shell
OC-9/10	2	9/27/2010	Hirudinea					5	Transect subsampled (20%); tiny
OC-9/10	2	9/27/2010	Insecta	Diptera	Chironomidae			10	Transect subsampled (20%)
OC-9/10	2	9/27/2010	Oligochaeta					15	Transect subsampled (20%)

Appendix C

QHEI Data Sheets and Field Photographs

35
33.5

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet — QHEI Score: 37.5 RG

Stream & Location: OC-24-25 Otter Creek RM: ___ Date: 9/28/10

Ryan Grafton and Shawn Roark — Scorers Full Name & Affiliation: Entrix

River Code: __-__-__ STORET #: ______ Lat./Long.: (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

ORIGIN (Check ONE (Or 2 & average)): ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☐ HEAVY [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate RG: ~~1.5~~ 3 — Maximum 20

Comments: Substrate is Silt and Very fine Sand

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1] ___ POOLS > 70cm [2] ___ OXBOWS, BACKWATERS [1]
1 OVERHANGING VEGETATION [1] ___ ROOTWADS [1] ___ AQUATIC MACROPHYTES [1]
___ SHALLOWS (IN SLOW WATER) [1] ___ BOULDERS [1] ___ LOGS OR WOODY DEBRIS [1]
___ ROOTMATS [1]

AMOUNT — Check ONE (Or 2 & average): ☑ EXTENSIVE >75% [11] ☑ MODERATE 25-75% [7] RG ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 13 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH RG (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☑☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☑ NARROW 5-10m [2]	☑☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☑☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☑ NONE [0]	☐☑ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments: 3+3 — 1+0 — 1+0

Riparian RG: ~~8~~ 4 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☑ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☐ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current: 3 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ☑ NO RIFFLE [metric=0]

Check ONE (Or 2 & average).

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 — Maximum 8

6] GRADIENT (5-8 ft/mi) DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4] ☑ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6] ~~4~~ 6 RG

%POOL: ___ %GLIDE: 100 %RUN: ___ %RIFFLE: ___

Gradient: 6 — Maximum 10

06/16/06

EPA 4520

A] SAMPLED REACH

Check ALL that apply

Comment RE: *Reach consistency/* Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD
- [ ] BOAT
- [ ] WADE
- [ ] L. LINE
- [x] OTHER

STAGE (1st -sample pass- 2nd)
- [ ] HIGH [ ]
- [ ] UP [ ]
- [x] NORMAL [ ]
- [ ] LOW [ ]
- [ ] DRY [ ]

DISTANCE
- [ ] 0.5 Km
- [x] 0.2 Km
- [ ] 0.15 Km
- [ ] 0.12 Km
- [ ] OTHER

_______ meters

CLARITY (1st—sample pass— 2nd)
- [x] < 20 cm [ ]
- [ ] 20-<40 cm [ ]
- [ ] 40-70 cm [ ]
- [ ] > 70 cm/ CTB [ ]
- [ ] SECCHI DEPTH [ ]

CANOPY
- [x] > 85%- OPEN
- [ ] 55%-<85%
- [ ] 30%-<55%
- [ ] 10%-<30%
- [ ] <10%- CLOSED

pass 1st _______ cm
2nd _______ cm

B] AESTHETICS
- [ ] NUISANCE ALGAE
- [ ] INVASIVE MACROPHYTES
- [x] EXCESS TURBIDITY
- [ ] DISCOLORATION
- [ ] FOAM / SCUM
- [ ] OIL SHEEN
- [ ] TRASH / LITTER
- [ ] NUISANCE ODOR
- [ ] SLUDGE DEPOSITS
- [x] CSOs/SSOs/OUTFALLS

C] RECREATION
AREA DEPTH
POOL: [ ] >100ft² [ ] >3ft

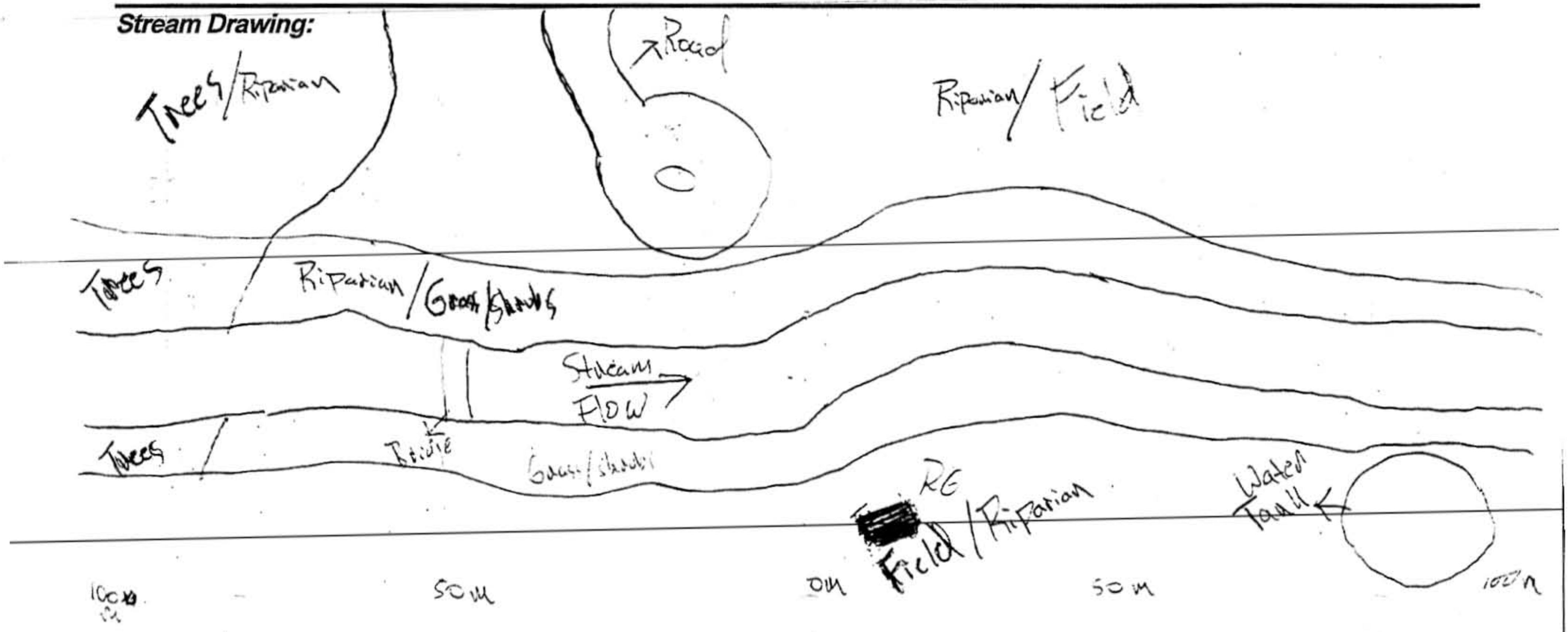
D] MAINTENANCE
PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

Circle some & *COMMENT*

E] ISSUES
WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:



OC-24-25 Photo 1: Otter Creek segment with very narrow riparian width.

OC-24-25 Photo 2: Flood plain consists of new field and rowcrops.

OC-24-25 Photo 3: Otter Creek segment exhibiting little to no bank erosion.


OC-24-25 Photo 4: Otter Creek segment exhibiting little to no stream sinuosity.


OC-24-25 Photo 5: Otter Creek segment exhibiting moderate overhanging vegetation.

33.5
31.5

Ohio EPA — **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet**

QHEI Score: 35.5 RG

Stream & Location: OC-22 Otter Creek RM: ___ Date: 9/28/10

Ryan Grafton and Shawn Roark Scorers Full Name & Affiliation: Entrix

River Code: __-___-___ STORET #: ______ Lat./Long.: (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

ORIGIN (Check ONE (Or 2 & average)): ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate RG: ~~5~~ 2.5 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
_2_ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
_1_ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
_1_ LOGS OR WOODY DEBRIS [1]

AMOUNT (Check ONE (Or 2 & average)): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 7 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☑☑ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0] RG
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments 3 2

Riparian: ~~10~~ 6 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH (Check ONE (ONLY!)): ☐ > 1m [6] ☑ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH (Check ONE (Or 2 & average)): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY (Check ALL that apply): ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☐ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current: 6 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments 5-8 (ft/mi?) (9/12)

Riffle / Run: 0 (Maximum 8)

6] GRADIENT
GRADIENT (~~5.75~~ ft/mi) ☐ VERY LOW - LOW [2-4] ☒ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6] (4) (6)

DRAINAGE AREA (mi²)

%POOL: ( ) %GLIDE: (100) %RUN: ( ) %RIFFLE: ( )

Gradient: 6 (Maximum 10)

EPA 4520 06/16/06

A] SAMPLED REACH

Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions, etc.

- Assessment covered only 125 meters due to private property.

METHOD

☐ BOAT
☐ WADE
☐ L. LINE
☑ OTHER

STAGE

1st -sample pass- 2nd

☐ HIGH ☐
☐ UP ☐
☑ NORMAL ☐
☐ LOW ☐
☐ DRY ☐

DISTANCE

☐ 0.5 Km
☒ 0.2 Km
☐ 0.15 Km
☐ 0.12 Km
☒ OTHER 125 meters

CLARITY

1st –sample pass– 2nd

☑ < 20 cm ☐
☐ 20-<40 cm ☐
☐ 40-70 cm ☐
☐ > 70 cm/ CTB ☐
☐ SECCHI DEPTH ☐

CANOPY

☐ > 85%- OPEN
☑ 55%-<85%
☐ 30%-<55%
☐ 10%-<30%
☐ <10%- CLOSED

pass 1st ______ cm
2nd ______ cm

C] RECREATION

AREA DEPTH
POOL: ☐>100ft² ☐>3ft

B] AESTHETICS

☐ NUISANCE ALGAE
☐ INVASIVE MACROPHYTES
☑ EXCESS TURBIDITY
☐ DISCOLORATION
☐ FOAM / SCUM
☑ OIL SHEEN
☐ TRASH / LITTER
☐ NUISANCE ODOR
☐ SLUDGE DEPOSITS
☑ CSOs/SSOs/OUTFALLS

D] MAINTENANCE

Circle some & COMMENT

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

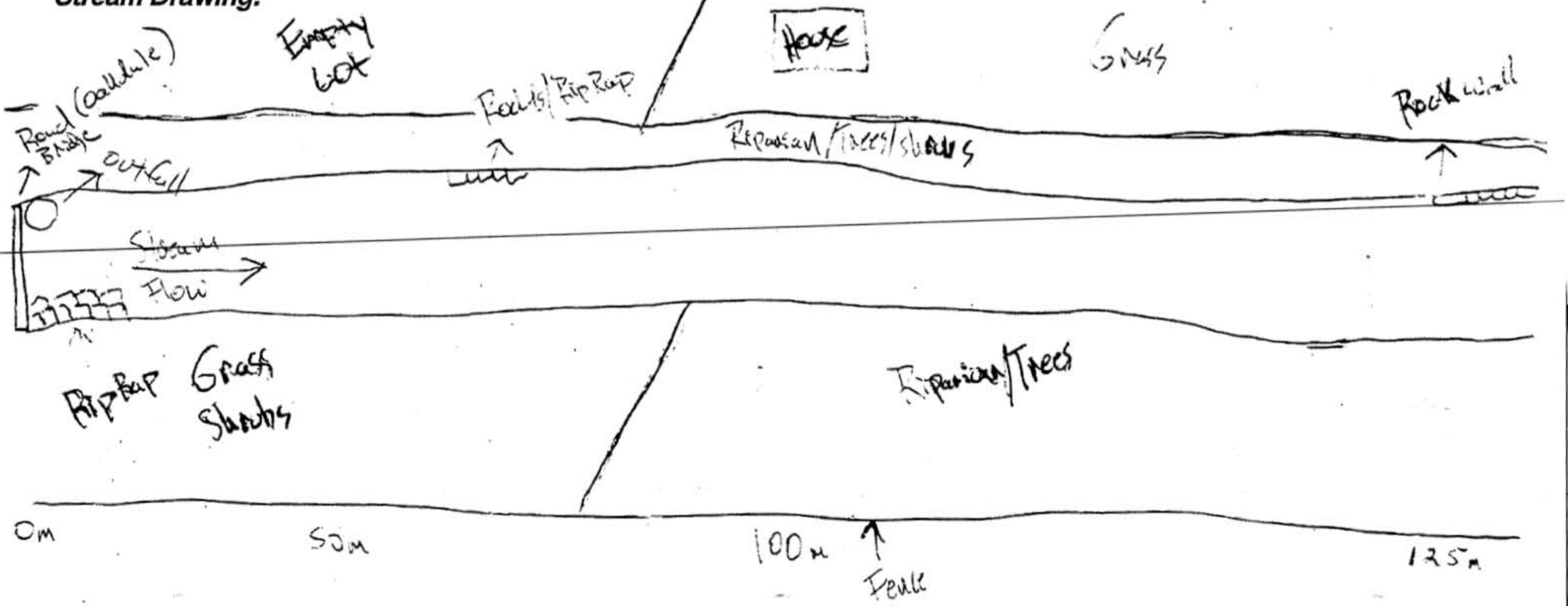
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:




OC-22 Photo 1: Otter Creek segment exhibiting little to no bank erosion and high bank stability.

OC-22 Photo 2: Otter Creek segment exhibiting moderate to very narrow riparian width in a residential flood plain.

OC-22 Photo 3: Large outfall pipe along Otter Creek.


OC-22 Photo 4: Otter Creek segment exhibiting logs and woody debris.

OC-22 Photo 5: Otter Creek segment exhibiting overhanging vegetation and poor water clarity.

OC-22 Photo 6: Outfall pipe along Otter Creek.


OC-22 Photo 7: Rock wall along Otter Creek.


OC-22 Photo 8: Otter Creek segment exhibiting minimal canopy cover.

OC-22 Photo 9: Otter Creek running through road culvert.


OC-22 Photo 10: Otter Creek segment with residential flood plain.

33
31

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet.** **QHEI Score:** 34.5 R6

Stream & Location: OC-16 Otter Creek *RM:* ___ . ___ *Date:* 9/28/10

Ryan Gratton and Shawn Rosell *Scorers Full Name & Affiliation:* Entrix

River Code: __ - ___ - ___ *STORET #:* ______ *Lat./ Long.:* (NAD 83 - decimal °) __ . _____ /8_ . _____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]		✓
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☑ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY
SILT
- ☑ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate: ~~5~~ 2.5 R6 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- 1 BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 6 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 8 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

L R EROSION	L R RIPARIAN WIDTH	L R FLOOD PLAIN QUALITY	L R
☑☑ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

3 + 3 3   3 + 4 3.5

Comments

Riparian: ~~10~~ 6.5 R6 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☑ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☐ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 — Maximum 8

6] GRADIENT (4-5 ft/mi)
DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☑ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

(8) 6

%POOL: ( ) %GLIDE: (100)
%RUN: ( ) %RIFFLE: ( )

Gradient: 6 — Maximum 10

EPA 4520   06/16/06

A] SAMPLED REACH
Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions, etc.

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☑ OTHER

STAGE (1st-sample pass-2nd)
- ☐ HIGH ☐
- ☐ UP ☐
- ☑ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER
- ______ meters

CLARITY (1st-sample pass-2nd)
- ☑ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

1st pass ______ cm
2nd pass ______ cm

CANOPY
- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☑ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☑ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☑ CSOs/SSOs/OUTFALLS

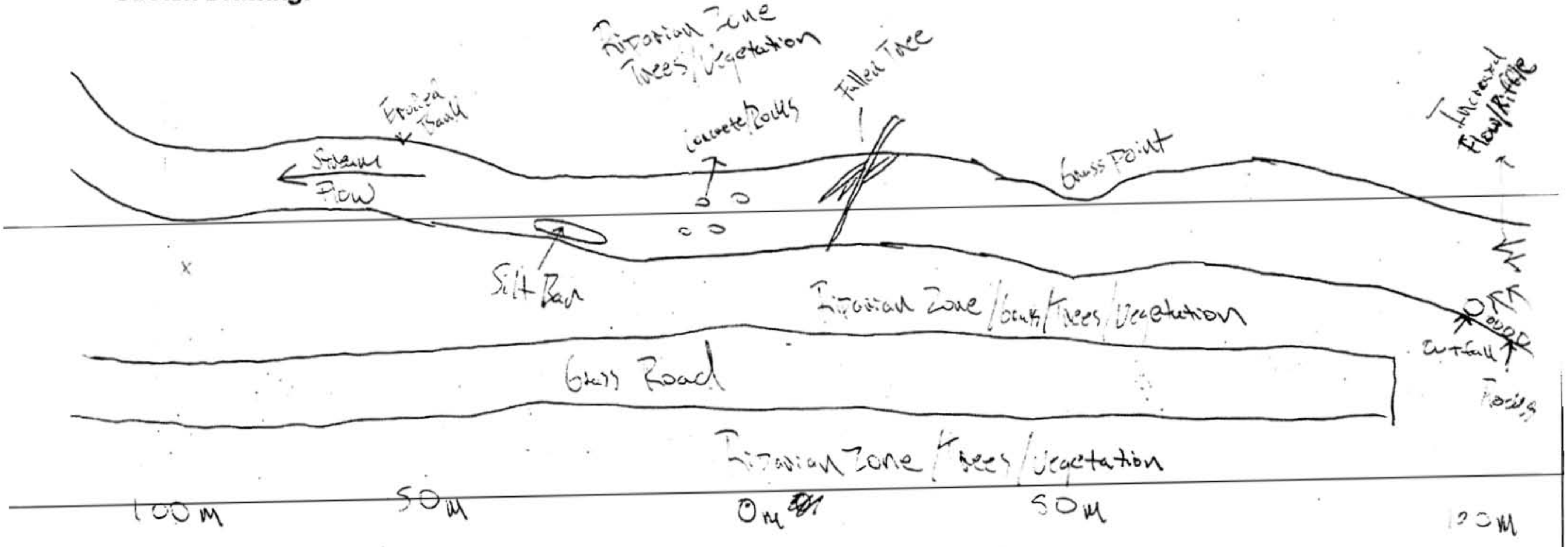
C] RECREATION AREA DEPTH
POOL: ☐>100ft² ☐>3ft

D] MAINTENANCE (Circle some & COMMENT)
PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES
WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:



OC-16 Photo 1: Otter Creek segment exhibiting moderate current velocity.

OC-16 Photo 2: Outfall pipe along Otter Creek.

OC-16 Photo 3: Outfall pipe along Otter Creek.


OC-16 Photo 4: Otter Creek segment exhibiting wide to moderate riparian width.


OC-16 Photo 5: Otter Creek segment exhibiting logs and woody debris.


OC-16 Photo 6: Otter Creek segment exhibiting overhanging vegetation.


OC-16 Photo 7: Otter Creek segment exhibiting wide to moderate riparian width.

OC-16 Photo 8: Otter Creek segment exhibiting High bank stability.


OC-16 Photo 9: Otter Creek segment with concrete debris representing artificial substrate.

OC-16 Photo 10: Otter Creek segment exhibiting silt substrate.


OC-16 Photo 11: Otter Creek segment exhibiting little to no bank erosion.

31 33
33.5
RG

OhioEPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet — **QHEI Score:** ~~37.5~~ 33.5

Stream & Location: OC-12-13 Otter Creek RM: ___ Date: 9/28/10

Ryan Grafton and Shawn Roark Scorers Full Name & Affiliation: Entrix

River Code: __-___-___ STORET #: ______ Lat./Long.: (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]; EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

RG

Substrate: ~~5~~ 2.5 (Maximum 20)

2] INSTREAM COVER

Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
1 OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
1 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 5 (Maximum 20)

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☑ MODERATE [2]
☑ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☑☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☑ MODERATE 10-50m [3]	☐☑ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☑☑ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Comments 3 3.5 1

RG

Riparian: ~~10~~ 7.5 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)	CHANNEL WIDTH Check ONE (Or 2 & average)	CURRENT VELOCITY Check ALL that apply	
~~☑ > 1m [6]~~ RG	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☐ SLOW [1]
☑ 0.7-<1m [4]	☑ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☐ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]		☑ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential — Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current: 6 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 (Maximum 8)

6] GRADIENT (4-5 ft/mi)

DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4] ☒ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

~~8~~ 6

%POOL: ( ) %GLIDE: (100) %RUN: ( ) %RIFFLE: ( )

Gradient: 6 (Maximum 10)

EPA 4520 06/16/06

A] SAMPLED REACH

Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD

- [ ] BOAT
- [ ] WADE
- [ ] L. LINE
- [x] OTHER

STAGE (1st -sample pass- 2nd)

- [ ] HIGH [ ]
- [ ] UP [ ]
- [x] NORMAL [ ]
- [ ] LOW [ ]
- [ ] DRY [ ]

DISTANCE

- [ ] 0.5 Km
- [x] 0.2 Km
- [ ] 0.15 Km
- [ ] 0.12 Km
- [ ] OTHER . ______ meters

CLARITY (1st -sample pass- 2nd)

- [x] < 20 cm [ ]
- [ ] 20-<40 cm [ ]
- [ ] 40-70 cm [ ]
- [ ] > 70 cm/ CTB [ ]
- [ ] SECCHI DEPTH [ ]

CANOPY

- [ ] > 85%- OPEN
- [ ] 55%-<85%
- [ ] 30%-<55%
- [x] 10%-<30%
- [ ] <10%- CLOSED

pass 1st ________ cm

pass 2nd ________ cm

B] AESTHETICS

- [ ] NUISANCE ALGAE
- [ ] INVASIVE MACROPHYTES
- [ ] EXCESS TURBIDITY
- [ ] DISCOLORATION
- [ ] FOAM / SCUM
- [ ] OIL SHEEN
- [ ] TRASH / LITTER
- [ ] NUISANCE ODOR
- [ ] SLUDGE DEPOSITS
- [ ] CSOs/SSOs/OUTFALLS

C] RECREATION

AREA DEPTH

POOL: [ ] >100ft² [ ] >3ft

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

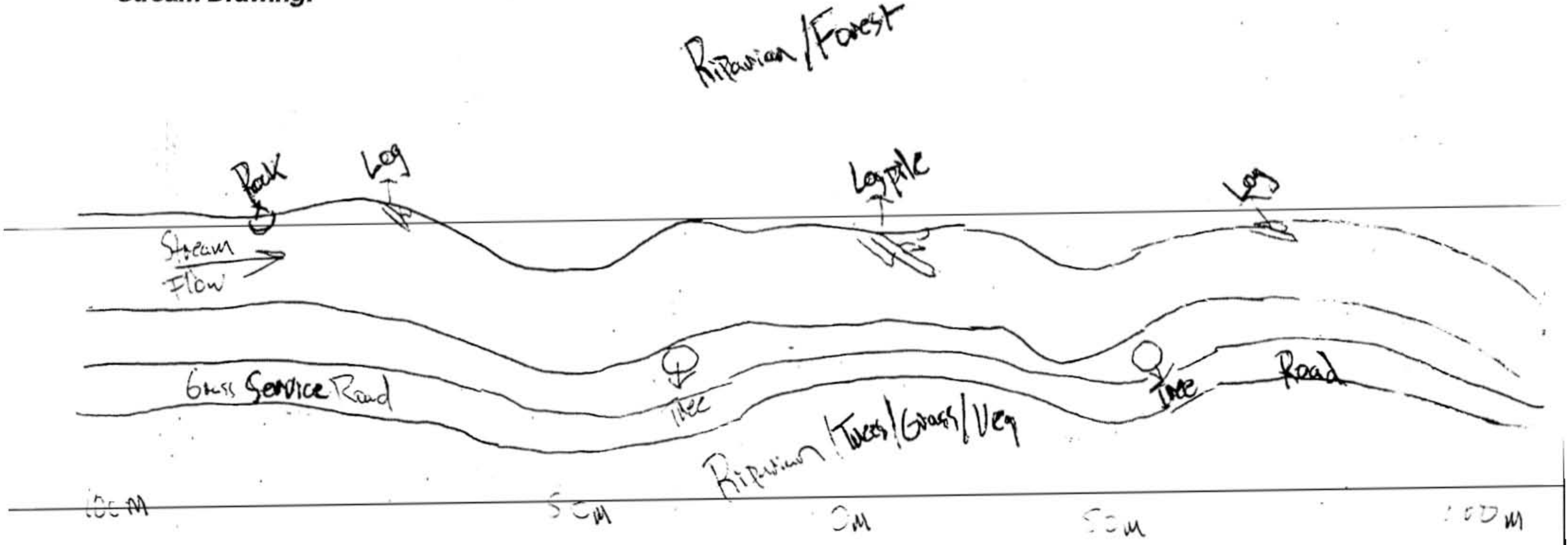
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:



OC-12-13 Photo 1: Outfall pipe of unknown origin along Otter Creek.

OC-12-13 Photo 2: Otter Creek segment exhibiting wide to moderate riparian width within a residential flood plain.

OC-12-13 Photo 3: Otter Creek segment exhibiting little to no erosion.

OC-12-13 Photo 4: Otter Creek segment exhibiting overhanging vegetation and woody debris represent sparse instream cover.

OC-12-13 Photo 5: Otter Creek stream segment exhibiting absence of riffles.

OC-12-13 Photo 6: Otter Creek segment exhibiting moderate current velocity.

OC-12-13 Photo 7: Otter Creek segment exhibiting low channel sinuosity.

42

~~40~~ RG

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet — **QHEI Score:** ~~44.5~~

Stream & Location: OC9-10 Otter Creek RM: ___ Date: 9/27/10

Ryan Grafton and Shawn Roark Scorers Full Name & Affiliation: Entrix

River Code: __-___-___ STORET #: ______ Lat./Long.: (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]	✓	
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		✓
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate RG ~~4~~ 2.5 Maximum 20

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 0 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 0 POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 1 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 0 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 7

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☑ FAIR [3]	☑ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 10

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

L R EROSION	L R RIPARIAN WIDTH	L R FLOOD PLAIN QUALITY	L R
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☑ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
3	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0] 2.5	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments: Upstream of bridge is little to none and downstream is 20-50 m both sides

Riparian Maximum 10: ~~10~~ 5.5 RG

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☑ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☑ FAST [1] ☐ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☑ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current Maximum 12: 6

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☑ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☑ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☑ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☑ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 5

6] GRADIENT (4.5 ft/mi) ☐ VERY LOW - LOW [2-4] ☑ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6] (6)

DRAINAGE AREA (mi²)

%POOL: 10 %GLIDE: 85 %RUN: %RIFFLE: 5

Gradient Maximum 10: 6

EPA 4520 06/16/06

A] SAMPLED REACH

Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD

- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE (1st -sample pass- 2nd)

- ☐ HIGH ☐
- ☐ UP ☐
- ☐ NORMAL ☐
- ☑ LOW ☐
- ☐ DRY ☐

DISTANCE

- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER.

____ meters

CLARITY (1st –sample pass– 2nd)

- ☐ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☑ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

CANOPY

- ☑ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

pass 1st ________ cm

2nd ________ cm

B] AESTHETICS

- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☑ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☑ CSOs/SSOs/OUTFALLS

C] RECREATION

AREA DEPTH

POOL: ☐ >100ft² ☐ >3ft

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

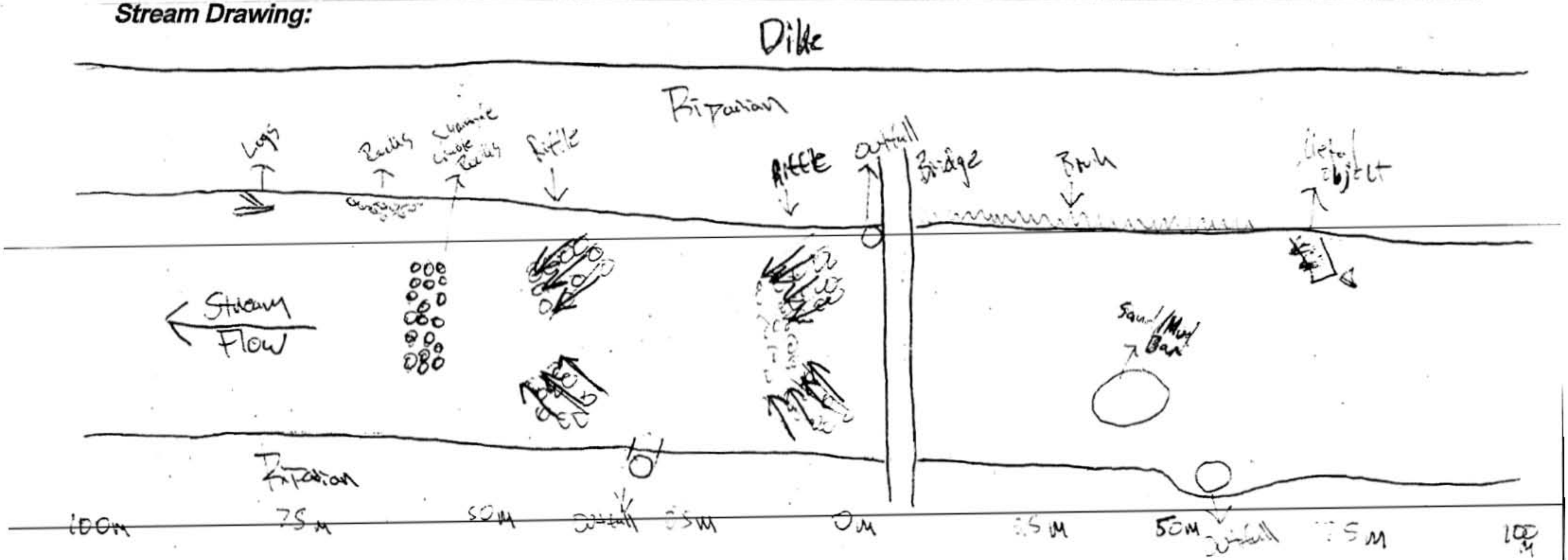
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:



OC-9-10 Photo 1: Otter Creek segment exhibiting minimal canopy cover.

OC-9-10 Photo 2: Otter Creek segment exhibiting sparse instream cover.

OC-9-10 Photo 3: Sample station OC9-10 exhibiting riffle, pool and glide characteristics.

OC-9-10 Photo 4: Otter Creek segment exhibiting little to no bank erosion.

OC-9-10 Photo 5: Boulders along Otter Creek.

OC-9-10 Photo 6: Otter Creek segment exhibiting riffle characteristics.

OC-9-10 Photo 7: Otter Creek segment exhibiting no channel sinuosity and high bank stability.

OC-9-10 Photo 8: Otter Creek segment with industrial flood plain.

OC-9-10 Photo 9: Sample station OC9-10 depicting a silt substrate that is extensively embedded.

33.5
32.5

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** **QHEI Score:** 36.5 (crossed out) RG

Stream & Location: OC6-7(2) Otter Creek **RM:** ___ **Date:** 9/29/10

Ryan Grafton and Shawn Roark **Scorers Full Name & Affiliation:** Entrix

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☑ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☐ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☑ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☑ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☑ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate 3.5 (crossed out) 4.5 RG — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- 3 OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- 1 BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- 2 LOGS OR WOODY DEBRIS [1]

AMOUNT
Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☑ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 12

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 6

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
3	☑☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Comments

Riparian Maximum 10: 8 (crossed out) 4 RG

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH
Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☑ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH
Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY
Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 4

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☒ VERY LOW - LOW [2-4] (3)
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: (100)
%RUN: ( ) %RIFFLE: ( )

Gradient Maximum 10: 3

EPA 4520 06/16/06

A] SAMPLED REACH
Check ALL that apply

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☑ OTHER

STAGE
1st -sample pass- 2nd
- ☐ HIGH ☐
- ☐ UP ☐
- ☑ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER
- ______ meters

CLARITY
1st –sample pass– 2nd
- ☐ < 20 cm ☐
- ☑ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

CANOPY
- ☑ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

1st pass ________ cm
2nd ________ cm

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

Invasive Macrophytes – Phragmites

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☑ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

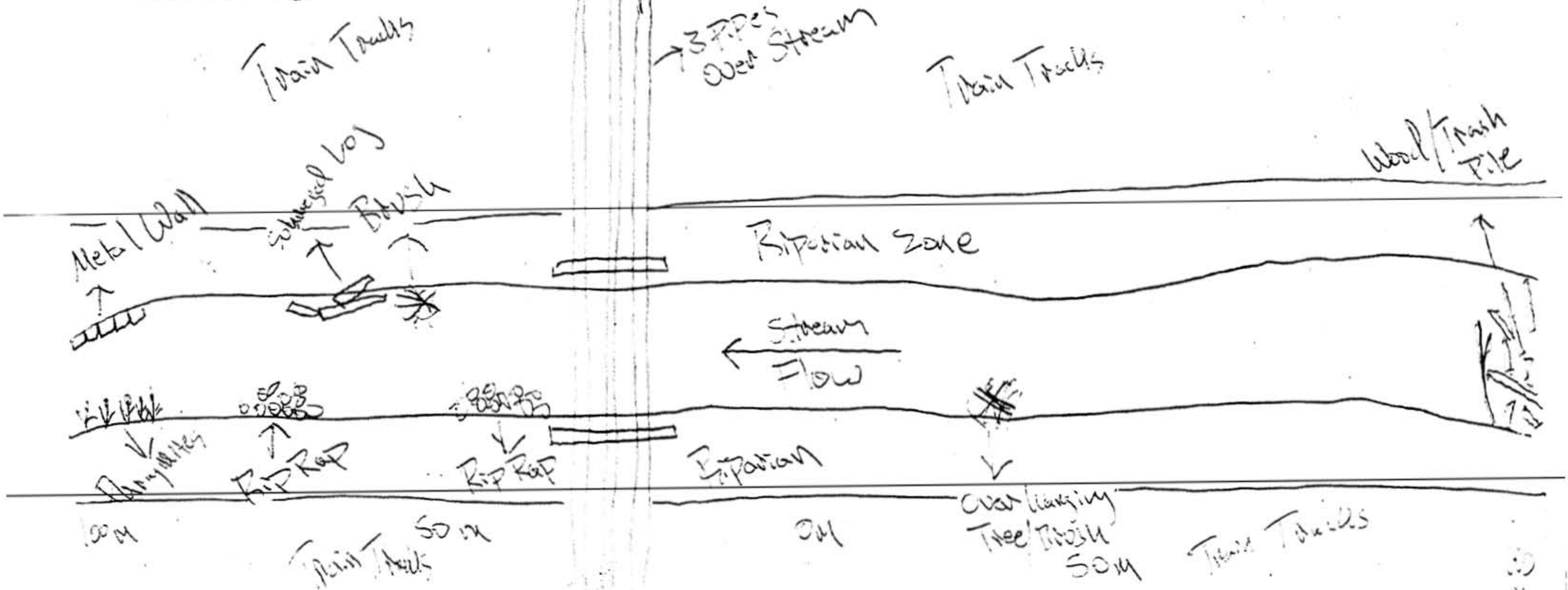
C] RECREATION AREA DEPTH
POOL: ☐ >100ft² ☐ >3ft

D] MAINTENANCE Circle some & *COMMENT*
- PUBLIC / PRIVATE / BOTH / NA
- ACTIVE / HISTORIC / BOTH / NA
- YOUNG-SUCCESSION-OLD
- SPRAY / SNAG / REMOVED
- MODIFIED / DIPPED OUT / NA
- LEVEED / ONE SIDED
- RELOCATED / CUTOFFS
- MOVING-BEDLOAD-STABLE
- ARMOURED / SLUMPS
- ISLANDS / SCOURED
- IMPOUNDED / DESICCATED
- FLOOD CONTROL / DRAINAGE

E] ISSUES
- WWTP / CSO / NPDES / INDUSTRY
- HARDENED / URBAN / DIRT&GRIME
- CONTAMINATED / LANDFILL
- BMPs-CONSTRUCTION-SEDIMENT
- LOGGING / IRRIGATION / COOLING
- BANK / EROSION / SURFACE
- FALSE BANK / MANURE / LAGOON
- WASH H_2O / TILE / H_2O TABLE
- ACID / MINE / QUARRY / FLOW
- NATURAL / WETLAND / STAGNANT
- PARK / GOLF / LAWN / HOME
- ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
- $\bar{x}$ width
- $\bar{x}$ depth
- max. depth
- $\bar{x}$ bankfull width
- bankfull $\bar{x}$ depth
- W/D ratio
- bankfull max. depth
- floodprone x^2 width
- entrench. ratio
- *Legacy Tree:*

Stream Drawing:




OC-6-7 Photo 1: Iron pellets making up a portion of the stream substrate at OC-6-7.


OC-6-7 Photo 2: Otter Creek segment exhibiting water clarity and slow current velocity.


OC-6-7 Photo 3: Otter Creek segment exhibiting little to no bank erosion.

OC-6-7 Photo 4: Otter Creek segment exhibiting woody debris and boulders.


OC-6-7 Photo 5: Otter Creek segment with an industrial flood plain.


OC-6-7 Photo 6: Otter Creek segment exhibiting overhanging vegetation.

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Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 32.5 R6

Stream & Location: OC-4 Otter Creek *RM:* ___ . ___ *Date:* 09/30/10

Shawn Roark *Scorers Full Name & Affiliation:* Entrix

River Code: __ - ___ - ___ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) __ . ____ /8__ . ____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES (POOL RIFFLE)
- ☐☐ BLDR /SLABS [10]
- ☐☐ BOULDER [9]
- ☐☐ COBBLE [8]
- ☐☐ GRAVEL [7]
- ☐☐ SAND [6]
- ☐☐ BEDROCK [5]

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

OTHER TYPES (POOL RIFFLE)
- ☐☐ HARDPAN [4]
- ☐☐ DETRITUS [3]
- ☐☐ MUCK [2]
- ☒☒ SILT [2]
- ☐☐ ARTIFICIAL [0]

(Score natural substrates; ignore sludge from point-sources)

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☑ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☒ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☒ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Comments

Substrate: ~~5~~ 2.5 R6 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 0 UNDERCUT BANKS [1]
- 2 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 0 POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 0 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 1 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☒ MODERATE 25-75% [7]
- ☒ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments 3 2 5

Cover: 10 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☒ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☒ NONE [1]	☒ POOR [1]	☒ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☒☒ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☒☐ VERY NARROW < 5m [1]
- ☐☒ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☐ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]
- ☐☐ CONSERVATION TILLAGE [1]
- ☒☒ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments 3 .5

Riparian: ~~7~~ 3.5 R6 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)
- ☐ > 1m [6]
- ☒ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☒ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☒ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 6 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☒ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 — Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☒ VERY LOW - LOW [2-4] (3)
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: (100)
%RUN: ( ) %RIFFLE: ( )

Gradient: 3 — Maximum 10

EPA 4520 06/16/06

A] SAMPLED REACH
Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD
- ☒ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE (1st -sample pass- 2nd)
- ☐ HIGH ☐
- ☐ UP ☐
- ☐ NORMAL ☐
- ☒ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☒ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

Approx
meters

CLARITY (1st –sample pass– 2nd)
- ☐ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

1st ________ cm
2nd ________ cm

CANOPY
- ☒ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☒ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☒ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

C] RECREATION AREA DEPTH
POOL: ☐ >100ft² ☐ >3ft

D] MAINTENANCE Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:

OC-4 Photo 1: Otter Creek segment exhibiting little to no bank erosion.

OC-4 Photo 2: Otter Creek segment exhibiting poor water clarity.

OC-4 Photo 3: Otter Creek segment exhibiting woody debris and silt substrate.

OC-4 Photo 4: Sample station OC-4, representing stream channelization and low to no sinuosity.


OC-4 Photo 5: Otter Creek segment exhibiting slow current velocity.


OC-4 Photo 6: Otter Creek segment exhibiting little to no canopy cover.

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38.6

Ohio EPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 42.5 RG

Stream & Location: DC-6-7 Duck Creek **RM:** ___ **Date:** 9/29/10

Ryan Grafton and Shawn Roark **Scorers Full Name & Affiliation:** Entrix

River Code: __ - __ - __ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __ . ____ /8_ . ____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☑☐ DETRITUS [3]		
☐☐ COBBLE [8]			☑☐ MUCK [2]		
☐☐ GRAVEL [7]		RG	☑☐ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate Maximum 20: 2.5 4 RG

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
3 OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
1 AQUATIC MACROPHYTES [1]
2 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☑ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 13

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 6

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

L R EROSION	L R RIPARIAN WIDTH	L R FLOOD PLAIN QUALITY	L R
☑☑ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☑ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☐ MODERATE 10-50m [3]	☑☐ SHRUB OR OLD FIELD [2]	☐☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	
3	2	1	

Comments

Riparian Maximum 10: 10 6 RG

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☑ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☑ SLOW [1] ☐ VERY FAST [1] ☐ INTERSTITIAL [-1] ☐ FAST [1] ☐ INTERMITTENT [-2] ☐ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current Maximum 12: 8

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT
(22.5 ft/mi) ☑ VERY LOW - LOW [2-4] (3) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ___ %GLIDE: 100 %RUN: ___ %RIFFLE: ___

Gradient Maximum 10: 3

EPA 4520 06/16/06

A] SAMPLED REACH
Check ALL that apply

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☑ OTHER

STAGE
1st -sample pass- 2nd
- ☐ HIGH ☐
- ☐ UP ☐
- ☑ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_______ meters

CLARITY
1st --sample pass-- 2nd
- ☐ < 20 cm ☐
- ☑ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

CANOPY
- ☑ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

1st pass ________ cm
2nd ________ cm

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

Invasive Macrophytes - Phragmites

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☑ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☑ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

C] RECREATION AREA DEPTH
POOL: ☐ >100ft² ☐ >3ft

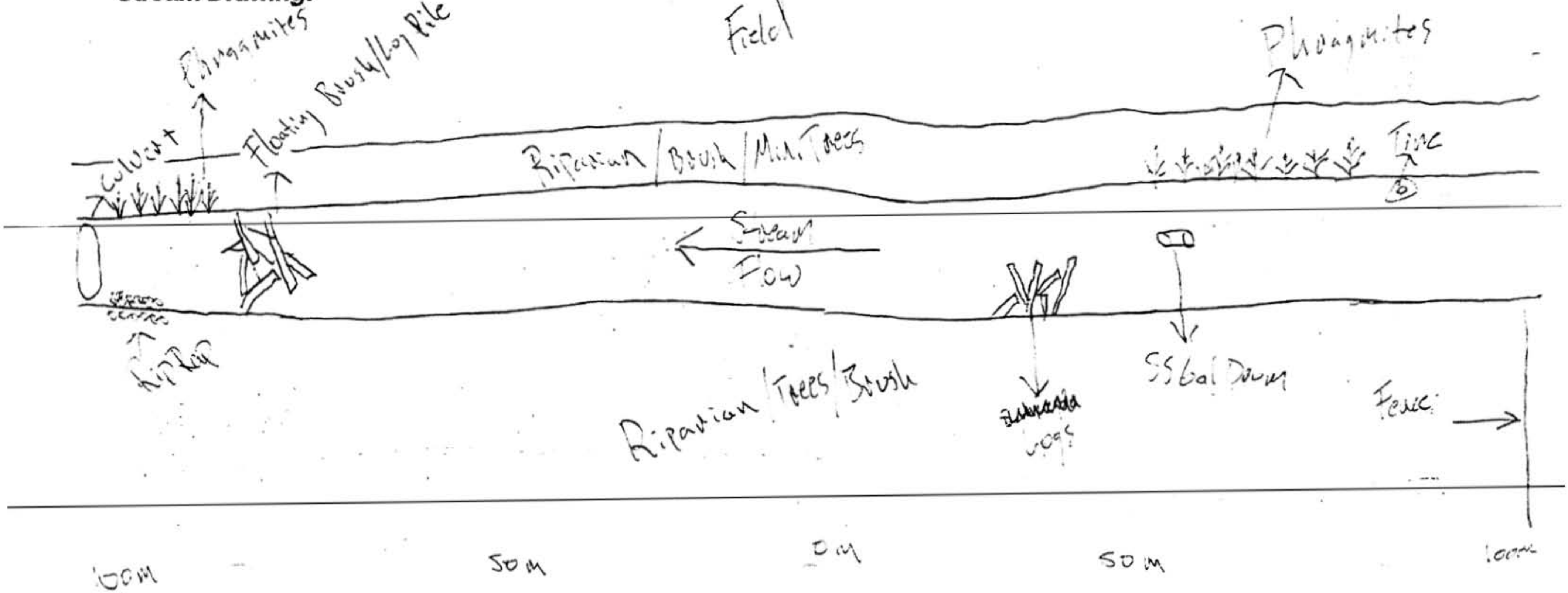
D] MAINTENANCE
PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

Circle some & *COMMENT*

E] ISSUES
WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
- x̄ width
- x̄ depth
- max. depth
- x̄ bankfull width
- bankfull x̄ depth
- W/D ratio
- bankfull max. depth
- floodprone x² width
- entrench. ratio
- *Legacy Tree:*

Stream Drawing:



DC-6-7 Photo 1: Duck Creek segment exhibiting overhanging vegetation

DC-6-7 Photo 2: Duck Creek segment exhibiting logs and woody debris.

DC-6-7 Photo 3: Duck Creek segment exhibiting slow current velocity and water clarity.

DC-6-7 Photo 4: Duck Creek segment with logs representing instream cover and exhibiting slow current velocity.

DC-6-7 Photo 5: Duck Creek segment exhibiting woody debris.

35.5 37.5

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 39.5 RG

Stream & Location: DC-5 Dull Creek **RM:** ___ **Date:** 9/28/10

Ryan Grafton and Shawn Roark **Scorers Full Name & Affiliation:** Entrix

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR/SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☑☐ MUCK [2]	30	
☐☐ GRAVEL [7]			☑☐ SILT [2]	70	
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY (SILT): ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate RG: 5 2.5 (Maximum 20)

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

	UNDERCUT BANKS [1]		POOLS > 70cm [2]		OXBOWS, BACKWATERS [1]
2	OVERHANGING VEGETATION [1]		ROOTWADS [1]	2	AQUATIC MACROPHYTES [1]
1	SHALLOWS (IN SLOW WATER) [1]		BOULDERS [1]	1	LOGS OR WOODY DEBRIS [1]
	ROOTMATS [1]				

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☑ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 13 (Maximum 20)

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☑ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 9 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☑ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
3	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian. RG

Comments 3

Riparian: 10 6 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☑ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☐ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments - Double check depth with affiliated

Pool / Current: 4 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 (Maximum 8)

6] GRADIENT (<2.5 ft/mi) ☒ VERY LOW - LOW [2-4] (3) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: 10 %GLIDE: 90 %RUN: ___ %RIFFLE: ___

Gradient: 3 (Maximum 10)

EPA 4520 06/16/06

A] SAMPLED REACH

Check ALL that apply

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☑ OTHER

STAGE (1st -sample pass- 2nd)
- ☐ HIGH ☐
- ☐ UP ☐
- ☑ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

-Water may have come up a few inches due to rain

-Phragmites -Invasive Macrophytes

DISTANCE
- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_______ meters

CLARITY (1st -sample pass- 2nd)
- ☑ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

CANOPY
- ☑ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

1st (pass) ________ cm

2nd ________ cm

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☑ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

C] RECREATION

AREA DEPTH

POOL: ☐ >100ft² ☐ >3ft

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

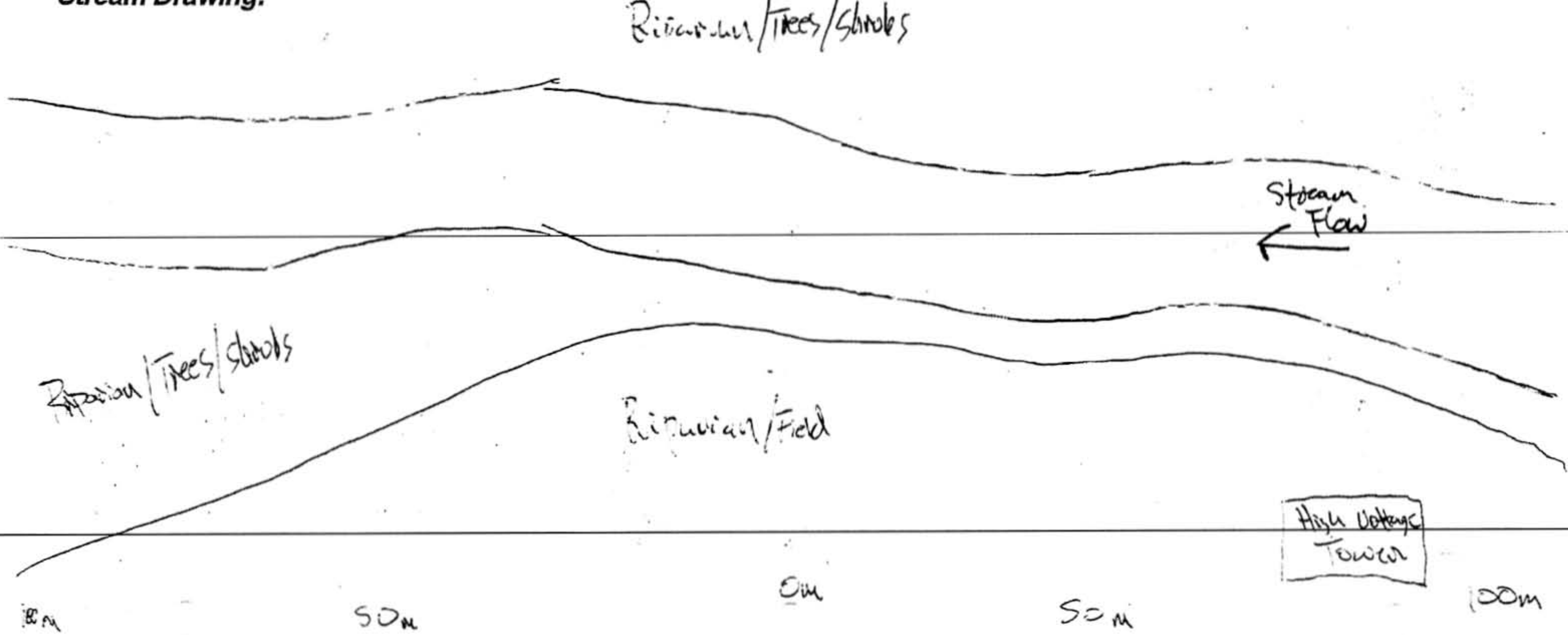
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

- $\bar{x}$ width
- $\bar{x}$ depth
- max. depth
- $\bar{x}$ bankfull width
- bankfull $\bar{x}$ depth
- W/D ratio
- bankfull max. depth
- floodprone x^2 width
- entrench. ratio
- *Legacy Tree:*

Stream Drawing:



DC-5 Photo 1: Duck Creek segment exhibiting overhanging vegetation.

DC-5 Photo 2: Duck Creek segment exhibiting aquatic macrophytes.


DC-5 Photo 3: Duck Creek segment exhibiting high channel stability with little to no erosion.


DC-5 Photo 4: Duck Creek segment located in an industrial flood plain.

DC-5 Photo 5: Duck Creek segment exhibiting low stream sinuosity within this recovering channel.

DC-5 Photo 6: Duck Creek segment exhibiting slow current velocity.

DC-5 Photo 7: Sample station DC5, representing moderate riparian width and relatively good instream cover.

23.5
~~21.5~~

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: ~~26.5~~ RG

Stream & Location: DC 3 Doll Creek *RM:* ___ *Date:* 9/28/10

Ryan Grafton and Shawn Roark *Scorers Full Name & Affiliation:* ENTRIX

River Code: __-__-__ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]	✓	
☐☐ GRAVEL [7]			☑☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☑ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

RG

Substrate ~~5~~ 2.5 Maximum 20

Comments

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
2 AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover 5 Maximum 20

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel 6 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☑ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
3	☑☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	
	2		

Indicate predominant land use(s) past 100m riparian.

RG

Comments

Riparian ~~10~~ 5 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☑ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☐ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 2 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run 0 Maximum 8

6] GRADIENT (<2.5 ft/mi) ☒ VERY LOW - LOW [2-4] (3) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ___ %GLIDE: 100 %RUN: ___ %RIFFLE: ___

Gradient 3 Maximum 10

EPA 4520 08/16/06

A] SAMPLED REACH
Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD
- [ ] BOAT
- [ ] WADE
- [ ] L. LINE
- [x] OTHER

STAGE (1st -sample pass- 2nd)
- [ ] HIGH [ ]
- [ ] UP [ ]
- [ ] NORMAL [ ]
- [x] LOW [ ]
- [ ] DRY [ ]

DISTANCE
- [ ] 0.5 Km
- [x] 0.2 Km
- [ ] 0.15 Km
- [ ] 0.12 Km
- [ ] OTHER ______ meters

CLARITY (1st –sample pass– 2nd)
- [ ] ≤ 20 cm [ ]
- [x] 20-<40 cm [ ]
- [ ] 40-70 cm [ ]
- [ ] > 70 cm/ CTB [ ]
- [ ] SECCHI DEPTH [ ]

1st pass ________ cm
2nd pass ________ cm

CANOPY
- [ ] > 85%- OPEN
- [x] 55%-<85%
- [ ] 30%-<55%
- [ ] 10%-<30%
- [ ] <10%- CLOSED

B] AESTHETICS
- [ ] NUISANCE ALGAE
- [ ] INVASIVE MACROPHYTES
- [ ] EXCESS TURBIDITY
- [ ] DISCOLORATION
- [ ] FOAM / SCUM
- [ ] OIL SHEEN
- [ ] TRASH / LITTER
- [ ] NUISANCE ODOR
- [ ] SLUDGE DEPOSITS
- [x] CSOs/SSOs/OUTFALLS

C] RECREATION AREA DEPTH
POOL: [ ] >100ft² [ ] >3ft

D] MAINTENANCE — Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

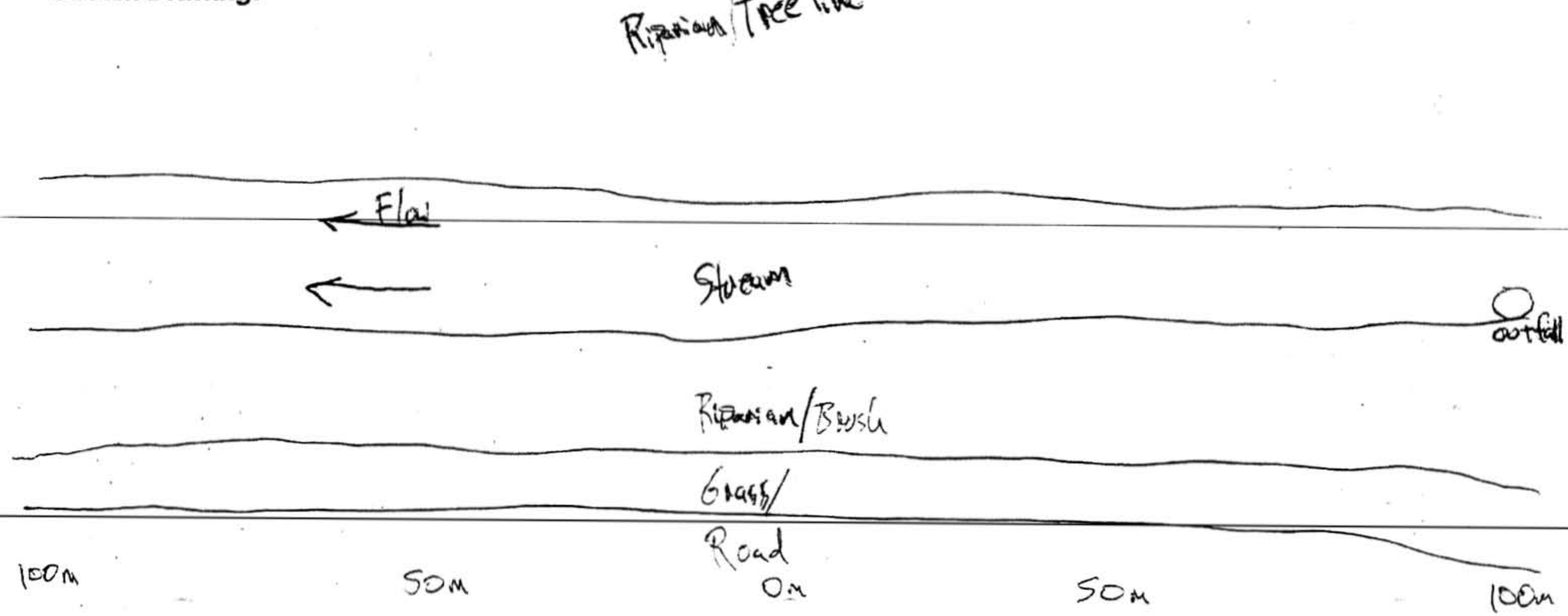
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:



DC-3 Photo 1: Duck Creek segment exhibiting minimal canopy cover and aquatic macrophytes.

DC-3 Photo 2: Road running along Otter Creek stream segment.

DC-3 Photo 3: Stormwater drain along Duck Creek.

DC-3 Photo 4: Stormwater outfall along Duck Creek.

DC-3 Photo 5: Sample station DC3, depicting stable stream bank conditions and straightened stream channel.

23
24

Ohio EPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

R6

QHEI Score: 24.5 R6

Stream & Location: Amolsch Ditch **RM:** ___ **Date:** 9/28/10

Ryan Grafton and Shawn Roark **Scorers Full Name & Affiliation:** Entrix

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☐ GRAVEL [7]			☑☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN	QUALITY
☐ LIMESTONE [1]	SILT: ☑ HEAVY [-2]
☑ TILLS [1]	☐ MODERATE [-1]
☐ WETLANDS [0]	☐ NORMAL [0]
☐ HARDPAN [0]	☐ FREE [1]
☐ SANDSTONE [0]	EMBEDDEDNESS: ☑ EXTENSIVE [-2]
☐ RIP/RAP [0]	☐ MODERATE [-1]
☑ LACUSTURINE [0]	☐ NORMAL [0]
☐ SHALE [-1]	☐ NONE [1]
☐ COAL FINES [-2]	

Substrate: .5 / 2.5 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
1 AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☑ NEARLY ABSENT <5% [1]

Comments

Cover: 2 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☑ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☑ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
3	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☑☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

R6

Comments .5

Riparian: 7 / 3.5 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)
☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☑ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☑ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply
☐ TORRENTIAL [-1]
☐ VERY FAST [1]
☐ FAST [1]
☑ MODERATE [1]
☐ SLOW [1]
☐ INTERSTITIAL [-1]
☐ INTERMITTENT [-2]
☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 3 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average).

☑ NO RIFFLE [metric=0]

RIFFLE DEPTH
☐ BEST AREAS > 10cm [2]
☐ BEST AREAS 5-10cm [1]
☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
☐ MAXIMUM > 50cm [2]
☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
☐ STABLE (e.g., Cobble, Boulder) [2]
☐ MOD. STABLE (e.g., Large Gravel) [1]
☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
☐ NONE [2]
☐ LOW [1]
☐ MODERATE [0]
☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 — Maximum 8

6] GRADIENT (5 ft/mi)
DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4]
☒ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

6

%POOL: ___ %GLIDE: 100
%RUN: ___ %RIFFLE: ___

Gradient: 6 — Maximum 10

EPA 4520 06/16/06

A] SAMPLED REACH
Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD
- [ ] BOAT
- [ ] WADE
- [ ] L. LINE
- [x] OTHER

STAGE (1st -sample pass- 2nd)
- [ ] HIGH [ ]
- [ ] UP [ ]
- [x] NORMAL [ ]
- [ ] LOW [ ]
- [ ] DRY [ ]

DISTANCE
- [ ] 0.5 Km
- [x] 0.2 Km
- [ ] 0.15 Km
- [ ] 0.12 Km
- [ ] OTHER

195 meters

CLARITY (1st –sample pass– 2nd)
- [ ] < 20 cm [ ]
- [x] 20-<40 cm [ ]
- [ ] 40-70 cm [ ]
- [ ] > 70 cm/ CTB [ ]
- [ ] SECCHI DEPTH [ ]

1st pass ______ cm
2nd pass ______ cm

CANOPY
- [x] > 85%- OPEN
- [ ] 55%-<85%
- [ ] 30%-<55%
- [ ] 10%-<30%
- [ ] <10%- CLOSED

B] AESTHETICS
- [ ] NUISANCE ALGAE
- [ ] INVASIVE MACROPHYTES
- [ ] EXCESS TURBIDITY
- [ ] DISCOLORATION
- [ ] FOAM / SCUM
- [x] OIL SHEEN
- [x] TRASH / LITTER
- [ ] NUISANCE ODOR
- [ ] SLUDGE DEPOSITS
- [x] CSOs/SSOs/OUTFALLS

C] RECREATION AREA DEPTH
POOL: [ ] >100ft² [ ] >3ft

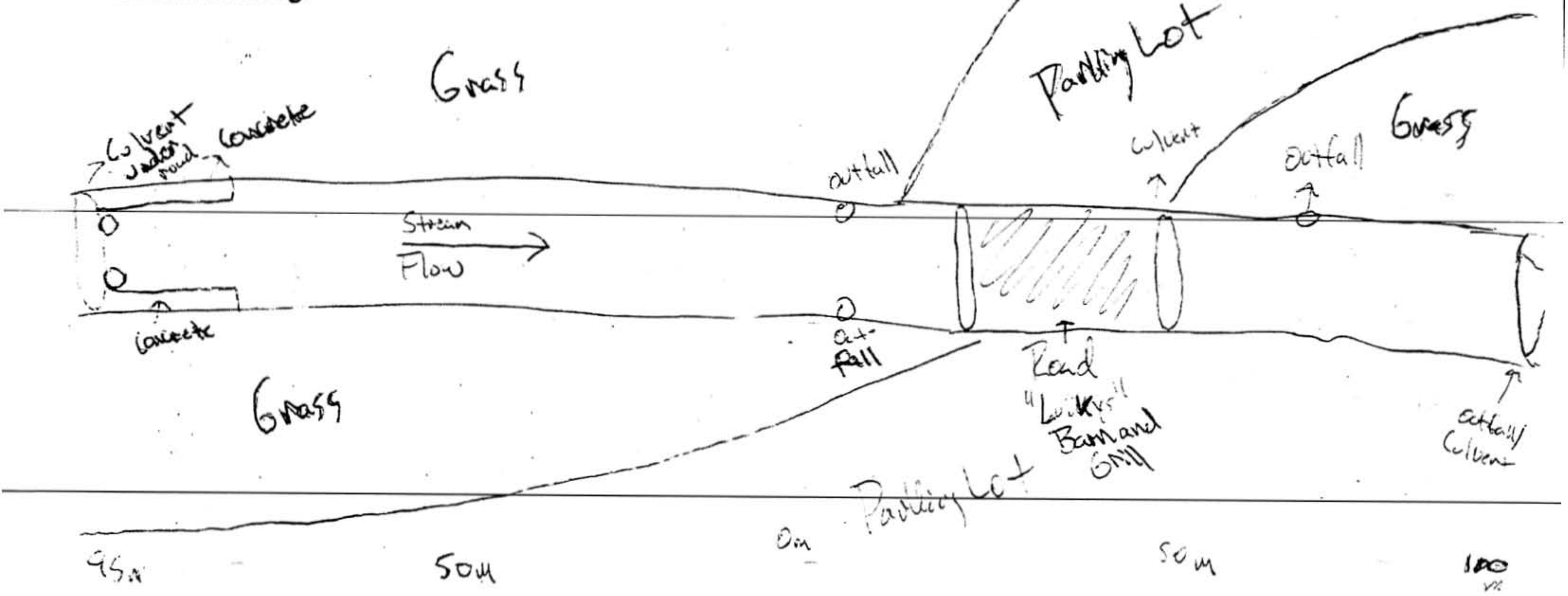
D] MAINTENANCE
PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

Circle some & *COMMENT*

E] ISSUES
WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:




Amlosch Ditch Photo 1: Amlosch Ditch passing through culvert.


Amlosch Ditch Photo 2: Deteriorating outfall pipe along Amlosch Ditch.


Amlosch Ditch Photo 3: Amlosch Ditch exhibiting lack of channel sinuosity.

Amlosch Ditch Photo 4: Near absence of instream cover.

Amlosch Ditch Photo 5: Sample station in Amlosch Ditch, depicting little to no bank erosion, high channel stability and little to no instream cover.


Amlosch Ditch Photo 6: Outfall pipes and culvert on Amlosch Ditch.

32.5
31.5

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** *QHEI Score:* 36.5 RG

Stream & Location: Grassy Creek at Elm St, Perrysburg OH *RM:* ___ *Date:* 9/29/10

Ryan Gratton and Shawn Roark *Scorers Full Name & Affiliation:* Entrix

River Code: __-__-__ *STORET #:* ______ *Lat./ Long.:* (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present. Check ONE (Or 2 & average)

BEST TYPES	POOL RIFFLE	OTHER TYPES	POOL RIFFLE	ORIGIN	QUALITY
☐☐ BLDR /SLABS [10]		☐☑ HARDPAN [4]		☐ LIMESTONE [1]	☐ HEAVY [-2]
☐☐ BOULDER [9]		☑☐ DETRITUS [3]		☑ TILLS [1]	☑ MODERATE [-1] (SILT)
☐☐ COBBLE [8]		☐☐ MUCK [2]		☐ WETLANDS [0]	☐ NORMAL [0]
☐☐ GRAVEL [7]		☑☐ SILT [2]		☐ HARDPAN [0]	☐ FREE [1]
☐☐ SAND [6]		☐☐ ARTIFICIAL [0]		☐ SANDSTONE [0]	☐ EXTENSIVE [-2] (EMBEDDEDNESS)
☐☐ BEDROCK [5]		(Score natural substrates; ignore sludge from point-sources)		☐ RIP/RAP [0]	☑ MODERATE [-1]
				☑ LACUSTURINE [0]	☐ NORMAL [0]
				☐ SHALE [-1]	☐ NONE [1]
				☐ COAL FINES [-2]	

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Substrate Maximum 20: ~~3.5~~ 4.5 RG

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 UNDERCUT BANKS [1] — ___ POOLS > 70cm [2] — ___ OXBOWS, BACKWATERS [1]
___ OVERHANGING VEGETATION [1] — ___ ROOTWADS [1] — ___ AQUATIC MACROPHYTES [1]
___ SHALLOWS (IN SLOW WATER) [1] — ___ BOULDERS [1] — 2 LOGS OR WOODY DEBRIS [1]
___ ROOTMATS [1]

AMOUNT Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☑ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 6

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☑ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☑ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 9

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☑☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☑☑ NARROW 5-10m [2]	☑☑ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Comments 3 2 1

Riparian Maximum 10: ~~10~~ 6 RG

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)	CHANNEL WIDTH Check ONE (Or 2 & average)	CURRENT VELOCITY Check ALL that apply	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☐ 0.7-<1m [4]	☑ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☐ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☑ 0.2-<0.4m [1]		☐ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT (7.5 ft/mi) ☒ VERY LOW - LOW [2-4] (4) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ___ %GLIDE: 100 %RUN: ___ %RIFFLE: ___

Gradient Maximum 10: 4

EPA 4520 06/16/06

A] SAMPLED REACH

Check ALL that apply

METHOD

- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☑ OTHER

STAGE

1st -sample pass- 2nd

- ☐ HIGH ☐
- ☐ UP ☐
- ☐ NORMAL ☐
- ☑ LOW ☐
- ☐ DRY ☐

DISTANCE

- ☐ 0.5 Km
- ☑ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_______ meters

CLARITY

1st --sample pass-- 2nd

- ☐ < 20 cm ☐
- ☑ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

CANOPY

- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☑ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

pass 1st__________ cm

2nd__________ cm

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

B] AESTHETICS

- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☑ CSOs/SSOs/OUTFALLS

C] RECREATION

AREA DEPTH

POOL: ☐>100ft² ☐>3ft

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

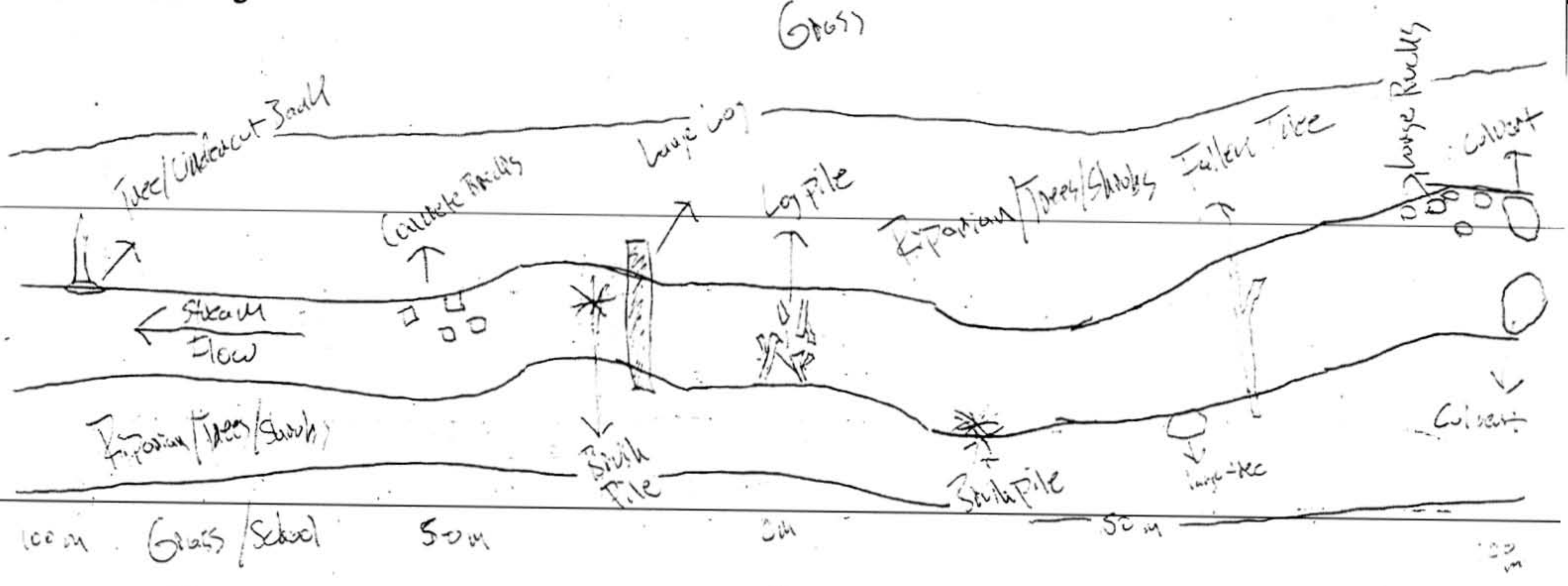
E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

- $\bar{x}$ width
- $\bar{x}$ depth
- max. depth
- $\bar{x}$ bankfull width
- bankfull $\bar{x}$ depth
- W/D ratio
- bankfull max. depth
- floodprone x^2 width
- entrench. ratio
- *Legacy Tree:*

Stream Drawing:



Grassy Creek Photo 1: Woody debris and leaf matter representing instream cover.

Grassy Creek Photo 2: Grassy Creek exhibiting moderate stream sinuosity.

Grassy Creek Photo 3: Sample station depicting narrow riparian width and a recovering channel.

Grassy Creek Photo 4: Grassy Creek exhibiting slow current velocity.

Grassy Creek Photo 5: Grassy Creek with residential neighborhood in background.

Grassy Creek Photo 6: Litter and stream substrate predominately consisting of leaf matter and woody debris.

Grassy Creek Photo 7: Sample station in Grassy Creek, depicting good quality floodplain, no riffle and shallow, slow moving water.

Grassy Creek Photo 8: Logs and woody debris representing instream cover.


Grassy Creek Photo 9: Undercut bank along Grassy Creek.


Grassy Creek Photo 10: Stream segment depicting canopy cover.

Appendix D

Stormwater Outfall Maps

Outfalls Duck Creek Segment D & E

Duck & Otter Creek
Lucas County, Ohio

N

Image:Bing
2011 Aerial

Cardno ENTRIX
3905 Crescent Park Drive
Riverview, FL 33578-3625
ph. (813) 664-4500
fx (813) 664-0440
www.cardnoentrix.com

Coordinate System:
NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map DocumentOutfallsegment_DC-DE_Duck_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document: Outfallsegment_DC-DE_Duck_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17

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Outfalls Otter Creek Segment A

Duck & Otter Creek
Lucas County, Ohio

N

Image:Bing
2011 Aerial

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Coordinate System:
NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document:Outfallsegment_OC-A_Otter_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document: Outfallsegment_OC-A_Otter_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17

Outfalls Otter Creek Segment B

Duck & Otter Creek
Lucas County, Ohio

Image:Bing
2011 Aerial

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Riverview, FL 33578-3625
ph. (813) 664-4500
fx (813) 664-0440
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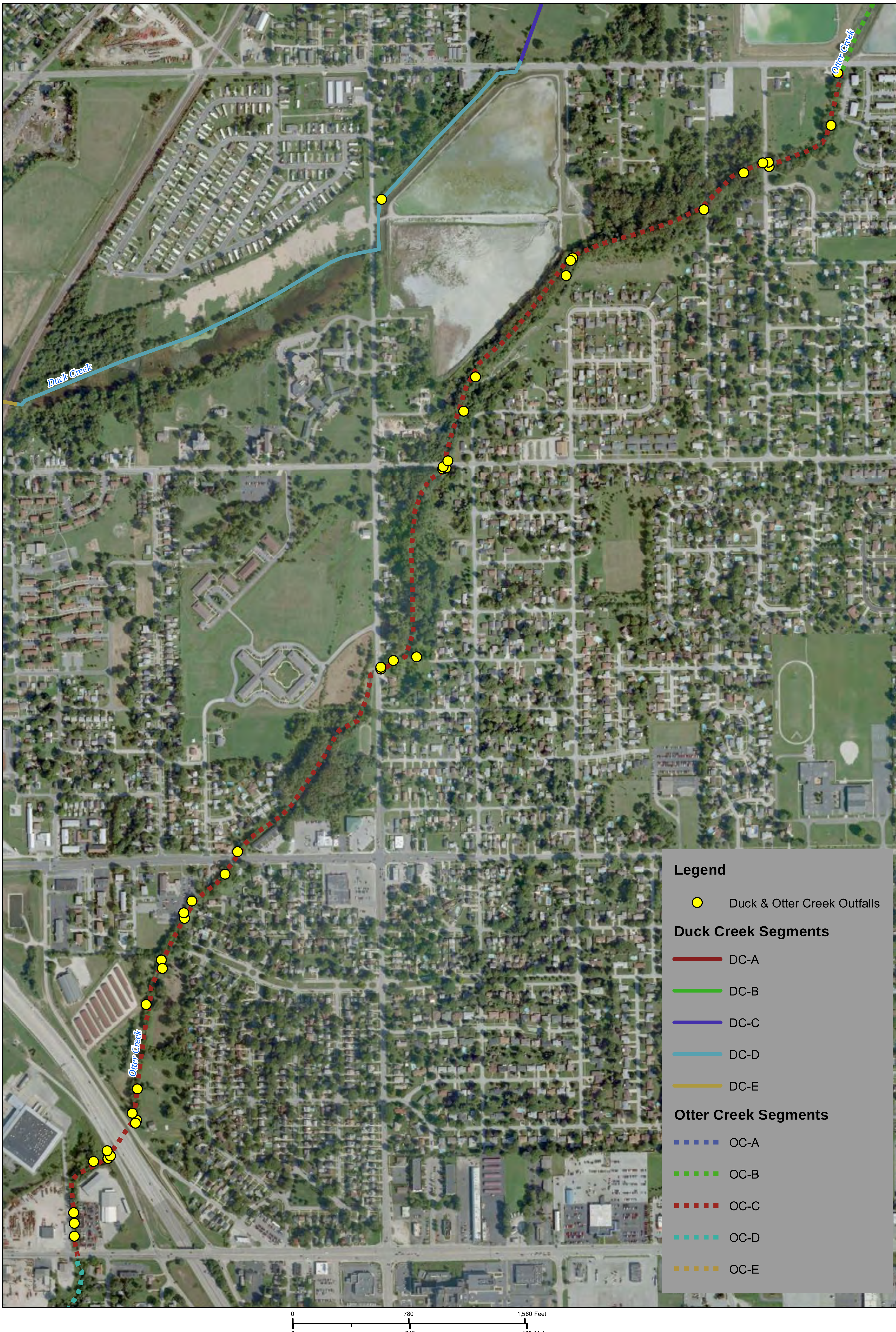
Coordinate System:
NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document:Outfallsegment_OC-B_Otter_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document:Outfallsegment_OC-B_Otter_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17



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Outfalls Otter Creek Segment C

Duck & Otter Creek
Lucas County, Ohio

Image:Bing
2011 Aerial

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Riverview, FL 33578-3625
ph. (813) 664-4500
fx (813) 664-0440
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Coordinate System:
NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document:Outfallsegment_OC-C_Otter_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document: Outfallsegment_OC-C_Otter_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17

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Outfalls Otter Creek Segment D

Duck & Otter Creek
Lucas County, Ohio

N

Image:Bing 2011 Aerial

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fx (813) 664-0440

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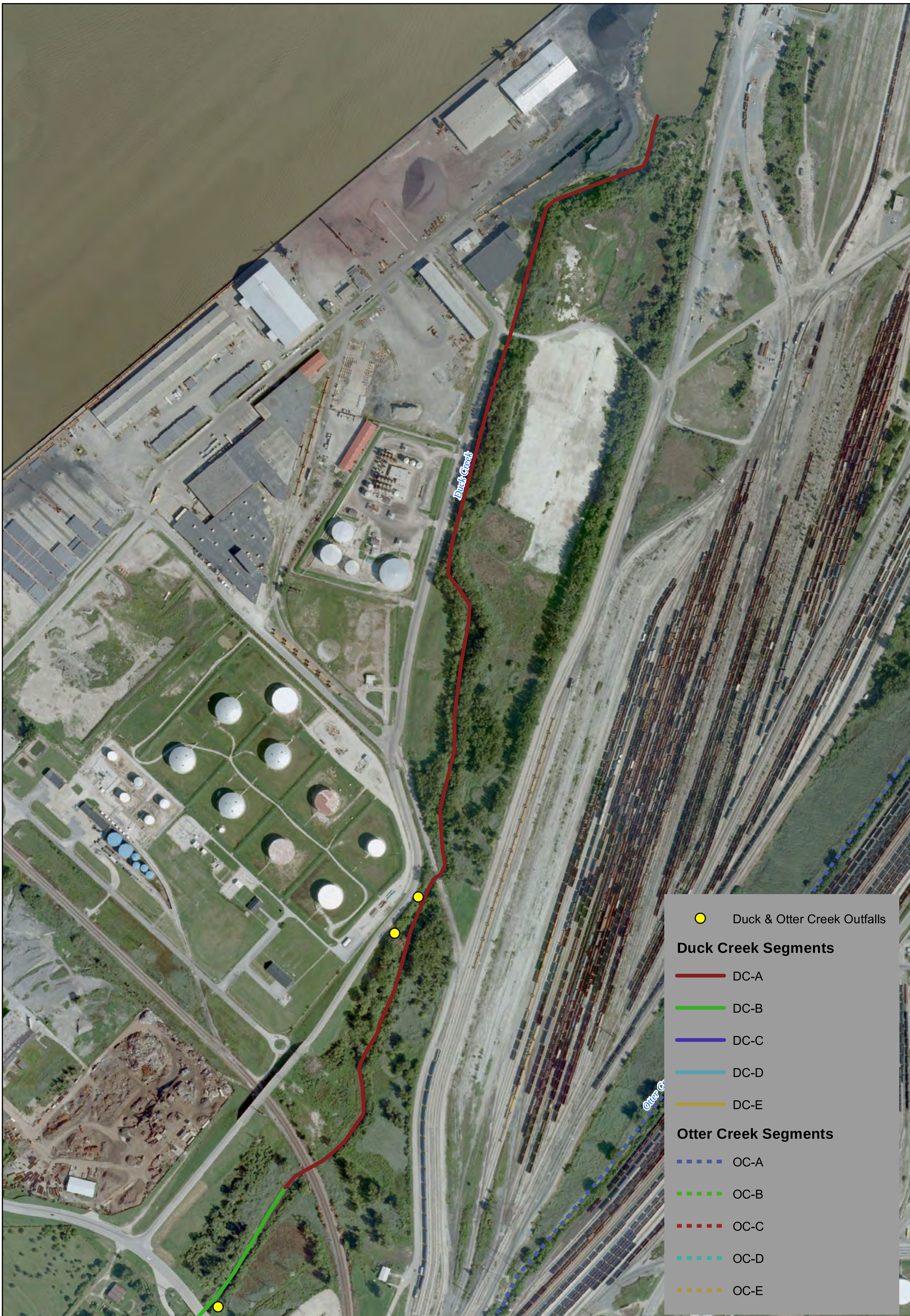
Coordinate System:
NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document:Outfallsegment_OC-D_Otter_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document:Outfallsegment_OC-D_Otter_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17



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Outfalls Duck Creek Segment A

Duck & Otter Creek
Lucas County, Ohio

Image:Bing
2011 Aerial

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NAD_1983_StatePlane_Ohio
North_FIPS_3401_Feet

Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document:Outfallssegment_DC-A_Duck_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document:Outfallssegment_DC-A_Duck_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17

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Outfalls Duck Creek Segment B

Duck & Otter Creek
Lucas County, Ohio

N

Image:Bing
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Outfalls Duck Creek Segment C

Duck & Otter Creek
Lucas County, Ohio

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Outfalls Otter Creek Segment E

Duck & Otter Creek
Lucas County, Ohio

N

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Date: 07/25/11 Rev. Date: xx/xx/xx PM: JK GIS Analyst: AJB Map Document: Outfallssegment_OC-E_Otter_creek_B_20110725_1_ajb.mxd Project Number: 72606001-2000-008 PDF Document: Outfallssegment_OC-E_Otter_creek_B_20110725_1_ajb.pdf Plot Size: 11 x 17

Appendix E

Sediment Physical Properties: particle size, solids content, total organic carbon

Table E-1. Physical Properties of Sediments from Urban Comparison Streams and Duck Creek.

Stream Segment		Urban		Duck Creek D			Duck Creek C		Duck Creek B			Duck Creek A						
Surface Grab Samples (0-6 inches depth)																		
Chemical name	CAS #	AD-1	GC-1	DC-11/12	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	DC-5/6	DC-5	DC-4	DC-3/4	DC-3		DC-2	DC-1
GRAVEL	GRAVEL	2.2	1.5	20.1		0.8	0.9		2.2	3.1	16.1	1.5	1.4	4.6	1.8			
SAND	SAND	49.1	5.3	37.5		9.1	9.0		35.3	20.0	21.5	8.6	21.9	20.4	89.9			
COARSE SAND	COARSE SAND	3.5	5.3	12.4		1.2	0.5		3.6	4.4	8.4	1.3	3.1	4.8	10.3			
MEDIUM SAND	MEDIUM SAND	2.8	0	12.4		1.3	1.2		11.3	1.7	4.8	1.4	1.6	5.0	27.2			
FINE SAND	FINE SAND	42.8	0	12.7		6.6	7.3		20.4	13.9	8.3	5.9	17.2	10.6	52.4			
SILT	SILT	43.6	89.3	28.0		70.1	71.8		49.3	70.9	57.2	72.2	42.9	66.9	5.0			
CLAY	CLAY	5.1	3.9	14.4		20.0	18.3		13.2	6.0	5.2	17.7	33.8	8.1	3.3			
SIEVE SIZE 3 INCH - PERCENT FINER	< 76.2 mm	100	100	100		100	100		100	100	100	100	100	100	100			
SIEVE SIZE 2 INCH - PERCENT FINER	< 50.8 mm	100	100	100		100	100		100	100	100	100	100	100	100			
SIEVE SIZE 1.5 INCH - PERCENT FINER	< 38.1 mm	100	100	100		100	100		100	100	100	100	100	100	100			
SIEVE SIZE 1 INCH - PERCENT FINER	< 25.4 mm	100	100	100		100	100		100	100	100	100	100	100	100			
SIEVE SIZE 0.75 INCH - PERCENT FINER	< 19.1 mm	100	100	100		100	100		100	100	95.7	100	100	100	100			
SIEVE SIZE 0.375 INCH - PERCENT FINER	< 9.53 mm	100	99.2	100		100	100		100	100	90.7	100	99.6	99.0	100			
SIEVE SIZE #4 - PERCENT FINER	< 4.76 mm	97.8	98.5	79.9		99.2	99.1		97.8	96.9	83.9	98.5	98.6	95.4	98.2			
SIEVE SIZE #10 - PERCENT FINER	< 2.00 mm	94.3	93.2	67.5		98.0	98.6		94.2	92.5	75.5	97.2	95.5	90.6	87.9			
SIEVE SIZE #20 - PERCENT FINER	< 0.841 mm	93.3	93.2	63.0		97.9	98.5		91.1	92.1	73.5	97.0	95.3	89.0	74.4			
SIEVE SIZE #40 - PERCENT FINER	< 0.420 mm	91.5	93.2	55.1		96.7	97.4		82.9	90.8	70.7	95.8	93.9	85.6	60.7			
SIEVE SIZE #60 - PERCENT FINER	< 0.250 mm	88.8	93.2	49.7		95.5	96.0		75.3	87.2	67.1	94.2	91.5	82.3	39.3			
SIEVE SIZE #80 - PERCENT FINER	< 0.177 mm	85.1	93.2	47.3		94.5	95.0		70.8	83.7	65.2	93.2	88.9	80.2	24.1			
SIEVE SIZE #100 - PERCENT FINER	< 0.149 mm	82.2	93.2	46.1		94.0	94.4		69.0	82.2	64.5	92.7	87.1	79.2	18.2			
SIEVE SIZE #200 - PERCENT FINER	< 0.074 mm	48.7	93.2	42.4		90.1	90.1		62.5	76.9	62.4	89.9	76.7	75.0	8.3			
HYDROMETER READING 1 - PERCENT FINER	HYD01	34.5	16.7	24.4		64.3	47.4		44.4	57.5	40.4	69.9	59.9	63.0	7.3			
HYDROMETER READING 2 - PERCENT FINER	HYD02	23.1	13.5	17.8		48.4	42.5		37.3	31.7	30.7	61.2	56.6	53.1	6.6			
HYDROMETER READING 3 - PERCENT FINER	HYD03	8.9	5.9	17.8		32.6	32.9		26.0	13.7	10.1	33.6	47.9	20.8	5.3			
HYDROMETER READING 4 - PERCENT FINER	HYD04	6	4	17.8		23.5	24.8		18.9	8.6	7.1	22.0	41.4	10.9	4.0			
HYDROMETER READING 5 - PERCENT FINER	HYD05	5.1	3.9	14.4		20.0	18.3		13.2	6.0	5.2	17.7	33.8	8.1	3.3			
HYDROMETER READING 6 - PERCENT FINER	HYD06	3	3.3	10.6		12.6	11.6		10.2	3.0	3.1	11.6	20.6	5.4	2.0			
HYDROMETER READING 7 - PERCENT FINER	HYD07	2.1	2.5	10.6		7.3	5.1		4.5	3.0	1.1	4.4	9.8	4.5	0.7			
TOTAL SOLIDS	TSOLIDS	47.8	69.3	12.2		28.7	33.3		41.4	20.6	20.8	29.3	33.8	43.2	72.9			
TOTAL ORGANIC CARBON	TOC	5.07	2.12	22.9		6.79	5.37		6.29	7.55	8.36	4.99	6.18	4.76	7.97			
Surface Core Samples (0-24 inches depth)																		
Chemical name	CAS #	AD-1	GC-1	DC-11/12	DC-11-02	DC-10/11	DC-9/10-02	DC-8-02	DC-7/8	DC-6/7	DC-5/6	DC-5-02	DC-4-02	DC-3/4-02	DC-3-02		DC-2-02	DC-1-02
TOTAL SOLIDS	TSOLIDS				39.8		73	44.2				41.2	40.3	56.6	67		57	55
TOTAL ORGANIC CARBON	TOC				5.6		1.57	5.41				3.38	3.4	1.99	2		3.09	2.71
Subsurface rface Core Samples (24 - 48 inches depth)																		
Chemical name	CAS #			DC-11/12	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	DC-5/6	DC-5-03	DC-4	DC-3/4	DC-3	DC-2A-03	DC-2-03	DC-1-03
TOTAL SOLIDS	TSOLIDS											60.2				45.3	64.2	72.5
TOTAL ORGANIC CARBON	TOC											2.76				6.2	3.21	0.85
note on preliminary draft: database includes solids and TOC data for DC-2A-03, which was not proposed in the plan and has the same coordinates as DC-2.																		

Table E-2. Physical Properties of Sediments from Otter Creek.

Stream Segment		Otter Creek E		Otter Creek D		Otter Creek C						Otter Creek B					Otter Creek A											
Surface Grab Samples (0-6 inches depth)																												
Chemical name	CAS #	OC-24/25	OC-23	OC-22	OC-18/19	OC-18	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10-11	OC-9-10	OC-8-9	OC-8	OC-7-8	OC-6/7(2)-01	OC-6/7(1)-01		OC-5A-01	OC-5	OC-4A-01	OC-4-01	OC-3A-01	OC-3	OC-2A	OC-2	OC-1A
GRAVEL	>2.0 mm	2.8		2.1	7.7		0	9.4	5.3	3.6	0.4	2.8	36.9	28.5		0.2	3.3	2		0		0.7	0	0		0		0
SAND	SAND	64.8		47.2	90.4		58.4	71.9	67	64	41.7	22.1	11.9	12.1		17.8	28.4	86.2		45.8		12.9	2.5	2.2		5.6		0.3
COARSE SAND	COARSE SAND	3.1		6.2	8.4		0.5	25.9	17.6	9.6	2.5	0.7	2.4	3		0.2	1.8	14.9		1.9		0.8	0	0		0		0
MEDIUM SAND	MEDIUM SAND	19.7		10.9	46.8		6.2	21.8	28	26	3.5	5.2	2	2.7		0.9	7.2	52.5		14.5		5.8	0.5	0.7		0.4		0
FINE SAND	FINE SAND	42		30.1	35.2		51.7	24.2	21.4	28.4	35.7	16.2	7.5	6.4		16.7	19.4	18.8		29.4		6.3	2	1.5		5.2		0.3
SILT	SILT	21.8		40.3	0.5		24.8	11.2	13.6	23.6	49.7	43.6	35.3	25.8		58.9	51.6	7.9		44.9		53.6	76.2	65.5		70.6		70.4
CLAY	<0.002 mm	10.6		10.4	1.5		16.8	7.5	14.1	8.8	8.2	31.5	15.9	33.6		23.1	16.7	3.9		9.3		32.8	21.3	32.3		23.8		29.3
SIEVE SIZE 3 INCH - PERCENT FINER	< 76.2 mm	100		100	100		100	100	100	100	100	100	100	100		100	100	100		100		100	100	100		100		100
SIEVE SIZE 2 INCH - PERCENT FINER	< 50.8 mm	100		100	100		100	100	100	100	100	100	100	100		100	100	100		100		100	100	100		100		100
SIEVE SIZE 1.5 INCH - PERCENT FINER	< 38.1 mm	100		100	100		100	100	100	100	100	100	100	100		100	100	100		100		100	100	100		100		100
SIEVE SIZE 1 INCH - PERCENT FINER	< 25.4 mm	100		100	100		100	100	100	100	100	100	100	100		100	100	100		100		100	100	100		100		100
SIEVE SIZE 0.75 INCH - PERCENT FINER	< 19.1 mm	100		100	100		100	100	100	100	100	100	82.1	100		100	100	100		100		100	100	100		100		100
SIEVE SIZE 0.375 INCH - PERCENT FINER	< 9.53 mm	98.5		100	96.5		100	100	100	99.9	100	100	72.6	90.3		100	100	100		100		99.7	100	100		100		100
SIEVE SIZE #4 - PERCENT FINER	< 4.76 mm	97.2		97.9	92.3		100	90.6	94.7	96.4	99.6	97.2	63.1	71.5		99.8	96.7	98		100		99.3	100	100		100		100
SIEVE SIZE #10 - PERCENT FINER	< 2.00 mm	94.1		91.7	83.9		99.5	64.7	77.1	86.8	97.1	96.5	60.7	68.5		99.6	94.9	83.1		98.1		98.5	100	100		100		100
SIEVE SIZE #20 - PERCENT FINER	< 0.841 mm	87.1		87	66.1		97.5	53.5	61.9	78	96.3	94.6	60.2	67		99.5	93.6	62		95.9		97.0	99.7	99.7		99.9		100
SIEVE SIZE #40 - PERCENT FINER	< 0.420 mm	74.4		80.8	37.1		93.3	42.9	49.1	60.8	93.6	91.3	58.7	65.8		98.7	87.7	30.6		83.6		92.7	99.5	99.3		99.6		100
SIEVE SIZE #60 - PERCENT FINER	< 0.250 mm	57.3		71	12.3		78.8	29.2	37	45.3	88	88.8	56.7	64.4		96.2	79.3	14.9		65.2		89.2	99	98.9		99.2		100
SIEVE SIZE #80 - PERCENT FINER	< 0.177 mm	45.4		64.1	6.4		60.9	23.1	32	40.1	81.2	85.4	56	63.4		92.7	75.7	12.9		58.1		87.9	98.5	98.6		98.6		100
SIEVE SIZE #100 - PERCENT FINER	< 0.149 mm	40.6		61.1	4.8		53.2	21.5	30.7	38.2	77	84	55.6	62.9		90.6	74.3	12.6		57		87.7	98.3	98.4		98.0		100
SIEVE SIZE #200 - PERCENT FINER	< 0.074 mm	32.4		50.7	1.9		41.6	18.7	27.7	32.4	57.9	75.1	51.2	59.4		82	68.3	11.8		54.2		86.4	97.5	97.8		94.4		99.7
HYDROMETER READING 1 - PERCENT FINER	HYD01	21.6		38.4	3.3		30.5	14.5	23.1	26.9	35.7	54.3	41.3	56.9		44.6	52.4	7.8		48.5		65.6	85.2	92.8		73.1		53.1
HYDROMETER READING 2 - PERCENT FINER	HYD02	18.7		31.8	3.3		28.5	12.7	21	22.5	27.8	49.5	33.7	52.8		40.5	46.1	7.4		42.5		58.3	76.7	86.8		59.7		48
HYDROMETER READING 3 - PERCENT FINER	HYD03	15		14.1	2.8		22.7	11	18.2	13.2	15.2	41	26.1	47.3		34.4	34.7	6.4		27.5		47.3	57.5	70.6		41.9		41.2
HYDROMETER READING 4 - PERCENT FINER	HYD04	12.8		11.9	1.9		19.7	9.2	16.2	10.7	10.6	35.3	19.7	40.5		29.3	25.8	4.9		15.3		40.1	36.2	52.5		30.0		34.4
HYDROMETER READING 5 - PERCENT FINER	HYD05	10.6		10.4	1.5		16.8	7.5	14.1	8.8	8.2	31.5	15.9	33.6		23.1	16.7	3.9		9.3		32.8	21.3	32.3		23.8		29.3
HYDROMETER READING 6 - PERCENT FINER	HYD06	6.8		9	1		11.9	5.8	9.8	7	5.9	22.8	10.9	15.8		13.8	7.6	2.4		4.8		20.0	12.8	16.1		17.8		17.3
HYDROMETER READING 7 - PERCENT FINER	HYD07	3.8		5.3	0.5		8	3.1	6.4	4.5	2.5	17.2	7	8.9		7.7	3.8	1.0		0		10.9	8.5	10.4		12.1		12.2
TOTAL SOLIDS	TSOLIDS	62.8		58.3	83.1		74.4	76.3	73.4	66	39.7	71.2	43.5	61.2		54.1	36.9	72.9		37.8		38.7	30.6	35.3		48.0		37.8
TOTAL ORGANIC CARBON	TOC	1.74		3.79	3.26		3.02	3.56	3.26	1.62	8.91	3.71	4.68	3.05		3.34	3.92	1.96		3.17		3.39	4.95	2.21		3.97		3.81

Surface Core Samples (0-24 inches depth)																												
Chemical name	CAS #	OC-24/25	OC-23-02	OC-22	OC-18/19	OC-18-02	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10/11	OC-9/10	OC-8/9	OC-8-02	OC-7/8	OC-6/7(2)-02	OC-6/7(1)-02		OC-5a-02	OC-5-02	OC-4A-02	OC-4-02	OC-3A-02	OC-3-02	OC-2A-02	OC-2-02	OC-1A-02
TOTAL SOLIDS	TSOLIDS		66.2			64.5									48.7		45	49.9		36	32.8	33.8	33.4	31.4	49.7	49	52.2	43.5
TOTAL ORGANIC CARBON	TOC		5.81			8.04									3.67		4.45	6.27		2.36	1.1	3.51	3.73	4.05	5.26	3.89	3.5	2.72

Subsurface Core Samples (24-48 inches depth)																												
Chemical name	CAS #	OC-24/25	OC-23-03	OC-22	OC-18/19	OC-18	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10/11	OC-9/10	OC-8/9	OC-8	OC-7/8	OC-6/7(2)	OC-6/7(1)-03	OC-6-03	OC-5a-03	OC-5-03	OC-4A-03	OC-4-03	OC-3A-03	OC-3-03	OC-2A-03	OC-2-03	OC-1A-03
TOTAL SOLIDS	TSOLIDS		74															49.1	58.8	43.3	37.9	40.7	33.2	34	51.9		61.2	
TOTAL ORGANIC CARBON	TOC		2.4															3.15	7.44	6.03	4.42	3.84	5.99	8.94	4.97		3.29	

Deep Core Samples (48-72 inches depth)																												
Chemical name	CAS #	OC-24/25	OC-23	OC-22	OC-18/19	OC-18	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10-11	OC-9-10	OC-8-9	OC-8	OC-7-8	OC-6/7(2)	OC-6/7(1)		OC-5A	OC-5	OC-4A	OC-4	OC-3A	OC-3	OC-2A-04	OC-2	OC-1A
TOTAL SOLIDS	TSOLIDS																									36.1		
TOTAL ORGANIC CARBON	TOC																									8.8		

note on preliminary draft: database includes solids and TOC data for OC-6-03, which was not sampled according to other information.

Appendix F

Riparian and Watershed Land Use and Impervious Surface Data

Table F-1. Duck and Otter Creek Watershed Land Cover Characterization from NLCD 2006

Land Use Categories	Area Square Meters	% Watershed
11 - Open Water	59,400.00	0.20%
21 - Developed, Open Space	4,631,573.18	15.65%
22 - Developed, Low Intensity	10,439,102.44	35.28%
23 - Developed, Medium Intensity	6,906,164.96	23.34%
24 - Developed, High Intensity	3,226,073.52	10.90%
31 - Barren Land	98,582.08	0.33%
41 - Deciduous Forest	595,106.56	2.01%
71 - Grassland/Herbaceous	171,917.89	0.58%
81 - Pasture Hay	142,036.93	0.48%
82 - Cultivated Crops	2,739,042.90	9.26%
95 - Emergent Herbaceous Wetlands	580,971.76	1.96%
Grand Total	29,589,972.22	100.00%

Summary of Area under a Percentage of Impervious Surface for the Duck and Otter Creek Watershed					
Impervious Surface Category	0% to 19%	20% to 49%	50% to 79%	80% to 100%	Total Area Sq. Meters
Duck and Otter Creek Watershed	8,972,766.33	10,383,242.25	7,012,768.28	3,221,191.15	29,589,968.01
Percentage of Total Area	30.32%	35.09%	23.70%	10.89%	100.00%

Table F-2. Duck and Otter Creek Riparian Zone Land Cover Characterization from NLCD 2006

Land Use Categories	5 m buffer zone	100 m buffer zone	250 m buffer zone
11 - Open Water	0.11%	0.67%	0.71%
21 - Developed, Open Space	24.76%	25.07%	23.37%
22 - Developed, Low Intensity	25.59%	28.73%	31.51%
23 - Developed, Medium Intensity	9.34%	12.21%	17.24%
24 - Developed, High Intensity	8.42%	11.46%	13.28%
31 - Barren Land	0.00%	0.15%	0.17%
41 - Deciduous Forest	5.04%	3.96%	2.83%
71 - Grassland/Herbaceous	0.00%	0.28%	0.32%
81 - Pasture Hay	0.00%	0.00%	0.12%
82 - Cultivated Crops	3.43%	3.30%	3.48%
95 - Emergent Herbaceous Wetlands	23.32%	14.17%	6.95%
Grand Total			

categories of impervious surface	percent of 5 m buffer	percent of 100 m buffer	percent of 250 m buffer
0% to 19%	57%	47%	36%
20% to 49%	26%	30%	33%
50% to 79%	9%	13%	18%
80% to 100%	8%	10%	12%

Table F3. Summary of Land Use by Size for Five Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 5 meter buffer (Area in Sq. Meters)									
Segment_ID	11 - Open Water	21 - Developed, Open Space	22 - Developed, Low Intensity	23 - Developed, Medium Intensity	24 - Developed, High Intensity	41 - Deciduous Forest	82 - Cultivated Crops	95 - Emergent Herbaceous Wetlands	Grand Total
DC-A			4,027	5,364	3,374			4,248	17,014
DC-B		1,527	4,030	1,415				5,925	12,897
DC-C		8,053	334						8,387
DC-D	175	8,245	3,985	36	530				12,971
DC-E	19	317	720						1,056
OC-A		2,053	3,472	3,027	2,689			20,871	32,113
OC-B		5,158	3,724	1,182	967			5,361	16,392
OC-C		7,168	9,939	2,458	740	5,159		5,178	30,642
OC-D		2,822	9,195	1,389	4,419				17,824
OC-E		9,238	6,649	1,940	2,435	3,921	6,172	414	30,768
Grand Total	**194**	**44,581**	**46,075**	**16,811**	**15,154**	**9,080**	**6,172**	**41,998**	**180,064**

Summary of Area (Sq. Meters) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 5 meter buffer					
Segment_ID	0-19%	20-49%	50-79%	80-100%	Grand Total
DC-A	4,079	5,753	4,268	2,914	17,014
DC-B	7,645	3,931	1,321	0	12,897
DC-C	8,042	344	0	0	8,387
DC-D	8,771	3,662	539	0	12,971
DC-E	347	276	433	0	1,056
OC-A	23,234	4,833	2,022	2,024	32,113
OC-B	11,121	2,710	1,389	1,172	16,392
OC-C	17,636	9,660	2,125	1,221	30,642
OC-D	4,584	7,079	1,767	4,393	17,824
OC-E	16,949	8,850	3,107	1,863	30,768
Grand Total	**102,408**	**47,098**	**16,972**	**13,587**	**180,064**

Table F4. Summary of Land Use by Size for One Hundred Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 100 meter buffer (Area in Sq. Meters)											
Segment_ID	11 - Open Water	21 - Developed, Open Space	22 - Developed, Low Intensity	23 - Developed, Medium Intensity	24 - Developed, High Intensity	31 - Barren Land	41 - Deciduous Forest	71 - Grassland/Herbaceous	82 - Cultivated Crops	95 - Emergent Herbaceous Wetlands	Grand Total
DC-A		6,279	113,879	73,343	75,463					71,370	340,333
DC-B		53,295	91,145	13,986	4,023		6,197			89,166	257,812
DC-C		153,547	9,151	5,044							167,742
DC-D	8,546	151,038	68,310	22,922	5,330		1,782				257,928
DC-E	610	4,847	11,829	1,739			2,103				21,127
OC-A	951	37,950	133,553	96,094	156,101		4,658			213,001	642,307
OC-B	14,076	99,294	72,290	40,609	23,247			9,499		66,397	325,411
OC-C		154,917	248,345	70,898	33,648		41,101			63,531	612,440
OC-D		64,156	141,732	70,474	79,263						355,626
OC-E		173,374	139,539	42,464	33,728	5,387	85,931	428	118,360	4,500	603,710
Grand Total	24,182	898,697	1,029,773	437,572	410,803	5,387	141,772	9,927	118,360	507,964	3,584,437

Summary of Area (Sq. Meters) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 100 meter buffer					
Segment_ID	0-19%	20-49%	50-79%	80-100%	Grand Total
DC-A	96,094	110,336	66,128	67,776	340,333
DC-B	154,494	81,241	17,873	4,204	257,813
DC-C	150,345	13,285	3,636	475	167,742
DC-D	159,080	74,943	21,406	2,499	257,928
DC-E	8,465	9,327	3,335	0	21,127
OC-A	254,277	179,215	98,047	110,768	642,307
OC-B	189,763	70,247	38,822	26,580	325,411
OC-C	268,982	227,701	83,642	32,114	612,440
OC-D	64,431	141,042	72,309	77,844	355,626
OC-E	322,980	182,481	69,214	29,035	603,710
Grand Total	**1,668,912**	**1,089,818**	**474,413**	**351,294**	**3,584,437**

Table F5. Summary of Land Use by Size for Two Hundred Fifty Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 250 meter buffer (Area in Sq. Meters)												
Segment_ID	11 - Open Water	21 - Developed, Open Space	22 - Developed, Low Intensity	23 - Developed, Medium Intensity	24 - Developed, High Intensity	31 - Barren Land	41 - Deciduous Forest	71 - Grassland/Herbaceous	81 - Pasture Hay	82 - Cultivated Crops	95 - Emergent Herbaceous Wetlands	Grand Total
DC-A	15,870	35,598	248,250	216,185	249,371						85,069	850,343
DC-B		226,830	200,767	55,389	47,944		22,107				91,328	644,365
DC-C		285,430	113,856	20,070								419,355
DC-D	14,400	235,266	207,068	171,725	9,000		2,656				318	640,433
DC-E	610	8,474	35,787	5,204			2,744					52,818
OC-A	4,893	164,512	312,915	309,963	513,840		9,000	0		43	291,377	1,606,542
OC-B	23,002	311,591	199,171	129,916	36,419			17,100		16,088	78,300	811,586
OC-C	4,899	295,930	778,137	252,389	88,948		41,400				68,400	1,530,103
OC-D		128,972	386,405	209,826	160,809							886,011
OC-E		389,828	325,223	165,768	77,175	15,300	174,472	11,748	10,801	293,643	4,351	1,468,310
Grand Total	63,674	2,082,429	2,807,577	1,536,435	1,183,506	15,300	252,379	28,848	10,801	309,774	619,143	8,909,866

Summary of Area (Sq. Meters) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 250 meter buffer					
Segment_ID	0-19%	20-49%	50-79%	80-100%	Grand Total
DC-A	180,609	236,422	202,303	231,009	850,344
DC-B	355,897	186,485	60,883	41,099	644,365
DC-C	282,409	112,605	22,541	1,800	419,354
DC-D	247,523	220,822	155,784	16,305	640,433
DC-E	11,217	33,711	7,890	0	52,817
OC-A	448,694	388,390	326,922	442,536	1,606,542
OC-B	431,220	205,736	129,431	45,200	811,587
OC-C	408,628	739,697	291,200	90,579	1,530,104
OC-D	129,622	379,662	212,664	164,062	886,010
OC-E	736,358	455,417	197,761	78,774	1,468,310
Grand Total	**3,232,177**	**2,958,947**	**1,607,378**	**1,111,364**	**8,909,866**

Table F6. Summary of Land Use Percentages for Five Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 5 meter buffer (Area as % of total stream segmen

Segment_ID	Open Water %	Developed, Open Space %	Developed, Low Intensity %	Developed, Medium Intensity %	Developed, High Intensity %	Deciduous Forest %	Cultivated Crops %	Emergent Herbaceous Wetlands %	Grand Total
DC-A	0.00%	0.00%	23.67%	31.53%	19.83%	0.00%	0.00%	24.97%	100.00%
DC-B	0.00%	11.84%	31.25%	10.97%	0.00%	0.00%	0.00%	45.94%	100.00%
DC-C	0.00%	96.02%	3.98%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
DC-D	1.35%	63.56%	30.72%	0.28%	4.09%	0.00%	0.00%	0.00%	100.00%
DC-E	1.80%	30.02%	68.18%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
OC-A	0.00%	6.39%	10.81%	9.43%	8.37%	0.00%	0.00%	64.99%	100.00%
OC-B	0.00%	31.46%	22.72%	7.21%	5.90%	0.00%	0.00%	32.71%	100.00%
OC-C	0.00%	23.39%	32.44%	8.02%	2.42%	16.83%	0.00%	16.90%	100.00%
OC-D	0.00%	15.83%	51.59%	7.79%	24.79%	0.00%	0.00%	0.00%	100.00%
OC-E	0.00%	30.02%	21.61%	6.31%	7.91%	12.74%	20.06%	1.35%	100.00%
% of Total Area	0.11%	24.76%	25.59%	9.34%	8.42%	5.04%	3.43%	23.32%	100.00%

Summary of Area (Area as % of total stream segment area) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream s

Segment_ID	0-19	20-49	50-79	80-100	Total %
DC-A	23.97%	33.81%	25.09%	17.13%	100.00%
DC-B	59.28%	30.48%	10.24%	0.00%	100.00%
DC-C	95.89%	4.11%	0.00%	0.00%	100.00%
DC-D	67.62%	28.23%	4.15%	0.00%	100.00%
DC-E	32.85%	26.17%	40.98%	0.00%	100.00%
OC-A	72.35%	15.05%	6.30%	6.30%	100.00%
OC-B	67.84%	16.53%	8.48%	7.15%	100.00%
OC-C	57.55%	31.52%	6.94%	3.99%	100.00%
OC-D	25.72%	39.72%	9.91%	24.65%	100.00%
OC-E	55.09%	28.76%	10.10%	6.05%	100.00%
% of Total Area	**56.87%**	**26.16%**	**9.43%**	**7.55%**	**100.00%**

Table F7. Summary of Land Use Percentages for One Hundred Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 100 meter buffer (Area as % of total stream segment area)

Segment_ID	11 - Open Water	21 - Developed, Open Space	22 - Developed, Low Intensity	23 - Developed, Medium Intensity	24 - Developed, High Intensity	31 - Barren Land	41 - Deciduous Forest	71 - Grassland/Herbaceous	82 - Cultivated Crops	95 - Emergent Herbaceous Wetlands	Grand Total
DC-A	0.00%	1.84%	33.46%	21.55%	22.17%	0.00%	0.00%	0.00%	0.00%	20.97%	100.00%
DC-B	0.00%	20.67%	35.35%	5.42%	1.56%	0.00%	2.40%	0.00%	0.00%	34.59%	100.00%
DC-C	0.00%	91.54%	5.46%	3.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
DC-D	3.31%	58.56%	26.48%	8.89%	2.07%	0.00%	0.69%	0.00%	0.00%	0.00%	100.00%
DC-E	2.89%	22.94%	55.99%	8.23%	0.00%	0.00%	9.95%	0.00%	0.00%	0.00%	100.00%
OC-A	0.15%	5.91%	20.79%	14.96%	24.30%	0.00%	0.73%	0.00%	0.00%	33.16%	100.00%
OC-B	4.33%	30.51%	22.21%	12.48%	7.14%	0.00%	0.00%	2.92%	0.00%	20.40%	100.00%
OC-C	0.00%	25.30%	40.55%	11.58%	5.49%	0.00%	6.71%	0.00%	0.00%	10.37%	100.00%
OC-D	0.00%	18.04%	39.85%	19.82%	22.29%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
OC-E	0.00%	28.72%	23.11%	7.03%	5.59%	0.89%	14.23%	0.07%	19.61%	0.75%	100.00%
% of Total Area	0.67%	25.07%	28.73%	12.21%	11.46%	0.15%	3.96%	0.28%	3.30%	14.17%	100.00%

Summary of Area (Area as % of total stream segment area) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segm

Segment_ID	0-19	20-49	50-79	80-100	Grand Total
DC-A	28.24%	32.42%	19.43%	19.91%	100.00%
DC-B	59.92%	31.51%	6.93%	1.63%	100.00%
DC-C	89.63%	7.92%	2.17%	0.28%	100.00%
DC-D	61.68%	29.06%	8.30%	0.97%	100.00%
DC-E	40.07%	44.15%	15.79%	0.00%	100.00%
OC-A	39.59%	27.90%	15.26%	17.25%	100.00%
OC-B	58.31%	21.59%	11.93%	8.17%	100.00%
OC-C	43.92%	37.18%	13.66%	5.24%	100.00%
OC-D	18.12%	39.66%	20.33%	21.89%	100.00%
OC-E	53.50%	30.23%	11.46%	4.81%	100.00%
% of Total Area	**46.56%**	**30.40%**	**13.24%**	**9.80%**	**100.00%**

Table F8. Summary of Land Use Percentages for Two Hundred Fifty Meter Riparian Buffer Along Duck and Otter Creeks.

Summary of Land Cover Classes (NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 250 meter buffer (Area as % of total stream segment area)

Segment_ID	11 - Open Water	21 - Developed, Open Space	22 - Developed, Low Intensity	23 - Developed, Medium Intensity	24 - Developed, High Intensity	31 - Barren Land	41 - Deciduous Forest	71 - Grassland/Herbaceous	81 - Pasture Hay	82 - Cultivated Crops	95 - Emergent Herbaceous Wetlands	Grand Total
DC-A	1.87%	4.19%	29.19%	25.42%	29.33%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	100.00%
DC-B	0.00%	35.20%	31.16%	8.60%	7.44%	0.00%	3.43%	0.00%	0.00%	0.00%	14.17%	100.00%
DC-C	0.00%	68.06%	27.15%	4.79%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
DC-D	2.25%	36.74%	32.33%	26.81%	1.41%	0.00%	0.41%	0.00%	0.00%	0.00%	0.05%	100.00%
DC-E	1.15%	16.04%	67.75%	9.85%	0.00%	0.00%	5.20%	0.00%	0.00%	0.00%	0.00%	100.00%
OC-A	0.30%	10.24%	19.48%	19.29%	31.98%	0.00%	0.56%	0.00%	0.00%	0.00%	18.14%	100.00%
OC-B	2.83%	38.39%	24.54%	16.01%	4.49%	0.00%	0.00%	2.11%	0.00%	1.98%	9.65%	100.00%
OC-C	0.32%	19.34%	50.86%	16.49%	5.81%	0.00%	2.71%	0.00%	0.00%	0.00%	4.47%	100.00%
OC-D	0.00%	14.56%	43.61%	23.68%	18.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
OC-E	0.00%	26.55%	22.15%	11.29%	5.26%	1.04%	11.88%	0.80%	0.74%	20.00%	0.30%	100.00%
% of Total Area	0.71%	23.37%	31.51%	17.24%	13.28%	0.17%	2.83%	0.32%	0.12%	3.48%	6.95%	100.00%

Summary of Area (Area as % of total stream segment area) within an estimated percentage of Impervious Surface (USGS, NLCD, 2006) according to Duck (DC) and Otter Creek (OC) sampled stream segments with a 250 meter buffer

Segment_ID	0-19	20-49	50-79	80-100	Grand Total
DC-A	21.24%	27.80%	23.79%	27.17%	100.00%
DC-B	55.23%	28.94%	9.45%	6.38%	100.00%
DC-C	67.34%	26.85%	5.38%	0.43%	100.00%
DC-D	38.65%	34.48%	24.32%	2.55%	100.00%
DC-E	21.24%	63.83%	14.94%	0.00%	100.00%
OC-A	27.93%	24.18%	20.35%	27.55%	100.00%
OC-B	53.13%	25.35%	15.95%	5.57%	100.00%
OC-C	26.71%	48.34%	19.03%	5.92%	100.00%
OC-D	14.63%	42.85%	24.00%	18.52%	100.00%
OC-E	50.15%	31.02%	13.47%	5.36%	100.00%
% of Total Area	36.28%	33.21%	18.04%	12.47%	100.00%

Appendix G

Toxicity Test Report

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Acute Toxicity Evaluation of Duck and Otter Creek Sediments with C*hironomus dilutus* (Data Gap Investigation)

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1 April 2011

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EXECUTIVE SUMMARY

The Great Lakes National Program Office (GLNPO) requested the Army Engineer Research and Development Center (ERDC) to conduct acute toxicity testing on sediments from Duck and Otter Creeks as part of its Great Lakes Legacy Act initiative. Fourteen (14) sediments were evaluated using the midge *Chironomus dilutus*. This report summarizes the biological testing of sediment collected from Duck and Otter Creeks conducted in basic accordance with guidance provided in "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates" (USEPA 2000). Four separate experiments were conducted. Indigenous planarians were encountered that impacted survival in some sediment samples. Significant reduction in survival was detected in OC-4 and GC-1 sediment samples. Significant reductions in ash-free biomass per initial organism were observed for sediments OC-4, OC-5A-01, OC-9-10 and GC-1 (Tables 3 and 4). A significant decrease in individual ash-free dry weight was observed for sediments OC-4, OC-5A-01, DC-5, and OC-16. No significant effects on survival or biomass were detected for the remaining sediment samples evaluated.

INTRODUCTION

At the request of the USEPA Great Lakes National Program Office (GLNPO), the US Army Engineer Research and Development Center (ERDC) conducted sediment toxicity tests of bottom sediment collected from Duck and Otter Creeks. Duck and Otter Creeks are located in an industrialized area of Northwest Ohio. The creeks are part of the Maumee River watershed which empties into Lake Erie. The evaluations were conducted as part of a data gap investigation under the Great Lakes Legacy Act with support from the GLNPO and industrial partners. The evaluation consisted of whole sediment acute toxicity tests with the midge *Chironomus dilutus*. Studies were conducted in basic accordance with the guidance provided in "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates" (USEPA 2000). The evaluation was conducted blind, in that the ERDC was unaware of the amounts or types of contaminants in the sediment samples and where they were collected.

TEST SEDIMENTS

Fourteen (14) sediments were received by the ERDC in five (5) separate shipments. Shipments were received 14-22 October 2010. Sediments were immediately inspected, logged and placed in cold storage at 4°C where they remained until test initiation. Chain of custody sheets are provided in Appendix D. A list of sediment samples evaluated is provided in Table 1.

Table 1. Summary of the test sediments and sediment identification

Sample Name	Customer ID
AD-1	AD-1
GC-1	GC-1
DC-3	DC-3
DC-5	DC-5
DC-6/7	DC-6/7
DC-11/12	DC-11/12
OC-4	OC-4
OC-5A-01	OC-5a-01
OC-6/7	OC-6/7(2)-01
OC-9-10	OC-9-10
OC-12/13	OC-12/13
OC-16	OC-16
OC-22	OC-22
OC-24/25	OC-24/25

METHODS

Chironomus dilutus whole sediment toxicity bioassay

Chironomus dilutus 10-day sediment exposures were conducted in basic accordance with guidance provided in “Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates (USEPA 2000). Due to logistics related to the number of samples tested, the study was divided into 4 separate experiments. Testing was initiated on the 29th of October 2010 and was completed on 17th January 2011.

Egg masses were obtained from Environmental Consulting and Testing (Superior, WI) and maintained in culture until the correct age (~ 10 days old) organisms were obtained to initiate testing. On the day prior to test initiation, approximately 75 mL of each sediment was added to eight (8) replicate 300 mL beakers. Sediment from the University of Mississippi field station, (Oxford, MS) was included as a negative control. Beakers were placed in a temperature controlled water bath or environmental chamber at 23 °C and allowed to equilibrate over night. Pore water ammonia measurements were taken on sediments prior to addition to beakers. Pore water was collected by centrifuging 50 mL of each sediment at 3000 RPM for 15 minutes. Pore water analysis was performed on the supernatant of the centrifuged sediment. All pore water total ammonia concentrations were below the 20 mg/L guidance for freshwater organisms provided in the Inland Testing Manual (USEPA /USACE 1998) (Appendix B; Table B1).

Overlying water quality (temperature, pH, dissolved oxygen, hardness, alkalinity, conductivity and ammonia) was recorded for each replicate beaker at test initiation. Ten organisms were added to each replicate and 1 mL of a Tetrafin® food mixture was provided. Initial weights of all organisms added were within the 0.08 to 0.23 mg/individual dry weight range indicative of the correct developmental stage (USEPA 2000). Temperature and dissolved oxygen were measured daily on a single replicate of each sediment throughout the exposure period. Animals were fed 1 mL of a Tetrafin® food mixture and two full water renewals were conducted daily. Water renewals were conducted using a modified Zumwalt water renewal system (USEPA 2000) (Appendix A; Photo A1 and A2). Due to low dissolved oxygen concentrations encountered on day 3 of test 1, all replicates of test 1 were aerated beginning on day 4 and beginning at test initiation of the remaining tests.

On day 10, overlying water quality was measured and each replicate beaker was terminated by passing the sediment through a 425 µm screen. Surviving organisms were recovered and enumerated. Following enumeration organisms from each replicate were placed on pre-weighed pans and placed in a drying oven for 24 hours at 60 °C. Following the drying period, pans were removed from the oven and dry mass for each replicate was recorded. Pans were then placed in a muffle furnace at 550 °C for 2 hours. After 2 hours, pans were removed from the furnace allowed to cool and ash-free mass was recorded for each replicate.

Water quality parameters

The water quality during bioassay testing was measured using a Thermo Scientific Orion 4Star meter (Thermo Scientific, Beverly, MA) for electrical conductivity, a model 315i meter (WTW; Weilheim, Germany) for pH, and a model Oxi 330 meter (WTW; Weilheim, Germany) for dissolved oxygen (D.O.). Total overlying water ammonia, hardness and alkalinity were measured using LeMotte titration kits (Chestertown, MD, USA). Total pore water ammonia was measured using a 720A ion-selective electrode (ISE) meter (Thermo Orion Electron Corp., Beverly, MA) equipped with a 95-12 ammonia-sensitive electrode (Thermo Orion Electron Corp., Beverly, MA).

Statistical analysis

Data normality (Kolmogorov–Smirnov test), homogeneity (Levene's Test), and sediment differences compared to the control were conducted using SigmaStat software (Version 3.5, SPSS, Chicago, IL). Statistical significance was determined at $\alpha = 0.05$. Survival data were arcsine-square-root transformed prior to analysis. Where data were normal and homogenous or could be made normal and homogenous through a data transformation procedure (i.e., Log_{10} or Square root) a One Way ANOVA was conducted followed by means comparison to the control using the Dunnett's mean comparison method. Where data were not normal and/or homogenous, the Kruskal–Wallis one-way ANOVA on ranks was applied followed by means comparison to the control using the Dunn's Mean comparison procedure. For all sediments evaluated, replicates impacted by the presence of indigenous organisms were not included in statistical analyses. Data endpoints analyzed were survival, ash-free biomass per initial organism and ash-free weight per surviving organism.

RESULTS

Other than temperature in test 1, water quality parameters for all bioassays were within the acceptability ranges specified by testing guidance (US EPA 2000) (Appendix B; Tables B2-B5). Temperature in several replicates of test 1 was 19.9 °C which is 0.1 degrees lower than the minimum recommended instantaneous temperature measurement of 20°C. Average daily temperature measurement from the previous day was 22.7 °C suggesting this was a short term occurrence and likely had little to no impact on the test results. Survival in the negative control was greater than 82% in all tests and exceeded the 70% performance requirement indicated in testing guidance (US EPA 2000) (Tables 3-6).

Indigenous planarians of various sizes ranging from about 2 mm to 7-8 cm were observed at test termination in replicates of several of the sediments tested. These planarians were retained on the 425 µm sieve used to separate midge larvae from the test sediment at test termination. Although all test beakers were sieved in the same manner, not all beakers contained planarians large enough to be retained on the 425 µm sieve. It is also unclear the number and influence planarians smaller that 425 µm in size, which likely passed through the sieve at test termination, had on test results. One of the larger planarians encountered is illustrated in Appendix A photos

A3 and A4. Low survival in these sediments is likely due in part to carnivorous feeding of the planarians on midges. This behavior was observed in test 4 where laboratory staff witnessed a planarian ingesting a midge larvae. Sediments AD-1 and GC-1 were the most impacted by the presence of planarians. These two sediments were retested (test 4) after sediment had been in cold storage for approximately 80 days. Despite the longer storage time, planarians were encountered again in the second test. Since the degree of impact of planarians on survival in these replicates is unknown, all replicates from Duck and Otter Creeks which contained planarians were excluded from statistical analyses. Sediment sample replicates impacted by planarians are provided in Table 2.

Survival ranged from 37.5% to 92.9% in the sediment samples tested. Statistically significant reductions in survival relative to the control were detected in OC-4 and GC-1 sediments (Tables 3 and 4). Most effects were detected following analyses of the biomass endpoints. Significant effects on ash-free biomass per initial organism were detected for sediments OC-4, OC-5A-01, OC-9-10 and GC-1 (Tables 3 and 4). A significant decrease in individual ash-free dry weight was observed for sediments OC-4, OC-5A-01, DC-5, and OC-16. No significant effects on survival or the biomass endpoints examined were detected for sediments OC-6/7, DC-3, AD-1, OC-12/13, DC-6/7, DC-11/12, OC-22 and OC-24/25.

Table 2. Sediment sample replicates containing planarians.

Sediment	# Replicates Impacted
AD-1 (Test 1)	5
GC-1 (Test 1)	4
AD-1 (Test 4)	4
GC-1 (Test 4)	2
DC-3	1
DC-5	1
OC-4	1
OC 6/7	1
OC-9-10	1
OC-12/13	1
OC-16	1

Table 3. Test 1 *Chironomus dilutus* mean survival and mass (± one standard deviation). Asterisks denote a statistically significant reduction in survival or mass relative to the control sediment.

Sample Name	(% Survival)	Ash-Free Biomass per Initial Organism (mg)	Ash-free Dry weight per Surviving Organism (mg)
Control	93.8 ± 7.4	1.35 ± 0.35	1.50 ± 0.39
OC-4	41.3 ± 25.3*	0.12 ± 0.04*	0.27 ± 0.08*
OC-6/7	78.8 ± 33.6	1.18 ± 0.23	1.31 ± 0.13
OC-5A-01	70.0 ± 23.3	0.26 ± 0.16*	0.36 ± 0.14*
DC-3	70.0 ± 29.4	1.21± 0.40	1.80 ± 0.31
OC-9-10	82.9 ± 18.0	0.66 ± 0.24*	0.80 ± 0.12

Table 4. Test 2 *Chironomus dilutus* mean survival and mass (± one standard deviation). Asterisks denote a statistically significant reduction in survival or mass relative to the control sediment.

Sample Name	(% Survival)	Ash-Free Biomass per Initial Organism (mg)	Ash-free Dry weight per Surviving Organism (mg)
Control	82.5 ± 8.9	1.41 ± 0.22	1.81 ± 0.48
DC-5	87.1 ± 11.1	1.11 ± 0.18	1.28 ± 0.14*
AD-1	70.0 ± 30.0	1.08 ± 0.41	1.59 ± 0.26
GC-1	37.5 ± 20.6*	0.74 ± 0.36*	2.13 ± 0.42
OC-12/13	92.9 ± 9.5	1.26 ± 0.11	1.37 ± 0.20
OC-16	91.4 ± 9.0	1.19 ± 0.26	1.31 ± 0.30*

Table 5. Test 3 *Chironomus dilutus* mean survival and mass (± one standard deviation). Asterisks denote a statistically significant reduction in survival or mass relative to the control sediment.

Sample Name	(% Survival)	Ash-Free Biomass per Initial Organism (mg)	Ash-free Dry weight per Surviving Organism (mg)
Control	87.5 ± 14.9	2.84 ± 1.40	3.10 ± 1.12
DC-6/7	83.8 ± 17.7	1.96 ± 0.49	2.42 ± 0.73
DC-11/12	83.8 ± 19.2	1.54 ± 0.40	1.92 ± 0.72
OC-22	91.3 ± 9.9	2.43 ± 0.63	2.64 ± 0.55
OC-24/25	81.3 ± 23.6	2.29 ± 0.90	2.73 ± 0.58

Table 6. Test 4 *Chironomus dilutus* mean survival and mass (± one standard deviation). Asterisks denote a statistically significant reduction in survival or mass relative to the control sediment.

Sample Name	(% Survival)	Ash-Free Biomass per Initial Organism (mg)	Ash-free Dry weight per Surviving Organism (mg)
Control	82.5 ± 13.9	1.13 ± 0.19	1.39 ± 0.22
GC-1	85.0 ± 18.7	1.14 ± 0.25	1.37 ± 0.30
AD-1	80.0 ± 14.1	1.37 ± 0.31	1.72 ± 0.32

REFERENCES

US Environmental Protection Agency / US Army Corps of Engineers (US EPA / USACE). 1998. Evaluation of Material Proposed for Discharge to Waters of the U.S. - Testing Manual (Inland Testing Manual). EPA-823-B-98-004, Office of Water, Washington DC.

US Environmental Protection Agency. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, Second Edition. EPA 600/R-99/064, Office of Water, Washington, D.C.

Appendix A. Photos from *Chironomus dilutus* bioassays

Photo A1. Zumwalt Water Delivery System used during Bioassay Testing.

Photo A2. Close-up of Zumwalt Water Delivery System and Exposure Chambers used during Bioassay Testing.

Photo A3. Planarian in 300 mL beaker.

Photo A4. Planarian from Photo A3 on paper towel. Flatworm is Approximately 3 inches (7.62 cm) in length.

Appendix B. Water quality parameters for *Chironomus dilutus* bioassays

Table B1. Total pore water ammonia concentrations at test initiation.

Treatment	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)	pH (SU)	Temperature (°C)
AD-1	13.7	0.161	7.38	23.1
GC-1	7.38	0.106	7.47	23.0
DC-3	4.93	0.112	7.67	23.1
DC-5	15.8	0.161	7.32	23.0
DC-6/7	8.58	0.118	7.45	23.1
DC-11/12	3.15	0.026	7.22	23.0
OC-4	11.6	0.327	7.77	23.0
OC-5A-01	12.0	0.598	8.03	22.9
OC-6/7	7.01	0.075	7.34	23.0
OC-9-10	2.08	0.061	7.79	23.0
OC-12/13	5.38	0.175	7.83	23.1
OC-16	4.09	0.049	7.40	22.8
OC-22	2.24	0.045	7.61	23.2
OC-24/25	14.5	0.183	7.41	23.1

Table B2. Test 1 overlying water quality parameters. Means and one standard deviation from the mean are indicated, with the minimum and maximum range of the data provided in parentheses.

Treatment	Temperature (° C)	pH (SU)	Dissolved oxygen (mg/L)	Conductivity (µS/cm)	*Maximum Ammonia (mg/L)	*Alkalinity (mg/L)	*Hardness (mg/L)
Control	22.0 ± 2.1 (19.9 - 24.2)	7.4 ± 0.1 (7.2 - 7.6)	7.7 ± 0.3 (7.0 - 8.0)	227 ± 21 (185 - 280)	<1	75 ± 0.2 (74 - 75)	80 ± 0 (80-80)
OC-4	22.0 ± 2.0 (19.9 - 24.0)	8.2 ± 0.3 (7.9 - 8.7)	7.6 ± 0.3 (7.0 - 8.0)	326 ± 56 (260 - 384)	<1	135 ± 64 (90 -180)	113 ± 39 (85 - 140)
OC-6/7	22.0 ± 2.0 (19.9 - 24.0)	8.3 ± 0.2 (8.0 - 8.5)	7.6 ± 0.2 (7.2 - 7.9)	313 ± 71 (220 - 385)	<1	125 ± 50 (90 -160)	113 ± 39 (85 - 140)
OC-5A-01	22.0 ± 2.0 (20.1 - 24.0)	8.0 ± 0.5 (7.3 - 8.6)	7.5 ± 0.2 (7.2 - 7.8)	325 ± 59 (253 - 384)	<1	118 ± 32 (95 -140)	115 ± 35 (90 - 140)
DC-3	22.1 ± 2.0 (20.1 – 24.0)	8.2 ± 0.2 (7.9 - 8.4)	7.7 ± 0.2 (7.3 - 8.0)	303 ± 31 (262 - 338)	<1	105 ± 21 (90 - 120)	105 ± 21 (90 - 120)
OC-9-10	22.0 ± 2.0 (19.9 - 24.0)	8.0 ± 0.6 (7.3 - 8.7)	7.3 ± 0.2 (7.0 – 7.8)	232 ± 22 (185 – 255)	<1	87 ± 9.9 (80 - 94)	90 ± 14 (80 - 100)

*Measurement taken on composite sample

Table B3. Test 2 overlying water quality parameters. Means and one standard deviation from the mean are indicated, with the minimum and maximum range of the data provided in parentheses.

Treatment	Temperature (° C)	pH (SU)	Dissolved oxygen (mg/L)	Conductivity (µS/cm)	*Maximum Ammonia (mg/L)	*Alkalinity (mg/L)	*Hardness (mg/L)
Control	22.7 ± 1.5 (21.1 - 24.2)	7.5 ± 0.1 (7.3 - 7.7)	7.7 ± 0.2 (7.2 – 7.9)	214 ± 15 (185 - 235)	<1	73 ± 11 (65 - 80)	65 ± 7.1 (60-70)
DC-5	22.9 ± 1.2 (20.9 - 24.2)	7.7 ± 0.2 (7.5 – 8.0)	7.2 ± 0.4 (6.5 – 7.8)	395 ± 41 (325 - 462)	<1	160 ± 0 (160 -160)	140 ± 0 (140 - 140)
AD-1	23.1 ± 1.1 (21.2 - 24.2)	8.0 ± 0.3 (7.7 - 8.3)	7.7 ± 0.2 (7.3 - 8.0)	438 ± 87 (325 - 565)	<1	170 ± 14 (160 -180)	160 ± 28 (140 - 180)
GC-1	23.0 ± 1.2 (21.7 - 24.2)	8.0 ± 0.4 (7.5 - 8.4)	7.5 ± 0.3 (7.1 – 8.1)	439 ± 62 (370 - 515)	<1	190 ± 14 (180 -200)	180 ± 28 (160 - 200)
OC-12/13	22.9 ± 1.3 (21.5 - 24.2)	8.0 ± 0.3 (7.7 - 8.3)	7.6 ± 0.2 (7.2 – 7.9)	391 ± 31 (353 - 460)	<1	110 ± 14 (100 - 120)	121 ± 16 (110 - 132)
OC-16	22.8 ± 1.4 (21.2 - 24.3)	8.1 ± 0.2 (7.9 - 8.4)	7.5 ± 0.2 (7.1 – 7.7)	385 ± 28 (350 - 450)	<1	121 ± 0.7 (120 - 121)	125 ± 21 (110 - 140)

*Measurement taken on composite sample

Table B4. Test 3 overlying water quality parameters. Means and one standard deviation from the mean are indicated, with the minimum and maximum range of the data provided in parentheses.

Treatment	Temperature (° C)	pH (SU)	Dissolved oxygen (mg/L)	Conductivity (µS/cm)	*Maximum Ammonia (mg/L)	*Alkalinity (mg/L)	*Hardness (mg/L)
Control	23.3 ± 0.2 (23.1 - 23.6)	7.4 ± 0.2 (7.1 - 7.7)	7.7 ± 0.4 (6.9 - 8.6)	230 ± 7 (221 - 245)	<1	35 ± 7 (30 - 40)	78 ± 4 (75 - 80)
DC-6/7	23.2 ± 0.2 (22.9 - 23.5)	8.0 ± 0.1 (7.7 - 8.1)	7.1 ± 1.1 (3.0 - 7.9)	417 ± 49 (365 - 515)	<1	110 ± 14 (100 -120)	150 ± 0 (150 - 150)
DC-11/12	23.1 ± 0.1 (22.7 – 23.2)	7.8 ± 0.1 (7.6 - 7.9)	7.3 ± 0.6 (5.4 - 7.8)	350 ± 18 (320 - 371)	1	75 ± 0 (75 -75)	58 ± 25 (40 - 75)
OC-22	23.1 ± 0.1 (22.9 - 23.2)	8.2 ± 0.2 (7.9 - 8.5)	7.8 ± 0.2 (7.5 - 8.4)	473 ± 70 (392 - 560)	1	165 ± 7 (160 -170)	180 ± 14 (170 - 190)
OC-24/25	22.9 ± 0.3 (22.5 – 23.2)	7.9 ± 0.3 (7.4 - 8.5)	6.8 ± 0.9 (4.1 - 8.2)	400 ± 59 (325 - 540)	1	95 ± 7 (90 - 100)	138 ± 25 (120 - 155)

*Measurement taken on composite sample

Table B5. Test 4 overlying water quality parameters. Means and one standard deviation from the mean are indicated, with the minimum and maximum range of the data provided in parentheses.

Treatment	Temperature (° C)	pH (SU)	Dissolved oxygen (mg/L)	Conductivity (µS/cm)	*Maximum Ammonia (mg/L)	*Alkalinity (mg/L)	*Hardness (mg/L)
Control	22.6 ± 0.4 (22.1 - 23.2)	7.9 ± 0.6 (7.2 – 8.5)	7.6 ± 0.2 (7.3 - 8.1)	256 ± 26 (210 - 300)	1	50 ± 14 (40 - 60)	60 ± 0 (60 - 60)
AD-1	22.7 ± 0.6 (21.8 - 23.5)	8.0 ± 0.3 (7.4 - 8.4)	7.9 ± 0.4 (7.4 - 8.5)	430 ± 57 (340 - 530)	1	99 ± 13 (90 -108)	135 ± 35 (110 - 160)
GC-1	22.7 ± 0.6 (22.1 - 23.3)	8.3 ± 0.1 (8.2 - 8.5)	7.8 ± 0.3 (7.2 – 8.2)	423 ± 47 (370 - 530)	1	99 ± 30 (78 -120)	110 ± 14 (100 - 120)

*Measurement taken on composite sample

Appendix C. Survival and Growth Endpoint data for *Chironomus dilutus* bioassays

Table 1. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 1 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (mg)	Pan & Animal Dry Weight (mg)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (mg)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
Control	A	10	100%	9	46.432	66.768	20.336	2.260	53.946	12.822	1.425	2.034	1.282	mean	93.8%	mean	1.35	mean	1.50
Control	B	9	90%	8	51.807	68.300	16.493	2.062	56.884	11.416	1.427	1.649	1.142	S.D.	7.4%	S.D.	0.35	S.D.	0.39
Control	C	10	100%	10	46.616	68.042	21.426	2.143	54.492	13.550	1.355	2.143	1.355	C.V.	7.9%	C.V.	26.1%	C.V.	25.7%
Control	D	8	80%	8	46.618	62.688	16.070	2.009	51.048	11.640	1.455	1.607	1.164	n	8	n	8	n	8
Control	E	10	100%	10	51.940	72.928	20.988	2.099	60.124	12.804	1.280	2.099	1.280						
Control	F	9	90%	9	50.070	69.054	18.984	2.109	57.926	11.128	1.236	1.898	1.113						
Control	G	10	100%	9	53.966	80.508	26.542	2.949	58.562	21.946	2.438	2.654	2.195						
Control	H	9	90%	9	55.194	81.410	26.216	2.913	68.906	12.504	1.389	2.622	1.250						
OC-4	A	6	60%	6	48.016	49.980	1.964	0.327	48.386	1.594	0.266	0.196	0.159	mean	41.3%	mean	0.11	mean	0.27
OC-4	B	5	50%	5	48.334	49.550	1.216	0.243	48.639	0.911	0.182	0.122	0.091	S.D.	25.3%	S.D.	0.04	S.D.	0.08
OC-4	C	1	10%	1	49.160	49.740	0.580	0.580	49.344	0.396	0.396	0.058	0.040	C.V.	61.4%	C.V.	37.1%	C.V.	31.0%
OC-4	D	6	60%	6	47.585	49.268	1.683	0.281	47.964	1.304	0.217	0.168	0.130	n	8	n	7	n	7
OC-4	E	0	0%	0															
OC-4	F	7	70%	7	45.208	48.119	2.911	0.416	46.890	1.229	0.176	0.291	0.123						
OC-4	G	3	30%	3	50.466	51.906	1.440	0.480	50.908	0.998	0.333	0.144	0.100						
OC-4	H	5	50%	5	55.604	57.674	2.070	0.414	56.056	1.618	0.324	0.207	0.162						
OC-6/7	A	10	100%	10	48.417	64.790	16.373	1.637	52.874	11.916	1.192	1.637	1.192	mean	78.8%	mean	1.18	mean	1.31
OC-6/7	B	0	0%	0										S.D.	33.6%	S.D.	0.23	S.D.	0.13
OC-6/7	C	10	100%	10	52.278	69.660	17.382	1.738	56.718	12.942	1.294	1.738	1.294	C.V.	42.6%	C.V.	19.3%	C.V.	10.0%
OC-6/7	D	9	90%	9	53.778	70.558	16.780	1.864	58.366	12.192	1.355	1.678	1.219	n	8	n	7	n	7
OC-6/7	E	7	70%	7	56.130	67.693	11.563	1.652	59.139	8.554	1.222	1.156	0.855						
OC-6/7	F	9	90%	9	49.242	65.026	15.784	1.754	52.492	12.534	1.393	1.578	1.253						
OC-6/7	G	10	100%	10	55.350	72.146	16.796	1.680	56.829	15.317	1.532	1.680	1.532						
OC-6/7	H	8	80%	8	64.437	76.520	12.083	1.510	67.252	9.268	1.159	1.208	0.927						
OC-5A-01	A	7	70%	7	50.912	55.620	4.708	0.673	52.474	3.146	0.449	0.471	0.315	mean	70.0%	mean	0.26	mean	0.36
OC-5A-01	B	6	60%	6	60.226	61.736	1.510	0.252	60.620	1.116	0.186	0.151	0.112	S.D.	23.3%	S.D.	0.16	S.D.	0.14
OC-5A-01	C	9	90%	9	57.280	65.536	8.256	0.917	59.906	5.630	0.626	0.826	0.563	C.V.	33.3%	C.V.	59.3%	C.V.	40.1%
OC-5A-01	D	7	70%	7	64.360	68.227	3.867	0.552	65.330	2.897	0.414	0.387	0.290	n	8	n	8	n	8
OC-5A-01	E	3	30%	3	40.044	48.902	8.858	2.953	48.306	0.596	0.199	0.886	0.060						
OC-5A-01	F	10	100%	10	49.136	53.032	3.896	0.390	50.000	3.032	0.303	0.390	0.303						
OC-5A-01	G	9	90%	9	53.314	57.746	4.432	0.492	54.636	3.110	0.346	0.443	0.311						
OC-5A-01	H	5	50%	5	49.716	51.948	2.232	0.446	50.330	1.618	0.324	0.223	0.162						

Table 1. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 1 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (mg)	Pan & Animal Dry Weight (mg)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (mg)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
DC-3	A	8	80%	8	56.278	76.141	19.863	2.483	62.464	13.677	1.710	1.986	1.368	mean	70.0%	mean	1.21	mean	1.80
DC-3	B	10	100%	10	50.310	72.576	22.266	2.227	56.734	15.842	1.584	2.227	1.584	S.D.	29.4%	S.D.	0.40	S.D.	0.31
DC-3	C	10	100%	10	51.312	71.459	20.147	2.015	56.834	14.625	1.463	2.015	1.463	C.V.	42.1%	C.V.	33.5%	C.V.	17.0%
DC-3	D	4	40%	4	53.238	62.898	9.660	2.415	55.242	7.656	1.914	0.966	0.766	n	7	n	7	n	7
DC-3	E	3	30%	3	54.082	61.158	7.076	2.359	55.766	5.392	1.797	0.708	0.539						
DC-3	F	5	50%	5	54.240	67.037	12.797	2.559	54.986	12.051	2.410	1.280	1.205						
DC-3	G	0		0															
DC-3	H	9	90%	9	42.770	65.454	22.684	2.520	50.088	15.366	1.707	2.268	1.537						
OC-9-10	A	7	70%	7	54.552	63.800	9.248	1.321	57.598	6.202	0.886	0.925	0.620	mean	82.9%	mean	0.66	mean	0.80
OC-9-10	B	8	80%	8	50.730	62.036	11.306	1.413	54.006	8.030	1.004	1.131	0.803	S.D.	18.0%	S.D.	0.17	S.D.	0.12
OC-9-10	C	9	90%	9	49.432	58.696	9.264	1.029	51.602	7.094	0.788	0.926	0.709	C.V.	21.7%	C.V.	25.3%	C.V.	15.0%
OC-9-10	D	10	100%	10	51.207	62.834	11.627	1.163	55.212	7.622	0.762	1.163	0.762	n	7	n	7	n	7
OC-9-10	E	10	100%	10	53.110	63.507	10.397	1.040	55.464	8.043	0.804	1.040	0.804						
OC-9-10	F	0		0															
OC-9-10	G	9	90%	9	47.766	55.770	8.004	0.889	49.602	6.168	0.685	0.800	0.617						
OC-9-10	H	5	50%	5	47.999	52.724	4.725	0.945	49.468	3.256	0.651	0.472	0.326						

Replicate contained one or more indigenous organisms

Signifcantly different from Control

Table 2. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 2 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (g)	Pan & Animal Dry Weight (g)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (g)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
Control	A	9	90%	9	0.14731	0.16363	16.32	1.81	0.15205	11.582	1.287	1.632	1.158	mean	82.5%	mean	1.41	mean	1.81
Control	B	9	90%	9	0.13512	0.15432	19.20	2.13	0.14122	13.096	1.455	1.920	1.310	S.D.	8.9%	S.D.	0.22	S.D.	0.48
Control	C	7	70%	7	0.13265	0.14931	16.66	2.38	0.13780	11.508	1.644	1.666	1.151	C.V.	10.7%	C.V.	15.9%	C.V.	26.3%
Control	D	9	90%	9	0.15093	0.17166	20.73	2.30	0.15738	14.280	1.587	2.073	1.428	n	8	n	8	n	8
Control	E	7	70%	6	0.13340	0.15603	22.63	3.77	0.13946	16.572	2.762	2.263	1.657						
Control	F	9	90%	8	0.14423	0.16655	22.32	2.79	0.14997	16.579	2.072	2.232	1.658						
Control	G	8	80%	8	0.13517	0.16008	24.91	3.11	0.14338	16.703	2.088	2.491	1.670						
Control	H	8	80%	8	0.12923	0.14657	17.34	2.17	0.13391	12.662	1.583	1.734	1.266						
DC-5	A	10	100%	10	0.12201	0.13843	16.42	1.64	0.12765	10.782	1.078	1.642	1.078	mean	87.1%	mean	1.11	mean	1.28
DC-5	B	7	70%	7	0.12625	0.13958	13.33	1.90	0.13006	9.516	1.359	1.333	0.952	S.D.	11.1%	S.D.	0.18	S.D.	0.14
DC-5	C	8	80%	8	0.13826	0.15333	15.07	1.88	0.14336	9.968	1.246	1.507	0.997	C.V.	12.8%	C.V.	16.2%	C.V.	11.2%
DC-5	D	8	80%	8	0.13185	0.14461	12.76	1.60	0.13558	9.030	1.129	1.276	0.903	n	7	n	7	n	7
DC-5	E	9	90%	9	0.13174	0.14933	17.59	1.95	0.13789	11.445	1.272	1.759	1.144						
DC-5	F	10	100%	10	0.12721	0.14572	18.51	1.85	0.13227	13.446	1.345	1.851	1.345						
DC-5	G	0		0															
DC-5	H	9	90%	9	0.14252	0.16105	18.53	2.06	0.14758	13.469	1.497	1.853	1.347						
AD-1	A	0		0										mean	70.0%	mean	1.08	mean	1.59
AD-1	B	10	100%	10	0.13368	0.15726	23.58	2.36	0.14186	15.404	1.540	2.358	1.540	S.D.	30.0%	S.D.	0.41	S.D.	0.26
AD-1	C	7	70%	7	0.12833	0.14189	13.56	1.94	0.13233	9.562	1.366	1.356	0.956	C.V.	42.9%	C.V.	38.0%	C.V.	16.0%
AD-1	D	1		1	0.13112	0.13233			0.13149					n	3	n	3	n	3
AD-1	E	4	40%	4	0.13653	0.14722	10.69	2.67	0.13975	7.474	1.869	1.069	0.747						
AD-1	F	0		0															
AD-1	G	0		0															
AD-1	H	0		0															
GC-1	A	1	10%	1	0.14412	0.14775	3.63	3.63	0.14504	2.713	2.713	0.363	0.271	mean	37.5%	mean	[illegible]	mean	2.13
GC-1	B	6	60%	6	0.13061	0.14602	15.41	2.57	0.13463	11.386	1.898	1.541	1.139	S.D.	20.6%	S.D.	0.36	S.D.	0.42
GC-1	C	0												C.V.	55.0%	C.V.	48.7%	C.V.	19.6%
GC-1	D	2		2	0.14063	0.14533			0.14199					n	4	n	4	n	4
GC-1	E	4	40%	4	0.14665	0.15668	10.03	2.51	0.14958	7.102	1.775	1.003	0.710						
GC-1	F	0																	
GC-1	G	4	40%	4	0.14658	0.15936	12.78	3.20	0.15089	8.466	2.116	1.278	0.847						
GC-1	H	0		0															

Table 2. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 2 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (g)	Pan & Animal Dry Weight (g)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (g)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
OC-12/13	A	9	90%	9	0.13757	0.15672	19.15	2.13	0.14225	14.472	1.608	1.915	1.447	mean	92.9%	mean	1.26	mean	1.37
OC-12/13	B	8	80%	8	0.13566	0.15391	18.25	2.28	0.14121	12.695	1.587	1.825	1.270	S.D.	9.5%	S.D.	0.11	S.D.	0.20
OC-12/13	C	10	100%	10	0.14663	0.16349	16.86	1.69	0.15138	12.110	1.211	1.686	1.211	C.V.	10.2%	C.V.	8.9%	C.V.	14.8%
OC-12/13	D	0												n	7	n	7	n	7
OC-12/13	E	10	100%	10	0.13015	0.14823	18.08	1.81	0.13449	13.736	1.374	1.808	1.374						
OC-12/13	F	10	100%	10	0.14998	0.16668	16.70	1.67	0.15490	11.781	1.178	1.670	1.178						
OC-12/13	G	10	100%	10	0.14922	0.16492	15.70	1.57	0.15361	11.308	1.131	1.570	1.131						
OC-12/13	H	8	80%	8	0.13733	0.15391	16.58	2.07	0.14170	12.214	1.527	1.658	1.221						
OC-16	A	10	100%	10	0.13965	0.15715	17.50	1.75	0.14520	11.949	1.195	1.750	1.195	mean	91.4%	mean	1.19	mean	[illegible]
OC-16	B	8	80%	8	0.13402	0.14722	13.20	1.65	0.13856	8.655	1.082	1.320	0.866	S.D.	9.0%	S.D.	0.26	S.D.	0.30
OC-16	C	8	80%	8	0.15621	0.17353	17.32	2.17	0.16179	11.738	1.467	1.732	1.174	C.V.	9.8%	C.V.	21.6%	C.V.	23.3%
OC-16	D	10	100%	10	0.13163	0.14642	14.79	1.48	0.13570	10.716	1.072	1.479	1.072	n	7	n	7	n	7
OC-16	E	10	100%	10	0.14457	0.15921	14.64	1.46	0.14913	10.076	1.008	1.464	1.008						
OC-16	F	9	90%	9	0.14468	0.16369	19.01	2.11	0.15030	13.390	1.488	1.901	1.339						
OC-16	G	9	90%	9	0.13556	0.15933	23.77	2.64	0.14273	16.600	1.844	2.377	1.660						
OC-16	H	1		1	0.15282	0.15375			0.15311										

Replicate contained one or more indigenous organisms (yellow)
Signifcantly different from Control (red)

Table 3. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 3 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (mg)	Pan & Animal Dry Weight (mg)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (mg)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
Control	A	7	70%	7	125.836	145.600	19.764	2.823	131.580	14.020	2.003	1.976	1.402	mean	87.5%	mean	2.84	mean	3.10
Control	B	10	100%	10	122.650	172.550	49.900	4.990	135.037	37.513	3.751	4.990	3.751	S.D.	14.9%	S.D.	1.40	S.D.	1.12
Control	C	10	100%	10	135.345	193.756	58.411	5.841	149.877	43.879	4.388	5.841	4.388	C.V.	17.0%	C.V.	49.2%	C.V.	36.1%
Control	D	7	70%	7	147.756	167.086	19.330	2.761	153.598	13.488	1.927	1.933	1.349	n	8	n	8	n	8
Control	E	10	100%	10	121.134	178.242	57.108	5.711	134.551	43.691	4.369	5.711	4.369						
Control	F	10	100%	10	144.266	196.818	52.552	5.255	156.975	39.843	3.984	5.255	3.984						
Control	G	9	90%	9	150.327	177.162	26.835	2.982	158.057	19.105	2.123	2.684	1.911						
Control	H	7	70%	7	139.589	160.250	20.661	2.952	144.559	15.691	2.242	2.066	1.569						
DC-6/7	A	10	100%	10	147.078	172.640	25.562	2.556	153.123	19.517	1.952	2.556	1.952	mean	83.8%	mean	1.96	mean	2.42
DC-6/7	B	7	70%	7	141.866	169.034	27.168	3.881	149.295	19.739	2.820	2.717	1.974	S.D.	17.7%	S.D.	0.49	S.D.	0.73
DC-6/7	C	9	90%	9	148.712	168.070	19.358	2.151	152.752	15.318	1.702	1.936	1.532	C.V.	21.1%	C.V.	24.8%	C.V.	30.2%
DC-6/7	D	10	100%	10	151.212	179.414	28.202	2.820	157.733	21.681	2.168	2.820	2.168	n	8	n	8	n	8
DC-6/7	E	10	100%	10	132.198	160.350	28.152	2.815	140.746	19.604	1.960	2.815	1.960						
DC-6/7	F	8	80%	8	150.656	172.018	21.362	2.670	156.886	15.132	1.891	2.136	1.513						
DC-6/7	G	8	80%	8	138.650	180.150	41.500	5.188	150.184	29.966	3.746	4.150	2.997						
DC-6/7	H	5	50%	5	143.733	163.829	20.096	4.019	148.047	15.782	3.156	2.010	1.578						
DC-11/12	A	6	60%	6	158.076	170.667	12.591	2.099	161.694	8.973	1.496	1.259	0.897	mean	83.8%	mean	1.54	mean	1.92
DC-11/12	B	10	100%	10	139.948	166.519	26.571	2.657	146.083	20.436	2.044	2.657	2.044	S.D.	19.2%	S.D.	0.40	S.D.	0.72
DC-11/12	C	9	90%	9	129.098	149.924	20.826	2.314	135.758	14.166	1.574	2.083	1.417	C.V.	23.0%	C.V.	26.2%	C.V.	37.4%
DC-11/12	D	9	90%	9	134.664	164.930	30.266	3.363	144.003	20.927	2.325	3.027	2.093	n	8	n	8	n	8
DC-11/12	E	8	80%	8	138.117	155.710	17.593	2.199	143.123	12.587	1.573	1.759	1.259						
DC-11/12	F	10	100%	10	154.742	173.487	18.745	1.875	159.032	14.455	1.446	1.875	1.446						
DC-11/12	G	10	100%	10	142.866	160.667	17.801	1.780	146.613	14.054	1.405	1.780	1.405						
DC-11/12	H	5	50%	5	133.869	156.328	22.459	4.492	138.789	17.539	3.508	2.246	1.754						
OC-22	A	9	90%	9	151.422	177.028	25.606	2.845	158.330	18.698	2.078	2.561	1.870	mean	91.3%	mean	2.43	mean	2.64
OC-22	B	10	100%	10	149.346	195.574	46.228	4.623	163.835	31.739	3.174	4.623	3.174	S.D.	9.9%	S.D.	0.63	S.D.	0.55
OC-22	C	10	100%	10	112.910	156.066	43.156	4.316	123.410	32.656	3.266	4.316	3.266	C.V.	10.9%	C.V.	26.1%	C.V.	20.8%
OC-22	D	8	80%	8	146.158	165.326	19.168	2.396	151.808	13.518	1.690	1.917	1.352	n	8	n	8	n	8
OC-22	E	8	80%	8	146.656	176.984	30.328	3.791	153.552	23.432	2.929	3.033	2.343						
OC-22	F	8	80%	8	142.798	172.798	30.000	3.750	149.603	23.195	2.899	3.000	2.319						
OC-22	G	10	100%	10	142.698	173.800	31.102	3.110	149.755	24.045	2.405	3.110	2.405						
OC-22	H	10	100%	10	138.296	174.656	36.360	3.636	147.665	26.991	2.699	3.636	2.699						

Table 3. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 3 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	# Animals on Pan	Pan Ash Weight (mg)	Pan & Animal Dry Weight (mg)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (mg)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
OC-24/25	A	8	80%	8	142.390	172.646	30.256	3.782	151.202	21.444	2.681	3.026	2.144	mean	81.3%	mean	2.29	mean	2.73
OC-24/25	B	10	100%	10	136.649	174.838	38.189	3.819	145.933	28.905	2.891	3.819	2.891	S.D.	23.6%	S.D.	0.90	S.D.	0.58
OC-24/25	C	9	90%	9	143.549	194.340	50.791	5.643	159.150	35.190	3.910	5.079	3.519	C.V.	29.0%	C.V.	39.4%	C.V.	21.3%
OC-24/25	D	10	100%	10	139.890	179.320	39.430	3.943	149.340	29.980	2.998	3.943	2.998	n	8	n	8	n	8
OC-24/25	E	3	30%	3	133.582	141.750	8.168	2.723	136.082	5.668	1.889	0.817	0.567						
OC-24/25	F	7	70%	7	125.609	148.547	22.938	3.277	130.414	18.133	2.590	2.294	1.813						
OC-24/25	G	8	80%	8	134.740	161.938	27.198	3.400	142.180	19.758	2.470	2.720	1.976						
OC-24/25	H	10	100%	10	149.926	184.420	34.494	3.449	160.056	24.364	2.436	3.449	2.436						

Replicate contained one or more indigenous organisms

Significantly different from Control

Table 4. GLNPO Duck and Otter Creeks *Chironomus dilutus* Test 4 Data Summary

Sediment	Replicate	Organisms recovered	Replicate % Survival	Pan #	# Animals on Pan	Pan Ash Weight (mg)	Pan & Animal Dry Weight (mg)	Total Dry Biomass (mg)	Individual Dry Weight (mg)	Pan & Animal Ash Weight (mg)	Total Ash-free Biomass (mg)	Individual Ash-free Dry Weight (mg)	Dry biomass (mg)/Intial Organism	Ash-free Dry biomass (mg)/Initial Organism	Survival		Ash-Free Dry Biomass (mg)/ Initial Organism		Individual Ash Weight (mg)	
Control	A	8	80%	1	8	106.772	124.146	17.374	2.172	112.140	12.006	1.501	1.737	1.201	mean	82.5%	mean	1.13	mean	1.39
Control	B	6	60%	2	6	95.362	117.356	21.994	3.666	107.484	9.872	1.645	2.199	0.987	S.D.	13.9%	S.D.	0.19	S.D.	0.22
Control	C	8	80%	3	8	121.056	138.828	17.772	2.222	126.188	12.640	1.580	1.777	1.264	C.V.	16.8%	C.V.	17.0%	C.V.	15.9%
Control	D	10	100%	4	10	129.964	159.866	29.902	2.990	144.722	15.144	1.514	2.990	1.514	n	8	n	8	n	8
Control	E	8	80%	5	8	125.882	144.088	18.206	2.276	134.938	9.150	1.144	1.821	0.915						
Control	F	9	90%	3	9	122.528	154.834	32.306	3.590	143.950	10.884	1.209	3.231	1.088						
Control	G	10	100%	4	10	123.124	140.638	17.514	1.751	130.096	10.542	1.054	1.751	1.054						
Control	H	7	70%	5	7	118.498	134.438	15.940	2.277	124.252	10.186	1.455	1.594	1.019						
GC-1	A	1		1	0										mean	85.0%	mean	1.14	mean	1.37
GC-1	B	10	100%	2	10	134.074	153.618	19.544	1.954	141.920	11.698	1.170	1.954	1.170	S.D.	18.7%	S.D.	0.25	S.D.	0.30
GC-1	C	2		3	2	137.428	142.910			138.958					C.V.	22.0%	C.V.	21.8%	C.V.	21.6%
GC-1	D	10	100%	4	10	132.828	152.318	19.490	1.949	141.342	10.976	1.098	1.949	1.098	n	6	n	6	n	6
GC-1	E	9	90%	5	9	145.912	162.412	16.500	1.833	152.890	9.522	1.058	1.650	0.952						
GC-1	F	8	80%	3	8	110.084	130.260	20.176	2.522	116.466	13.794	1.724	2.018	1.379						
GC-1	G	5	50%	4	5	118.790	129.966	11.176	2.235	122.022	7.944	1.589	1.118	0.794						
GC-1	H	9	90%	5	9	111.116	130.066	18.950	2.106	115.624	14.442	1.605	1.895	1.444						
AD-1	A	9	90%	1	9	112.272	131.202	18.930	2.103	118.064	13.138	1.460	1.893	1.314	mean	80.0%	mean	1.37	mean	1.72
AD-1	B	9	90%	2	9	111.066	136.976	25.910	2.879	122.876	14.100	1.567	2.591	1.410	S.D.	14.1%	S.D.	0.31	S.D.	0.32
AD-1	C	0		3	0										C.V.	17.7%	C.V.	22.7%	C.V.	18.8%
AD-1	D	6	60%	4	6	108.728	123.768	15.040	2.507	113.796	9.972	1.662	1.504	0.997	n	4	n	4	n	4
AD-1	E	3		5	3	110.986	121.070			113.530										
AD-1	F	3		3	3	111.460	118.878			112.460										
AD-1	G	6		4	6	107.428	124.404			115.124										
AD-1	H	8	80%	5	8	117.338	141.030	23.692	2.962	123.524	17.506	2.188	2.369	1.751						

(Yellow) Replicate contained one or more indigenous organisms
(Red) Signifcantly different from Control

Appendix D. Statistical analyses for *Chironomus dilutus* sediment bioassays

TEST 1

Test 1 Survival

One Way Analysis of Variance Sunday, January 09, 2011, 2:28:35 AM

Data source: Data 1 in Notebook 1

Normality Test: Passed (P > 0.050)

Equal Variance Test: Passed (P = 0.104)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.392	0.197	0.0695
OC-4	7	0	0.748	0.227	0.0859
OC-6/7	7	0	1.330	0.242	0.0915
OC-5A-01	8	0	1.038	0.310	0.110
DC-3	7	0	1.078	0.409	0.155
OC-9-10	7	0	1.218	0.289	0.109

Source of Variation	DF	SS	MS	F	P
Between Groups	5	1.989	0.398	4.857	0.002
Residual	38	3.112	0.0819		
Total	43	5.102			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.002).

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: **Sediment**

Comparison	Diff of Means	q'	P	P<0.050
Control vs. OC-4	0.644	4.350	--	Yes
Control vs. OC-5A-01	0.354	2.477	--	No
Control vs. DC-3	0.314	2.120	--	Do Not Test
Control vs. OC-9-10	0.175	1.178	--	Do Not Test
Control vs. OC-6/7	0.0624	0.421	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Test 1 Ash-free Biomass per Initial Organism (Square root transformed)

One Way Analysis of Variance Friday, April 01, 2011, 10:35:08 AM

Data source: Test 1 Data in Biomass stats re-do (3-31-11)

Dependent Variable: sqrt(col(2))

Normality Test: Passed (P = 0.077)

Equal Variance Test: Passed (P = 0.569)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.154	0.137	0.0486
OC-4	7	0	0.333	0.0701	0.0265
OC-6/7	7	0	1.083	0.107	0.0403
OC-5A-01	8	0	0.492	0.158	0.0560
DC-3	7	0	1.083	0.202	0.0762
OC-9-10	7	0	0.807	0.114	0.0432

Source of Variation	DF	SS	MS	F	P
Between Groups	5	4.380	0.876	45.717	<0.001
Residual	38	0.728	0.0192		
Total	43	5.108			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: **Sediment**

Comparison	Diff of Means	q'	P	P<0.050
Control vs. OC-4	0.821	11.458	--	Yes
Control vs. OC-5A-01	0.661	9.557	--	Yes
Control vs. OC-9-10	0.346	4.834	--	Yes
Control vs. OC-6/7	0.0711	0.993	--	No
Control vs. DC-3	0.0703	0.981	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Test 1 Individual Ash-free Weight

One Way Analysis of Variance Thursday, March 31, 2011, 4:20:26 PM

Data source: Data 2 in Notebook 1

Dependent Variable: AFDW/I

Normality Test: Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Thursday, March 31, 2011, 4:20:26 PM

Data source: Data 2 in Notebook 1

Group	**N**	**Missing**	**Median**	**25%**	**75%**
Control	8	0	1.407	1.318	1.441
OC-4	7	0	0.266	0.191	0.330
OC-6/7	7	0	1.294	1.199	1.383
OC-5A-01	8	0	0.335	0.251	0.432
DC-3	7	0	1.710	1.615	1.885
OC-9-10	7	0	0.788	0.705	0.866

H = 38.901 with 5 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	**Diff of Ranks**	**Q**	**P<0.05**
OC-4 vs Control	26.143	3.932	Yes
OC-5A-01 vs Control	23.063	3.591	Yes
OC-9-10 vs Control	13.500	2.031	No
DC-3 vs Control	7.357	1.107	Do Not Test
OC-6/7 vs Control	4.214	0.634	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

TEST 2

Test 2 Survival

One Way Analysis of Variance Wednesday, February 16, 2011, 10:19:22 PM

Data source: Test 2 Survival Data in Stats(2-13-11)

Dependent Variable: asinsqrt(col(2))

Normality Test: Passed (P = 0.631)

Equal Variance Test: Passed (P = 0.051)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.149	0.115	0.0408
DC-5	7	0	1.264	0.228	0.0862
AD-1	3	0	1.082	0.450	0.260
GC-1	4	0	0.644	0.235	0.118
OC-12/13	7	0	1.392	0.228	0.0860
OC-16	7	0	1.346	0.218	0.0823

Source of Variation	DF	SS	MS	F	P
Between Groups	5	1.734	0.347	6.620	<0.001
Residual	30	1.572	0.0524		
Total	35	3.306			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: **Sediment**

Comparison	Diff of Means	q'	P	P<0.050
Control vs. GC-1	0.505	3.601	--	Yes
Control vs. OC-12/13	0.243	2.054	--	No
Control vs. OC-16	0.197	1.666	--	Do Not Test
Control vs. DC-5	0.114	0.967	--	Do Not Test
Control vs. AD-1	0.0669	0.432	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Test 2 Ash-free Biomass per Initial Organism

One Way Analysis of Variance Sunday, February 13, 2011, 5:57:22 PM

Data source: Test 2 Dry and Ash-free Biomass per Initial Organism Data in Stats(2-13-11)

Dependent Variable: ADM/IO

Normality Test: Passed (P = 0.282)

Equal Variance Test: Passed (P = 0.177)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.412	0.224	0.0793
DC-5	7	0	1.109	0.180	0.0680
AD-1	3	0	1.081	0.411	0.237
GC-1	4	0	0.742	0.361	0.180
OC-12/13	7	0	1.262	0.112	0.0423
OC-16	7	0	1.188	0.257	0.0971

Source of Variation	DF	SS	MS	F	P
Between Groups	5	1.311	0.262	4.506	0.004
Residual	30	1.746	0.0582		
Total	35	3.057			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.004).

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: **Sediment**

Comparison	Diff of Means	q'	P	P<0.050
Control vs. GC-1	0.671	4.539	--	Yes
Control vs. AD-1	0.331	2.026	--	No
Control vs. DC-5	0.303	2.426	--	Do Not Test
Control vs. OC-16	0.225	1.800	--	Do Not Test
Control vs. OC-12/13	0.151	1.206	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Test 2 Individual Ash-free Weight

One Way Analysis of Variance Sunday, January 30, 2011, 8:21:43 PM

Data source: Test 2 Mass Data in Stats

Dependent Variable: Mass

Normality Test: Passed (P = 0.222)

Equal Variance Test: Passed (P = 0.700)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.810	0.475	0.168
DC-5	7	0	1.275	0.143	0.0539
AD-1	3	0	1.592	0.255	0.147
GC-1	4	0	2.126	0.416	0.208
OC-12/13	7	0	1.374	0.203	0.0768
OC-16	7	0	1.308	0.304	0.115

Source of Variation	DF	SS	MS	F	P
Between Groups	5	3.024	0.605	5.749	<0.001
Residual	30	3.156	0.105		
Total	35	6.180			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: **Sediment**

Comparison	Diff of Means	q'	P	P<0.050
Control vs. DC-5	0.535	3.185	--	Yes
Control vs. OC-16	0.502	2.989	--	Yes
Control vs. OC-12/13	0.436	2.598	--	No
Control vs. GC-1	0.316	1.590	--	Do Not Test
Control vs. AD-1	0.218	0.993	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

TEST 3

Test 3 Survival

One Way Analysis of Variance Sunday, January 09, 2011, 2:43:02 AM

Data source: Data 5 in Notebook 1

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Sunday, January 09, 2011, 2:43:02 AM

Data source: Data 5 in Notebook 1

Group	**N**	**Missing**	**Median**	**25%**	**75%**
Control	8	0	1.410	0.991	1.571
DC-6/7	8	0	1.178	1.049	1.571
DC-11/12	8	0	1.249	0.997	1.571
DC-13	8	0	1.249	1.178	1.571
OC-22	8	0	1.410	1.107	1.571
OC-24/25	8	0	1.178	1.049	1.571

H = 1.042 with 5 degrees of freedom. (P = 0.959)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.959)

Test 3 Ash-free Biomass per Initial Organism (Log 10 Transformed)

One Way Analysis of Variance Friday, April 01, 2011, 10:44:12 AM

Data source: Data 3 in Biomass stats (3-31-11)

Dependent Variable: log10(col(2))

Normality Test: Passed (P = 0.154)

Equal Variance Test: Passed (P = 0.114)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
Control	8	0	0.401	0.233	0.0824
DC-6/7	8	0	0.282	0.0986	0.0348
DC-11/12	8	0	0.173	0.120	0.0424
DC-13	8	0	0.380	0.191	0.0674
OC-22	8	0	0.371	0.125	0.0441
OC-24/25	8	0	0.314	0.247	0.0872

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Between Groups	5	0.286	0.0573	1.799	0.134
Residual	42	1.337	0.0318		
Total	47	1.623			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.134).

Test 3 Individual Ash-Free Weight

One Way Analysis of Variance Sunday, January 09, 2011, 2:44:01 AM

Data source: Data 6 in Notebook 1

Normality Test: Passed (P > 0.050)

Equal Variance Test: Passed (P = 0.143)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	3.098	1.118	0.395
DC-6/7	8	0	2.424	0.732	0.259
DC-11/12	8	0	1.921	0.718	0.254
DC-13	8	0	2.915	0.895	0.316
OC-22	8	0	2.642	0.548	0.194
OC-24/25	8	0	2.733	0.582	0.206

Source of Variation	DF	SS	MS	F	P
Between Groups	5	6.845	1.369	2.196	0.073
Residual	42	26.188	0.624		
Total	47	33.033			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.073).

TEST 4

Test 4 Survival

One Way Analysis of Variance Sunday, January 30, 2011, 8:27:45 PM

Data source: Test 6 Survival in Stats

Dependent Variable: asinsqrt(col(2))

Normality Test: Passed (P = 0.624)

Equal Variance Test: Passed (P = 0.782)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.199	0.252	0.0892
GC-1	6	0	1.255	0.297	0.121
AD-1	4	0	1.123	0.171	0.0857

Source of Variation	DF	SS	MS	F	P
Between Groups	2	0.0422	0.0211	0.325	0.728
Residual	15	0.975	0.0650		
Total	17	1.018			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.728).

Test 4 Ash-free Biomass per Initial Organism

One Way Analysis of Variance Sunday, February 13, 2011, 6:16:45 PM

Data source: Test 6 Dry and Ash-free Biomass per Initial Organism Data in Stats(2-13-11)

Dependent Variable: ABM/IO

Normality Test: Passed (P = 0.581)

Equal Variance Test: Passed (P = 0.660)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
Control	8	0	1.130	0.192	0.0678
GC-1	6	0	1.140	0.248	0.101
AD-1	4	0	1.368	0.310	0.155

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Between Groups	2	0.170	0.0850	1.495	0.256
Residual	15	0.853	0.0569		
Total	17	1.023			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.256).

Test 6 Individual Ash-Free Weight

One Way Analysis of Variance Sunday, January 30, 2011, 8:31:24 PM

Data source: Data 12 in Stats

Dependent Variable: Mass

Normality Test: Passed (P = 0.263)

Equal Variance Test: Passed (P = 0.561)

Group Name	N	Missing	Mean	Std Dev	SEM
Control	8	0	1.388	0.220	0.0778
GC-1	6	0	1.374	0.297	0.121
AD-1	4	0	1.719	0.323	0.162

Source of Variation	DF	SS	MS	F	P
Between Groups	2	0.355	0.177	2.433	0.122
Residual	15	1.093	0.0729		
Total	17	1.448			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.122).

Appendix E. Chain of Custody sheets

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638
Client No:
SDG No:
L

Date Shipped: 10/21/2010
Carrier Name: FedEx
Airbill: 7940 3070 4592
Shipped to: USACE-ERDC
3909 Halls Ferry Road
Vicksburg MS 39180
(601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/21/10 1600	[signature]	22Oct10 1400
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
DC-11/12	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	DC-11/12	S: 10/19/2010 15:25	
DC-6/7	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	DC-6/7	S: 10/19/2010 12:15	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 111573-4
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? ___ Shipment Iced? ___

TR Number: 5-350091276-102110-0007

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F2V5.1.047 Page 1 of 1

EPA **USEPA Contract Laboratory Program**
Generic Chain of Custody

Reference Case 40638 L
Client No:
SDG No:

Date Shipped:	10/20/2010
Carrier Name:	FedEx
Airbill:	7963 6192 4898
Shipped to:	USACE-ERDC 3909 Halls Ferry Road Vicksburg MS 39180 (601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] FOR MATT BEER

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/20/10 1600	Burton Suedel	10/21/10 1330
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
OC-22	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-22	S: 10/19/2010 10:35	
OC-24/25	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-24/25	S: 10/19/2010 9:25	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 110190- 110191
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? ___ Shipment Iced? ___

TR Number: 5-350091276-102010-0008

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F2V5.1.047 Page 1 of 1

EPA **USEPA Contract Laboratory Program**
Generic Chain of Custody

Reference Case 40638
Client No:
SDG No:
L

Date Shipped:	10/19/2010
Carrier Name:	FedEx
Airbill:	7940 2355 4020
Shipped to:	USACE-ERDC 3909 Halls Ferry Road Vicksburg MS 39180 (601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/19/10 1600	Burton Suedel	10/20/10 1315
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
✓OC-12/13	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-12/13	S: 10/15/2010 13:40	
✓OC-16	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-16	S: 10/15/2010 10:15	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 111570-1
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? __ Shipment Iced? __

TR Number: 5-350091276-101910-0005

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F2V5.1.047 **Page 1 of 1**

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638 L
Client No:
SDG No:

Date Shipped:	10/18/2010
Carrier Name:	FedEx
Airbill:	7963 5281 7796
Shipped to:	USACE-ERDC 3909 Halls Ferry Road Vicksburg MS 39180 (601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/18/10 1700	Burton Suedel	10/19/10 1310
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
AD-1	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	AD-1	S: 10/14/2010 10:31	
GC-1	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	GC-1	S: 10/14/2010 14:57	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 111147-8
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? __ Shipment Iced? __

TR Number: 5-350091276-101810-0005

LABORATORY COPY

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F2V5.1.047 **Page 1 of 1**

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638
Client No:
SDG No:
L

Date Shipped: 10/18/2010
Carrier Name: FedEx
Airbill: 7940 1987 1234
Shipped to: USACE-ERDC
3909 Halls Ferry Road
Vicksburg MS 39180
(601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/18/10 1400	Burton Suedel	10/19/10 1310
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
✓DC-3	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	DC-3	S: 10/13/2010 9:42	
✓DC-5	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	DC-5	S: 10/14/2010 10:50	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 111143-4
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? __ Shipment Iced? __

TR Number: 5-350091276-101810-0004

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 15000 Conference Center Dr., Chantilly, VA. 20151-3819 Phone 703/818-4200; Fax 703/818-4602

LABORATORY COPY

F2V5.1.047 **Page 1 of 1**

EPA **USEPA Contract Laboratory Program**
Generic Chain of Custody

Reference Case 40638
Client No:
SDG No:
L

Date Shipped:	10/13/2010
Carrier Name:	FedEx
Airbill:	7940 0581 3853
Shipped to:	USACE-ERDC 3909 Halls Ferry Road Vicksburg MS 39180 (601) 634-4578

Chain of Custody Record

Sampler Signature: Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1		10/13/10 1600		10/14/10 1300
2				
3				
4				

For Lab Use Only

Lab Contract No: ____
Unit Price: ____
Transfer To: ____
Lab Contract No: ____
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
OC-6/7(2)-01	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-6/7(2)-01	S: 10/11/2010 15:10	
OC-9-10	Sediment/ Matt Beer	L/G	TOX (21)	(Ice Only) (1)	OC-9-10	S: 10/7/2010 14:30	

Shipment for Case Complete ?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 103374, 75
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? __ Shipment Iced? __

TR Number: 5-350091276-101310-0005

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 15000 Conference Center Dr., Chantilly, VA. 20151-3819 Phone 703/818-4200; Fax 703/818-4602

F2V5.1.047 Page 1 of 1

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638 L
Client No:
SDG No:

Date Shipped:	10/13/2010
Carrier Name:	FedEx
Airbill:	7940 0581 3853
Shipped to:	USACE-ERDC 3909 Halls Ferry Road Vicksburg MS 39180 (601) 634-4578

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/13/10 1600	Burton Suedel	10/14/10 1300
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
OC-4	Sediment/ Matt Beer	L/G	TOX (21)	(Ice Only) (1)	OC-4	S: 10/7/2010 15:15	
OC-5a-01	Sediment/ Matt Beer	L/C	TOX (21)	(Ice Only) (1)	OC-5a-01	S: 10/8/2010 13:15	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 103374, 7
Analysis Key: TOX = Toxicity	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? ___ Shipment Iced? ___

TR Number: 5-350091276-101310-0004

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 15000 Conference Center Dr., Chantilly, VA. 20151-3819 Phone 703/818-4200; Fax 703/818-4602

F2V5.1.047 Page 1 of 1

Appendix F. Data Sheets for Chironomus dilutus sediment bioassays

Testing for Duck and Otter Creeks data gap and confluence site investigations were conducted simultaneously. The test number in the data sheets corresponds to when the sediments were evaluated. For the data gap investigation, test 4 described in the report corresponds with test 6 in the data sheets.

TEST 1

Initial Growth Information

Project: GLNPO-Otter and Duck Creek test 1

Day: 0
Date: 10/29/10

Initials of Technician performing masss determinations: DF
Date inial mass determined: 10/30/10

Replicate	Pan #	No. animals on pan	Pan Weight (g)	Pan & animal dry weight (g)
1	1	5	0.115	0.11556
2	2	5	0.115	0.11692

Signature: [signature]

Disclosed and Understood by: [signature]

Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 1

Test Day: 0 Date: 10-29-10 Time: 10:30 Technician initials: JW

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	24.2	7.28	8.0	80	75	221	<1
Control	B	24.1	7.31	7.9			220	
Control	C	24.0	7.39	7.5			205	
Control	D	24.0	7.46	7.5			235	
Control	E	24.0	7.38	7.4			185	
Control	F	24.1	7.26	7.9			204	
Control	G	24.1	7.19	8.0			235	
Control	H	23.9	7.23	7.7			226	
OC-4	A	24.0	8.01	8.0	85	90	290	<1
OC-4	B	24.0	8.02	7.9			280	
OC-4	C	24.0	8.01	7.3			275	
OC-4	D	24.0	7.99	7.2			260	
OC-4	E	24.0	8.03	7.3			275	
OC-4	F	24.0	7.92	7.8			266	
OC-4	G	23.9	7.93	7.5			268	
OC-4	H	24.0	8.02	7.4			270	
OC-6/7	A	23.9	8.03	7.3	85	90	256	<1
OC-6/7	B	24.0	8.02	7.2			240	
OC-6/7	C	24.0	8.11	7.4			226	
OC-6/7	D	23.9	8.05	7.5			238	
OC-6/7	E	23.9	8.07	7.5			239	
OC-6/7	F	23.9	8.07	7.8			242	
OC-6/7	G	24.0	8.03	7.5			268	
OC-6/7	H	23.9	8.00	7.7			261	
OC-5A-01	A	23.8	7.52	7.8	90	95	280	<1
OC-5A-01	B	23.9	7.53	7.6			278	
OC-5A-01	C	24.0	7.51	7.3			275	
OC-5A-01	D	24.0	7.42	7.5			253	
OC-5A-01	E	24.0	7.53	7.4			257	
OC-5A-01	F	24.0	7.50	7.4			265	
OC-5A-01	G	23.9	7.41	7.3			269	
OC-5A-01	H	24.0	7.28	7.2			268	
DC-3	A	23.9	8.03	8.00	90	90	262	<1
DC-3	B	23.5	8.01	7.99			269	
DC-3	C	24.0	7.98	7.95			280	
DC-3	D	24.0	7.92	7.95			274	
DC-3	E	23.9	7.93	7.91			276	
DC-3	F	23.9	7.85	7.9			282	
DC-3	G	24.0	7.95	7.9			273	
DC-3	H	24.0	8.00	7.7			272	

Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 1

Test Day: 0 Date: 10-28-10 Time: 10.30 Technician initials: JW

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-9-10	A	24.0	7.29	7.4	80	94	225	<1
OC-9-10	B	24.0	7.41	7.3			228	
OC-9-10	C	24.0	7.43	7.2			223	
OC-9-10	D	23.9	7.42	7.2			225	
OC-9-10	E	24.0	7.41	7.3			200	
OC-9-10	F	24.0	7.38	7.4			185	
OC-9-10	G	24.0	7.40	7.5			204	
OC-9-10	H	24.0	7.43	7.4			220	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: [signature]

Disclosed and Understood by: [signature]

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 1

Test Day: 10 Date: 11-8-10 Time: 10:30 Technician initials: JW/JS

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	20.0	7.38	7.8	80	74	237	<1
Control	B	19.9	7.54	7.8 [55]			280	
Control	C	20.0	7.51	7.7			227	
Control	D	20.0	7.48	7.6			225	
Control	E	20.0	7.49	7.8			230	
Control	F	19.9	7.57	7.9			222	
Control	G	20.0	7.61	7.8			243	
Control	H	20.0	7.61	7.7			245	
OC-4	A	20.0	8.08	7.7	140	180	380	<1
OC-4	B	20.0	8.25	7.9			377	
OC-4	C	20.1	8.37	7.7			380	
OC-4	D	20.1	8.58	7.9			384	
OC-4	E	20.1	8.62	7.9			372	
OC-4	F	20.1	8.67	7.5			383	
OC-4	G	20.1	8.62	7.4			381	
OC-4	H	19.9	8.61	7.0			384	
OC-6/7	A	19.9	8.48	7.8	140	160	384	<1
OC-6/7	B	20.1	8.49	7.7			382	
OC-6/7	C	20.1	8.45	7.4			377	
OC-6/7	D	20.1	8.45	7.4			378	
OC-6/7	E	20.0	8.51	7.6			385	
OC-6/7	F	20.0	8.52	7.7			383	
OC-6/7	G	20.1	8.47	7.8			380	
OC-6/7	H	20.1	8.44	7.8			376	
OC-5A-01	A	20.2	8.47	7.8	140	140	381	4
OC-5A-01	B	20.1	8.45	7.3			380	
OC-5A-01	C	20.1	8.44	7.4			382	
OC-5A-01	D	20.1	8.47	7.4			382	
OC-5A-01	E	20.1	8.51	7.6			378	
OC-5A-01	F	20.1	8.50	7.6			379	
OC-5A-01	G	20.1	8.47	7.5			384	
OC-5A-01	H	20.1	8.56	7.6			383	
DC-3	A	20.1	8.42	7.5	120	120	335	<1
DC-3	B	20.2	8.36	7.6			325	
DC-3	C	20.3	8.29	7.4			330	
DC-3	D	20.3	8.35	7.3			336	
DC-3	E	20.1	8.34	7.7			331	
DC-3	F	20.2	8.39	7.8			338	
DC-3	G	20.1	8.41	7.5			332	
DC-3	H	20.1	8.42	7.6			333	

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 1

Test Day: 10 Date: 11-8-10 **Time:** 10:30 **Technician initials:** JL/SS

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-9-10	A	20.0	8.44	7.2	100	80	250	<1
OC-9-10	B	19.9	8.68	7.8			245	
OC-9-10	C	20.1	8.64	7.3			255	
OC-9-10	D	20.0	8.63	7.0			253	
OC-9-10	E	20.2	8.68	7.4			257	
OC-9-10	F	20.2	8.60	7.4			249	
OC-9-10	G	20.1	8.68	7.0			253	
OC-9-10	H	20.1	8.71	7.3			250	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: ______

Disclosed and Understood by: ______

Daily Overlying Water Temperature (°C) and D.O. (mg/L), Feeding and Maintenance Checklist

Test Day	1		2		3		4		5		6		7		8		9	
	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.
Control	22	5.98	23	6.04	23.1	4.30	22.9	5.39	22.5	8.26	22.4	7.75	22.4	7.83	22.8	7.83	22.7	7.51
OC-4	22	5.53	23	4.87	23.0	3.25	22.8	4.11	22.6	7.92	22.3	7.83	22.4	7.76	23.0	7.75	22.6	7.68
OC-6/7	22	4.73	23	6.06	23.1	2.81	22.8	3.28	22.5	8.30	22.3	8.10	22.4	7.87	23.1	7.68	22.6	7.63
OC-5A-01	22	5.54	23	5.78	23.0	4.92	22.8	4.95	22.5	7.88	22.4	7.87	22.4	7.85	23.2	7.77	22.7	7.70
DC-3	22	3.68	23	5.63	23.0	2.75	22.7	2.86	22.4	8.13	22.4	7.93	22.5	7.91	23.1	7.7	22.6	7.78
OC-9-10	22	5.58	23	5.05	23.0	4.15	22.8	4.60	22.5	8.14	22.4	7.88	22.4	7.93	23.2	7.7	22.7	7.69
Water Exchanged AM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Water Exchanged PM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Fed?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Aeration OK?	–		–		–		–		✓		✓		✓		✓		✓	
Zumwalt needles clear?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Timer OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Remcor OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Daily Observations Recorded?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Technician intials/date	DF		DF		DF		DF		DF		DF		DF		DF		DF	

If temperature falls outside the range of 20-26°C or dissolved oxygen falls below 2.5 mg/L contact the study coordinator

Signature: [signature]

Disclosed and Understood by: [signature]

Daily Observations

Day: -1

Date: 10/28/16 **Technician Initials:** DF, JG
Time: PM

Water exchange counter: N/A

Comments: Added Sediment to exposure Chambers. Sediments OC-4 and OC-5A had distinct chemical odor. Both sediments contained grass. Sediment OC-9-10 contained rocks. Sediment OC-6/7 contained sticks. OC-3 was very sandy and compact. Placed beakers into waterbath at 23°C and under 16:8 L:D cycle. Test setup as described in EPA guidance document. Pore water NH_3 measured.

Day: 0

Date: 10/29/16 **Technician Initials:** DF, JS
Time: PM

Water exchange counter: N/A

Comments: Counted out midge larvae and added 10 to each exposure chamber following WQ measurements. 1 water exchange was conducted prior to adding animals and measuring WQ. Animals were fed (6mg tetramin per beaker).

Daily Observations

Day: 1

Date: 10/30/31 **Technician Initials:** DF

Time: 9am

Water exchange counter: N/A

Comments: Measured and recorded D.O. and temp for 1 replicate of each sediment. Performed water exchange. Fed animals.

Day: 2

Date: 10/31/16 **Technician Initials:** DF

Time: 9am

Water exchange counter: N/A

Comments: Recorded D.O. and temp on single replicate of each sediment. Fed animals. Performed water exchange prior to feeding. Animals in [illegible] and [illegible] appear to be not constructing tubes. Animals alive but sitting on sediment surface.

Daily Observations

Day: 3

Date: 11/1/16 **Technician Initials:** DF
Time: PM

Water exchange counter: N/A

Comments: D.O. was low in some tests. Will have to watch closely over next few days as food is added to ensure it does not drop below 2.5 mg/L. Recorded daily temp & D.O. and fed following water exchange.
AM - water exchange conducted by J. Williams

Day: 4

Date: 11/2/16 **Technician Initials:** DF
Time: AM/PM

Water exchange counter: N/A

Comments: AM water exchange conducted. DO's were low so all beakers placed on air. OC-5A and OC-4 appear to contain dead animals.

PM water exchange conducted. Animals fed.

Daily Observations

Day: 5

Date: 1/13/16 **Technician Initials:** DF

Time: PM

Water exchange counter: N/A

Comments: D.O.s much higher after aeration. Took DO and Temp on 1 rep per test. Performed AM & PM water exchange. Fed animals.

Day: 6

Date: 1/14/16 **Technician Initials:** DF

Time: PM

Water exchange counter: N/A

Comments: AM & PM water exchange conducted. Recorded daily WQ prior to PM exchange. Fed animals. OC-4 still has live animals on surface. They are not building tubes.

Daily Observations

Day: 7

Date: 11/5/16 **Technician Initials:** DJS
Time: Pm

Water exchange counter: NA

Comments: Am & Pm water exchange conducted. Daily D.O. & Temp recorded. Animals fed.

Day: 8

Date: 11/06/16 **Technician Initials:** [illegible]
Time: PM

Water exchange counter: ________

Comments: WATER CHANGE CONDUCTED. MODULE TEMP. @ 22.5 °C. Animals fed.

Daily Observations

Day: 9

Date: 11/07/10 **Technician Initials:** [illegible]

Time: 0959

Water exchange counter:________

Comments: MOD. TEMP. @ 22.7° (ADJUSTED SENSOR DOWN TO LOWER TEMP.), WATER CHANGE CONDUCTED.

PM ~~[illegible]~~ - H2O Conducted following daily procedure. Animals fed.

Day: 10

Date: 11-8-16 **Technician Initials:** JW

Time: 10:30

Water exchange counter:________

Comments: Breakdown conducted as described in EPA guidance document. Found planarians in several beakers. Beakers containing the flatworms had no survival and appear to be outliers. Flatworms may be eating Chironomids?

Signature: [signature]

Disclosed and Understood by: [signature]

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 1

Day: 10

Date: 11-8-16 Time: AM

Initials of Technician performing masss determinations: JW, DF

Date dry mass determined: —

Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments
Control	A	DF	10	9	1	46.432	66.768	53.946	1 Pupae
Control	B		9	8	2	51.867	68.300	56.884	1 Pupae
Control	C		10	10	3	46.616	68.042	54.492	
Control	D		8	8	4	46.618	62.688	51.048	
Control	E		10	10	5	51.940	72.928	60.124	
Control	F		9	9	6	50.070	69.054	57.926	
Control	G		10	9	7	53.966	80.508	58.562	1 pupae
Control	H		9	9	8	55.194	81.410	68.906	
OC-4	A	JW	6	6	9	48.616	49.980	48.386	
OC-4	B		5	5	10	48.334	49.550	48.639	
OC-4	C		1	1	11	49.160	49.746	49.344	
OC-4	D		6	6	12	47.585	49.268	47.964	
OC-4	E		0	0		—	—	—	1 flatworm
OC-4	F		7	7	13	45.208	48.119	46.890	
OC-4	G		3	3	15	50.466	51.906	50.908	
OC-4	H		5	5	16	55.604	57.674	56.056	
OC-6/7	A		10	10	17	48.417	64.790	52.874	
OC-6/7	B		0	0	18	—	—	—	1 flatworm
OC-6/7	C		10	10	19	52.278	69.660	56.718	
OC-6/7	D		9	9	20	53.778	70.558	58.366	
OC-6/7	E		7	7	21	56.130	67.693	59.139	
OC-6/7	F		9	9	22	49.242	65.026	52.492	
OC-6/7	G		10	10	23	55.350	72.146	56.829	
OC-6/7	H		8	8	24	64.437	76.520	67.252	

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 1

Day: 10
Date: 11-8-10 Time: AM

Initials of Technician performing masss determinations: JW, DF

Date dry mass determined: —

Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments
OC-5A-01	A	JW	7	7	25	50.912	55.626	52.474	
OC-5A-01	B		6	6	26	60.229	61.736	60.620	
OC-5A-01	C		9	9	27	57.280	65.536	59.906	
OC-5A-01	D		7	7	28	64.360	68.227	65.330	
OC-5A-01	E		3	3	29	46.044	48.902	48.366	
OC-5A-01	F		10	10	30	49.136	53.632	50.000	
OC-5A-01	G		9	9	31	53.314	57.746	54.636	
OC-5A-01	H		5	5	32	49.716	51.948	50.330	
DC-3	A		8	8	33	56.278	76.141	62.464	
DC-3	B		10	10	34	50.310	72.576	56.734	
DC-3	C		10	10	35	51.312	71.459	56.834	
DC-3	D		4	4	36	53.230	62.898	55.242	
DC-3	E		3	3	37	54.082	61.158	55.766	
DC-3	F		5	5	38	54.246	67.637	54.986	
DC-3	G		0	0	39	—	—	—	1 flatworm
DC-3	H		9	9	40	42.770	65.454	50.088	
OC-9-10	A		7	7	41	54.552	63.800	57.598	
OC-9-10	B		8	8	42	50.730	62.036	54.006	
OC-9-10	C		9	9	43	49.432	58.696	51.602	
OC-9-10	D		10	10	44	51.207	62.834	55.212	
OC-9-10	E		10	10	45	53.110	63.567	55.464	
OC-9-10	F		0	0	46	—	—	—	1 flatworm
OC-9-10	G		9	9	47	47.766	55.770	49.602	
OC-9-10	H		5	5	48	47.999	52.724	49.468	

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 1

Day: 10 Initials of Technician performing masss determinations: JW, DF

Date: 11-8-16 Time: Am Date dry mass determined: — Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments

Signature: [signature]

Disclosed and Understood by: [signature]

Test 2

Initial Growth Information

Project: GLNPO-Otter and Duck Creek test 2

Day: 0
Date: 11/12/10

Initials of Technician performing masss determinations: DF
Date inial mass determined: 11/13/10

Replicate	Pan #	No. animals on pan	Pan Weight (g)	Pan & animal dry weight (g)
1	1	10	0.0781	0.07534
2	2	10	0.0657	0.07110

Signature:

Disclosed and Understood by:

Daily Overlying Water Temperature (°C) and D.O. (mg/L), Feeding and Maintenance Checklist

Test Day	1		2		3		4		5		6		7		8		9	
	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.
Control	22.2	3.8	22.3	6.93	21.9	7.2	22.4	6.80	22.3	7.10	22.7	7.03	22.4	7.03	22.5	7.03	23.0	6.99
DC-5	22.3	4.2	22.3	7.04	22.0	7.18	22.3	7.01	22.3	7.08	22.8	7.01	22.3	6.98	22.6	7.04	22.9	6.98
AD-1	22.2	4.2	22.3	7.26	22.0	7.05	22.3	6.99	22.4	7.03	22.6	6.98	22.4	6.97	22.6	7.04	22.9	6.93
GC-1	22.2	4.7	22.3	7.03	22.1	7.03	22.5	6.98	22.4	7.07	22.6	6.97	22.4	6.98	22.7	7.03	22.5	6.98
OC-12/13	22.2	3.5	22.3	7.21	22.1	7.02	22.5	7.05	22.4	7.04	22.6	7.01	22.4	6.98	22.6	7.03	23.0	6.95
OC-16	22.3	3.2	22.3	7.05	22.6	7.00	22.5	7.11	22.3	7.06	22.6	7.01	22.4	7.01	22.6	7.02	22.9	6.85
Water Exchanged AM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Water Exchanged PM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Fed?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Aeration OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Zumwalt needles clear?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Timer OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Remcor OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Daily Observations Recorded?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Technician Intials/date	DF/11/13		DF/11/14		DF/11/15		DF/11/16		DF/11/17		DF/11/18		DF/11/19/16		DF/11/20/16		DF/11/21/16	

If temperature falls outside the range of 20-26°C or dissolved oxygen falls below 2.5 mg/L contact the study coordinator

Signature: ____________

Disclosed and Understood by: ____________

Daily Observations

Day: -1

Date: 11/11/16 **Technician Initials:** DF
Time: pm

Water exchange counter: N/A

Comments: Sediment homogenized and added to beakers. Beakers placed in exposure chamber after addition of overlying water. Chamber temp set at 23°C. Light cycle at 16:8 L:D. Test setup as described in EPA Guidance document. Measured parameters daily

Day: 0

Date: 11/12/16 **Technician Initials:** DF, DM
Time: pm

Water exchange counter: N/A

Comments: Water exchange conducted on beakers in Am. WQ Parameters recorded in the pm prior to addition of organisms. Ten chironomids (~11 days old) added to each beaker. Two pans containing 10 chironomids each placed in oven for initial wt. determination

Daily Observations

Day: 1

Date: 11/13/16 **Technician Initials:** DF
Time: Am/pm

Water exchange counter: N/A

Comments: Am & Pm water exchange conducted. Daily D.O. & temp recorded. D.O.s were generally low. Based on experience of low D.O.s in test 1, all beakers were placed on air. animals fed.

Day: 2

Date: 11/14/16 **Technician Initials:** DF
Time: ________

Water exchange counter: N/A

Comments: Water exchanges conducted. Animals fed. Daily WQ recorded.

Daily Observations

Day: 3

Date: 11/15/16 **Technician Initials:** DF

Time: PM

Water exchange counter: N/A

Comments: water exchange conducted. Parameters recorded. animals fed.

Day: 4

Date: 11/16/16 **Technician Initials:** DF

Time: PM

Water exchange counter: N/A

Comments: Water exchange conducted. Parameters recorded prior to water exchange. animals fed.

Daily Observations

Day: 5

Date: 11/17/10 **Technician Initials:** DF

Time: AM/PM

Water exchange counter: N/A

Comments: AM & PM water exchange conducted. Daily parameters recorded. Animals fed, aeration good on all beakers.

Day: 6

Date: 11/18/10 **Technician Initials:** DF

Time: AM/PM

Water exchange counter: N/A

Comments: AM & PM H_2O exchange conducted. Daily parameters recorded. Animals fed.

Daily Observations

Day: 7

Date: 11/19/16 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Conducted Am & Pm water exchange. Recorded daily parameters. Fed organisms.

Day: 8

Date: 11/20/16 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Am & Pm water exchange conducted. Daily parameters recorded. Animals fed.

Daily Observations

Day: 9

Date: 11/21/10 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Performed Am + Pm water exchange. Recorded daily WQ parameters. Fed animals. Found 1 floater in Control rep B. Floater appeared healthy and was sunk with a water droplet.

Day: 10

Date: 11/22/10 **Technician Initials:** [illegible]

Time: 1140

Water exchange counter:

Comments: MODULE TEMP. @ 22.0°C; TEST TERMINATION DAY; PARAMETERS TEMP. pH, D.O. Test broken down as described in EPA guidance document. Flatworms found in tests with low survival. Flatworms may be eating Chironomids.

Signature: [signature]

Disclosed and Understood by: [signature]

Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 2

Test Day: 0 Date: 11-12-16 Time: Am Technician initials: DF

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	24.1	7.42	7.8	70	65	222	<1
Control	B	24.1	7.44	7.8			235	
Control	C	24.1	7.51	7.6			225	
Control	D	24.1	7.48	7.8			230	
Control	E	24.2	7.39	7.9			219	
Control	F	24.1	7.27	7.8			220	
Control	G	24.1	7.41	7.5			220	
Control	H	24.1	7.49	7.6			226	
DC-5	A	24.2	7.77	7.2	120	140	350	<1
DC-5	B	24.1	7.63	7.1			375	
DC-5	C	24.1	7.65	6.9			316	
DC-5	D	24.1	7.64	6.9			380	
DC-5	E	24.1	7.52	7.1			400	
DC-5	F	24.2	7.52	7.0			390	
DC-5	G	24.2	7.58	6.5			365	
DC-5	H	24.0	7.67	6.9			370	
AD-1	A	24.1	7.71	7.6	140	160	370	<1
AD-1	B	24.1	7.71	7.5			385	
AD-1	C	24.1	7.76	7.8			366	
AD-1	D	24.2	7.80	7.6			372	
AD-1	E	24.1	7.65	7.7			350	
AD-1	F	24.1	7.71	7.8			345	
AD-1	G	24.2	7.73	7.9			325	
AD-1	H	24.1	7.72	7.8			370	
GC-1	A	24.2	7.52	7.2	160	180	390	<1
GC-1	B	24.2	7.57	7.3			380	
GC-1	C	24.1	7.60	7.5			370	
GC-1	D	24.2	7.71	7.2			375	
GC-1	E	24.1	7.68	7.1			372	
GC-1	F	24.1	7.55	7.1			377	
GC-1	G	24.1	7.59	7.2			383	
GC-1	H	24.2	7.62	7.1			391	
OC-12/13	A	24.1	7.71	7.6	110	100	353	<1
OC-12/13	B	24.1	7.68	7.7			355	
OC-12/13	C	24.1	7.67	7.7			360	
OC-12/13	D	24.2	7.72	7.9			354	
OC-12/13	E	24.1	7.72	7.8			367	
OC-12/13	F	24.1	7.73	7.8			371	
OC-12/13	G	24.1	7.64	7.7			378	
OC-12/13	H	24.2	7.71	7.2			380	

Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 2

Test Day: 0 **Date:** 11-12-10 **Time:** Am **Technician initials:** DF

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-16	A	24.3	8.10	7.5	110	120	370	<1
OC-16	B	24.2	7.58	7.5			362	
OC-16	C	24.2	7.55	7.6			375	
OC-16	D	24.2	7.53	7.7			374	
OC-16	E	24.3	7.52	7.5			368	
OC-16	F	24.2	7.96	7.7			370	
OC-16	G	24.2	7.51	7.6			378	
OC-16	H	24.2	7.88	7.5			383	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: [signature]

Disclosed and Understood by: [signature]

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 2

Test Day: 10 Date: 11/22/10 Time: 1140 Technician initials: S.S.

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	21.2	7.71	7.7	60	80	200	<1
Control	B	21.5	7.68	7.3			193	
Control	C	21.4	7.62	7.6			218	
Control	D	21.1	7.64	7.9			200	
Control	E	21.1	7.66	7.9			192	
Control	F	21.1	7.65	7.9			185	
Control	G	21.2	7.58	7.2			225	
Control	H	21.1	7.53	7.8			215	
DC-5	A	20.8	7.82	7.5	140	160	420	<1
DC-5	B	21.9	7.80	7.3			462	
DC-5	C	20.9	7.48	7.7			407	
DC-5	D	21.8	7.61	7.7			438	
DC-5	E	21.9	7.63	6.8			430	
DC-5	F	21.8	8.05	7.5			430	
DC-5	G	21.9	7.71	7.8			415	
DC-5	H	21.9	7.78	7.6			448	
AD-1	A	21.9	8.24	8.0	~~220~~ 180	180	465	<1
AD-1	B	21.2	8.21	7.9			550	
AD-1	C	21.9	8.31	7.8			530	
AD-1	D	21.9	8.28	7.4			565	
AD-1	E	21.5	8.25	7.3			540	
AD-1	F	22.8	8.33	7.8			522	
AD-1	G	22.9	8.37	7.7			480	
AD-1	H	21.8	8.21	7.7			490	
GC-1	A	21.8	8.03	7.4	200	200	510	<1
GC-1	B	21.9	8.35	7.9			485	
GC-1	C	21.8	8.31	7.8			510	
GC-1	D	21.7	8.39	8.1			515	
GC-1	E	21.8	8.43	8.0			466	
GC-1	F	21.9	8.39	7.7			505	
GC-1	G	21.9	8.41	7.9			496	
GC-1	H	21.8	8.41	7.7			498	
OC-12/13	A	21.8	8.37	7.7	132	120	386	<1
OC-12/13	B	21.5	8.21	7.5			408	
OC-12/13	C	21.6	8.22	7.2			425	
OC-12/13	D	21.8	8.22	7.2			390	
OC-12/13	E	21.5	8.20	7.3			420	
OC-12/13	F	21.7	8.26	7.3			426	
OC-12/13	G	21.7	8.11	7.3			407	
OC-12/13	H	21.8	8.20	7.4			460	

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 2

Test Day: 10 **Date:** 11/22/10 **Time:** 1005 **Technician initials:** JS, JW

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-16	A	21.4	8.34	7.5	140	121	390	<1
OC-16	B	21.4	8.41	7.3			385	
OC-16	C	21.4	8.37	7.5			402	
OC-16	D	21.5	8.38	7.4			385	
OC-16	E	21.6	8.33	7.3			450	
OC-16	F	21.7	8.33	7.4			380	
OC-16	G	21.2	8.21	7.5			434	
OC-16	H	21.5	8.36	7.1			411	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: ______

Disclosed and Understood by: ______

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 2

Day: 10

Date: 11-22-10 **Time:** Pm

Initials of Technician performing masss determinations: JW, DF

Date dry mass determined: –

Date ash-free dry mass determined: –

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (g)	Pan & animal dry weight (g)	Pan & animal ash-free dry weight (g)	Comments
Control	A	DF	9	9	1	0.14731	0.16363	0.15205	
Control	B	JS	9	9	2	0.13572	0.15432	0.14122	
Control	C	JG	7	7	3	0.13265	0.14931	0.13780	
Control	D	JG	9	9	4	0.15073	0.17166	0.15738	
Control	E	JS	7	6	5	0.13340	0.15603	0.13946	1 pupae
Control	F	DF	9	8	6	0.14423	0.16655	0.14937	1 pupae
Control	G	DF	8	8	7	0.13517	0.16008	0.14338	
Control	H	DF	8	8	8	0.12823	0.14657	0.13391	
DC-5	A	JG	10	10	9	0.12201	0.13843	0.12765	
DC-5	B	JS	7	7	10	0.12625	0.13958	0.13006	
DC-5	C	JW	8	8	11	0.13826	0.15333	0.14336	
DC-5	D	JS	8	8	12	0.13185	0.14461	0.13558	
DC-5	E	JG	9	9	13	0.13174	0.14933	0.13789	
DC-5	F	JG	10	10	14	0.12721	0.14572	0.13227	
DC-5	G	JG	0	0	15	–	–	–	flatworms
DC-5	H	JS	9	9	16	0.14212	0.16105	0.14758	
AD-1	A	JG	0	0	17	–	–	–	flat worms
AD-1	B	JS	10	10	18	0.13368	0.15726	0.14186	
AD-1	C	JG	7	7	19	0.12833	0.14189	0.13233	.
AD-1	D	JS	1	1	20	0.13112	0.13233	0.13149	flat worms
AD-1	E	JS	4	4 0	21	0.13653	0.14722	0.13975	
AD-1	F	JS	0	0	22	–	–	–	flatworms
AD-1	G	JS	0	0	23	–	–	–	flatworms
AD-1	H	JS	0	0	24	–	–	–	flatworms

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 2

Day: 10

Date: 11-22-10 **Time:** Pm

Initials of Technician performing masss determinations: JW, DF

Date dry mass determined: —

Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (g)	Pan & animal dry weight (g)	Pan & animal ash-free dry weight (g)	Comments
GC-1	A	JS	1	1	25	0.14412	0.14775	0.14504	
GC-1	B	JW	6	6	26	0.13661	0.14602	0.13463	
GC-1	C	JS	0	0	27	—	—	—	flatworms
GC-1	D	JS	2	2	28	0.14063	0.14533	0.14199	flatworms
GC-1	E	JG	4	4	29	0.14665	0.15668	0.14958	
GC-1	F	JS	0	0	30	—	—	—	flatworms
GC-1	G	JW	4	4	31	0.14658	0.15936	0.15089	
GC-1	H	JG	0	0	32	—	—	—	flatworms
OC-12/13	A	JW	9	9	33	0.13757	0.15672	0.14225	
OC-12/13	B	JW	8	8	34	0.13566	0.15391	0.14121	
OC-12/13	C	JW	10	10	35	0.14663	0.16349	0.15138	
OC-12/13	D	JW	0	0	36				flatworms
OC-12/13	E	JW	10	10	37	0.13015	0.14823	0.13449	
OC-12/13	F	JW	10	10	38	0.14998	0.16668	0.15490	
OC-12/13	G	JW	10	10	39	0.14922	0.16492	0.15361	
OC-12/13	H	JS	8	8	40	0.13733	0.15391	0.14170	
OC-16	A	JS	10	10	41	0.13965	0.15715	0.14520	
OC-16	B	JS	8	8	42	0.13402	0.14722	0.13856	
OC-16	C	JS	8	8	43	0.15621	0.17353	0.16179	
OC-16	D	JS	10	10	44	0.13163	0.14642	0.13570	
OC-16	E	JS	10	10	45	0.14457	0.15937	0.14273	
OC-16	F	JS	9	9	46	0.14468	0.16369	0.15030	
OC-16	G	JG	9	9	47	0.13556	0.15933	0.14273	
OC-16	H	JS	1	1	48	0.15282	0.15375	0.15311	

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 2

Day: 10

Initials of Technician performing masss determinations: JW, PF

Date: 11-22-10 **Time:** PM

Date dry mass determined: — **Date ash-free dry mass determined:** —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (g)	Pan & animal dry weight (g)	Pan & animal ash-free dry weight (g)	Comments

Signature: [signature]

Disclosed and Understood by: [signature]

Test 3

Initial Growth Information

Project: GLNPO-Otter and Duck Creek test 3

Day: 0 **Initials of Technician performing masss determinations:** DF

Date: 11-19-10 **Date inial mass determined:** 11-20-10

Replicate	Pan #	No. animals on pan	Pan Weight (g)	Pan & animal dry weight (g)
1	1	10	0.12242	0.12453
2	2	10	0.10289	0.10457

Signature: [signature]

Disclosed and Understood by: [signature]

Daily Overlying Water Temperature (°C) and D.O. (mg/L), Feeding and Maintenance Checklist

Test Day	1		2		3		4		5		6		7		8		9	
	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.
Control	22.9	6.93	22.8	6.83	22.6	7.18	22.9	7.12	22.8	7.08	22.9	7.08	22.8	7.11	22.6	7.07	22.8	7.13
DC-6/7	22.7	6.98	22.7	6.85	22.7	7.13	22.9	7.05	22.7	7.09	23.0	7.03	22.8	7.12	22.7	7.12	22.8	7.10
DC-11/12	22.8	6.96	22.8	6.93	22.6	7.25	22.9	7.08	22.8	7.05	22.9	7.09	22.8	7.10	22.7	7.11	22.8	7.11
DC-13	22.5	7.01	22.8	6.87	22.6	7.26	22.9	7.06	22.8	7.08	22.9	7.10	22.8	7.09	22.6	7.12	22.8	7.0[illegible]
OC-22	22.8	7.01	22.8	6.84	22.6	7.13	22.9	7.05	22.9	7.03	22.1	7.11	22.8	7.11	22.8	7.20	22.8	7.13
OC-24/25	22.6	6.81	22.8	6.73	22.7	7.14	22.5	7.03	22.8	7.03	22.1	7.01	22.8	7.13	22.7	7.19	22.8	7.15
Water Exchanged AM?	✓		✓		✓		✓		✓		✓		✓				✓	
Water Exchanged PM?	✓		✓		✓		✓		✓		✓		✓				✓	
Fed?	✓		✓		✓		✓		✓		✓		✓				✓	
Aeration OK?	✓		✓		✓		✓		✓		✓		✓				✓	
Zumwalt needles clear?	✓		✓		✓		✓		✓		✓		✓				✓	
Timer OK?	✓		✓		✓		✓		✓		✓		✓				✓	
Remcor OK?	✓		✓		✓		✓		✓		✓		✓				✓	
Daily Observations Recorded?	✓		✓		✓		✓		✓		✓		✓				✓	
Technician intials/date	DF / 11/20/10		DF / 11/21/10		DF / 11/22/10		DF / 11/23/10		DF 11/24/10		DF / 11/25/10		DF 11/26/10		[illegible] 11/27/10		DF / 11/28/10	

If temperature falls outside the range of 20-26°C or dissolved oxygen falls below 2.5 mg/L contact the study coordinator

Signature: [signature]

Disclosed and Understood by: [signature]

Daily Observations

Day: -1

Date: 11/18/16 **Technician Initials:** DF, PM
Time: PM

Water exchange counter: N/A

Comments: Mixed sediments until homogenous with lightnin mixer. Added sediment to beakers as described in EPA guidance. Sediment descriptions are as follows: DC-11/12 - fine/silty sed, contains grass & twigs. OC-22 fine silty sediment with little organic matter. DC-6/7 - fine sediment with grass & twigs. OC-24/25 light in color, sandy. DC-13- sandy. Beakers will be aerated due to D.O. issues encountered in the previous 2 tests. Measured parameter NH_3.

Day: 0

Date: 11/19/16 **Technician Initials:** DF, PM
Time: PM

Water exchange counter: N/A

Comments: Recorded WQ parameters. Added 10 midge larvae to each beaker. Test setup as described in EPA guidance document. Initials placed on pre-weighed pans.

Daily Observations

Day: 1

Date: 11/2016 **Technician Initials:** DF
Time: Am/Pm

Water exchange counter: N/A

Comments: Am & Pm water exchange conducted, aeration adjusted. Daily parameters recorded. Animals fed. Tube building, animal behavior appears normal.

Day: 2

Date: 11/21/16 **Technician Initials:** DF
Time: Am/Pm

Water exchange counter: N/A

Comments: Am & Pm water exchange conducted. Daily parameters recorded. Animals fed. Aeration adjusted

Daily Observations

Day: 3

Date: 11/22/16 **Technician Initials:** DF
Time: AM/PM

Water exchange counter: N/A

Comments: Water exchanges conducted. Daily parameters recorded. Animals fed. Adjusted aeration rate down.

Day: 4

Date: 11/23/16 **Technician Initials:** DF
Time: AM/PM

Water exchange counter: N/A

Comments: AM 2 PM water exchange conducted. Daily parameters recorded. Animals fed.

Daily Observations

Day: 5

Date: 11/24/10 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Water exchanges conducted. Parameters recorded. Animals fed.

Day: 6

Date: 11-25-10 **Technician Initials:** JS

Time: 7:00

Water exchange counter:

Comments: Water change, aeration good on all beakers. Test look

Daily Observations

Day: 7

Date: 11/26/10 **Technician Initials:** DU
Time: AM/PM

Water exchange counter: N/A

Comments: Water exchange completed. Daily parameters recorded. animals fed.

Day: 8

Date: 11/27/10 **Technician Initials:** [illegible]
Time: 1600

Water exchange counter: N/A

Comments: HOLDING TEMP. @ 22.2°C, AERATION O.K., TEST FED. Parameters recorded.

Daily Observations

Day: 9

Date: 11/28/16 **Technician Initials:** DF

Time:

Water exchange counter: N/A

Comments: Water exchange conducted. Parameters recorded. Animals fed. Animal behavior appears normal.

Day: 10

Date: 11/29/16 **Technician Initials:** DF

Time: PM

Water exchange counter: N/A

Comments: Test terminated as described in EPA guidance documents.

Signature: [signature]

Disclosed and Understood by: [signature]

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 3

Test Day: ~~10~~ ED 0 Date: 11-19-10 Time: An Technician initials: DF

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	23.1	7.13	7.5	75	40	240	<1
Control	B	23.1	7.18	7.5			225	
Control	C	23.1	7.23	7.7			230	
Control	D	23.2	7.39	7.6			228	
Control	E	23.1	7.28	7.5			227	
Control	F	23.2	7.27	7.3			232	
Control	G	23.2	7.23	6.9			245	
Control	H	23.1	7.26	7.1			226	
DC-6/7	A	23.1	8.01	7.5	150	100	380	<1
DC-6/7	B	23.1	8.03	7.6			375	
DC-6/7	C	23.3	7.99	7.5			365	
DC-6/7	D	23.2	7.92	7.8			372	
DC-6/7	E	23.1	7.91	7.2			373	
DC-6/7	F	23.2	7.93	7.0			381	
DC-6/7	G	23.2	8.02	7.1			366	
DC-6/7	H	23.2	7.98	7.1			373	
DC-11/12	A	23.1	7.86	7.8	75	75	370	<1
DC-11/12	B	23.2	7.85	7.8			365	
DC-11/12	C	23.1	7.89	7.8			355	
DC-11/12	D	23.2	7.79	7.7			360	
DC-11/12	E	23.1	7.81	7.5			362	
DC-11/12	F	23.1	7.85	7.3			371	
DC-11/12	G	23.1	7.56	7.2			365	
DC-11/12	H	23.2	7.79	7.3			366	
DC-13	A	23.1	8.02	7.1	120	90	382	<1
DC-13	B	23.2	8.01	7.1			371	
DC-13	C	23.1	8.03	6.9			360	
DC-13	D	23.2	8.01	6.8			367	
DC-13	E	23.1	8.00	6.7			373	
DC-13	F	23.1	7.95	6.9			371	
DC-13	G	23.2	7.93	7.1			369	
DC-13	H	23.1	7.85	7.0			375	
OC-22	A	23.1	7.98	7.9	170	160	392	<1
OC-22	B	23.2	7.99	7.8			461	
OC-22	C	23.1	8.01	7.8			408	
OC-22	D	23.1	7.85	7.7			416	
OC-22	E	23.1	7.95	7.5			412	
OC-22	F	23.2	7.74	7.6			421	
OC-22	G	23.2	7.93	7.8			408	
OC-22	H	23.2	7.85	7.7			353	

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 3

Test Day: 10 Date: 11-19-16 Time: AM Technician initials: DF

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-24/25	A	23.2	7.77	6.9	120	96	325	<1
OC-24/25	B	23.2	7.78	7.0			316	
OC-24/25	C	23.2	7.76	7.1			386	
OC-24/25	D	23.2	7.73	7.1			390	
OC-24/25	E	23.2	7.65	6.8			375	
OC-24/25	F	23.2	7.71	6.5			365	
OC-24/25	G	23.2	7.68	6.8			328	
OC-24/25	H	23.2	7.65	6.7			333	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature:

Disclosed and Understood by:

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 3

Test Day: 10 Date: 11/29/10 Time: 1000 Technician initials: D.H. / [illegible]

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	23.3	7.10	8.6	80	30	245	<1
Control	B	23.5	7.27	8.1			228	
Control	C	23.6	7.42	8.2			221	
Control	D	23.5	7.55	8.1			226	
Control	E	23.6	7.61	7.6			227	
Control	F	23.5	7.68	7.7			231	
Control	G	23.3	7.71	8.1			225	
Control	H	23.2	7.71	8.1			226	
DC-6/7	A	23.5	8.05	7.5	150	120	460	<1
DC-6/7	B	23.1	7.69	3.0			515	
DC-6/7	C	23.5	8.03	7.1			460	
DC-6/7	D	23.2	8.02	7.8			450	
DC-6/7	E	23.3	8.00	7.9			460	
DC-6/7	F	23.3	7.87	7.3			419	
DC-6/7	G	22.9	8.03	7.1			465	
DC-6/7	H	23.1	7.88	6.9			450	
DC-11/12	A	22.9	7.89	7.6	40	75	370	1
DC-11/12	B	23.1	7.85	7.6			327	
DC-11/12	C	23.1	7.80	7.6			362	
DC-11/12	D	23.2	7.65	7.0			334	
DC-11/12	E	23.0	7.57	5.4			335	
DC-11/12	F	23.1	7.59	6.9			325	
DC-11/12	G	22.9	7.59	7.2			327	
DC-11/12	H	22.7	7.70	7.5			350	
DC-13	A	23.2	8.05	7.7	130	120	370	<1
DC-13	B	23.0	8.00	7.7			348	
DC-13	C	23.0	7.86	7.6			390	
DC-13	D	23.0	7.90	7.8			415	
DC-13	E	22.8	7.95	8.0			420	
DC-13	F	22.8	7.95	7.0			395	
DC-13	G	22.8	7.97	7.8			405	
DC-13	H	22.7	7.87	7.6			415	
OC-22	A	23.0	8.49	8.2	190	170	560	1
OC-22	B	23.0	8.49	8.4			545	
OC-22	C	23.0	8.19	7.7			525	
OC-22	D	23.0	8.42	7.5			535	
OC-22	E	23.0	8.44	7.9			527	
OC-22	F	23.1	8.31	7.8			560	
OC-22	G	23.0	8.35	7.9			555	
OC-22	H	22.9	8.32	8.0			509	

Final Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 3

Test Day: 10 Date: 11/29 Time: 10:00 Technician initials: JW/pm

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
OC-24/25	A	22.8	7.43	4.1	155	100	380	1
OC-24/25	B	22.8	7.87	5.4			415	
OC-24/25	C	22.8	7.95	7.3			470	
OC-24/25	D	22.5	8.30	8.2			460	
OC-24/25	E	22.5	8.20	7.3			435	
OC-24/25	F	22.7	8.29	7.2			399	
OC-24/25	G	22.7	8.31	6.8			450	
OC-24/25	H	22.5	8.48	7.9			540	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: [signature]

Disclosed and Understood by: [signature]

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 3

Day: 10

Date: 11-25-10 Time: Pm

Initials of Technician performing masss determinations: JW, DF

Date dry mass determined: —

Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments
Control	A	JS	7	7	1	125.836	145.600	131.580	
Control	B	DM	10	10	2	122.650	172.550	135.037	
Control	C	DM	10	10	3	135.345	193.756	149.877	
Control	D	DM	7	7	4	147.756	167.086	153.598	
Control	E	JW	10	10	5	121.134	178.242	134.551	
Control	F	JS	10	10	6	144.266	196.818	156.975	
Control	G	JS	9	9	7	150.327	177.162	158.057	
Control	H	JW	7	7	8	139.589	160.250	144.559	
DC-6/7	A	JS	10	10	9	147.078	172.640	153.123	
DC-6/7	B	DM	7	7	10	141.866	169.034	149.295	
DC-6/7	C	DM	9	9	11	148.712	168.070	152.752	
DC-6/7	D	DM	10	10	12	151.212	179.414	157.733	
DC-6/7	E	DF	10	10	13	132.198	160.350	140.746	
DC-6/7	F	JS	8	8	14	150.656	172.018	156.886	
DC-6/7	G	JS	8	8	15	138.650	180.150	150.184	
DC-6/7	H	JS	5	5	16	143.733	163.829	148.047	
DC-11/12	A	JS	6	6	17	158.076	170.667	161.694	
DC-11/12	B	DM	10	10	18	139.948	166.519	146.083	
DC-11/12	C	DM	9	9	19	129.098	149.724	135.758	
DC-11/12	D	DM	9	9	20	134.664	164.930	144.003	
DC-11/12	E	JW	8	8	21	138.117	155.710	143.123	
DC-11/12	F	DF	10	10	22	154.742	173.489	159.032	
DC-11/12	G	DF	10	10	23	142.866	160.667	146.613	
DC-11/12	H	JS	5	5	24	133.869	156.328	138.789	

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 3

Day: 10 Initials of Technician performing masss determinations: JW, DF

Date: 12-29-10 Time: Pm Date dry mass determined: — Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments
DC-13	A	JS	9	9	25	153.762	191.354	163.229	
DC-13	B	JS	8	8	26	145.600	168.329	152.834	
DC-13	C	JS	9	9	27	162.892	215.716	174.008	
DC-13	D	Pm	10	10	28	162.376	205.984	174.459	
DC-13	E	JW	10	10	29	152.467	194.464	162.462	
DC-13	F	JW	10	10	30	142.622	182.362	152.052	
DC-13	G	JS	9	9	31	145.917	169.142	153.077	
DC-13	H	JS	5	5	32	147.038	163.536	151.283	
OC-22	A	JS	9	9	33	151.422	177.028	158.330	
OC-22	B	Pm	10	10	34	149.346	195.574	163.835	
OC-22	C	Pm	10	10	35	112.910	156.066	123.410	
OC-22	D	Pm	8	8	36	146.158	165.326	151.508	
OC-22	E	Pm	8	8	37	146.656	176.784	153.552	
OC-22	F	Pm	8	8	38	142.798	172.798	149.603	
OC-22	G	Pm	10	10	39	142.698	173.800	149.755	
OC-22	H	JW	10	10	40	138.296	174.656	147.665	
OC-24/25	A	JS	8	8	41	142.390	172.646	151.262	
OC-24/25	B	JW	10	10	42	136.649	174.838	145.533	
OC-24/25	C	JW	9	9	43	143.549	194.340	159.110	
OC-24/25	D	JW	10	10	44	133.890	179.320	149.340	
OC-24/25	E	JW	3	3	45	133.582	141.750	136.082	
OC-24/25	F	JW	7	7	46	125.609	148.547	136.444	
OC-24/25	G	JW	8	8	47	134.740	161.938	142.180	
OC-24/25	H	JW	10	10	48	149.926	184.420	160.056	

Signature: [signature]

Final Survival and Growth Information

Project: GLNPO-Otter and Duck Creek test 3

Day: 10 Initials of Technician performing masss determinations: JW, DF

Date: 11-25-10 Time: PM Date dry mass determined: — Date ash-free dry mass determined: —

Sediment	Replicate	Technician initials	# live recovered	# animals Weighed	Pan #	Pan Weight (mg)	Pan & animal dry weight (mg)	Pan & animal ash-free dry weight (mg)	Comments

Disclosed and Understood by:

Test 4

Initial Growth Information

Project: GLNPO-Otter and Duck Creek test 6

Day: 0 **Initials of Technician performing masss determinations:** T.J.H.

Date: 01/07/11 **Date inial mass determined:** 01/07/11

Replicate	Pan #	No. animals on pan	Pan Weight (mg)	Pan & animal dry weight (mg)
1	1	10	121.936	~~123.336~~ 123.736
2	2	10	122.442	124.342

Signature: [signature]

Disclosed and Understood by: [signature]

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Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 6

Test Day: 0 Date: 01/07/16 Time: 1000 Technician initials: [illegible]

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	23.0	8.48	8.0	~~120~~ 60 (PF)	40	260	1
Control	B	23.1	8.42	7.9			270	
Control	C	23.1	8.46	8.1			290	
Control	D	23.0	8.47	7.4			260	
Control	E	23.1	8.44	7.4			270	
Control	F	23.2	8.40	7.3			210	
Control	G	22.8	8.45	7.9			300	
Control	H	22.9	8.33	7.4			290	
GC-1	A	23.2	8.31	8.0	120	78	370	1
GC-1	B	23.3	8.32	7.9			390	
GC-1	C	23.3	8.45	7.5			390	
GC-1	D	23.3	8.46	7.4			410	
GC-1	E	23.2	8.34	7.2			410	
GC-1	F	23.3	8.41	7.4			380	
GC-1	G	23.0	8.43	7.8			410	
GC-1	H	23.2	8.46	7.5			420	
AD-1	A	23.2	7.40	7.7	110	90	530	1
AD-1	B	23.0	7.83	8.0			410	
AD-1	C	23.1	7.97	7.7			390	
AD-1	D	23.5	8.10	7.4			390	
AD-1	E	23.4	8.31	7.6			350	
AD-1	F	23.1	8.29	7.6			380	
AD-1	G	23.3	8.33	7.4			390	
AD-1	H	23.5	8.38	7.5			340	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: [signature]

Disclosed and Understood by: [signature]

Final

Initial Overlying Water Quality

Project: GLNPO-Otter and Duck Creek test 6

Test Day: 10 Date: 1-17-11 Time: 8:15 Technician initials: SS

Sediment	Replicate	Temp. (20-26°C)	pH	D.O. (>2.5 mg/L)	*Hardness (PPM $CaCO_3$)	*Alkalinity (PPM $CaCO_3$)	Conductivity (uS)	*Ammonia (PPM)
Control	A	22.2	7.61	7.4	60	60	280	<1
Control	B	22.2	7.25	7.5			260	
Control	C	22.2	7.22	7.5			260	
Control	D	22.3	7.25	7.5			230	
Control	E	22.2	7.21	7.5			240	
Control	F	22.1	7.26	7.6			240	
Control	G	22.2	7.25	7.5			230	
Control	H	22.2	7.26	7.5			230	
GC-1	A	22.1	8.43	8.0	100	120	530	<1
GC-1	B	22.2	8.44	8.1			420	
GC-1	C	22.2	8.29	8.1			510	
GC-1	D	22.2	8.32	7.9			370	
GC-1	E	22.2	8.21	8.2			450	
GC-1	F	22.1	8.25	7.8			~~370~~ 430	
GC-1	G	22.1	8.22	7.7			420	
GC-1	H	22.2	8.22	8.1			430	
AD-1	A	22.2	7.90	8.5	168	108	490	<1
AD-1	B	22.3	7.90	8.1			490	
AD-1	C	22.2	7.84	8.2			440	
AD-1	D	22.1	7.54	8.4			470	
AD-1	E	22.2	7.56	8.3			500	
AD-1	F	22.2	7.79	8.0			430	
AD-1	G	22.2	7.84	8.1			480	
AD-1	H	21.8	7.90	8.0			400	

*Measured from a composite of overlying water from all treatment replicates (2-5 mL per replicate).

Signature: [signature]

Disclosed and Understood by: [signature]

Daily Observations

Day: -1

Date: 1/6/10 **Technician Initials:** DF
Time: pm

Water exchange counter: N/A

Comments: Sediment added to beakers. ~~chambers~~ Beakers placed in water bath at 23 °C. Aeration provided. OC-26 has strong odor.

Day: 0

Date: 01/07/10 **Technician Initials:** [illegible]

Time: 0900

Water exchange counter: N/A

Comments: MOD. TEMP. @ , WATER CHANGE CONDUCTED ON ALL BEAKERS, PARAMETERS - TEMP. pH, D.O., CONDUCTIVITY, ALKALINITY, HARDNESS, AND AMMONIA TAKEN.

Daily Observations

Day: 1

Date: ~~1/10/11~~ 1/8/11 DF **Technician Initials:** DF

Time:

Water exchange counter: N/A

Comments: Daily parameters recorded. Organisms fed.
No unusual observations.

Day: 2

Date: 1/9/11 **Technician Initials:** DF

Time: AM/PM

Water exchange counter: N/A

Comments: Water exchanges conducted (AM/PM). Daily parameters recorded. Animals fed.

Daily Observations

Day: 3

Date: 1/10/11 **Technician Initials:** DF

Time: AM/PM

Water exchange counter: N/A

Comments: Twice daily water exchanges conducted. Daily parameters recorded. Animals fed. aeration adjusted.

Day: 4

Date: 1/11/11 **Technician Initials:** DF

Time: AM/PM

Water exchange counter: N/A

Comments: Water exchanges conducted. Daily WQ parameters recorded. organisms fed.

Daily Observations

Day: 5

Date: 1/12/11 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Recorded daily WQ. Conducted twice daily water exchange. Aeration adjusted. Fed animals.

Day: 6

Date: 1/13/11 **Technician Initials:** DF

Time: Am/Pm

Water exchange counter: N/A

Comments: Water exchanges conducted. Water quality parameters recorded. Animals fed.

Daily Observations

Day: 7

Date: 11/4/11 **Technician Initials:** DF
Time: Am/Pm

Water exchange counter: N/A

Comments: Daily WQ recorded. Am+Pm water exchanges conducted Animals Fed.

Day: 8

Date: 11/5/11 **Technician Initials:** DF
Time: Am/Pm

Water exchange counter: N/A

Comments: Conducted twice daily water exchange / Recorded daily WQ. [illegible] Fed organisms.

Daily Observations

Day: 9

Date: 11/16/11 **Technician Initials:** DF
Time: AM/PM

Water exchange counter: N/A

Comments: Recorded WQ parameters. Performed daily water exchanges. Fed animals. Adjusted aeration.

Day: 10

Date: 11/17/11 **Technician Initials:** DF
Time: AM

Water exchange counter: N/A

Comments: Water Quality recorded on all beakers. Test terminated as described in EPA Guidance.

Signature: [signature]

Disclosed and Understood by: ______

Daily Overlying Water Temperature (°C) and D.O. (mg/L), Feeding and Maintenance Checklist

Test Day	1		2		3		4		5		6		7		8		9	
	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.	Temperature	D.O.
Control	22.9	7.6	22.9	7.7	22.7	7.8	22.9	7.6	23.0	7.3	22.8	7.2	22.9	7.3	23.1	7.4	23.0	7.3
GC-1	22.9	7.7	23.0	7.6	22.7	7.6	22.9	7.1	23.0	7.2	22.8	7.1	22.9	7.4	23.1	7.7	23.6	7.2
AD-1	22.9	7.8	22.5	7.7	22.8	7.2	22.5	7.5	23.0	7.2	22.8	7.2	22.9	7.3	23.0	7.5	23.6	7.2
Water Exchanged AM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Water Exchanged PM?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Fed?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Aeration OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Zumwalt needles clear?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Timer OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Remcor OK?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Daily Observations Recorded?	✓		✓		✓		✓		✓		✓		✓		✓		✓	
Technician intials/date	DF 1/8/11		DF 1/9/11		DF, 1/10/11		DF 1/11/11		DF, 1/12/11		DF, 1/13/11		DF, 1/14/11		DF, 1/15/11		DF 1/16/11	

If temperature falls outside the range of 20-26°C or dissolved oxygen falls below 2.5 mg/L contact the study coordinator

Signature: [signature]

Disclosed and Understood by: [signature]

Final Surv ınd Growth Information

Project: GLNPO-Otter and Duck Creek test 6

Day: 10

Initials of Technician performing masss determinations: —

Date: 11/3/16 Time: 1pm

Date dry mass determined: —

Date ash-free dry mass determined: —

Sediment	Replicate	Technician Initials	# live recovered	# animals Weighed	Pan #	Pan Weight (g)	Pan & animal dry weight (g)	Pan & animal ash-free dry weight (g)	Comments
Control	A	JS	8	8	1	~~106.746~~ 106.932	124.146	112.140 DF	
Control	B X	JS	6	6	2	95.362	117.356	~~112.426~~ 107.484	
Control	C	DF	8	8	3	121.056	138.828	126.188	
Control	D	DF	10	10	4	129.964	159.866	144.722	
Control	E	DF	8	8	5	125.882	144.088	134.938	
Control	F	DF	9	9	6	122.528	154.834	143.950	
Control	G	DF	10	10	7	123.124	140.638	130.096	
Control	H	DF	7	7	8	118.498	134.438	124.252	
GC-1	A	JS	1 eaten	0	9	126.726	—	—	1 eaten by flatworm
GC-1	B	JS	10	10	10	134.074	153.618	141.920	
GC-1	C	JS	2	2	11	137.428	142.210	138.958	Planarians / flatworms present
GC-1	D	JS	10	10	12	132.828	152.318	141.342	
GC-1	E	JS	9	9	13	145.912	162.412	152.890	
GC-1	F	JS	8	8	14	110.084	130.260	116.466	
GC-1	G	DF	5	5	15	118.796	129.966	122.022	
GC-1	H X	DF	9	9	16	111.116	130.066	115.624	
AD-1	A	JS	9	9	17	112.272	131.202	118.064	
AD-1	B	JS	9	9	18	111.066	136.976	122.876	
AD-1	C	JS	planaria 0	0	19	115.248	—	—	flatworms
AD-1	D	DF	oligochaetes 6	6	20	108.728	123.768	113.796	oligochaetes
AD-1	E	JS	3 planaria	3	21	110.986	121.070	113.530 DF	flatworms
AD-1	F X	JS	planaria 3	2 1 eaten	22	111.460	118.878	~~107.484~~ 112.466	flatworms
AD-1	G X	JS DF	planaria 6 1 pupa	5	23	107.428	124.404	115.124	1 pupae flatworms
AD-1	H	DF	8	8	24	117.338	~~141.032~~ 141.030 DF	123.524	

Signature: [signature]

Disclosed and Understood by: [signature]

Appendix H

Chemistry Data Tables: Sediment, Pore Water, Tissues

Table H-1. Metals Concentrations (mg/kg dry wt) measured in Sediment Samples from Urban Comparison Streams and Duck Creek.

Surface Sediment Grab Samples (0-6 inches depth)

		Urban				Duck Creek D						Duck Creek C				Duck Creek B						Duck Creek A												PEC
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ		VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ	mg/kg
ALUMINUM	7429-90-5	7070	J-	7150	J-	16800				11500		11000				11100		10800		10500		12400		8440		8960		2640						
ANTIMONY	7440-36-0	1	J-	0.97	J-	2.7	J			1.6	J	1.2	J			1.4	J	5.4	J	6.5	J	1.8	J	1.0	J	1.4	J	0.77	J					
ARSENIC	7440-38-2	6.6	J-	7.4	J-	**80.1**	J	**39.9**		18.6		11.8				15.7		31.2	J	32		26.6		16.8		**36.8**		3.4		12.8				33
BARIUM	7440-39-3	53.1	J-	57.2	J-	241				154		123				111		140		177		149		93.4		123		44.1						
BERYLLIUM	7440-41-7	0.74	U	0.68	U	1.8	J			0.56	J	0.57	J			0.7	J	0.68	J	0.72	J	1.5	U	0.85	U	0.83	U	0.61	U					
CADMIUM	7440-43-9	0.85	J-	0.68	U	2.8	U			1.4	U	1.4	U			1.5	U	2.9		1.5		1.5	U	0.85	U	0.98		0.61	U					4.98
CALCIUM	7440-70-2	27400	J-	49500	J-	13500				139000		137000				84700		91600		82100		154000		92600		148000		89200						
CHROMIUM	7440-47-3	20.1	J-	12.5	J-	47.7				18.4		24.5				20.9		64.6		42.9		29.2		20.0		22.8		6.9						111
COBALT	7440-48-4	7.4	U	9.2	J-	8.6	J			14.1	U	14.0	U			14.7	U	20.0		11.8	U	14.8	U	8.5	U	8.4		6.1	U					
COPPER	7440-50-8	35.6	J-	80.3	J-	60.1	J			35.1		42.4				41.2		221	J	95.2		54.9		29.6		32.9		19.8						149
IRON	7439-89-6	14500	J-	17200	J-	18300				23800		20800				24600		60600		97600		21600		13000		15800		5100						
LEAD	7439-92-1	33.5	J-	28.4	J-	66.1				34.6		34.9				38.6		**156**		125		67.3		46		38.1		14.5						128
MAGNESIUM	7439-95-4	12100	J-	9540	J-	5040				17600		18300				13400		11000		9160		11400		6000		10400	J	39800						
MANGANESE	7439-96-5	244	J-	228	J-	167				643		685				936		1250		1200		774		343		555		212						
MERCURY	7439-97-6	0.055	J-	0.032	J-	0.25	J			0.062	J	0.094	J			0.1	J	0.21	J	0.33		0.14	J	0.096	J	0.083	J	0.092	J					1.06
NICKEL	7440-02-0	17.4	J-	22.3	J-	32.4				22.7		22.6				27.8		**59.7**		**50.8**		37.2		22.1		28.6		12.9						48.6
POTASSIUM	7440-09-7	952	J-	1070	J-	2800	U			1470		1400	U			1680		1850	U	1240		1670		1040		1130		613	U					
SELENIUM	7782-49-2	5.2	R	4.8	R	26.7				9.9	U	9.8	U			10.3	U	13.0	U	8.2	U	4	J	5.0	J	4.6	J	4.3	U					
SILVER	7440-22-4	1.5	R	1.4	R	5.6	U			2.8	U	2.8	U			2.9	U	3.7	U	2.4	U	3	U	1.7	U	1.7	U	0.033	J					
SODIUM	7440-23-5	742	UJ	683	UJ	2800	U			1410	UJ	1400	UJ			1470	UJ	1850	U	1180	UJ	1480	UJ	854	UJ	835	UJ	613	UJ					
THALLIUM	7440-28-0	3.7	U	3.4	U	14	U			7.1	U	7.0	U			7.3	U	9.3	U	5.9	U	7.4	U	4.3	U	4.2	U	3.1	U					
VANADIUM	7440-62-2	18.7	J-	17	J-	96.5				19.5		19.0				23.4		40.0		36.4		30		29.2		33.5		25.8						
ZINC	7440-66-6	180	J-	113	J-	156	J			185		174.0				164		783.0	J	440		304		141		151		55.9						459

Surface Sediment Core Samples (0-24 inches depth)

Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11-02	VQ	DC-10/11	VQ	DC-9/10-02	VQ	DC-8-02	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-02	VQ	DC-4-02	VQ	DC-3/4-02	VQ	DC-3-02	VQ	DC-2-02	VQ	DC-1-02	VQ	mg/kg
ALUMINUM	7429-90-5							9330						10900								12400		12200		10000		7470		7970		12700		
ANTIMONY	7440-36-0							1.6	J					1.6	J							2	J	1.6	J	1.8	J	1.1	J	0.8	J	1.6	J	
ARSENIC	7440-38-2							27.7						18.9								52.9		**38.2**		18.5		8.7		14.1		32.5		33
BARIUM	7440-39-3							160						115								149		127		82.5		65.9		75.5		141		
BERYLLIUM	7440-41-7							0.71	J					0.74	J							0.93	U	1	U	0.58	U	0.64	U	0.5	J	0.8		
CADMIUM	7440-43-9							0.85	U					1	U							1.2		1	U	0.97		0.65		0.65	U	1.9		4.98
CALCIUM	7440-70-2							72500						79200								140000		144000		83200		66100		71600		102000		
CHROMIUM	7440-47-3							19						20.5								33.5		30.2		26.7		16.5		21.7	J	42.8	J	111
COBALT	7440-48-4							8.5	U					10.3	U							9.3	U	10.5	U	11		6.8		7.1		9.2		
COPPER	7440-50-8							34.8						34.5								47.4		38.5		36.1		26.8		27.2	J	52	J	149
IRON	7439-89-6							23000						20600								20100		19600		22400		17000		18500		25400		
LEAD	7439-92-1							37.7						37								55.8		57.8		40.3		24.7		29.3		57.7		128
MAGNESIUM	7439-95-4							11900						9660								11400		12500		15200		22400		17800		16300		
MANGANESE	7439-96-5							482						518								393		574		512		359		416		470		
MERCURY	7439-97-6							0.071	J					0.18	J							0.098	J	0.06	J	0.097	J	0.092	J	0.074	J	0.17	J	1.06
NICKEL	7440-02-0							22.4						26.8								35.5		29.6		28.1		20.3		21.6		35		48.6
POTASSIUM	7440-09-7							1230						1320								1600		1520		1510		1560		1250	J	1810	J	
SELENIUM	7782-49-2							2.4	J					1.5	J							4.7	J	2.5	J	4.1	U	4.5	U	4.5	U	4.9	U	
SILVER	7440-22-4							1.7	U					2.1	U							1.9	U	2.1	U	0.11	J	0.058	J	1.3	U	1.4	U	
SODIUM	7440-23-5							853	UJ					1030	UJ							928	UJ	1050	UJ	582	UJ	644	UJ	649	UJ	1870	J	
THALLIUM	7440-28-0							4.3	U					5.1	U							4.6	U	5.2	U	2.9	U	3.2	U	1.5	J	2	J	
VANADIUM	7440-62-2							25.5						26.8								39.1		30.3		22.6		17.7		20.9		32.2		
ZINC	7440-66-6							156						131								172		166		113		91		117	J	184	J	459

Subsurface Sediment Core Samples (24-48 inches depth)

Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-03	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2-03	VQ	DC-1-03	VQ	mg/kg
ALUMINUM	7429-90-5																					12000								10700		6010		
ANTIMONY	7440-36-0																					1.7	J							1.4	J	0.8	J	
ARSENIC	7440-38-2																					16.8								11.7		8.7		33
BARIUM	7440-39-3																					102								90.2		46.4		
BERYLLIUM	7440-41-7																					0.65								0.63	J	0.54	U	
CADMIUM	7440-43-9																					1.4								1.1		0.54	U	4.98
CALCIUM	7440-70-2																					48900								74600		54000		
CHROMIUM	7440-47-3																					33.4								26.4	J	13.6	J	111
COBALT	7440-48-4																					10.1								9.5		7.2		
COPPER	7440-50-8																					46.3								36	J	20.6	J	149
IRON	7439-89-6																					27100								24800		15300		
LEAD	7439-92-1																					55								41.4		14		128
MAGNESIUM	7439-95-4																					15800								19000		13900		
MANGANESE	7439-96-5																					573								479		328		
MERCURY	7439-97-6																					0.13	J							0.11	J	0.037	J	1.06
NICKEL	7440-02-0																					32.1								28		18.7		48.6
POTASSIUM	7440-09-7																					1610								1810	J	1160	J	
SELENIUM	7782-49-2																					4.4	U							4.4	U	3.8	U	
SILVER	7440-22-4																					0.12	J							1.3	U	1.1	U	
SODIUM	7440-23-5																					630	UJ							635	UJ	1980	J	
THALLIUM	7440-28-0																					3.1	U							2.1	J	1.3	J	
VANADIUM	7440-62-2																					26.3								23.9		14.7		
ZINC	7440-66-6																					157								126	J	62.5	J	459

PEC Benchmark is from MacDonald et al 2000

Table H-2. Metals Concentrations (mg/kg dry wt) measured in Sediment Samples from Otter Creek.

Surface Sediment Grab Samples (0-6 inches delpth)

		Otter Creek E		Otter Creek D		Otter Creek C						Otter Creek B						Otter Creek A												PEC
Chemical name	CAS #	OC-24/25 VQ	OC-23 VQ	OC-22 VQ	OC-18/19 VQ	OC-18 VQ	OC-16/17 VQ	OC-16 VQ	OC-15/16 VQ	OC-12/13 VQ	OC-11/12 VQ	OC-10-11 VQ	OC-9-10 VQ	OC-9-01 VQ	OC-8-9 VQ	OC-8 VQ	OC-7-8 VQ	OC-6/7(2)-01 VQ	OC-6/7(1)-01 VQ		OC-5A-01 VQ	OC-5 VQ	OC-4A-01 VQ	OC-4-01 VQ	OC-3A-01 VQ	OC-3 VQ	OC-2A VQ	OC-2 VQ	OC-1A VQ	mg/kg
ALUMINUM	7429-90-5	5910		11200	4930		8350	7130	10800	9410	7280	10800	7910 J		8150		16100	18100	5790		7320		12700	3570	6150		14300		14700	
ANTIMONY	7440-36-0	1.2 J		1.8 J	1.6 J		1.5 J	1.6 J	1.6 J	1.8 J	3.4 J	1.4 J	2 J		2.7 J		3.2 J	2.3 J	1.2 J		2.1 J		1.9 J	1.1 J	2 J		2.3 J		2.2 J	
ARSENIC	7440-38-2	8.6		22.9	30.7 J		20.4 J	28.5	31.2 J	19.7	19.9	17.7	11.7 J		15.4		19.8	20.8	11.5		10.9		11.3	6.5	8.7		14		11.6	33
BARIUM	7440-39-3	48.1		99.1	97.2 J		89.9	107	114	120	247	86.3	86		237		199	123	56.7		86.5		128	64.8	107		137		126	
BERYLLIUM	7440-41-7	0.41 J		0.64 J	0.64		0.57 J	0.54 J	0.88	0.65 J	0.48 J	0.71 U	0.77 U		0.69 U		1.3 U	0.68 J	0.44 J		0.39 J		0.71 J	0.51 U	0.32 J		0.89 U		0.98 U	
CADMIUM	7440-43-9	0.47 U		0.85 U	0.62 U		0.69 U	1.8	0.7 U	0.68 U	1.2	0.98 J	1.1 J		1.1 J		3.9 J	1	0.47 U		0.58 J		0.84 J	0.51 UJ	1.1 J		1.4 J		2.7 J	4.98
CALCIUM	7440-70-2	46900		86400	72000		34800	62100	29100	27900	42200	26800	131000 J		204000		178000	74200	82100		123000		115000	123000	295000		114000		147000	
CHROMIUM	7440-47-3	39.1		44	62.7		56.5	58.9	48.7	102	**392**	35.7	51.4 J		**252**		**126**	**124** J	54.9 J		130		79.2	79.6	**117**		94.3		**119**	111
COBALT	7440-48-4	7.4		10.7	7.4		9	13.1	14.9	10	8.6	9.4	7.7 U		6.9 U		13.4 U	8.2 J	5.6		5 J		8.5 J	5.1 U	11.1 U		10.3		9.8 U	
COPPER	7440-50-8	22.3		41.3	24.6 J		44.2 J	33	31.7 J	75.5	**347**	303 J	85.5 J		126 J		**165** J	**153** J	45.6 J		64.9		92.2	33.7 J	43.7		110 J		84.2 J	149
IRON	7439-89-6	17200		26300	20100 J		18000	22900	26300	19900	21100	22500	16500 J		17200		32800	25200	15700		16300		23000	6040	8980		26600		24700	
LEAD	7439-92-1	116		94.5	91.9 J		122	44.8	42.8	115	**192**	145	70.3 J		127		**138**	106	36.9 J		46.8		77	26.1	32.2		78.3		58	128
MAGNESIUM	7439-95-4	11800		29200	29400		16000	33800	13800	9910	11900	9340	65600 J		29200		21300	12500	17500		11600		14200	6170	10400		17200		13500	
MANGANESE	7439-96-5	452		532	514		470	889	754	309	343	369	300		339		647	550	607 J		353 J		748 J	160	244 J		500		497	
MERCURY	7439-97-6	0.018 J		0.1 J	0.044 J		0.11 J	0.057 J	0.059 J	0.16 J	**1.1**	0.38	0.28		0.79		0.46	0.37	0.076 J		0.25		0.21 J	0.17	0.49		0.32		0.26	1.06
NICKEL	7440-02-0	18		38.7	30.1 J		23.4	28.4	32.4	31.6	33.7	30.7	23.2 J		26.5		**61.6**	34.1	17		20.7		32.8	11.3	30.1		36.3		37.9	48.6
POTASSIUM	7440-09-7	911		2020	629		939	785	1270	1130	972	1260	1160		980		2140	1580 J	709 J		929 J		1890 J	514 U	1110 UJ		2060		2100	
SELENIUM	7782-49-2	3.3 U		6 U	4.3 U		4.8 U	4.1 U	4.9 U	4.7 U	2.3 J	5 U	1.7 J		4.9 U		9.4 U	6.3 U	3.3 U		6.3 U		7.2 U	3.6 U	7.8 U		1.5 J		6.9 U	
SILVER	7440-22-4	0.95 U		1.7 U	1.2 U		1.4 U	1.2 U	1.4 U	1.4 U	1.5 U	1.4 U	1.5 U		1.4 U		2.7 U	1.8 U	0.95 U		1.8 U		2.1 U	1 U	0.12 J		1.8 U		0.33 J	
SODIUM	7440-23-5	474 UJ		854 UJ	616 U		688 U	587 UJ	696 U	675 UJ	769 UJ	713 UJ	773 UJ		693 UJ		1340 UJ	897 UJ	474 UJ		893 U		1030 U	514 UJ	1110 U		893 UJ		984 UJ	
THALLIUM	7440-28-0	2.4 U		4.3 U	3.1 U		3.4 U	2.9 U	3.5 U	3.4 U	3.8 U	3.6 U	3.9 U		3.5 U		6.7 U	2.1 J	1.4 J		1.5 J		1.8 J	2.6 U	0.35 J		4.5 U		4.9 U	
VANADIUM	7440-62-2	16.9		24.4	11.1		17.9	21.3	27.6	21.3	129	25.3	21.2		23.8		41.2	28.1	11.8		13.7		22.9	7.8	10.7 J		30.7		28.1	
ZINC	7440-66-6	53.4		217	148 J		177 J	103	152 J	220	440	146 J	218 J		228 J		346 J	226 J	68.6 J		133		254	73.6 J	122		262 J		189 J	459

Surface Sediment Core Samples (0-24 inches delpth)

Chemical name	CAS #	OC-24/25 VQ	OC-23-02 VQ	OC-22 VQ	OC-18/19 VQ	OC-18-02 VQ	OC-16/17 VQ	OC-16 VQ	OC-15/16 VQ	OC-12/13 VQ	OC-11/12 VQ	OC-10/11 VQ	OC-9/10 VQ	OC-9 VQ	OC-8/9 VQ	OC-8-02 VQ	OC-7/8 VQ	OC-6/7(2)-02 VQ	OC-6/7(1)-02 VQ		OC-5a-02 VQ	OC-5-02 VQ	OC-4A-02 VQ	OC-4-02 VQ	OC-3A-02 VQ	OC-3-02 VQ	OC-2A-02 VQ	OC-2-02 VQ	OC-1A-02 VQ	PEC mg/kg
ALUMINUM	7429-90-5		6410			5550										9380		8200	11500		9740	8840	8990	7420	5770	13000	8010	9750	8270	
ANTIMONY	7440-36-0		2.1 J			1.6 J										1.8 J		2.2 J	2.7 J		3.2 J	2.6 J	2.8 J	2.4 J	2.4 J	3.1 J	2.1 J	2.5 J	1.8 J	
ARSENIC	7440-38-2		**56.4**			20.2										31.3		11	18.6		22.6	17.5	21.2	19.1	19.1	12.3	9.5	11.7	10.9	33
BARIUM	7440-39-3		108			78.1										109		107	119		148	136	141	159	167	130	103	128	75.5	
BERYLLIUM	7440-41-7		0.7			0.42 J										0.47 J		0.4 J	0.54 J		0.67 J	0.49 J	1.4 U	0.57 J	0.31 J	0.64 J	0.55 U	0.86 U	0.62 U	
CADMIUM	7440-43-9		1.4			0.59 U										0.8		0.7 U	0.64 U		0.78 J	0.79 J	1.4 UJ	0.59 J	0.63 J	1.8	0.92 J	1.3 J	1.2 J	4.98
CALCIUM	7440-70-2		53500			51200										98400		187000	133000		227000	208000	248000	266000	265000	127000	153000	204000	93800	
CHROMIUM	7440-47-3		121			77.7										86.5 J		**138** J	**179** J		**146**	**150**	**139**	**151**	**150**	**208**	**116**	**172**	103	111
COBALT	7440-48-4		36			7.8										5.8 J		4.5 J	6.4 J		6.8 J	5.1 J	13.6 U	10.4 U	12.8 U	9.2	5.5 U	8.6 U	6.8	
COPPER	7440-50-8		36.8			42.1										162 J		78.8 J	133 J		101	104	81.1 J	77.4	74.3	86.3	131 J	107 J	139 J	149
IRON	7439-89-6		32000			17400										18800		16800	20600		22600	16200	17300	13700	13300	24300	12900	16000	18000	
LEAD	7439-92-1		26.6			56.2										292		70	87.3		84.5	76	51.2	67	57.2	65.4	40.1	51.2	114	128
MAGNESIUM	7439-95-4		10900			19000										7630		10200	8700		13800	13700	14700	14100	12900	11800	9200	11900	11400	
MANGANESE	7439-96-5		3110			253										368		304	329		289 J	273 J	298	269 J	248 J	451 J	242	348	350	
MERCURY	7439-97-6		0.028 J			0.13 J										0.32		0.21	0.3		0.33	0.49	0.5	0.42	0.46	0.23	0.25	0.3	0.4	1.06
NICKEL	7440-02-0		**71.8**			25.6										22.8		22.2	27.3		30.5	27.1	29.7	22.8	23.1	37.4	23.9	28.3	22.8	48.6
POTASSIUM	7440-09-7		925			769										995 J		1080 J	1130 J		1390 UJ	1340 UJ	1360 U	1040 UJ	1280 UJ	1780 J	1090	1310	1100	
SELENIUM	7782-49-2		4.6 U			1.1 J										5.3 U		4.9 U	4.5 U		9.7 U	9.4 U	9.5 U	7.3 U	9 U	5.9 U	1.3 J	1.1 J	4.3 U	
SILVER	7440-22-4		1.3 U			0.1 J										1.5 U		1.4 U	1.3 U		2.8 U	2.7 U	2.7 U	2.1 U	2.6 U	0.34 J	1.1 U	1.7 U	1.2 U	
SODIUM	7440-23-5		657 UJ			591 UJ										762 UJ		702 UJ	640 UJ		1390 U	1340 U	1360 UJ	1040 U	1280 U	843 U	551 UJ	859 UJ	620 UJ	
THALLIUM	7440-28-0		3.3 U			3 U										1.4 J		1.3 J	1.5 J		1.5 J	1 J	6.8 U	0.94 J	0.65 J	1.6 J	2.8 U	4.3 U	3.1 U	
VANADIUM	7440-62-2		25.1			16										19.5		19.3	19.7		18	14.6	15.9	14.2	10.8 J	25.8	25	23.7	19.4	
ZINC	7440-66-6		58.8			176										126 J		99 J	119 J		137	119	143 J	124	130	171	209 J	192 J	107 J	459

Subsurface Sediment Core Samples (24-48 inches delpth)

Chemical name	CAS #	OC-24/25 VQ	OC-23-03 VQ	OC-22 VQ	OC-18/19 VQ	OC-18 VQ	OC-16/17 VQ	OC-16 VQ	OC-15/16 VQ	OC-12/13 VQ	OC-11/12 VQ	OC-10/11 VQ	OC-9/10 VQ	OC-9 VQ	OC-8/9 VQ	OC-8 VQ	OC-7/8 VQ	OC-6/7(2) VQ	OC-6/7(1)-03 VQ	OC-6-03 VQ	OC-5a-03 VQ	OC-5-03 VQ	OC-4A-03 VQ	OC-4-03 VQ	OC-3A-03 VQ	OC-3-03 VQ	OC-2A-03 VQ	OC-2-03 VQ	OC-1A-03 VQ	PEC mg/kg
ALUMINUM	7429-90-5		4460																12700	10400	11300	7330	8220	11600	9420	13400	9990	11900	5900	
ANTIMONY	7440-36-0		3.5 J																3.1 J	3.3 J	2.9 J	2.2 J	2.4 J	2.9 J	1.9 J	1.4 J	3.4 J	2 J	2.3 J	
ARSENIC	7440-38-2		**41.3**																21.6	20.6	21	22.7	23.5	23.8	15.8	9.2	13.8	12.5	8.4	33
BARIUM	7440-39-3		53.9																93.8	106	121	156	138	138	130	89.6	130	103	26.7	
BERYLLIUM	7440-41-7		0.39 J																0.47 J	0.49 J	0.53 J	0.4 J	1 U	0.59 J	0.61 J	0.79 J	0.5 J	0.64 U	0.51 U	
CADMIUM	7440-43-9		0.54 U																0.8 U	0.91 U	0.7 J	0.74 J	1 UJ	0.74 J	0.52 J	1.1 U	0.84 U	1.4 J	0.98 J	4.98
CALCIUM	7440-70-2		41100																95100	150000	160000	251000	200000	193000	115000	45500	179000	81800	114000	
CHROMIUM	7440-47-3		**340**																**243** J	**319** J	**243**	**154**	**119**	**198**	105	22	**323** J	107	21.9	111
COBALT	7440-48-4		13.2																7.1 J	6.2 J	6.5 J	4.9 J	10.5 U	6.3 J	9.2 J	15.5	6.8 J	9.9	8.9	
COPPER	7440-50-8		36.5																**189** J	**177** J	135	136	99.5 J	120	76.6	32.3	**206** J	93.2 J	38.1 J	149
IRON	7439-89-6		32900																17800	18000	16500	13000	16100	18000	21600	25000	17600	25200	38700	
LEAD	7439-92-1		20																119	98.9	85	67.8	55.6	73.2	53.4	43.1	**150**	70.5	15.9	128
MAGNESIUM	7439-95-4		14500																6950	10800	7820	11800	13200	10700	9290	13600	12500	13900	44200	
MANGANESE	7439-96-5		749																275	287	239 J	268 J	231	255 J	274 J	398 J	315	385	2050	
MERCURY	7439-97-6		0.21																0.28	0.31	0.3	0.55	0.39	0.37	0.22 J	0.045 J	0.43	0.4	0.094 J	1.06
NICKEL	7440-02-0		34																25.2	24.8	25	19.3	23.8	27.2	28.1	36.1	30.7	31.3	24.7	48.6
POTASSIUM	7440-09-7		625																1040 J	1090 J	1200 J	1240 UJ	1050 U	1260 J	1280 J	1730 J	1230 J	1490	841	
SELENIUM	7782-49-2		3.8 U																5.6 U	6.4 U	6.6 U	8.7 U	7.3 U	8 U	7.7 U	7.4 U	5.9 U	4.5 U	3.6 U	
SILVER	7440-22-4		1.1 U																1.6 U	1.8 U	1.9 U	2.5 U	2.1 U	2.3 U	2.2 U	2.1 U	1.7 U	1.3 U	1 U	
SODIUM	7440-23-5		543 UJ																802 UJ	910 UJ	938 U	1240 U	1050 UJ	1140 U	1100 U	1060 U	837 UJ	637 UJ	509 UJ	
THALLIUM	7440-28-0		2.7 U																1.3 J	1.4 J	0.85 J	1 J	5.2 U	1.3 J	1.3 J	1.7 J	1.2 J	3.2 U	3.9	
VANADIUM	7440-62-2		18.7																23	22.3	19.4	14.1	18.2	20	19.9	32.4	24.2	26.7	18	
ZINC	7440-66-6		68.8																98.9 J	105 J	94.8	130	106 J	120	121	82.6	157 J	129 J	72.2 J	459

Deep Sediment Core Samples (48-72 inches delpth)

Chemical name	CAS #	OC-24/25 VQ	OC-23 VQ	OC-22 VQ	OC-18/19 VQ	OC-18 VQ	OC-16/17 VQ	OC-16 VQ	OC-15/16 VQ	OC-12/13 VQ	OC-11/12 VQ	OC-10/11 VQ	OC-9/10 VQ	OC-9 VQ	OC-8/9 VQ	OC-8 VQ	OC-7/8 VQ	OC-6/7(2) VQ	OC-6/7(1) VQ		OC-5a VQ	OC-5 VQ	OC-4A VQ	OC-4 VQ	OC-3A VQ	OC-3 VQ	OC-2A-04 VQ	OC-2 VQ	OC-1A VQ	PEC mg/kg
ALUMINUM	7429-90-5																										6300			
ANTIMONY	7440-36-0																										0.7 J			
ARSENIC	7440-38-2																										3.4			33
BARIUM	7440-39-3																										50.2			
BERYLLIUM	7440-41-7																										0.71 U			
CADMIUM	7440-43-9																										0.71 UJ			4.98
CALCIUM	7440-70-2																										25600			
CHROMIUM	7440-47-3																										11.7			111
COBALT	7440-48-4																										7.1 U			
COPPER	7440-50-8																										28.3 J			149
IRON	7439-89-6																										12400			
LEAD	7439-92-1																										30.4			128
MAGNESIUM	7439-95-4																										6110			
MANGANESE	7439-96-5																										164			
MERCURY	7439-97-6																										0.044 J			1.06
NICKEL	7440-02-0																										17.6			48.6
POTASSIUM	7440-09-7																										867			
SELENIUM	7782-49-2																										5 U			
SILVER	7440-22-4																										1.4 U			
SODIUM	7440-23-5																										708 UJ			
THALLIUM	7440-28-0																										3.5 U			
VANADIUM	7440-62-2																										13.1			
ZINC	7440-66-6																										45.4 J			459

note on preliminary draft: database includes metals data for OC-6-03, which was not sampled according to other information.

Table H-3. Acid-Volatile Sulfide and Simultaneously Extracted Metals Concentrations (umole/g dry wt) measured in Sediment Samples from Urban Comparison Streams and Duck Creek.

		Surface Sediment Grab Samples (0-6 inches depth)																																
		Urban				**Duck Creek D**						**Duck Creek C**				**Duck Creek B**						**Duck Creek A**												Benchmark
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ	
CADMIUM, AVS	7440-43-9AVS	0.0035		0.0037		0.0049				0.0062		0.0052				0.0044		0.0133		0.0171		0.01		0.0066		0.0052		0.0021						
COPPER, AVS	7440-50-8AVS	0.0088		0.0264		0.0493				0.0175		0.0311				0.0083		0.0236		0.0507		0.0161		0.0238		0.0048	U	0.0239						
LEAD, AVS	7439-92-1AVS	0.053		0.042		0.064				0.1		0.08				0.092		0.23		0.432		0.203		0.176		0.068		0.033						
NICKEL, AVS	7440-02-0AVS	0.038		0.055		0.065				0.075		0.065				0.069		0.181		0.406		0.144		0.115		0.105		0.024						
SILVER, AVS	7440-22-4AVS	0.0025	U	0.0026	U	0.0095	U			0.0044	U	0.0055	U			0.0044	U	0.0064	U	0.0064	U	0.0064	U	0.0038	U	0.0029	U	0.0024	U					
ZINC, AVS	7440-66-6AVS	1.04		0.638		0.263				1.16		0.977				0.67		4.63		7.06		3.4		1.29		0.791		0.454						
ΣSEM	µmole/g dry wt	1.1446		0.7664		0.4510				1.3609		1.1611				0.8459		5.0811		7.9690		3.7763		1.6133		0.9755		0.5382						
SULFIDE-AV	18496-25-8	38.1		20.7		8.06				49.6		25.6				37.1		111		209		97		13.7		29.8		13.8						
TOC (%)		5.07		2.12		22.9				6.79		5.37				6.29		7.55		8.36		4.99		6.18		4.76		7.97						
foc	gOC/g dry wt	0.0507		0.0212		0.229				0.0679		0.0537				0.0629		0.0755		0.0836		0.0499		0.0618		0.0476		0.0797						
ΣSEM-AVS		-36.955		-19.934		-7.609				-48.239		-24.439				-36.254		-105.919		-201.031		-93.224		-12.087		-28.825		-13.262						
(ΣSEM-AVS)/foc	µmol/g OC	-729		-940		-33				-710		-455				-576		-1403		-2405		-1868		-196		-606		-166						130

(ΣSEM-AVS)/foc = ([Cd] + [Cu] + [Pb] + [Ni] + [Ag]/2 + [Zn] - [sulfide]) / fOC
Benchmark and equation from USEPA 2005, adopted by OEPA (2010)

Table H-4. Acid-Volatile Sulfide and Simultaneously Extracted Metals Concentrations (umole/g dry wt) measured in Sediment Samples from Otter Creek.

Surface Sediment Grab Samples (0-6 inches depth)

		Otter Creek E				Otter Creek D			
Chemical name	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ
CADMIUM, AVS	7440-43-9AVS	0.0019				0.0042		0.0035	
COPPER, AVS	7440-50-8AVS	0.0228				0.0037	U	0.0943	
LEAD, AVS	7439-92-1AVS	0.043				0.058		0.098	
NICKEL, AVS	7440-02-0AVS	0.049				0.077		0.121	
SILVER, AVS	7440-22-4AVS	0.0026	U			0.0022	U	0.0027	U
ZINC, AVS	7440-66-6AVS	0.308				1.14		1.13	
ΣSEM	µmole/g dry wt	0.4260				1.2840		1.4482	
SULFIDE-AV	18496-25-8	14				41.6		1.03	
TOC (%)		1.74				3.79		3.26	
foc	gOC/g dry wt	0.0174				0.0379		0.0326	
ΣSEM-AVS		-13.574				-40.316		0.418	
(ΣSEM-AVS)/foc	µmol/g OC	-780				-1064		13	

		Otter Creek C											
Chemical name	CAS #	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ
CADMIUM, AVS	7440-43-9AVS			0.002		0.002		0.0021		0.0029		0.0084	
COPPER, AVS	7440-50-8AVS			0.11		0.0597		0.0803		0.0787		0.0055	U
LEAD, AVS	7439-92-1AVS			0.148		0.073		0.086		0.17		0.49	
NICKEL, AVS	7440-02-0AVS			0.037		0.047		0.062		0.075		0.17	
SILVER, AVS	7440-22-4AVS			0.0012	U	0.0014	U	0.0013	U	0.0027	U	0.0033	U
ZINC, AVS	7440-66-6AVS			0.594		0.412		0.453		0.939		4.01	
ΣSEM	µmole/g dry wt			0.8916		0.5944		0.6841		1.2670		4.6856	
SULFIDE-AV	18496-25-8			1.19		2.02		0.74		13		77	
TOC (%)				3.02		3.56		3.26		1.62		8.91	
foc	gOC/g dry wt			0.0302		0.0356		0.0326		0.0162		0.0891	
ΣSEM-AVS				-0.298		-1.426		-0.056		-11.733		-72.314	
(ΣSEM-AVS)/foc	µmol/g OC			-10		-40		-2		-724		-812	

		Otter Creek B											
Chemical name	CAS #	OC-10-11	VQ	OC-9-10	VQ	OC-9-01	VQ	OC-8-9	VQ	OC-8	VQ	OC-7-8	VQ
CADMIUM, AVS	7440-43-9AVS	0.0031		0.0061				0.0051				0.0039	
COPPER, AVS	7440-50-8AVS	0.843		0.0486				0.473				0.127	
LEAD, AVS	7439-92-1AVS	0.239		0.255				0.364				0.237	
NICKEL, AVS	7440-02-0AVS	0.081		0.131				0.109				0.098	
SILVER, AVS	7440-22-4AVS	0.0025	U	0.0041	U			0.0029	U			0.0034	U
ZINC, AVS	7440-66-6AVS	0.459		2.17				1.58				1.19	
ΣSEM	µmole/g dry wt	1.6264		2.6128				2.5326				1.6576	
SULFIDE-AV	18496-25-8	0.408		30.5				6.11				5.5	
TOC (%)		3.71		4.68				3.05				3.34	
foc	gOC/g dry wt	0.0371		0.0468				0.0305				0.0334	
ΣSEM-AVS		1.218		-27.887				-3.577				-3.842	
(ΣSEM-AVS)/foc	µmol/g OC	33		-596				-117				-115	

		Otter Creek A																						Benchmark
Chemical name	CAS #	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ	OC-5A-01	VQ	OC-5	VQ	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	VQ	OC-2A	VQ	OC-2	VQ	OC-1A	VQ	
CADMIUM, AVS	7440-43-9AVS	0.0073		0.0022		0.0057				0.0047		0.0056		0.009				0.0029				0.0052		
COPPER, AVS	7440-50-8AVS	0.168		0.17		0.387				0.0282		0.0275		0.154				0.0054	U			0.0712		
LEAD, AVS	7439-92-1AVS	0.339		0.071		0.183				0.157		0.154		0.115				0.087				0.127		
NICKEL, AVS	7440-02-0AVS	0.14		0.041		0.131				0.09		0.173		0.324				0.062				0.22		
SILVER, AVS	7440-22-4AVS	0.0054	U	0.0026	U	0.0051	U			0.0047	U	0.0055	U	0.0052	U			0.0032	U			0.0035	U	
ZINC, AVS	7440-66-6AVS	1.73		0.395		1.15				1.34		1.23		0.941				0.855				0.982		
ΣSEM	µmole/g dry wt	2.3870		0.6805		1.8593				1.6223		1.5929		1.5456				1.0139				1.4072		
SULFIDE-AV	18496-25-8	12.8		0.45		2.7				1.32		21.3		5.4				19				7.2		
TOC (%)		3.92		1.96		3.17				3.39		4.95		2.21				3.97				3.81		
foc	gOC/g dry wt	0.0392		0.0196		0.0317				0.0339		0.0495		0.0221				0.0397				0.0381		
ΣSEM-AVS		-10.413		0.231		-0.841				0.302		-19.707		-3.854				-17.986				-5.793		
(ΣSEM-AVS)/foc	µmol/g OC	-266		12		-27				9		-398		-174				-453				-152		130

(ΣSEM-AVS)/foc = ([Cd] + [Cu] + [Pb] + [Ni] + [Ag]/2 + [Zn] - [sulfide]) / fOC
Benchmark and equation from USEPA 2005, adopted by OEPA (2010)

Table H-5. Metals (ug/L), Ammonia (mg/L), Hardness (mg/L as CaCO3) and Dissolved Organic Carbon (mg/L) in Sediment Pore Water from Urban Comparison Streams and Duck Creek.

		Surface Sediment Grab Samples (0-6 inches depth)																																OEPA
		Urban				Duck Creek D						Duck Creek C				Duck Creek B						Duck Creek A												OMZA
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ	WQC (ug/L)
ALUMINUM	7429-90-5	4.1		3		11.6												0.9	UJ			5.7						6.7						
ANTIMONY	7440-36-0	0.283		0.395		1.05												0.24				0.324						0.426						
ARSENIC	7440-38-2	2.2		2.2		42												3.5				18.1						2.9						150
BARIUM	7440-39-3	74.5		69.1		**329**												69.1				91.7						133						220
BERYLLIUM	7440-41-7	0.007	J	0.007	J	0.025												0.006	U			0.02	U					0.04	U					Hardness
CADMIUM	7440-43-9	0.045		0.049		0.032												0.034				0.04						0.04	U					Hardness
CALCIUM METAL	7440-70-2	154000		75800		242000												73900				67500						79700						
CHROMIUM	7440-47-3	0.32		0.52		1.39												0.22				1.17						1.15						Hardness
COBALT	7440-48-4	0.529		0.259		2.51												0.562				1.11						0.516						24
COPPER	7440-50-8	1.19		0.65		0.84												0.25				1.07						1.06						Hardness
IRON	7439-89-6	31		65.3		113												65.3				38.9						48.3						
LEAD	7439-92-1	0.089		0.179		0.116												0.069				0.098						0.092	J					Hardness
MAGNESIUM	7439-95-4	36400		16700		93000												35200				96400						23500						
MANGANESE	7439-96-5	1320		312		955												1810				2510						1280						
MERCURY	7439-97-6	0.2	U	0.2	U	0.02	U											0.02	U			0.2	U					0.2	U					0.91
NICKEL	7440-02-0	2.66		2.17		7.81												2.19				6.59						4						Hardness
POTASSIUM	9/7/7440	5370		4470		13000												5120				6270						15600						
SELENIUM	7782-49-2	0.5	J	0.4	J	3.7												0.3	U			0.9	J					2	U					5
SILVER	7440-22-4	0.007	J	0.008	J	0.004	U											0.004	U			0.02	U					0.04	U					1.3
SODIUM	7440-23-5	88500		85500		174000												15400				30100						17100						
THALLIUM	7440-28-0	0.071		0.076		0.068												0.066				0.073						0.04	U					17
VANADIUM	7440-62-2	0.75		0.6		1.33												0.1	UJ			1.48						1.01						44
ZINC	7440-66-6	4.5		1.6		2.7												0.6				13.4						1.5						Hardness
hardness (mg/L)		536		258		986												330				566						296						
DOC (mg/L)		49.4		54.3		95												20.5				28.2						73.2						
pH		7.29		7.5		7.3												7.27				7.47						7.3						
ammonia mg N/L		**3.36**		0.416		**8.36**												**10.8**				**12.7**						**6.89**						
Hardness-based (surface) water quality criteria																																		
Beryllium	ug/L	102		50		102												75				102						102						
Cadmium	ug/L	7.3		5.2		7.3												6.3				7.3						5.8						
Chromium	ug/L	268		187		268												229				268						210						
Copper	ug/L	30		21		30												26				30						24						
Lead	ug/L	37		21		37												29				37						26						
Nickel	ug/L	169		116		169												143				169						131						
Zinc	ug/L	388		267		388												329				388						300						
pH-based (surface) water quality criteria; assuming sediment temperature range of 14 to 19 degrees C (March-November)																																		
Ammonia	mg/L	3.3		3.3		3.3												3.3				3.3						3.3						

All reported elemental concentrations are based on total concentration (suspended and dissolved).

Hardness-based chronic (surface) water quality criteria: Total Residual Concentration Outside Mixing Zone Average (TR OMZA) for warmwater habitats in the Lake Erie Basin; Chapter 3745-1 of the Ohio Adminisrative Code updated October 20, 2009

Beryllium = EXP(1.609*(LN([hardness]))-5.017)
Cadmium = EXP(0.7852*(LN([hardness]))-2.715)
Chromium = EXP(0.819*(LN([hardness]))+0.6848)
Copper = EXP(0.8545*(LN([hardness]))-1.702)
Lead = EXP(1.273*(LN([hardness]))-4.003)
Nickel = EXP(0.846*(LN([hardness]))+0.0584)
Zinc = EXP(0.8473*(LN([hardness]))+0.884)
Note that for all equations, 400 is used if the hardnes exceeds 400 ug/L per Ohio Rule 3745-1-07

Table H-6. Metals (ug/L), Ammonia (mg/L), Hardness (mg/L as CaCO3) and Dissolved Organic Carbon (mg/L) in Sediment Pore Water from Otter Creek.

		Surface Sediment Grab Samples (0-6 inches delpth)																																																						OEPA
		Otter Creek E				Otter Creek D				Otter Creek C												Otter Creek B												Otter Creek A																						OMZA
Chemical name	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-9-01	VQ	OC-8-9	VQ	OC-8	VQ	OC-7-8	VQ	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ	OC-5A-01	VQ	OC-5	VQ	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	VQ	OC-2A	VQ	OC-2	VQ	OC-1A	VQ	WQC (ug/L)
ALUMINUM	7429-90-5	1.5	UJ			6.4								3.4				2.8						60.5										2.4				6.2						6.7												
ANTIMONY	7440-36-0	0.349				1.77								0.713				0.538						1.81										0.213				0.349						0.805												
ARSENIC	7440-38-2	4.4				48.7								2.2				9.1						18.2										6.5				18.4						29.2												150
BARIUM	7440-39-3	91.2				94.4								99.6				74.6						58.9										52.6				40.8						15.7												220
BERYLLIUM	7440-41-7	0.006	U			0.006	U							0.006	U			0.006	U					0.009	J									0.02	U			0.02	U					0.02	U											Hardness
CADMIUM	7440-43-9	0.051				0.054								0.051				0.047						0.011	UJ									0.006	J			0.012	UJ					0.006	UJ											Hardness
CALCIUM METAL	7440-70-2	86000				79600								88800				80400						48700										69300				58000						53500												
CHROMIUM	7440-47-3	0.36				0.53								0.79				0.74						0.99										1.25				3.27						8.56												Hardness
COBALT	7440-48-4	1.61				0.211								0.38				0.548						0.232										0.423				0.463						1.07												24
COPPER	7440-50-8	1.56				0.66								1.51				1.36						0.92										1.38				1.03						1.12												Hardness
IRON	7439-89-6	65.4				19.9								15.8				34						44.6										46.2				11.3						26.2												
LEAD	7439-92-1	0.157				0.234								0.295				0.432						1.12										0.06				0.299						0.647												Hardness
MAGNESIUM	7439-95-4	23500				17700								17000				16800						13800										25400				53600						72700												
MANGANESE	7439-96-5	3250				388								143				905						297										2460				221						156												
MERCURY	7439-97-6	0.02	U			0.02	U							0.02	U			0.02	U					0.2	U									0.2	U			0.2	U					0.2	U											0.91
NICKEL	7440-02-0	4.31				3.42								4.12				3.86						2.18										2.8				5.83						9.31												Hardness
POTASSIUM	9/7/7440	4100				4030								3950				3280						2400										2900				2740						2870												
SELENIUM	7782-49-2	0.5	J			0.3	J							0.6	J			0.5	J					1.1										0.4	J			0.5	J					0.8	J											5
SILVER	7440-22-4	0.004	U			0.004	U							0.004	U			0.004	U					0.005	UJ									0.02	U			0.02	U					0.004	UJ											1.3
SODIUM	7440-23-5	57800				68900								62900				63900						25000										20600				30800						31600												
THALLIUM	7440-28-0	0.066				0.068								0.071				0.07						0.006	UJ									0.02	U			0.012	UJ					0.017	UJ											17
VANADIUM	7440-62-2	0.64				2.87								0.75				0.59						4.48										0.34				2.44						5.02												44
ZINC	7440-66-6	3.3				1.1								2.1				1.6						6.9										1.7				3.3						2.7												Hardness
Hardness	mg/L	311				272								292				270						178										278				366						433												
DOC (mg/L)		49.4				61.7								58.9				96.7						9.8										60.3				24						65.5												
pH		7.29				7.19								7.37				7.63						7.35										7.4				7.46						6.93												
ammonia mg N/L		**3.36**				**3.48**								1.01				0.347						0.655										**5.64**				**5.05**						**5.56**												
Hardness-based (surface) water quality criteria																																																								
Beryllium	ug/L	68				55								61				54						28										57				88						102												
Cadmium	ug/L	6.0				5.4								5.7				5.4						3.9										5.5				6.8						7.3												
Chromium	ug/L	218				196								207				194						138										199				249						268												
Copper	ug/L	25				22								23				22						15										22				28						30												
Lead	ug/L	27				23								25				23						13										24				33						37												
Nickel	ug/L	136				122								129				121						85										124				156						169												
Zinc	ug/L	313				280								297				278						195										285				360						388												
pH-based (surface) water quality criteria; assuming sediment temperature range of 14 to 19 degrees C (March-November)																																																							
Ammonia	mg/L	3.3				3.3								3.3				3.3						3.3										3.3				3.3						3.3												

All reported elemental concentrations are based on total concentration (suspended and dissolved).

Hardness-based chronic (surface) water quality criteria: Total Residual Concentration Outside Mixing Zone Average (TR OMZA) for warmwater habitats in the Lake Erie Basin; Chapter 3745-1 of the Ohio Adminisrative Code updated October 20, 2009

Beryllium = EXP(1.609*(LN([hardness]))-5.017)
Cadmium = EXP(0.7852*(LN([hardness]))-2.715)
Chromium = EXP(0.819*(LN([hardness]))+0.6848)
Copper = EXP(0.8545*(LN([hardness]))-1.702)
Lead = EXP(1.273*(LN([hardness]))-4.003)
Nickel = EXP(0.846*(LN([hardness]))+0.0584)
Zinc = EXP(0.8473*(LN([hardness]))+0.884)

Note that for all equations, 400 is used if the hardnes exceeds 400 ug/L per Ohio Rule 3745-1-07

Table H-7. Metals Concentrations (mg/kg dry wt) in Aquatic Invertebrate Tissue Samples from Duck, Otter and Grassy Creeks and Amlosch Ditch.

chemical_name	cas_rn	AD-1T	VQ	GC-2T	VQ	DC-11/12T	VQ	DC-5T	VQ	OC-16T	VQ	OC-12/13T	VQ	OC-5AT	VQ	OC-4T	VQ	Benchmark
ALUMINUM	7429-90-5	859		219		190		347		414		254		111		300		
ANTIMONY	7440-36-0	5.9	U	5.3	U	5	U	5.4	U	5.7	U	5.1	U	5.7	U	5	U	
ARSENIC	7440-38-2	1.3		0.62	J	2.6		1.1		2.1		1.8		0.66	J	1.1		
BARIUM	7440-39-3	7.6	J	5.5	J	6.9	J	10.3	J	12.2	J	12.5	J	9.1	J	23		
BERYLLIUM	7440-41-7	0.06	J	0.44	U	0.42	U	0.45	U	0.48	U	0.42	U	0.48	U	0.42	U	
CADMIUM	7440-43-9	0.13	J	0.44	U	0.063	J	0.056	J	0.11	J	0.1	J	0.48	U	0.073	J	
CALCIUM	7440-70-2	11600		40200		25400		45400		14500		26500		21400		36500		
CHROMIUM	7440-47-3	4.1		3.3		3.4		5.5		5.7		5.4		6.9		3.9		
COBALT	7440-48-4	0.68	J	0.25	J	0.19	J	0.23	J	0.4	J	0.3	J	0.13	J	0.17	J	
COPPER	7440-50-8	15.5		11.5		7.2		12.7		19.9		33		16.6		37		
IRON	7439-89-6	1780		507		620		796		1120		631		208		332		
LEAD	7439-92-1	3.6		1.2		0.48	J	1.8		4.7		3.6		0.78	J	1.4		
MAGNESIUM	7439-95-4	1590	B	694	B	505	B	681	B	1160	B	553	B	336	J	636	B	
MANGANESE	7439-96-5	33.8	B	31.4	B	14.8	B	81.5	B	39.2	B	47.9	B	26.9	B	68.4	B	
MERCURY	7439-97-6	0.011	UJ	0.028	U	0.025	UJ	0.027	U	0.025	U	0.013	UJ	0.016	UJ	0.026	U	
NICKEL	7440-02-0	2.9	J	2.1	J	2.1	J	3.4	J	3	J	2.7	J	3.6	J	2.1	J	
POTASSIUM	7440-09-7	809		986		972		675		1670		1800		1230		1820		
SELENIUM	7782-49-2	0.78	J	3.1	U	0.56	J	0.74	J	1.1	J	0.75	J	3.3	U	1	J	7.91
SILVER	7440-22-4	0.98	U	0.88	U	0.84	U	0.89	U	0.95	U	0.85	U	0.95	U	0.84	U	
SODIUM	7440-23-5	788		859		903		745		1490		1820		1400		1570		
THALLIUM	7440-28-0	2.5	U	2.2	U	2.1	U	2.2	U	2.4	U	2.1	U	2.4	U	2.1	U	
VANADIUM	7440-62-2	2.3	J	0.56	J	0.59	J	1	J	1.2	J	0.78	J	0.14	J	0.4	J	
ZINC	7440-66-6	49.6	B	35.7	B	16	B	36.6	B	25.5	B	22.8	B	14	B	19.8	B	

the USEPA (2004) has developed a whole-body tissue standard for the protection of fish reproduction of 7.91 mg/kg dry weight for selenium

Table H-8. Metals Concentrations (mg/kg dry wt) in Whole Body Forage Fish Composite Samples from Duck and Otter Creeks.

		Duck Creek D[1]		Duck Creek A[2]		Otter Creek C[1]		Otter Creek A[2]		
Chemical name	CAS #	FWS1590-DCD-CCH1-C	VQ	FWS1632-DCA LP-1-C93	VQ	FWS1626-OCC-CCH2-C8	VQ	FWS1622-OCA-LP1-C	VQ	Benchmark
ARSENIC	7440-38-2	0.42	J	0.93		0.69		0.8		
BARIUM	7440-39-3	7.03		8.41		5.64		7.42		
CADMIUM	7440-43-9	0.151		0.065		0.179		0.092		
CHROMIUM	7440-47-3	2.04	J	1.93	J	1.75	J	1.94	J	
LEAD	7439-92-1	0.194		0.278		**0.627**		0.394		
MERCURY	7439-97-6	0.275		0.074		0.184		0.12		
SELENIUM	7782-49-2	3.06		1.79		3.2		2.38		7.91
SILVER	7440-22-4	0.024		ND	U	ND	U	ND	U	
Solids, Total (% wet wt)	24.6	28.7		26.4				27		

[1] Whole body composite samples of creek chubs
[2] Whole body composite samples of logperch

the USEPA (2004) has developed a whole-body tissue standard for the protection of fish reproduction of 7.91 mg/kg dry weight for selenium

Table H-9. Pyrethroid Pesticides (ug/kg dry wt) Concentrations in Sediment Samples from Urban Comparison Streams and Duck Creek.

Surface Sediment Grab Samples (0-6 inches depth)																							
		Urban				Duck Creek D				Duck Creek C		Duck Creek B				Duck Creek A							
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	VQ	DC-5/6	DC-5	VQ	DC-4	DC-3/4	DC-3	VQ	DC-2	DC-1
BIFENTHRIN	BIFENTHRIN	10.4		1.2	J	4.06	U						3.06	J		1.69	U			0.649	U		
DANITOL	Danitol	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
DELTAMETHRIN	Deltamethrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
ESFENVALERATE	Esfenvalerate	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
FENVALERATE	Fenvalerate	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
L-CYHALOTHRIN	L-Cyhalothrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
PERMETHRIN	52645-53-1	15.2	J	7.13	U	40.6	U						24.1	U		16.9	U			6.49	U		
PRALLETHRIN	Prallethrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
TOTAL ALLETHRIN	T Allethrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
TOTAL CYFLUTHRIN	T Cyfluthrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
TOTAL CYPERMETHRIN	T Cypermethrin	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
TOTAL FLUVALINATE	T Fluvalinate	1.29	U	0.713	U	4.06	U						2.41	U		1.69	U			0.649	U		
Total Organic Carbon (%)	TOC	5.07		2.12		22.9							7.55			4.99				7.97			
Total Organic Carbon (g/g)		0.0507		0.0212		0.229							0.0755			0.0499				0.0797			

Sediment Benchmarks from Starner et al 2006 (in ug/gOC) - based on 10-Day LC50 for the amphipod *Hyalella azteca*

Bifenthrin (ug/gOC)	0.52
Esfenvalerate (ug/gOC)	1.54
L Cyhalothrin (ug/gOC)	0.45
Permethrin (ug/gOC)	10.83
Cyfluthrin (ug/gOC)	1.08
Cypermethrin (ug/gOC)	0.38

GLLA data as ug/gOC	AD-1	GC-1	DC-6/7
Bifenthrin (ug/gOC)	0.2051	0.0566	0.0405
Esfenvalerate (ug/gOC)			
L Cyhalothrin (ug/gOC)			
Permethrin (ug/gOC)	0.300		
Cyfluthrin (ug/gOC)			
Cypermethrin (ug/gOC)			

Organic carbon-normalized values calculated as [pesticide (ug/kg dw)]*$[TOC (g/g)]^{-1}$ * [0.001]

Table H-10. Pyrethroid Pesticides (ug/kg dry wt) Concentrations in Sediment Samples from Otter Creek.

		Surface Sediment Grab Samples (0-6 inches depth)																																	
		Otter Creek A			Otter Creek D			Otter Creek C								Otter Creek B						Otter Creek A													
Chemical name	CAS #	OC-24/25	VQ	OC-23	OC-22	VQ	OC-18/19	OC-18	OC-16/17	OC-16	VQ	OC-15/16	OC-12/13	VQ	OC-11/12	OC-10-11	OC-9-10	VQ	OC-8-9	OC-8	OC-7-8	OC-6/7(2)-01	VQ	OC-6/7(1)-01	OC-5A-01	VQ	OC-5	OC-4A-01	OC-4-01	VQ	OC-3A-01	OC-3	OC-2A	OC-2	OC-1A
BIFENTHRIN	BIFENTHRIN	0.786	U		2.74	J				0.739	J		1.22	J			3.62	J				7.38			2.13	J			1.57	U					
DANITOL	Danitol	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
DELTAMETHRIN	Deltamethrin	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
ESFENVALERATE	Esfenvalerate	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
FENVALERATE	Fenvalerate	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
L-CYHALOTHRIN	L-Cyhalothrin	0.786	U		0.848	U				0.62	U		0.745	U			2.67	J				1.33	U		1.28	U			1.57	U					
PERMETHRIN	52645-53-1	7.86	U		19.8	J				6.2	U		7.45	U			11.4	U				13.3	U		12.8	U			15.7	U					
PRALLETHRIN	Prallethrin	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
TOTAL ALLETHRIN	T Allethrin	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
TOTAL CYFLUTHRIN	T Cyfluthrin	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
TOTAL CYPERMETHRIN	T Cypermethrin	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
TOTAL FLUVALINATE	T Fluvalinate	0.786	U		0.848	U				0.62	U		0.745	U			1.14	U				1.33	U		1.28	U			1.57	U					
Total Organic Carbon	TOC	1.74			3.79					3.56			8.91				4.68					3.92			3.17				4.95						
Total Organic Carbon (g/g)		0.0174			0.0379					0.0356			0.0891				0.0468					0.0392			0.0317				0.0495						
Sediment Benchmarks from Starner et al 2006 (in ug/gOC) - based on 10-Day LC50 for the amphipod *Hyalella azteca*																																			
Bifenthrin (ug/gOC)	0.52																																		
Esfenvalerate (ug/gOC)	1.54																																		
L Cyhalothrin (ug/gOC)	0.45																																		
Permethrin (ug/gOC)	10.83																																		
Cyfluthrin (ug/gOC)	1.08																																		
Cypermethrin (ug/gOC)	0.38																																		
GLLA data as ug/gOC																																			
Bifenthrin (ug/gOC)					0.072296					0.0208			0.013692				0.0774					0.188			0.067192										
Esfenvalerate (ug/gOC)																																			
L Cyhalothrin (ug/gOC)																	0.0571																		
Permethrin (ug/gOC)					0.522																														
Cyfluthrin (ug/gOC)																																			
Cypermethrin (ug/gOC)																																			

Organic carbon-normalized values calculated as [pesticide (ug/kg dw)]*[TOC (g/g)]$^{-1}$ * [0.001]

Table H-11. Polychlorinated Biphenyls (ug/kg dry wt) Concentrations in Sediment Samples from Urban Comparison Streams and Duck Creek.

		Surface Sediment Grab Samples (0-6 inches depth)																																Benchmark
		Urban				Duck Creek D						Duck Creek C				Duck Creek B						Duck Creek A												
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11		DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ	PEC (ug/kg)
PCB-1016	12674-11-2	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1221	11104-28-2	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1232	11141-16-5	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1242	53469-21-9	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1248	12672-29-6	69	U	290	J	160	U			100	U	97	U			82	U	140	U	78	J	170	J	64	U	72	U	44	U					
PCB-1254	11097-69-1	69	U	300		160	U			100	U	97	U			82	U	140	U	110		110	R	64	U	72	U	44	U					
PCB-1260	11096-82-5	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1262	37324-23-5	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
PCB-1268	11100-14-4	69	U	51	U	160	U			100	U	97	U			82	U	140	U	100	U	110	U	64	U	72	U	44	U					
Sum of Aroclors				590		ND				ND		ND				ND		ND		78		170		ND		ND		ND						676
surface cores																																		
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11-02	VQ	DC-10/11	VQ	DC-9/10-02	VQ	DC-8-02	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-02	VQ	DC-4-02	VQ	DC-3/4-02	VQ	DC-3-02	VQ	DC-2-02	VQ	DC-1-02	VQ	
PCB-1016	12674-11-2							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1221	11104-28-2							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1232	11141-16-5							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1242	53469-21-9							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1248	12672-29-6							75	U					75	U							120	R	80	U	56	U	48	U	59	UJ	63		
PCB-1254	11097-69-1							75	U					75	U							110	R	80	U	56	U	48	U	59	UJ	61	U	
PCB-1260	11096-82-5							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1262	37324-23-5							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
PCB-1268	11100-14-4							75	U					75	U							73	U	80	U	56	U	48	U	59	UJ	61	U	
Sum of Aroclors								ND						ND								ND		ND		ND		ND		ND		63		676
subsurface cores																																		
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-03	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2-03	VQ	DC-1-03	VQ	
PCB-1016	12674-11-2																					53	U							51	U	44	U	
PCB-1221	11104-28-2																					53	U							51	U	44	U	
PCB-1232	11141-16-5																					53	U							51	U	44	U	
PCB-1242	53469-21-9																					53	U							51	U	44	U	
PCB-1248	12672-29-6																					140	R							51	U	44	U	
PCB-1254	11097-69-1																					120	R							51	U	44	U	
PCB-1260	11096-82-5																					53	U							51	U	44	U	
PCB-1262	37324-23-5																					53	U							51	U	44	U	
PCB-1268	11100-14-4																					53	U							51	U	44	U	
Sum of Aroclors																						ND								ND		ND		676

Sum of Aroclors reported as the sum of all detected Aroclors (non-detects not included in sum)
PEC Benchmark is from McDonald et al 2000

Table H-12. Polychlorinated Biphenyls (ug/kg dry wt) Concentrations in Sediment Samples from Otter Creek.

		Surface Sediment Grab Samples (0-6 inches delpth)																																																								Benchmark
		Otter Creek E				Otter Creek D				Otter Creek C												Otter Creek B												Otter Creek A																								
Chemical name	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-9-01	VQ	OC-8-9	VQ	OC-8	VQ	OC-7-8	VQ	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ			OC-5A-01	VQ	OC-5	VQ	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	VQ	OC-2A	VQ	OC-2	VQ	OC-1A	VQ	PEC (ug/kg)
PCB-1016	12674-11-2	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1221	11104-28-2	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1232	11141-16-5	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1242	53469-21-9	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1248	12672-29-6	46	U			54	U	41	U			46	U	45	U	41	U	48	U	310	R	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1254	11097-69-1	46	U			220	NJ	170				46	U	45	U	410	J	48	U	320		46	U	60	U			450				56	U	76	U	60	U			78	U			78	U	240		55	J			68	U			59	J	
PCB-1260	11096-82-5	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1262	37324-23-5	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
PCB-1268	11100-14-4	46	U			54	U	41	U			46	U	45	U	41	U	48	U	61	U	46	U	60	U			59	U			56	U	76	U	60	U			78	U			78	U	100	U	94	U			68	U			83	U	
Sum of Aroclors		ND				220		170				ND		ND		410		ND		320		ND		ND				450				ND		ND		ND				ND				ND		240		55				ND				59		676

surface core

Chemical name	CAS #	OC-24/25	VQ	OC-23-02	VQ	OC-22	VQ	OC-18/19	VQ	OC-18-02	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-9	VQ	OC-8/9	VQ	OC-8-02	VQ	OC-7/8	VQ	OC-6/7(2)-02	VQ	OC-6/7(1)-02	VQ			OC-5a-02	VQ	OC-5-02	VQ	OC-4A-02	VQ	OC-4-02	VQ	OC-3A-02	VQ	OC-3-02	VQ	OC-2A-02	VQ	OC-2-02	VQ	OC-1A-02	VQ	
PCB-1016	12674-11-2			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1221	11104-28-2			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1232	11141-16-5			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1242	53469-21-9			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1248	12672-29-6			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1254	11097-69-1			600	J					270	J																			28	J			65	J	200				93	U	95	U	210		470		340	J	140	J	49	J	220		270		
PCB-1260	11096-82-5			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1262	37324-23-5			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U	59	U	
PCB-1268	11100-14-4			46	U					50	U																			61	U			65	U	62	U			93	U	95	U	98	U	97	U	110	U	66	U	100	U	55	U		U	
Sum of Aroclors				600						270																				28				65		200				ND		ND		210		470		340		140		49		220		270		676

subsurface core

Chemical name	CAS #	OC-24/25	VQ	OC-23-03	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-9	VQ	OC-8/9	VQ	OC-8	VQ	OC-7/8	VQ	OC-6/7(2)	VQ	OC-6/7(1)-03	VQ	OC-6-03	VQ	OC-5a-03	VQ	OC-5-03	VQ	OC-4A-03	VQ	OC-4-03	VQ	OC-3A-03	VQ	OC-3-03	VQ	OC-2A-03	VQ	OC-2-03	VQ	OC-1A-03	VQ	
PCB-1016	12674-11-2			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1221	11104-28-2			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1232	11141-16-5			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1242	53469-21-9			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1248	12672-29-6			170	J																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1254	11097-69-1			270	J																															53	J	87		78	U	170	J	530		180	J	330	R	68	U	320		460		540	J	
PCB-1260	11096-82-5			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1262	37324-23-5			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
PCB-1268	11100-14-4			45	U																															66	U	72	U	78	U	92	U	99	U	85	U	92	U	68	U	76	U	57	U	84	U	
Sum of Aroclors				440																																53		87		ND		170		530		180		ND		ND		320		460		540		676

deep core

Chemical name	CAS #	OC-24/25	VQ	OC-23-03	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-9	VQ	OC-8/9	VQ	OC-8	VQ	OC-7/8	VQ	OC-6/7(2)	VQ	OC-6/7(1)	VQ			OC-5A	VQ	OC-5	VQ	OC-4A	VQ	OC-4	VQ	OC-3A	VQ	OC-3	VQ	OC-2A-04	VQ	OC-2	VQ	OC-1A	VQ	
PCB-1016	12674-11-2																																																			50	U					
PCB-1221	11104-28-2																																																			50	U					
PCB-1232	11141-16-5																																																			50	U					
PCB-1242	53469-21-9																																																			50	U					
PCB-1248	12672-29-6																																																			50	U					
PCB-1254	11097-69-1																																																			120						
PCB-1260	11096-82-5																																																			50	U					
PCB-1262	37324-23-5																																																			50	U					
PCB-1268	11100-14-4																																																			50	U					
Sum of Aroclors																																																				120						676

note on preliminary draft: database includes PCB data for OC-6-03, which was not sampled according to other information.
PEC Benchmark is from McDonald et al 2000

Table H-13. Polychlorinated Biphenyls Concentrations (µg/kg wet wt) in Aquatic Invertebrate Tissue Samples from Duck, Otter and Grassy Creeks and Amlosch Ditch.

		Urban				Duck Creek D		Duck Creek A		Otter Creek C				Otter Creek A				
Chemical name	CAS #	AD-1T	VQ	GC-2T	VQ	DC-11/12T	VQ	DC-5T	VQ	OC-16T	VQ	OC-12/13T	VQ	OC-5AT	VQ	OC-4T	VQ	Benchmark
PCB-1016	12674-11-2	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1221	11104-28-2	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1232	11141-16-5	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1242	53469-21-9	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1248	12672-29-6	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1254	11097-69-1	11	U	16	p	5.8	p	24		21	p	25		36		81		5000
PCB-1260	11096-82-5	11	U	5.2	p	4.9	U	5.8	p	3.3	Jp	3.9	Jp	4.8	Jp	9.7	Jp	
PCB-1262	37324-23-5	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
PCB-1268	11100-14-4	11	U	4.7	U	4.9	U	5.3	U	5	U	4.7	U	5	U	10	U	
percent lipid	LIPID	0.57		0.67		0.68		0.34		1.5		1.1		0.55		0.90		

Benchmark is from Monosson 2000 and is based on larval fish data for Aroclor 1254 (PCB-1254)

Table H-14. Polychlorinated Biphenyls Concentrations (µg/kg wet wt) in Forage Fish Samples from Duck and Otter Creeks .

		composite of whole creek chubs from Duck Creek D		composite of whole log perch from Duck Creek A		composite of whole creek chubs from Otter Creek C		composite of whole log perch from Otter Creek A		
Chemical name	CAS #	FWS1590-DCD-CCH1-C	VQ	FWS1632-DCA LP-1-C93	VQ	FWS1626-OCC-CCH2-C8	VQ	FWS1622-OCA-LP1-C	VQ	Benchmark
Aroclor 1016	12674-11-2	ND	U	ND	U	ND	U	ND	U	
Aroclor 1221	11104-28-2	ND	U	ND	U	ND	U	ND	U	
Aroclor 1232	11141-16-5	ND	U	ND	U	ND	U	ND	U	
Aroclor 1242	53469-21-9	ND	U	51	J	ND	U	ND	U	
Aroclor 1248	12672-29-6	ND	U	ND	U	ND	U	ND	U	
Aroclor 1254	11097-69-1	ND	U	99		150	J	260		5000
Aroclor 1260	11096-82-5	ND	U	95		ND	U	ND	U	
Lipids, Total (% wet wt)		2.89		3.83		4.75		4.27		
PCB 8		ND	U	0.51	J	0.48	J	0.51		
PCB 18		0.33	J	1.8		1.3		2		
PCB 28		0.47	J	5		3.7		4.5		
PCB 44		0.9		4		4.7		7.5		
PCB 52		2.2		8.5		8.1		18		
PCB 66		1.4	J	5.5		6.8	J	9.6	J	
PCB 87		ND	U	ND	U	ND	U	11	J	
PCB 101		ND	U	8.7		13	J	28		
PCB 114		ND	U	0.15	J	ND	U	0.31	J	
PCB 123		ND	U	ND	U	ND	U	ND	U	
PCB 138		4.5		8.7		19		22		
PCB 156		0.63	J	1.1	J	1.6	J	2.3		
PCB 167		ND	U	ND	U	ND	U	ND	U	
PCB 180		1.8		4		5.4		5.5		
PCB 183		0.71		1.8		2.6		2.6		
PCB 184		ND	U	ND	U	ND	U	ND	U	
PCB 187		3.2		4.4		13		6.2		
PCB 189		ND	U	ND	U	ND	U	ND	U	
PCB 195		ND	U	ND	U	ND	U	ND	U	
PCB 206		0.32	J	0.31	J	0.5	J	0.39	J	
PCB 209		ND	U	ND	U	ND	U	ND	U	
PCB 60		ND	U	ND	U	8.6		ND	U	
PCB 77		ND	U	ND	U	ND	U	ND	U	1300
PCB 81		ND	U	8.2	J	ND	U	29		
PCB 90		ND	UJ	ND	UJ	ND	UJ	ND	UJ	
PCB 105		0.95		1.5		4.4	J	5.6		
PCB 118		2.5		4.3		8.1		15		
PCB 126		ND	U	ND	U	ND	U	ND	U	
PCB 128		1.1		1.9		4.4		5		
PCB 153		4		9.1		13	J	18	J	
PCB 157		0.23	J	0.24	J	0.46	J	0.55		
PCB 158		0.37	J	0.82		1.7		3.1		
PCB 166		ND	U	ND	U	ND	U	ND	U	
PCB 169		ND	U	ND	U	ND	U	ND	U	
PCB 170		ND	U	1.3	J	2	J	2.1	J	

Benchmarks are from Monosson 2000 and are based on larval fish for Aroclor 1254 and fish eggs for PCB Congener 77 (PCB 77)

Table H-15. Total Petroleum Hydrocarbons in Gasoline, Diesel and Residual Ranges (mg/kg dry wt) in sediment samples from Urban Comparison Streams and Duck Creek.

Surface Grab Samples (0-6 inches depth)

Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO	13	J	8.3	U	12	U			6.1	U	5.2	U			4.1	U	8.7	U	8.5	U	24	UJ	20	UJ	15	UJ	7.7	UJ				
DIESEL RANGE ORGANICS (DRO)	PHCD	500	D	180		120	J			530	D	280				220		530		530		500		310		240		110	J				
RESIDUAL RANGE ORGANICS (RRO)	RRO	2600	D	640		770				3100	D	1900				1100		3300		2700		2200		1200		1000		580	J				
total organic carbon (% dry wt)	TOC	5.07		2.12		22.9				6.79		5.37				6.29		7.55		8.36		4.99		6.18		4.76		7.97					
TOC (kg/kg dry sediment)		0.0507		0.0212		0.229				0.0679		0.0537				0.0629		0.0755		0.0836		0.0499		0.062		0.048		0.0797					

Surface Core Samples (0-24 inches depth)

Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12		DC-11-02	VQ	DC-10/11	VQ	DC-9/10-02	VQ	DC-8-02	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-02	VQ	DC-4-02	VQ	DC-3/4-02	VQ	DC-3-02	VQ	DC-2-02	VQ	DC-1-02	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO							4.2	U			2	U	3.8	U							16	UJ	16	UJ	11	UJ	8.5	UJ	11	UJ	14	
DIESEL RANGE ORGANICS (DRO)	PHCD							200				31	J	420								1500		590		1300		570		430		3000	
RESIDUAL RANGE ORGANICS (RRO)	RRO							1200				69		1400								1700		1000		1200		1000		1100		3000	D
total organic carbon (% dry wt)	TOC							5.60				1.57		5.41								3.38		3.40		1.99		2.00		3.09		2.71	
TOC (kg/kg dry sediment)								0.0560				0.0157		0.0541								0.0338		0.0340		0.0199		0.0200		0.0309		0.0271	

Subsurface Core Samples (24-48 inches depth)

Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12		DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-03	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2-03	VQ	DC-1-03	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO																					14								8.9	UJ	7.7	UJ
DIESEL RANGE ORGANICS (DRO)	PHCD																					3400								740		590	
RESIDUAL RANGE ORGANICS (RRO)	RRO																					5500	D							970		690	
total organic carbon (% dry wt)	TOC																					2.76								3.21		0.850	
TOC (kg/kg dry sediment)																						0.0276								0.0321		0.00850	

Table H-16. Total Petroleum Hydrocarbons in Gasoline, Diesel and Residual Ranges (mg/kg dry wt) in sediment samples from Otter Creek.

Surface Grab Samples (0-6 inches depth)

Chemical name	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-8-9	VQ	OC-8	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO	3.3	U			11	UJ	1.7	U			2	U	1.8	U	2	U	2.3	U	64		8	UJ	15	UJ	9.5	UJ		
DIESEL RANGE ORGANICS (DRO)	PHCD	120				1600	D	230	D			520	D	310	D	240	D	680		16000	J	1300	J	2100	D	3800	D		
RESIDUAL RANGE ORGANICS (RRO)	RRO	450				3700	D	510	D			1300	D	720	D	600	D	1400		22000	D	2400	D	4200	D	410	U		
TOTAL ORGANIC CARBON (% dry wt)	TOC	1.74				3.79		3.26				3.02		3.56		3.26		1.62		8.91		3.71		4.68		3.05			
total organic carbon (kg/kg dry sediment)		0.0174				0.0379		0.0326				0.0302		0.0356		0.0326		0.0162		0.0891		0.0371		0.0468		0.0305			

Chemical name	OC-7-8	VQ	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ			OC-5A-01	VQ	OC-5	VQ	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	VQ	OC-2A	VQ	OC-2	VQ	OC-1A	VQ
GASOLINE RANGE ORGANICS (GRO)	12	UJ	17	J	7.9	UJ			29				17	UJ	110		54				18				1600	J
DIESEL RANGE ORGANICS (DRO)	1300		2800	J	170				2600				1300		6000	D	3200				3000				6700	D
RESIDUAL RANGE ORGANICS (RRO)	2500		3400		240				2900				2800		5500	D	3500				4600	D			5900	D
TOTAL ORGANIC CARBON (% dry wt)	3.34		3.92		1.96				3.17				3.39		4.95		2.21				3.97				3.81	
total organic carbon (kg/kg dry sediment)	0.0334		0.0392		0.0196				0.0317				0.0339		0.0495		0.0221				0.0397				0.0381	

Surface Core Samples (0-24 inches depth)

Chemical name	CAS #	OC-24/25		OC-23-02	VQ	OC-22	VQ	OC-18/19	VQ	OC-18-02	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-8/9	VQ	OC-8-02	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO			8.9	UJ					9	UJ																	40	
DIESEL RANGE ORGANICS (DRO)	PHCD			900						1600	D																	8200	
RESIDUAL RANGE ORGANICS (RRO)	RRO			1000						2800	D																	8400	D
TOTAL ORGANIC CARBON	TOC			5.81						8.04																		3.67	
total organic carbon (kg/kg dry sediment)				0.0581						0.0804																		0.0367	

Chemical name	OC-7/8	VQ	OC-6/7(2)-02	VQ	OC-6/7(1)-02	VQ	OC-6		OC-5a-02	VQ	OC-5-02	VQ	OC-4A-02	VQ	OC-4-02	VQ	OC-3A-02	VQ	OC-3-02	VQ	OC-2A-02	VQ	OC-2-02	VQ	OC-1A-02	VQ
GASOLINE RANGE ORGANICS (GRO)			15	UJ	75				85		170		130		160		240		170	J	960	J	1100	J	7000	
DIESEL RANGE ORGANICS (DRO)			3000		4800				5600		8400		7600	D	9500	D	15000	D	5100	D	9900	J	6600	J	13000	J
RESIDUAL RANGE ORGANICS (RRO)			3400	D	4800	D			4500		6000	D	6400	D	7800	D	13000	D	5300	D	7600	D	7900	D	9000	D
TOTAL ORGANIC CARBON			4.45		6.27				2.36		1.1		3.51		3.73		4.05		5.26		3.89		3.5		2.72	
total organic carbon (kg/kg dry sediment)			0.0445		0.0627				0.0236		0.011		0.0351		0.0373		0.0405		0.0526		0.0389		0.035		0.0272	

Subsurface Core Samples (24-48 inches depth)

Chemical name	CAS #	OC-24/25		OC-23-03	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-8/9	VQ	OC-8	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO			7.5	UJ																								
DIESEL RANGE ORGANICS (DRO)	PHCD			1600																									
RESIDUAL RANGE ORGANICS (RRO)	RRO			1700																									
TOTAL ORGANIC CARBON	TOC			2.4																									
total organic carbon (kg/kg dry sediment)				0.024																									

Chemical name	OC-7/8	VQ	OC-6/7(2)	VQ	OC-6/7(1)-03	VQ	OC-6-03	VQ	OC-5a-03	VQ	OC-5-03	VQ	OC-4A-03	VQ	OC-4-03	VQ	OC-3A-03	VQ	OC-3-03	VQ	OC-2A-03	VQ	OC-2-03	VQ	OC-1A-03	VQ
GASOLINE RANGE ORGANICS (GRO)					120		48		68		180		150		180		120		12	UJ			1100	J		
DIESEL RANGE ORGANICS (DRO)					9100	J	5800		7000		27000	J	5400	D	11000	D	9000		280				8000	J		
RESIDUAL RANGE ORGANICS (RRO)					7900	D	4700	D	6200	D	10000	D	4400	D	8900	D	7600	D	460				6900	D		
TOTAL ORGANIC CARBON					3.15		7.44		6.03		4.42		3.84		5.99		8.94		4.97				3.29			
total organic carbon (kg/kg dry sediment)					0.0315		0.0744		0.0603		0.0442		0.0384		0.0599		0.0894		0.0497				0.0329			

Deep Core Samples (48-72 inches depth)

Chemical name	CAS #	OC-24/25		OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-8-9	VQ	OC-8	VQ
GASOLINE RANGE ORGANICS (GRO)	GRO																												
DIESEL RANGE ORGANICS (DRO)	PHCD																												
RESIDUAL RANGE ORGANICS (RRO)	RRO																												
TOTAL ORGANIC CARBON	TOC																												
total organic carbon (kg/kg dry sediment)																													

Chemical name	OC-7-8	VQ	OC-6/7(2)	VQ	OC-6/7(1)	VQ			OC-5A		OC-5	VQ	OC-4A	VQ	OC-4	VQ	OC-3A		OC-3	VQ	OC-2A-04	VQ	OC-2	VQ	OC-1A	VQ
GASOLINE RANGE ORGANICS (GRO)																					67					
DIESEL RANGE ORGANICS (DRO)																					2400					
RESIDUAL RANGE ORGANICS (RRO)																					2800					
TOTAL ORGANIC CARBON																					8.8					
total organic carbon (kg/kg dry sediment)																					0.088					

Table H-17. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Surface Sediment Grab Samples from Urban Comparison Streams and Duck Creek.

Surface Sediment Grab Samples (0-6 inches depth)																														
Stream Segments		**Urban**				**Duck Creek D**					**Duck Creek C**			**Duck Creek B**						**Duck Creek A**										Benchmark
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	DC-10/11	VQ	DC-9/10	VQ	DC-8	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	DC-1	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
1,2,4,5-TETRACHLOROBENZENE	95-94-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,4,5-TRICHLOROPHENOL	95-95-4	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,4,6-TRICHLOROPHENOL	88-06-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,4-DICHLOROPHENOL	120-83-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,4-DIMETHYLPHENOL	105-67-9	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,4-DINITROPHENOL	51-28-5	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			
2,4-DINITROTOLUENE	121-14-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2,6-DINITROTOLUENE	606-20-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2-CHLORONAPHTHALENE	91-58-7	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2-CHLOROPHENOL	95-57-8	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2-METHYLPHENOL	95-48-7	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
2-NITROANILINE	88-74-4	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			
2-NITROPHENOL	88-75-5	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
3,3'-DICHLOROBENZIDINE	91-94-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
3-NITROANILINE	99-09-2	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			
4,6-DINITRO-2-METHYLPHENOL	534-52-1	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			
4-BROMOPHENYL PHENYL ETHER	101-55-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
4-CHLORO-3-METHYLPHENOL	59-50-7	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
4-METHYLPHENOL	106-44-5	1400	U	260	U	810	U		2100	U	490	U		420	U	220	J	**630**		**990**		1600	U	**340**	J	1100	U			266
4-NITROPHENOL	100-02-7	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			
ACETOPHENONE	98-86-2	1400	U	110	J	810	U		2100	U	170	J		150	J	240	J	310	J	230	J	1600	U	180	J	1100	U			977
ATRAZINE	1912-24-9	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
BENZALDEHYDE	100-52-7	1400	U	190	J	360	J		2100	U	370	J		300	J	320	J	300	J	360	J	1600	U	280	J	1100	U			4572
BENZYL BUTYL PHTHALATE	85-68-7	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
BIS(2-CHLOROETHYL)ETHER	111-44-4	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	3300		850		700	J		2100	U	280	J		420	U	630	J	540	U	360	J	1600	U	370	U	1100	U			7316
CAPROLACTAM	105-60-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
CARBAZOLE	86-74-8	**1900**		110	J	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			186
CHLOROPHENOLS	58-90-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
DIBENZOFURAN	132-64-9	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
DIETHYL PHTHALATE	84-66-2	1400	U	260	U	**410**	J		2100	U	490	U		420	U	**260**	J	540	U	540	U	1600	U	370	U	1100	U			152
DIMETHYL PHTHALATE	131-11-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
DI-N-BUTYLPHTHALATE	84-74-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
DI-N-OCTYLPHTHALATE	117-84-0	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
HEXACHLORO-1,3-BUTADIENE	87-68-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
HEXACHLOROBENZENE	118-74-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
HEXACHLOROCYCLOPENTADIENE	77-47-4	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
HEXACHLOROETHANE	67-72-1	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	UJ	370	UJ	1100	UJ			
NITROBENZENE	98-95-3	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
N-NITROSODIPHENYLAMINE	86-30-6	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			240
P-CHLOROANILINE	106-47-8	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	540	U	1600	U	370	U	1100	U			
PENTACHLOROPHENOL	87-86-5	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	UJ	720	UJ	2200	UJ			
PHENOL	108-95-2	1400	U	260	U	810	U		2100	U	490	U		420	U	690	U	540	U	230	J	1600	U	370	U	1100	U			318
P-NITROANILINE	100-01-6	2800	U	510	U	1600	U		4100	U	960	U		820	U	1300	U	1000	U	1000	U	3200	U	720	U	2200	U			

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-18. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Surface Sediment Core Samples from Duck Creek.

Surface Sediment Core Samples (0-24 inches depth)																								
Stream Segments		**Duck Creek D**				**Duck Creek C**			**Duck Creek B**			**Duck Creek A**												Benchmark
Chemical name	CAS #	DC-11/12	DC-11-02	VQ	DC-10/11	DC-9/10-02	DC-8-02	VQ	DC-7/8	DC-6/7	DC-5/6	DC-5-02	VQ	DC-4-02	VQ	DC-3/4-02	VQ	DC-3-02	VQ	DC-2-02	VQ	DC-1-02	VQ	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
1,2,4,5-TETRACHLOROBENZENE	95-94-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,4,5-TRICHLOROPHENOL	95-95-4		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,4,6-TRICHLOROPHENOL	88-06-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,4-DICHLOROPHENOL	120-83-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,4-DIMETHYLPHENOL	105-67-9		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,4-DINITROPHENOL	51-28-5		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	
2,4-DINITROTOLUENE	121-14-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2,6-DINITROTOLUENE	606-20-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2-CHLORONAPHTHALENE	91-58-7		390	U			390	U				380	U	410	U	290	U	250	U	300	UJ	310	U	
2-CHLOROPHENOL	95-57-8		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2-METHYLNAPHTHALENE	91-57-6		390	U			390	U				450		410	U	290	U	250	U	100	J	310	U	
2-METHYLPHENOL	95-48-7		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
2-NITROANILINE	88-74-4		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	
2-NITROPHENOL	88-75-5		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
3,3'-DICHLOROBENZIDINE	91-94-1		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
3-NITROANILINE	99-09-2		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	
4,6-DINITRO-2-METHYLPHENOL	534-52-1		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	
4-BROMOPHENYL PHENYL ETHER	101-55-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
4-CHLORO-3-METHYLPHENOL	59-50-7		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
4-CHLOROPHENYL PHENYL ETHER	7005-72-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
4-METHYLPHENOL	106-44-5		110	J			**420**					**400**		410	U	290	U	120	J	300	U	310	U	266
4-NITROPHENOL	100-02-7		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	
ACETOPHENONE	98-86-2		190	J			270	J				150	J	170	J	140	J	130	J	300	U	110	J	977
ATRAZINE	1912-24-9		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
BENZALDEHYDE	100-52-7		250	J			240	J				360	J	270	J	200	J	160	J	300	U	160	J	4572
BENZYL BUTYL PHTHALATE	85-68-7		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
BIS(2-CHLOROETHYL)ETHER	111-44-4		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7		390	U			390	U				350	J	410	U	290	U	250	U	300	U	1100		7316
CAPROLACTAM	105-60-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
CARBAZOLE	86-74-8		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	186
CHLOROPHENOLS	58-90-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
DIBENZOFURAN	132-64-9		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
DIETHYL PHTHALATE	84-66-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	152
DIMETHYL PHTHALATE	131-11-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
DI-N-BUTYLPHTHALATE	84-74-2		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
DI-N-OCTYLPHTHALATE	117-84-0		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
HEXACHLORO-1,3-BUTADIENE	87-68-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
HEXACHLOROBENZENE	118-74-1		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
HEXACHLOROCYCLOPENTADIENE	77-47-4		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
HEXACHLOROETHANE	67-72-1		390	U			390	U				380	U	410	UJ	290	UJ	250	UJ	300	U	310	U	
NITROBENZENE	98-95-3		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
N-NITROSO-DI-N-PROPYLAMINE	621-64-7		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
N-NITROSODIPHENYLAMINE	86-30-6		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	240
P-CHLOROANILINE	106-47-8		390	U			390	U				380	U	410	U	290	U	250	U	300	U	310	U	
PENTACHLOROPHENOL	87-86-5		750	U			750	U				730	UJ	790	UJ	550	UJ	480	UJ	590	U	610	U	
PHENOL	108-95-2		390	U			180	J				180	J	410	U	290	U	250	U	300	U	310	U	318
P-NITROANILINE	100-01-6		750	U			750	U				730	U	790	U	550	U	480	U	590	U	610	U	

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-19. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Subsurface Sediment Core Samples from Duck Creek.

Subsurface Sediment Core Samples (24-48 inches depth)																			
Stream Segments		**Duck Creek D**			**Duck Creek C**		**Duck Creek B**			**Duck Creek A**									Benchmark
Chemical name	CAS #	DC-11/12	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	DC-5/6	DC-5-03	VQ	DC-4	DC-3/4	DC-3	DC-2-03	VQ	DC-1-03	VQ	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4									270	U				260	U	230	U	
1,2,4,5-TETRACHLOROBENZENE	95-94-3									270	U				260	U	230	U	
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1									270	U				260	U	230	U	
2,4,5-TRICHLOROPHENOL	95-95-4									270	U				260	U	230	U	
2,4,6-TRICHLOROPHENOL	88-06-2									270	U				260	U	230	U	
2,4-DICHLOROPHENOL	120-83-2									270	U				260	U	230	U	
2,4-DIMETHYLPHENOL	105-67-9									270	U				260	U	230	U	
2,4-DINITROPHENOL	51-28-5									520	U				510	U	440	U	
2,4-DINITROTOLUENE	121-14-2									270	U				260	U	230	U	
2,6-DINITROTOLUENE	606-20-2									270	U				260	U	230	U	
2-CHLORONAPHTHALENE	91-58-7									270	U				260	U	230	U	
2-CHLOROPHENOL	95-57-8									270	U				260	U	230	U	
2-METHYLNAPHTHALENE	91-57-6									230	J				260	U	230	U	
2-METHYLPHENOL	95-48-7									270	U				260	U	230	U	
2-NITROANILINE	88-74-4									520	U				510	U	440	U	
2-NITROPHENOL	88-75-5									270	U				260	U	230	U	
3,3'-DICHLOROBENZIDINE	91-94-1									270	U				260	U	230	U	
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1									270	U				260	U	230	U	
3-NITROANILINE	99-09-2									520	U				510	U	440	U	
4,6-DINITRO-2-METHYLPHENOL	534-52-1									520	U				510	U	440	U	
4-BROMOPHENYL PHENYL ETHER	101-55-3									270	U				260	U	230	U	
4-CHLORO-3-METHYLPHENOL	59-50-7									270	U				260	U	230	U	
4-CHLOROPHENYL PHENYL ETHER	7005-72-3									270	U				260	U	230	U	
4-METHYLPHENOL	106-44-5									130	J				260	U	230	U	266
4-NITROPHENOL	100-02-7									520	U				510	U	440	U	
ACETOPHENONE	98-86-2									270	U				260	U	230	U	977
ATRAZINE	1912-24-9									270	U				260	U	230	U	
BENZALDEHYDE	100-52-7									270	U				140	J	120	J	4572
BENZYL BUTYL PHTHALATE	85-68-7									270	U				260	U	230	U	1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1									270	U				260	U	230	U	
BIS(2-CHLOROETHYL)ETHER	111-44-4									270	U				260	U	230	U	
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7									160	J				180	J	230	U	7316
CAPROLACTAM	105-60-2									270	U				260	U	230	U	
CARBAZOLE	86-74-8									270	U				260	U	230	U	186
CHLOROPHENOLS	58-90-2									270	U				260	U	230	U	
DIBENZOFURAN	132-64-9									270	U				260	U	230	U	
DIETHYL PHTHALATE	84-66-2									270	U				260	U	230	U	152
DIMETHYL PHTHALATE	131-11-3									270	U				260	U	230	U	
DI-N-BUTYLPHTHALATE	84-74-2									270	U				260	U	230	U	
DI-N-OCTYLPHTHALATE	117-84-0									270	U				260	U	230	U	
HEXACHLORO-1,3-BUTADIENE	87-68-3									270	U				260	U	230	U	
HEXACHLOROBENZENE	118-74-1									270	U				260	U	230	U	
HEXACHLOROCYCLOPENTADIENE	77-47-4									270	U				260	U	230	U	
HEXACHLOROETHANE	67-72-1									270	U				260	U	230	U	
NITROBENZENE	98-95-3									270	U				260	U	230	U	
N-NITROSO-DI-N-PROPYLAMINE	621-64-7									270	U				260	U	230	U	
N-NITROSODIPHENYLAMINE	86-30-6									270	U				260	U	230	U	240
P-CHLOROANILINE	106-47-8									270	U				260	U	230	U	
PENTACHLOROPHENOL	87-86-5									520	UJ				510	U	440	U	
PHENOL	108-95-2									270	U				260	U	230	U	318
P-NITROANILINE	100-01-6									520	U				510	U	440	U	

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-20. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Surface Sediment Grab Samples from Otter Creek.

		Surface Sediment Grab Samples (0-6 inches depth)																																															
Stream Segments		Otter Creek E			Otter Creek D				Otter Creek C											Otter Creek B										Otter Creek A																			Benchmark
Chemical name	CAS #	OC-24/25	VQ	OC-23	OC-22	VQ	OC-18/19	VQ	OC-18	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-9-01	OC-8-9	VQ	OC-8	OC-7-8	VQ	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ	OC-5A-01	VQ	OC-5	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	OC-2A	VQ	OC-2	OC-1A	VQ	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
1,2,4,5-TETRACHLOROBENZENE	95-94-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,4,5-TRICHLOROPHENOL	95-95-4	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,4,6-TRICHLOROPHENOL	88-06-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,4-DICHLOROPHENOL	120-83-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,4-DIMETHYLPHENOL	105-67-9	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,4-DINITROPHENOL	51-28-5	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
2,4-DINITROTOLUENE	121-14-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2,6-DINITROTOLUENE	606-20-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2-CHLORONAPHTHALENE	91-58-7	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2-CHLOROPHENOL	95-57-8	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2-METHYLPHENOL	95-48-7	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
2-NITROANILINE	88-74-4	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
2-NITROPHENOL	88-75-5	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
3,3'-DICHLOROBENZIDINE	91-94-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
3-NITROANILINE	99-09-2	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
4,6-DINITRO-2-METHYLPHENOL	534-52-1	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
4-BROMOPHENYL PHENYL ETHER	101-55-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
4-CHLORO-3-METHYLPHENOL	59-50-7	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
4-METHYLPHENOL	106-44-5	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	200	J		350	U		430	U	266
4-NITROPHENOL	100-02-7	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
ACETOPHENONE	98-86-2	230	U		1100	U	850	U		930	U	930	U	850	U	120	J	640	J	240	U	130	J		100	J		290	U	3900	U	610	U	190	J		400	U	510	U	170	J		350	U		430	U	977
ATRAZINE	1912-24-9	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
BENZALDEHYDE	100-52-7	140	J		1100	U	850	U		930	U	930	U	850	U	240	J	1300	U	240	U	310	U		120	J		120	J	3900	U	610	U	270	J		200	J	180	J	250	J		140	J		230	J	4572
BENZYL BUTYL PHTHALATE	85-68-7	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	570	J	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
BIS(2-CHLOROETHYL)ETHER	111-44-4	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	230	U		1100	U	480	J		580	J	930	U	850	U	170	J	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	340	J		340	J	510	U	470	J		350	U		430	U	7316
CAPROLACTAM	105-60-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
CARBAZOLE	86-74-8	230	U		1100	U	850	U		930	U	930	U	**860**		250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	186
CHLOROPHENOLS	58-90-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
DIBENZOFURAN	132-64-9	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
DIETHYL PHTHALATE	84-66-2	230	U		1100	U	280	J		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	152
DIMETHYL PHTHALATE	131-11-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
DI-N-BUTYLPHTHALATE	84-74-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
DI-N-OCTYLPHTHALATE	117-84-0	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
HEXACHLORO-1,3-BUTADIENE	87-68-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
HEXACHLOROBENZENE	118-74-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
HEXACHLOROCYCLOPENTADIENE	77-47-4	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
HEXACHLOROETHANE	67-72-1	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
NITROBENZENE	98-95-3	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
N-NITROSODIPHENYLAMINE	86-30-6	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	240
P-CHLOROANILINE	106-47-8	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	
PENTACHLOROPHENOL	87-86-5	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	
PHENOL	108-95-2	230	U		1100	U	850	U		930	U	930	U	850	U	250	U	1300	U	240	U	310	U		300	U		290	U	3900	U	610	U	400	U		400	U	510	U	480	U		350	U		430	U	318
P-NITROANILINE	100-01-6	450	U		2100	U	1600	U		1800	U	1800	U	1600	U	480	U	2500	U	460	U	600	U		590	U		550	U	7600	U	1200	U	780	U		780	U	990	U	940	U		680	U		830	U	

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-21. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Surface Sediment Core Samples from Otter Creek.

		Surface Sediment Core Samples (0-24 inches depth)																																									
Stream Segments		**Otter Creek E**			**Otter Creek D**		**Otter Creek C**							**Otter Creek B**							**Otter Creek A**																						Benchmark
Chemical name	CAS #	OC-24/25	OC-23-02	VQ	OC-22	OC-18/19	OC-18-02	VQ	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10/11	OC-9/10	OC-9	OC-8/9	OC-8-02	VQ	OC-7/8	OC-6/7(2)-02	VQ	OC-6/7(1)-02	VQ	OC-6	OC-5a-02	VQ	OC-5-02	VQ	OC-4A-02	VQ	OC-4-02	VQ	OC-3A-02	VQ	OC-3-02	VQ	OC-2A-02	VQ	OC-2-02	VQ	OC-1A-02	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
1,2,4,5-TETRACHLOROBENZENE	95-94-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,4,5-TRICHLOROPHENOL	95-95-4		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,4,6-TRICHLOROPHENOL	88-06-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,4-DICHLOROPHENOL	120-83-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,4-DIMETHYLPHENOL	105-67-9		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,4-DINITROPHENOL	51-28-5		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
2,4-DINITROTOLUENE	121-14-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2,6-DINITROTOLUENE	606-20-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2-CHLORONAPHTHALENE	91-58-7		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2-CHLOROPHENOL	95-57-8		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2-METHYLNAPHTHALENE	91-57-6		940	U			1000	U										310	U		330	U	320	U		470	U	150	J	510	U	500	U	550	U	340	U	420	J	160	J		
2-METHYLPHENOL	95-48-7		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
2-NITROANILINE	88-74-4		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
2-NITROPHENOL	88-75-5		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
3,3'-DICHLOROBENZIDINE	91-94-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
3-NITROANILINE	99-09-2		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
4,6-DINITRO-2-METHYLPHENOL	534-52-1		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
4-BROMOPHENYL PHENYL ETHER	101-55-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
4-CHLORO-3-METHYLPHENOL	59-50-7		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
4-CHLOROPHENYL PHENYL ETHER	7005-72-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
4-METHYLPHENOL	106-44-5		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	190	J	550	U	340	U	510	U	280	U		266
4-NITROPHENOL	100-02-7		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
ACETOPHENONE	98-86-2		940	U			1000	U										310	U		330	U	110	J		170	J	210	J	170	J	500	U	230	J	130	J	510	U	120	J		977
ATRAZINE	1912-24-9		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
BENZALDEHYDE	100-52-7		940	U			1000	U										170	J		170	J	190	J		270	J	490	U	200	J	310	J	330	J	200	J	260	J	110	J		4572
BENZYL BUTYL PHTHALATE	85-68-7		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
BIS(2-CHLOROETHYL)ETHER	111-44-4		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7		940	U			1000	U										310	U		330	U	320	U		320	J	500		1500		470	J	430	J	430		510	U	280	U		7316
CAPROLACTAM	105-60-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
CARBAZOLE	86-74-8		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		186
CHLOROPHENOLS	58-90-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
DIBENZOFURAN	132-64-9		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
DIETHYL PHTHALATE	84-66-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		152
DIMETHYL PHTHALATE	131-11-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
DI-N-BUTYLPHTHALATE	84-74-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
DI-N-OCTYLPHTHALATE	117-84-0		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
HEXACHLORO-1,3-BUTADIENE	87-68-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
HEXACHLOROBENZENE	118-74-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
HEXACHLOROCYCLOPENTADIENE	77-47-4		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
HEXACHLOROETHANE	67-72-1		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
NITROBENZENE	98-95-3		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
N-NITROSO-DI-N-PROPYLAMINE	621-64-7		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
N-NITROSODIPHENYLAMINE	86-30-6		940	U			**570**	J										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		240
P-CHLOROANILINE	106-47-8		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		
PENTACHLOROPHENOL	87-86-5		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		
PHENOL	108-95-2		940	U			1000	U										310	U		330	U	320	U		470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U		318
P-NITROANILINE	100-01-6		1800	U			2000	U										600	U		650	U	620	U		920	U	950	U	980	U	960	U	1100	U	660	U	1000	U	550	U		

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-22. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Subsurface Sediment Core Samples from Otter Creek.

Subsurface Sediment Core Samples (24-48 inches depth)																																										
Stream Segments		Otter Creek E			Otter Creek D		Otter Creek C						Otter Creek B						Otter Creek A																							Benchmark
Chemical name	CAS #	OC-24/25	OC-23-03	VQ	OC-22	OC-18/19	OC-18	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10/11	OC-9/10	OC-9	OC-8/9	OC-8	OC-7/8	OC-6/7(2)	OC-6/7(1)-03	VQ	OC-6-03	VQ	OC-5a-03	VQ	OC-5-03	VQ	OC-4A-03	VQ	OC-4-03	VQ	OC-3A-03	VQ	OC-3-03	VQ	OC-2A-03	VQ	OC-2-03	VQ	OC-1A-03	VQ	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
1,2,4,5-TETRACHLOROBENZENE	95-94-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,4,5-TRICHLOROPHENOL	95-95-4		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,4,6-TRICHLOROPHENOL	88-06-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,4-DICHLOROPHENOL	120-83-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,4-DIMETHYLPHENOL	105-67-9		45	J																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,4-DINITROPHENOL	51-28-5		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
2,4-DINITROTOLUENE	121-14-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2,6-DINITROTOLUENE	606-20-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2-CHLORONAPHTHALENE	91-58-7		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2-CHLOROPHENOL	95-57-8		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2-METHYLNAPHTHALENE	91-57-6		220	J																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	2700		1300		660		
2-METHYLPHENOL	95-48-7		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
2-NITROANILINE	88-74-4		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
2-NITROPHENOL	88-75-5		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
3,3'-DICHLOROBENZIDINE	91-94-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
3-NITROANILINE	99-09-2		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
4,6-DINITRO-2-METHYLPHENOL	534-52-1		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
4-BROMOPHENYL PHENYL ETHER	101-55-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
4-CHLORO-3-METHYLPHENOL	59-50-7		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
4-CHLOROPHENYL PHENYL ETHER	7005-72-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
4-METHYLPHENOL	106-44-5		200	J																340	U	370	U	400	U	470	U	200	J	430	U	470	U	350	U	780	U	290	U	430	U	266
4-NITROPHENOL	100-02-7		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
ACETOPHENONE	98-86-2		150	J																130	J	120	J	400	U	340	J	170	J	170	J	170	J	350	U	780	U	110	J	260	J	977
ATRAZINE	1912-24-9		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
BENZALDEHYDE	100-52-7		160	J																220	J	230	J	400	U	390	J	190	J	270	J	300	J	160	J	390	J	220	J	300	J	4572
BENZYL BUTYL PHTHALATE	85-68-7		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
BIS(2-CHLOROETHYL)ETHER	111-44-4		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7		230	U																340	U	370	U	260	J	470	J	510	U	420	J	460	J	310	J	780	U	290	U	430	U	7316
CAPROLACTAM	105-60-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
CARBAZOLE	86-74-8		120	J																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	186
CHLOROPHENOLS	58-90-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
DIBENZOFURAN	132-64-9		170	J																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
DIETHYL PHTHALATE	84-66-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	152
DIMETHYL PHTHALATE	131-11-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
DI-N-BUTYLPHTHALATE	84-74-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
DI-N-OCTYLPHTHALATE	117-84-0		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
HEXACHLORO-1,3-BUTADIENE	87-68-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
HEXACHLOROBENZENE	118-74-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
HEXACHLOROCYCLOPENTADIENE	77-47-4		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
HEXACHLOROETHANE	67-72-1		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
NITROBENZENE	98-95-3		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
N-NITROSO-DI-N-PROPYLAMINE	621-64-7		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
N-NITROSODIPHENYLAMINE	86-30-6		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	240
P-CHLOROANILINE	106-47-8		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
PENTACHLOROPHENOL	87-86-5		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	
PHENOL	108-95-2		230	U																340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	318
P-NITROANILINE	100-01-6		450	U																660	U	720	U	780	U	920	U	980	U	840	U	920	U	680	U	1500	U	570	U	840	U	

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-23. Semivolatile Organic Compound Concentrations (ug/kg dry wt) in Deep Sediment Core Samples from Otter Creek.

Deep Sediment Core Samples (48-72 inches depth)

Stream Segments		**Otter Creek E**		**Otter Creek D**		**Otter Creek C**						**Otter Creek B**						**Otter Creek A**												Benchmark
Chemical name	CAS #	OC-24/25	OC-23	OC-22	OC-18/19	OC-18	OC-16/17	OC-16	OC-15/16	OC-12/13	OC-11/12	OC-10-11	OC-9-10	OC-9	OC-8-9	OC-8	OC-7-8	OC-6/7(2)	OC-6/7(1)	OC-5A	OC-5	OC-4A	OC-4	OC-3A	OC-3	OC-2A-04	VQ	OC-2	OC-1A	ug/kg @ 1%OC
1,1-BIPHENYL	92-52-4																									250	U			
1,2,4,5-TETRACHLOROBENZENE	95-94-3																									250	U			
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1																									250	U			
2,4,5-TRICHLOROPHENOL	95-95-4																									250	U			
2,4,6-TRICHLOROPHENOL	88-06-2																									250	U			
2,4-DICHLOROPHENOL	120-83-2																									250	U			
2,4-DIMETHYLPHENOL	105-67-9																									250	U			
2,4-DINITROPHENOL	51-28-5																									490	U			
2,4-DINITROTOLUENE	121-14-2																									250	U			
2,6-DINITROTOLUENE	606-20-2																									250	U			
2-CHLORONAPHTHALENE	91-58-7																									250	U			
2-CHLOROPHENOL	95-57-8																									250	U			
2-METHYLNAPHTHALENE	91-57-6																									320				
2-METHYLPHENOL	95-48-7																									250	U			
2-NITROANILINE	88-74-4																									490	U			
2-NITROPHENOL	88-75-5																									250	U			
3,3'-DICHLOROBENZIDINE	91-94-1																									250	U			
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	78-59-1																									250	U			
3-NITROANILINE	99-09-2																									490	U			
4,6-DINITRO-2-METHYLPHENOL	534-52-1																									490	U			
4-BROMOPHENYL PHENYL ETHER	101-55-3																									250	U			
4-CHLORO-3-METHYLPHENOL	59-50-7																									250	U			
4-CHLOROPHENYL PHENYL ETHER	7005-72-3																									250	U			
4-METHYLPHENOL	106-44-5																									250	U			266
4-NITROPHENOL	100-02-7																									490	U			
ACETOPHENONE	98-86-2																									150	J			977
ATRAZINE	1912-24-9																									250	U			
BENZALDEHYDE	100-52-7																									160	J			4572
BENZYL BUTYL PHTHALATE	85-68-7																									250	U			1207
BIS(2-CHLOROETHOXY)METHANE	111-91-1																									250	U			
BIS(2-CHLOROETHYL)ETHER	111-44-4																									250	U			
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7																									250	U			7316
CAPROLACTAM	105-60-2																									250	U			
CARBAZOLE	86-74-8																									250	U			186
CHLOROPHENOLS	58-90-2																									250	U			
DIBENZOFURAN	132-64-9																									250	U			
DIETHYL PHTHALATE	84-66-2																									250	U			152
DIMETHYL PHTHALATE	131-11-3																									250	U			
DI-N-BUTYLPHTHALATE	84-74-2																									250	U			
DI-N-OCTYLPHTHALATE	117-84-0																									250	U			
HEXACHLORO-1,3-BUTADIENE	87-68-3																									250	U			
HEXACHLOROBENZENE	118-74-1																									250	U			
HEXACHLOROCYCLOPENTADIENE	77-47-4																									250	U			
HEXACHLOROETHANE	67-72-1																									250	U			
NITROBENZENE	98-95-3																									250	U			
N-NITROSO-DI-N-PROPYLAMINE	621-64-7																									250	U			
N-NITROSODIPHENYLAMINE	86-30-6																									250	U			240
P-CHLOROANILINE	106-47-8																									250	U			
PENTACHLOROPHENOL	87-86-5																									490	U			
PHENOL	108-95-2																									250	U			318
P-NITROANILINE	100-01-6																									490	U			

Benchmarks based on Ohio Chronic Water Quality Criteria (Outside Mixing Zone Average) as reported in Chapter 3745-1 of the Ohio Administrative Code, updated October 20, 2009 and Equilibrium partitioning Partitioning assuming 1% total organic carbon content in sediments.

Table H-24. Polycyclic Aromatic Hydrocarbon Concentrations (ug/kg dry weight) in sediments collected from Urban Comparison Streams and Duck Creek.

Surface Sediment Grab samples (0-6 inches depth)																																		
stream segments		Urban				Duck Creek D						Duck Creek C				Duck Creek B						Duck Creek A												Benchgmark
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2	VQ	DC-1	VQ	PEC
NAPHTHALENE	91-20-3	140	U	51	U	160	U			100	U	9	U			82	U	130	U	220		540		120		110		52						561
1-METHYLNAPHTHALENE	90-12-0	40	J	16	J	29	J			23	J	2	J			82	U	38	J	160		170		50	J	40	J	41	J					
C1-NAPHTHALENES	C1NAPH	91	J	35	J	65	J			55	J	6	J			82	U	88	J	340	J	390	J	120	J	100	J	120	J					
2-METHYLNAPHTHALENE	91-57-6	140	U	51	U	160	U			100	U	9	U			82	U	130	U	200		240		69		65	J	80						
C2-NAPHTHALENES	C2NAPH	130	J	53	J	67	J			55	J	9	J			82	U	85	J	260	J	380	J	120	J	96	J	120	J					
C3-NAPHTHALENES	C3NAPH	320	J	210	J	420	J			340	J	250	J			82	U	410	J	490	J	770	J	290	J	280	J	270	J					
C4-NAPHTHALENES	C4NAPH	130	J	80	J	160	U			92	J	15	J			82	U	160	J	210	J	660	J	130	J	130	J	180	J					
ACENAPHTHYLENE	208-96-8	68	J	13	J	160	U			23	J	9	U			82	U	130	U	100	U	100	U	18	J	16	J	44	U					
ACENAPHTHENE	83-32-9	370		51	J	160	U			30	J	9	U			82	U	130	U	56	J	52	J	18	J	72	U	15	J					
FLUORENE	86-73-7	500		100		160	U			58	J	9	U			82	U	130	U	54	J	88	J	33	J	23	J	32	J					536
C1-FLUORENES	C1FLUOR	220	J	53	J	160	U			89	J	11	J			82	U	50	J	87	J	180	J	68	J	50	J	62	J					
C2-FLUORENES	C2FLUOR	510	J	39	J	160	U			100	U	4	J			82	U	130	U	80	J	420	J	81	J	73	J	96	J					
C3-FLUORENES	C3FLUOR	2400	J	42	J	160	U			100	U	7	J			82	U	130	U	140	J	410	J	130	J	77	J	140	J					
PHENANTHRENE	85-01-8	11000		1000		81	J			820		49				110		180		610		320		280		140		330						1170
ANTHRACENE	120-12-7	1400		220		160	U			130		9	J			25	J	43	J	130		76	J	49	J	34	J	75						845
C1-PHENANTHRENES/ANTHRACENES	C1PHAN	2900	J	290	J	160	U			240	J	18	J			47	J	110	J	300	J	350	J	220	J	130	J	230	J					
C2-PHENANTHRENES/ANTHRACENES	C2PHAN	1800	J	210	J	160	U			210	J	15	J			31	J	140	J	300	J	520	J	230	J	160	J	270	J					
C3-PHENANTHRENES/ANTHRACENES	C3PHAN	850	J	150	J	160	U			260	J	10	J			82	U	150	J	170	J	450	J	160	J	110	J	170	J					
C4-PHENANTHRENES/ANTHRACENES	C4PHAN	5300	J	340	J	160	U			510	J	16	J			82	U	85	J	160	J	360	J	160	J	110	J	270	J					
FLUORANTHENE	206-44-0	39000		2800		160				3200		130				190		470		1200		480		530		300		680						2230
PYRENE	129-00-0	29000		2000		140	J			2500		110				140		390		1000		450		420		260	J	590						1520
C1-FLUORANTHENES/PYRENES	C1FLPY	8800	J	700	J	88	J			880	J	38	J			78	J	200	J	430	J	300	J	240	J	160	J	320	J					
C2-FLUORANTHENES/PYRENES	C2FLPY	5200	J	270	J	160	U			570	J	22	J			42	J	130	J	220	J	260	J	170	J	130	J	230	J					
C3-FLUORANTHENES/PYRENES	C3FLPY	1500	J	130	J	160	U			410	J	11	J			82	U	130	U	130	J	260	J	90	J	66	J	130	J					
Chrysene	218-01-9	20000		1200		96	J			2100		68				100		280		610		250		270		170		400						1290
C1 CHRYSENES	C1CHRYS	4900	J	340	J	160	U			870	J	32	J			74	J	180	J	300	J	220	J	160	J	120	J	290	J					
C2 CHRYSENES	C2CHRYS	2200	J	130	J	160	U			390	J	13	J			82	U	130	U	100	J	190	J	75	J	64	J	170	J					
C3 CHRYSENES	C3CHRYS	970	J	92	J	160	U			290	J	9	U			82	U	130	U	100	U	180	J	64	U	72	U	130	J					
C4 CHRYSENES	C4CHRYS	490	J	51	U	160	U			300	J	9	U			82	U	130	U	100	U	100	U	64	U	72	U	170	J					
PERYLENE	198-55-0	5000		270		27	J			530		17				30	J	73	J	210		63	J	61	J	58	J	95						
BENZO[A]ANTHRACENE	56-55-3	12000		800		64	J			970		54				93		180		500		130		180		150		320						1050
BENZO[B]FLUORANTHENE	205-99-2	30000		1500		120	J			3400		85				130		390		830		260		290		230		410						
BENZO[K]FLUORANTHENE	207-08-9	10000		480		44	J			1000		29				47	J	130	J	260		75	J	95		80		130						
BENZO[A]PYRENE	50-32-8	17000		900		83	J			1800		64				93		240		610		130		190		160		300						1450
BENZO[E]PYRENE	192-97-2	18000		940		83	J			2100		55				75	J	250		520		230		200		160		320						
DIBENZ(A,H)ANTHRACENE	53-70-3	2800		160		160	U			350		9	J			16	J	51	J	99	J	35	J	38	J	44	J	81						
INDENO[1,2,3-CD]PYRENE	193-39-5	14000		790		68	J			1900		44				51	J	150		360		89	J	120		110		200						
BENZO[G,H,I]PERYLENE	191-24-2	12000		670		63	J			1700		43				68	J	160		340		120		120		120		240						
TOTAL 16 PPAH	TPPAH	**200000**	J	13000	J	960	J			20000	J	680	J			1100	J	2800	J	6900	J	3100	J	2800	J	2000	J	3900	J					22800
TOTAL PAH	TPAH	260000	J	17000	J	1700	J			28000	J	950	J			1400	J	4900	J	11000	J	9700	J	5500	J	4000	J	7600	J					
total organic carbon (% dry wt)	TOC	5.07		2.12		22.9				6.79		5.37				6.29		7.55		8.36		4.99		6.18		4.76		7.97						

Surface Sediment Core Samples (0-24 inches depth)																																		Benchgmark
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11-02	VQ	DC-10/11	VQ	DC-9/10-02	VQ	DC-8-02	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-02	VQ	DC-4-02	VQ	DC-3/4-02	VQ	DC-3-02	VQ	DC-2-02	VQ	DC-1-02	VQ	PEC
ACENAPHTHENE	83-32-9							390	U					390	U							380	U	410	U	290	U	250	U	300	UJ	310	U	
ACENAPHTHYLENE	208-96-8							390	U					390	U							380	U	410	U	290	U	250	U	300	UJ	310	U	
ANTHRACENE	120-12-7							390	U					390	U							380	U	410	U	120	J	130	J	300	U	310	U	845
BENZO[A]ANTHRACENE	56-55-3							640						300	J							380	UJ	230	J	300		190	J	300	UJ	310	UJ	1050
BENZO[A]PYRENE	50-32-8							640						310	J							380	UJ	210	J	260	J	160	J	300	UJ	310	UJ	1450
BENZO[B]FLUORANTHENE	205-99-2							1000						500								380	UJ	310	J	370		210	J	300	UJ	310	UJ	
BENZO[G,H,I]PERYLENE	191-24-2							410						200	J							380	UJ	130	J	150	J	91	J	300	UJ	310	UJ	
BENZO[K]FLUORANTHENE	207-08-9							360	J					390	U							380	UJ	410	U	120	J	250	U	300	UJ	310	UJ	
Chrysene	218-01-9							750						330	J							380	UJ	230	J	310		240	J	300	UJ	310	UJ	1290
DIBENZ(A,H)ANTHRACENE	53-70-3							390	U					390	U							380	UJ	410	U	290	U	250	U	300	UJ	310	UJ	
FLUORANTHENE	206-44-0							1300						760								310	J	420		480		310		300	UJ	310	UJ	2230
FLUORENE	86-73-7							390	U					390	U							140	J	410	U	120	J	88	J	300	U	310	U	536
INDENO[1,2,3-CD]PYRENE	193-39-5							470						210	J							380	UJ	410	U	150	J	250	U	300	UJ	310	UJ	
NAPHTHALENE	91-20-3							390	U					390	U							790		410	U	290	U	250	U	300	UJ	310	U	561
PHENANTHRENE	85-01-8							570						350	J							300	J	410	U	310		150	J	120	J	310	U	1170
PYRENE	129-00-0							1300						680								340	J	390	J	460		310		300	UJ	310	UJ	1520
sumPAH16								7440						3640								1880		1920		3150		1879		120		ND		22800
total organic carbon (% dry wt)	TOC							5.60				1.57		5.41								3.38		3.40		1.99		2.00		3.09		2.71		

Subsurface Sediment Core Samples(24-48 inches depth)																																		Benchgmark
Chemical name	CAS #	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	VQ	DC-10/11	VQ	DC-9/10	VQ	DC-8	VQ	DC-7/8	VQ	DC-6/7	VQ	DC-5/6	VQ	DC-5-03	VQ	DC-4	VQ	DC-3/4	VQ	DC-3	VQ	DC-2-03	VQ	DC-1-03	VQ	PEC
ACENAPHTHENE	83-32-9																					160	J							260	U	230	U	
ACENAPHTHYLENE	208-96-8																					270	U							260	U	230	U	
ANTHRACENE	120-12-7																					210	J							260	U	230	U	845
BENZO[A]ANTHRACENE	56-55-3																					570								260	UJ	230	UJ	1050
BENZO[A]PYRENE	50-32-8																					450								260	UJ	230	UJ	1450
BENZO[B]FLUORANTHENE	205-99-2																					580	J							260	UJ	230	UJ	
BENZO[G,H,I]PERYLENE	191-24-2																					350								260	UJ	230	UJ	
BENZO[K]FLUORANTHENE	207-08-9																					120	J							260	UJ	230	UJ	
Chrysene	218-01-9																					590								260	UJ	230	UJ	1290
DIBENZ(A,H)ANTHRACENE	53-70-3																					270	UJ							260	UJ	230	UJ	
FLUORANTHENE	206-44-0																					630								260	UJ	230	UJ	2230
FLUORENE	86-73-7																					260	J							260	U	230	U	536
INDENO[1,2,3-CD]PYRENE	193-39-5																					280								260	UJ	230	UJ	
NAPHTHALENE	91-20-3																					460								260	U	230	U	561
PHENANTHRENE	85-01-8																					820								260	U	230	U	1170
PYRENE	129-00-0																					980								260	UJ	230	UJ	1520
sumPAH16																						6460								ND		ND		22800
total organic carbon (% dry wt)	TOC																					2.76								3.21		0.850		
PEC Benchmarks are from MacDonald et al 2000																																		

Table H-25. Polycyclic Aromatic Hydrocarbon Concentrations (ug/kg dry wt) in sediments collected from Otter Creek.

Surface Sediment Grab Samples (0 to 6 inches depth)

stream segments		Otter Creek E				Otter Creek D				Otter Creek C												Otter Creek B										Otter Creek A																								Benchmark
PAHs	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-8-9	VQ	OC-8	VQ	OC-7-8	VQ	OC-6/7(2)-01	VQ	OC-6/7(1)-01	VQ			OC-5A-01	VQ	OC-5	VQ	OC-4A-01	VQ	OC-4-01	VQ	OC-3A-01	VQ	OC-3	VQ	OC-2A	VQ	OC-2	VQ	OC-1A	VQ	PEC
NAPHTHALENE	91-20-3	36	J			53	U	74	J			99		45	U	82	U	4	U	160		5		6	U	8				4	J	76	U	60	U			15				16		37		61				17				34		561
1-METHYLNAPHTHALENE	90-12-0	45	J			32	J	42	J			29	J	45	U	35	J	1	J	220		4		3	J	7				4	J	28	J	14	J			18				17		79		74				17				88		
C1-NAPHTHALENES	C1NAPH	90	J			71	J	87	J			65	J	45	U	75	J	4	J	370	J	11	J	7	J	20	J			11	J	78	J	37	J			38	J			37	J	140	J	150	J			45	J			200	J	
2-METHYLNAPHTHALENE	91-57-6	49				39	J	47	J			91	U	45	U	82	U	2	J	170		6		4	J	13				5	J	46	J	60	U			21				22		69		77				30				91		
C2-NAPHTHALENES	C2NAPH	100	J			79	J	170	J			80	J	16	J	120	J	7	J	1300	J	16	J	14	J	28	J			22	J	120	J	78	J			67	J			50	J	470	J	180	J			57	J			360	J	
C3-NAPHTHALENES	C3NAPH	260	J			230	J	400	J			240	J	140	J	290	J	130	J	5000	J	18	J	230	J	200	J			210	J	400	J	300	J			350	J			340	J	1200	J	450	J			77	J			690	J	
C4-NAPHTHALENES	C4NAPH	140	J			160	J	330	J			170	J	55	J	220	J	23	J	12000	J	34	J	96	J	55	J			54	J	370	J	210	J			160	J			110	J	850	J	240	J			170	J			430	J	
ACENAPHTHYLENE	208-96-8	45	U			19	J	190				91	U	45	U	82	U	4	U	28	J	1	J	6	U	5	U			1	J	76	U	18	J			7	U			7	U	9	U	9	U			6	U			8	U	
ACENAPHTHENE	83-32-9	45	U			100		58	J			83	J	24	J	120		1	J	160		2	J	3	J	5	U			12		76	U	60	U			3	J			3	J	14		8	J			4	J			7	J	
FLUORENE	86-73-7	14	J			120		130				110		34	J	220		2	J	310		3	J	4	J	2	J			12		27	J	36	J			5	J			5	J	28		12				6	J			13		536
C1-FLUORENES	C1FLUOR	40	J			150	J	210	J			150	J	53	J	100	J	8	J	2700	J	20	J	32	J	33	J			25	J	94	J	83	J			31	J			17	J	140	J	48	J			41	J			74	J	
C2-FLUORENES	C2FLUOR	71	J			98	J	240	J			160	J	50	J	260	J	6	J	7500	J	9	J	110	J	28	J			31	J	230	J	150	J			43	J			26	J	240	J	66	J			66	J			89	J	
C3-FLUORENES	C3FLUOR	30	J			380	J	530	J			400	J	170	J	830	J	12	J	21000	J	37	J	190	J	130	J			48	J	400	J	290	J			100	J			78	J	340	J	200	J			220	J			190	J	
PHENANTHRENE	85-01-8	84				1700		1600				2100		780		4200		47		1500		93		82		31				150		110		250				31				64		83		29				53				76		1170
ANTHRACENE	120-12-7	45	U			290		400				340		130		690		7		780		12		16		19				38		29	J	91				6	J			9		37		7	J			14				5	J	845
C1-PHENANTHRENES/ANTHRACENES	C1PHAN	74	J			500	J	1200	J			590	J	200	J	1100	J	20	J	6500	J	36	J	100	J	140	J			80	J	180	J	320	J			86	J			76	J	270	J	130	J			100	J			190	J	
C2-PHENANTHRENES/ANTHRACENES	C2PHAN	110	J			410	J	1000	J			530	J	190	J	930	J	20	J	32000	J	47	J	180	J	240	J			98	J	490	J	400	J			340	J			150	J	770	J	350	J			290	J			460	J	
C3-PHENANTHRENES/ANTHRACENES	C3PHAN	63	J			430	J	630	J			470	J	230	J	950	J	25	J	46000	J	58	J	370	J	520	J			140	J	840	J	410	J			430	J			180	J	680	J	600	J			520	J			590	J	
C4-PHENANTHRENES/ANTHRACENES	C4PHAN	41	J			700	J	990	J			960	J	380	J	1200	J	29	J	25000	J	77	J	230	J	560	J			110	J	660	J	280	J			280	J			160	J	520	J	440	J			410	J			410	J	
FLUORANTHENE	206-44-0	140				5500		4800				5100		1700		9300		110		3500		230		280		79				290		250		480				58				190		54		25				140				44		2230
PYRENE	129-00-0	120				3900		4200				3900		1400		7000		98		7400		180		220		120				210		89		110				75	J			170		170		82				170				140		1520
C1-FLUORANTHENES/PYRENES	C1FLPY	74	J			1400	J	2000	J			1400	J	500	J	2300	J	43	J	17000	J	79	J	150	J	530	J			150	J	200	J	230	J			110	J			110	J	430	J	160	J			260	J			300	J	
C2-FLUORANTHENES/PYRENES	C2FLPY	60	J			800	J	1300	J			750	J	340	J	1700	J	34	J	25000	J	79	J	140	J	1200	J			110	J	290	J	240	J			190	J			140	J	380	J	370	J			310	J			420	J	
C3-FLUORANTHENES/PYRENES	C3FLPY	45	U			400	J	540	J			290	J	190	J	610	J	22	J	20000	J	66	J	110	J	1300	J			83	J	280	J	140	J			160	J			120	J	370	J	360	J			270	J			330	J	
Chrysene	218-01-9	85				2500		2800				2400		740		4100		58		4700		120		160		140				140		180		150				51				120		210		56				150				230		1290
C1 CHRYSENES	C1CHRYS	54	J			1000	J	1600	J			1000	J	340	J	1600	J	28	J	13000	J	64	J	110	J	400	J			110	J	240	J	200	J			73	J			110	J	510	J	140	J			250	J			440	J	
C2 CHRYSENES	C2CHRYS	51	J			360	J	660	J			350	J	140	J	690	J	15	J	15000	J	47	J	91	J	680	J			94	J	270	J	150	J			110	J			88	J	380	J	240	J			270	J			400	J	
C3 CHRYSENES	C3CHRYS	45	U			280	J	300	J			240	J	100	J	460	J	14	J	14000	J	36	J	56	J	670	J			59	J	270	J	100	J			90	J			81	J	200	J	210	J			200	J			260	J	
C4 CHRYSENES	C4CHRYS	45	U			260	J	240	J			190	J	76	J	400	J	6	J	5900	J	18	J	28	J	300	J			24	J	86	J	60	U			29	J			33	J	170	J	74	J			91	J			49	J	
PERYLENE	198-55-0	18	J			640		700				660		200		880		15		1200		31		35		73				34		76	U	60	U			13				29		16		17				32				22		
BENZO[A]ANTHRACENE	56-55-3	45	J			1800		2600				1800		620		2900		45		2800		82		110		52				130		210		220				28				64		150		22				70				83		1050
BENZO[B]FLUORANTHENE	205-99-2	110				3400		3300				3200		1000		4800		78		3300		150		210		95				170		180		130				58				180		99		38				130				100		
BENZO[K]FLUORANTHENE	207-08-9	36	J			1100		1300				1000		360		1600		26		1400		56		72		28				62		79		71				21				57		22		12				43				18		
BENZO[A]PYRENE	50-32-8	64				2100		2200				2100		660		2900		51		3100		97		120		120				120		33	J	28	J			40				94		99		25				90				81	J	1450
BENZO[E]PYRENE	192-97-2	82				2100		1900				1900		620		2900		51		3700		97		120		180				100		30	J	15	J			40				120		140		46				140				190		
DIBENZ(A,H)ANTHRACENE	53-70-3	45	U			440		420				360		89		520		8		650		17		23		25				22		40	J	25	J			6	J			19		45		7	J			35				49		
INDENO[1,2,3-CD]PYRENE	193-39-5	41	J			1800		1400				1700		410		2300		37		1400		92		110		43				71		31	J	16	J			26				78		27		11				68				28		
BENZO[G,H,I]PERYLENE	191-24-2	51				1600		1100				1500		370		2000		34		2000		94		100		99				74		76	U	60	U			24				82		60		17				98				78		
TOTAL 16 PPAH	TPPAH	850	J			**27000**	J	**27000**	J			**26000**	J	8400	J	**43000**		610	J	**33000**	J	1200	J	1500	J	840	J			1500	J	1300	J	1700	J			470	J			1100	J	1400	J	410	J			1100	J			1000	J	22800
TOTAL PAH	TPAH	2200	J			37000	J	42000	J			36000	J	12000	J	60000	J	980	J	310000	J	1900	J	3900	J	8100	J			2700	J	6800	J	5300	J			3200	J			3100	J	9700	J	4900	J			5000	J			6800	J	
total organic carbon (% dry wt)	TOC	1.74				3.79		3.26				3.02		3.56		3.26		1.62		8.91		3.71		4.68		3.05				3.34		3.92		1.96				3.17				3.39		4.95		2.21				3.97				3.81		

Surface Sediment Core Samples (0 to 24 inches depth)

Chemical name	CAS #	OC-24/25	VQ	OC-23-02	VQ	OC-22	VQ	OC-18/19	VQ	OC-18-02	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-8/9	VQ	OC-8-02	VQ	OC-7/8	VQ	OC-6/7(2)-02	VQ	OC-6/7(1)-02	VQ			OC-5a-02	VQ	OC-5-02	VQ	OC-4A-02	VQ	OC-4-02	VQ	OC-3A-02	VQ	OC-3-02	VQ	OC-2A-02	VQ	OC-2-02	VQ	OC-1A-02	VQ	Benchmark PEC
ACENAPHTHENE	83-32-9			940	U					1000	U																	310	U			330	U	320	U			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			
ACENAPHTHYLENE	208-96-8			940	U					1000	U																	310	U			330	U	320	U			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			
ANTHRACENE	120-12-7			940	U					380	J																	310	U			330	U	320	U			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			845
BENZO[A]ANTHRACENE	56-55-3			370	J					1500																		310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	650		290	J	280	J			1050
BENZO[A]PYRENE	50-32-8			390	J					1400																		310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	810		510	U	280	U			1450
BENZO[B]FLUORANTHENE	205-99-2			490	J					2100																		310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	1100		320	J	360				
BENZO[G,H,I]PERYLENE	191-24-2			280	J					850	J																	310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	790		220	J	200	J			
BENZO[K]FLUORANTHENE	207-08-9			940	U					670	J																	310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			
Chrysene	218-01-9			940	U					1700																		310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	2500		800		900				1290
DIBENZ(A,H)ANTHRACENE	53-70-3			940	U					1000	U																	310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	420		510	U	280	U			
FLUORANTHENE	206-44-0			770	J					3500																		310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	290	J	240	J	220	J			2230
FLUORENE	86-73-7			940	U					1000	U																	310	U			330	U	320	U			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			536
INDENO[1,2,3-CD]PYRENE	193-39-5			940	U					860	J																	310	UJ			330	UJ	320	UJ			470	U	490	U	510	U	500	U	550	U	340		510	U	280	U			
NAPHTHALENE	91-20-3			940	U					1000	U																	310	U			330	U	320	U			470	U	490	U	510	U	500	U	550	U	340	U	510	U	280	U			561
PHENANTHRENE	85-01-8			510	J					1700																		310	U			330	U	320	U			470	U	210	J	510	U	200	J	220	J	510		470	J	540				1170
PYRENE	129-00-0			630	J					2900																		310	UJ			330	UJ	320	UJ			470	U	240	J	510	U	210	J	550	U	1200		760		620				1520
sumPAH16				3440						17560																		ND				ND		ND				ND		450		ND		410		220		8270		3100		3120				22800
total organic carbon (% dry wt)	TOC			5.81						8.04																		3.67				4.45		6.27				2.36		1.10		3.51		3.73		4.05		5.26		3.89		3.50		2.72		

Subsurface Sediment Core Samples (24 to 48 inches depth)

Chemical name	CAS #	OC-24/25	VQ	OC-23-03	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10/11	VQ	OC-9/10	VQ	OC-8/9	VQ	OC-8	VQ	OC-7/8	VQ	OC-6/7(2)	VQ	OC-6/7(1)-03	VQ	OC-6-03	VQ	OC-5a-03	VQ	OC-5-03	VQ	OC-4A-03	VQ	OC-4-03	VQ	OC-3A-03	VQ	OC-3-03	VQ	OC-2A-03	VQ	OC-2-03	VQ	OC-1A-03	VQ	Benchmark PEC
ACENAPHTHENE	83-32-9			180	J																													340	U	370	U	400	U	470	U	510	U	430	U	470	U	140	J	780	U	140	J	250	J	
ACENAPHTHYLENE	208-96-8			100	J																													340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	780	U	290	U	430	U	
ANTHRACENE	120-12-7			510																														340	U	370	U	400	U	230	J	510	U	430	U	470	U	130	J	780	U	330		750		845
BENZO[A]ANTHRACENE	56-55-3			1100	J																													340	UJ	370	UJ	400	U	470	U	510	U	430	U	200	J	350	U	790	J	2200		2400		1050
BENZO[A]PYRENE	50-32-8			730																														340	UJ	370	UJ	400	U	470	U	510	U	430	U	470	U	350	U	780	UJ	1400		1300		1450
BENZO[B]FLUORANTHENE	205-99-2			1100																														340	UJ	370	UJ	400	U	470	U	510	U	430	U	180	J	350	U	430	J	1900		1200		
BENZO[G,H,I]PERYLENE	191-24-2			290																														340	UJ	370	UJ	400	U	470	U	510	U	430	U	470	U	350	U	780	UJ	840		730		
BENZO[K]FLUORANTHENE	207-08-9			360																														340	UJ	370	UJ	400	U	470	U	510	U	430	U	470	U	350	U	780	UJ	150	J	190	J	
Chrysene	218-01-9			1200	J																													340	UJ	370	UJ	400	U	470	U	510	U	430	U	290	J	350	U	1300	J	5200		3300		1290
DIBENZ(A,H)ANTHRACENE	53-70-3			230	U																													340	UJ	370	UJ	400	U	470	U	510	U	430	U	470	U	350	U	780	UJ	580		550		
FLUORANTHENE	206-44-0			3500	J																													340	UJ	370	UJ	400	U	470	U	510	U	430	U	360	J	350	U	780	UJ	970		630		2230
FLUORENE	86-73-7			360																														340	U	370	U	400	U	180	J	510	U	430	U	470	U	350	U	410	J	430		660		536
INDENO[1,2,3-CD]PYRENE	193-39-5			350																														340	UJ	370	UJ	400	U	470	U	510	U	430	U	470	U	350	U	780	UJ	420		440		
NAPHTHALENE	91-20-3			120	J																													340	U	370	U	400	U	470	U	510	U	430	U	470	U	350	U	290	J	290	U	430	U	561
PHENANTHRENE	85-01-8			2200																														340	U	370	U	400	U	1500		200	J	170	J	380	J	350	U	1400		4200		1100		1170
PYRENE	129-00-0			3000	J																													340	UJ	370	UJ	400	U	500		510	U	240	J	470	J	150	J	780	UJ	3400		2500		1520
sumPAH16				15100																														ND		ND		ND		2410		200		410		2350		420		4620		22160		16000		22800
total organic carbon (% dry wt)	TOC			2.40																														3.15		7.44		6.03		4.42		3.84		5.99		8.94		4.97				3.29				

Deep Sediment Core Samples (48 to 72 inches depth)

Chemical name	CAS #	OC-24/25	VQ	OC-23	VQ	OC-22	VQ	OC-18/19	VQ	OC-18	VQ	OC-16/17	VQ	OC-16	VQ	OC-15/16	VQ	OC-12/13	VQ	OC-11/12	VQ	OC-10-11	VQ	OC-9-10	VQ	OC-8-9	VQ	OC-8	VQ	OC-7-8	VQ	OC-6/7(2)	VQ	OC-6/7(1)	VQ			OC-5A	VQ	OC-5	VQ	OC-4A	VQ	OC-4	VQ	OC-3A	VQ	OC-3	VQ	OC-2A-04	VQ	OC-2	VQ	OC-1A	VQ	Benchmark PEC
ACENAPHTHENE	83-32-9																																																	250	U					
ACENAPHTHYLENE	208-96-8																																																	250	U					
ANTHRACENE	120-12-7																																																	130	J					845
BENZO[A]ANTHRACENE	56-55-3																																																	440						1050
BENZO[A]PYRENE	50-32-8																																																	290						1450
BENZO[B]FLUORANTHENE	205-99-2																																																	330						
BENZO[G,H,I]PERYLENE	191-24-2																																																	220	J					
BENZO[K]FLUORANTHENE	207-08-9																																																	250	U					
Chrysene	218-01-9																																																	870						1290
DIBENZ(A,H)ANTHRACENE	53-70-3																																																	150	J					
FLUORANTHENE	206-44-0																																																	130	J					2230
FLUORENE	86-73-7																																																	120	J					536
INDENO[1,2,3-CD]PYRENE	193-39-5																																																	140	J					
NAPHTHALENE	91-20-3																																																	81	J					561
PHENANTHRENE	85-01-8																																																	520						1170
PYRENE	129-00-0																																																	710						1520
sumPAH16																																																		4131						22800
total organic carbon (% dry wt)	TOC																																																	8.80						

Benchmarks are from MacDonald et al 2000
note on preliminary draft: database includes PAH data for OC-6-03, which was not sampled according to other information.

surface sediment grab samples (0 to 6 inches depth)																								
stream segments		Urban				Duck D				Duck C		Duck B				Duck A								Benchmark
chemical_name	cas_rn	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	VQ	DC-5/6	DC-5	VQ	DC-4	DC-3/4	DC-3	VQ	DC-2	DC-1	FCV
NAPHTHALENE	91-20-3	0.19		0.125		0.1							0.1			0.11				0.12				193.5
1-METHYLNAPHTHALENE	90-12-0	0.05		0.05		0.05							0.05			0.05				0.05				75.37
2-METHYLNAPHTHALENE	91-57-6	0.05		0.05		0.05							0.05			0.05				0.05				72.16
C2-NAPHTHALENES	C2NAPH	0.15		0.15		0.15							0.15			0.15				0.15				30.24
C3-NAPHTHALENES	C3NAPH	0.08		0.05		0.05							0.05			0.05				0.15				11.10
C4-NAPHTHALENES	C4NAPH	0.15		0.15		0.15							0.15			0.15				0.15				4.048
ACENAPHTHYLENE	208-96-8	0.2		0.2		0.2							0.2			0.2				0.2				306.9
ACENAPHTHENE	83-32-9	0.14		0.1		0.1							0.1			0.1				0.1				55.85
FLUORENE	86-73-7	0.1		0.04		0.04							0.04			0.04				0.04				39.30
C1-FLUORENES	C1FLUOR	0.05		0.02		0.02							0.02			0.02				0.02				13.99
C2-FLUORENES	C2FLUOR	0.05		0.05		0.05							0.05			0.05				0.05				5.305
C3-FLUORENES	C3FLUOR	0.06		0.06		0.06							0.06			0.06				0.06				1.916
PHENANTHRENE	85-01-8	0.1		0.1		0.1							0.1			0.1				0.1				19.13
ANTHRACENE	120-12-7	0.05		0.05		0.05							0.05			0.05				0.05				20.73
C1-PHENANTHRENES/ANTHRACENES	C1PHAN	0.12		0.03		0.02							0.02			0.02				0.04				7.436
C2-PHENANTHRENES/ANTHRACENES	C2PHAN	0.08		0.05		0.05							0.05			0.05				0.1				3.199
C3-PHENANTHRENES/ANTHRACENES	C3PHAN	0.04		0.04		0.04							0.04			0.04				0.04				1.256
C4-PHENANTHRENES/ANTHRACENES	C4PHAN	0.02		0.02		0.02							0.02			0.02				0.02				0.5594
FLUORANTHENE	206-44-0	0.01		0.075		0.01							0.01			0.01				0.02				7.109
PYRENE	129-00-0	0.41		0.05		0.01							0.01			0.02				0.01				10.11
C1-FLUORANTHENES/PYRENES	C1FLPY	0.1		0.015		0.01							0.01			0.01				0.01				4.887
Chrysene	218-01-9	0.04		0.01		0.001							0.001			0.001				0				2.024
C1 CHRYSENES	C1CHRYS	0.005		0.005		0.005							0.005			0.005				0.005				0.8557
C2 CHRYSENES	C2CHRYS	0.01		0.01		0.01							0.01			0.01				0.01				0.4827
C3 CHRYSENES	C3CHRYS	0.01		0.01		0.01							0.01			0.01				0.01				0.1675
C4 CHRYSENES	C4CHRYS	0.01		0.01		0.01							0.01			0.01				0.01				0.07062
PERYLENE	198-55-0	0.004		0.004		0.004							0.004			0.004				0.004				0.9008
BENZO[A]ANTHRACENE	56-55-3	0.02		0		0.001							0.001			0.001				0				2.227
BENZO[B+K]FLUORANTHENE	207-08-9_bk	0.005		0.005		0.005							0.005			0.005				0.005				0.6415
BENZO[A]PYRENE	50-32-8	0.008		0.008		0.008							0.008			0.008				0.008				0.9573
BENZO[E]PYRENE	192-97-2	0.005		0.005		0.005							0.005			0.005				0.005				0.9008
DIBENZO[A,H]ANTHRACENE	53-70-3	0.002		0.002		0.002							0.002			0.002				0.002				0.2825
INDENO[1,2,3-CD]PYRENE	193-39-5	0.001		0.001		0.001							0.001			0.001				0.001				0.275
BENZO[G,H,I]PERYLENE	191-24-2	0.001		0.001		0.001							0.001			0.001				0.001				0.4391

calculation of chronic toxic units in sediment pore water samples																								Benchmark
	FCV	AD-1	VQ	GC-1	VQ	DC-11/12	VQ	DC-11	DC-10/11	DC-9/10	DC-8	DC-7/8	DC-6/7	VQ	DC-5/6	DC-5	VQ	DC-4	DC-3/4	DC-3	VQ	DC-2	DC-1	FCV
NAPHTHALENE	193.5	0.000982		0.000646		0.000517							0.000517			0.000568				0.000620				
1-METHYLNAPHTHALENE	75.37	0.000663		0.000663		0.000663							0.000663			0.000663				0.000663				
2-METHYLNAPHTHALENE	72.16	0.000693		0.000693		0.000693							0.000693			0.000693				0.000693				
C2-NAPHTHALENES	30.24	0.004960		0.004960		0.004960							0.004960			0.004960				0.004960				
C3-NAPHTHALENES	11.1	0.007207		0.004505		0.004505							0.004505			0.004505				0.013514				
C4-NAPHTHALENES	4.048	0.037055		0.037055		0.037055							0.037055			0.037055				0.037055				
ACENAPHTHYLENE	306.9	0.000652		0.000652		0.000652							0.000652			0.000652				0.000652				
ACENAPHTHENE	55.85	0.002507		0.001791		0.001791							0.001791			0.001791				0.001791				
FLUORENE	39.3	0.002545		0.001018		0.001018							0.001018			0.001018				0.001018				
C1-FLUORENES	13.99	0.003574		0.001430		0.001430							0.001430			0.001430				0.001430				
C2-FLUORENES	5.305	0.009425		0.009425		0.009425							0.009425			0.009425				0.009425				
C3-FLUORENES	1.916	0.031315		0.031315		0.031315							0.031315			0.031315				0.031315				
PHENANTHRENE	19.13	0.005227		0.005227		0.005227							0.005227			0.005227				0.005227				
ANTHRACENE	20.73	0.002412		0.002412		0.002412							0.002412			0.002412				0.002412				
C1-PHENANTHRENES/ANTHRACENES	7.436	0.016138		0.004034		0.002690							0.002690			0.002690				0.005379				
C2-PHENANTHRENES/ANTHRACENES	3.199	0.025008		0.015630		0.015630							0.015630			0.015630				0.031260				
C3-PHENANTHRENES/ANTHRACENES	1.256	0.031847		0.031847		0.031847							0.031847			0.031847				0.031847				
C4-PHENANTHRENES/ANTHRACENES	0.5594	0.035753		0.035753		0.035753							0.035753			0.035753				0.035753				
FLUORANTHENE	7.109	0.001407		0.010550		0.001407							0.001407			0.001407				0.002813				
PYRENE	10.11	0.040554		0.004946		0.000989							0.000989			0.001978				0.000989				
C1-FLUORANTHENES/PYRENES	4.887	0.020462		0.003069		0.002046							0.002046			0.002046				0.002046				
Chrysene	2.024	0.019763		0.004941		0.000494							0.000494			0.000494				0.000000				
C1 CHRYSENES	0.8557	0.005843		0.005843		0.005843							0.005843			0.005843				0.005843				
C2 CHRYSENES	0.4827	0.020717		0.020717		0.020717							0.020717			0.020717				0.020717				
C3 CHRYSENES	0.1675	0.059701		0.059701		0.059701							0.059701			0.059701				0.059701				
C4 CHRYSENES	0.07062	0.141603		0.141603		0.141603							0.141603			0.141603				0.141603				
PERYLENE	0.9008	0.004440		0.004440		0.004440							0.004440			0.004440				0.004440				
BENZO[A]ANTHRACENE	2.227	0.008981		0.000000		0.000449							0.000449			0.000449				0.000000				
BENZO[B+K]FLUORANTHENE	0.6415	0.007794		0.007794		0.007794							0.007794			0.007794				0.007794				
BENZO[A]PYRENE	0.9573	0.008357		0.008357		0.008357							0.008357			0.008357				0.008357				
BENZO[E]PYRENE	0.9008	0.005551		0.005551		0.005551							0.005551			0.005551				0.005551				
DIBENZO[A,H]ANTHRACENE	0.2825	0.007080		0.007080		0.007080							0.007080			0.007080				0.007080				
INDENO[1,2,3-CD]PYRENE	0.275	0.003636		0.003636		0.003636							0.003636			0.003636				0.003636				
BENZO[G,H,I]PERYLENE	0.4391	0.002277		0.002277		0.002277							0.002277			0.002277				0.002277				
	SUM	0.576129		0.479561		0.459967							0.459967			0.461008				0.487862				1.000000

Benchmark is the pore water final chronic value from Table 3-4 of USEPA 2003.

Table H-27. Polycyclic Aromatic Hydrocarbon Concentrations (ug/L pore water) in pore water of sediment samples from Otter Creek.

surface sediment grab samples (0 to 6 inches depth)																																					
stream segments		Otter E			Otter D			Otter C									Otter B						Otter A														Benchmark
chemical_name	cas_rn	OC-24/25	VQ	OC-23	OC-22	VQ	OC-18/19	OC-18	OC-16/17	OC-16	VQ	OC-15/16	OC-12/13	VQ	OC-11/12	OC-10-11	OC-9-10	VQ	OC-9-01	OC-8-9	OC-8	OC-7-8	OC-6/7(2)-01	VQ	OC-6/7(1)-01	OC-5A-01	VQ	OC-5	OC-4A-01	OC-4-01	VQ	OC-3A-01	OC-3	OC-2A	OC-2	OC-1A	FCV
NAPHTHALENE	91-20-3	0.1			0.1					0.1			0.11				0.23						0.1			0.76				0.87							193.5
1-METHYLNAPHTHALENE	90-12-0	0.05			0.05					0.05			0.05				0.05						0.05			0.66				3							75.37
2-METHYLNAPHTHALENE	91-57-6	0.05			0.05					0.05			0.05				0.05						0.05			0.13				0.86							72.16
C2-NAPHTHALENES	C2NAPH	0.15			0.15					0.15			0.15				0.18						0.15			3.36				**12.89**							30.24
C3-NAPHTHALENES	C3NAPH	0.06			0.11					0.27			0.2				1.25						0.74			7.99				**32.63**							11.10
C4-NAPHTHALENES	C4NAPH	0.15			0.17					0.57			0.34				3.92						2.32			**4.99**				**25.72**							4.048
ACENAPHTHYLENE	208-96-8	0.2			0.2					0.2			0.2				0.2						0.2			0.2				0.22							306.9
ACENAPHTHENE	83-32-9	0.1			0.1					0.1			0.1				0.1						0.1			0.1				0.36							55.85
FLUORENE	86-73-7	0.04			0.04					0.04			0.04				0.04						0.04			0.06				0.22							39.30
C1-FLUORENES	C1FLUOR	0.02			0.04					0.04			0.04				0.33						0.11			0.27				1.17							13.99
C2-FLUORENES	C2FLUOR	0.05			0.06					0.13			0.07				1.09						0.42			0.56				1.92							5.305
C3-FLUORENES	C3FLUOR	0.06			0.06					0.06			0.06				1.74						0.94			1.03				**2.42**							1.916
PHENANTHRENE	85-01-8	0.1			0.1					0.1			0.1				0.1						0.1			0.1				0.23							19.13
ANTHRACENE	120-12-7	0.05			0.05					0.05			0.05				0.05						0.05			0.05				0.07							20.73
C1-PHENANTHRENES/ANTHRACENES	C1PHAN	0.02			0.02					0.08			0.02				0.17						0.06			0.42				1.13							7.436
C2-PHENANTHRENES/ANTHRACENES	C2PHAN	0.05			0.11					0.15			0.08				1.02						0.57			1.46				2.99							3.199
C3-PHENANTHRENES/ANTHRACENES	C3PHAN	0.04			0.04					0.2			0.07				1.12						1.02			**1.36**				**2.48**							1.256
C4-PHENANTHRENES/ANTHRACENES	C4PHAN	0.02			0.02					0.09			0.02				0.42						0.92			**1.15**				**1.82**							0.5594
FLUORANTHENE	206-44-0	0.01			0.19					0.07			0.11				0.13						0.05			0.01				0.01							7.109
PYRENE	129-00-0	0.01			0.16					0.1			0.11				0.2						0.09			0.08				0.12							10.11
C1-FLUORANTHENES/PYRENES	C1FLPY	0.01			0.04					0.05			0.04				0.17						0.14			0.16				0.3							4.887
Chrysene	218-01-9	0.001			0.01					0.01			0.01				0.02						0.02			0.01				0.02							2.024
C1 CHRYSENES	C1CHRYS	0.005			0.005					0.005			0.005				0.01						0.01			0.01				0.02							0.8557
C2 CHRYSENES	C2CHRYS	0.01			0.01					0.01			0.01				0.01						0.01			0.01				0.01							0.4827
C3 CHRYSENES	C3CHRYS	0.01			0.01					0.01			0.01				0.01						0.01			0.01				0.01							0.1675
C4 CHRYSENES	C4CHRYS	0.01			0.01					0.01			0.01				0.01						0.01			0.01				0.01							0.07062
PERYLENE	198-55-0	0.004			0.004					0.004			0.004				0.004						0.004			0.004				0.004							0.9008
BENZO[A]ANTHRACENE	56-55-3	0.001			0.01					0			0				0						0.01			0				0							2.227
BENZO[B+K]FLUORANTHENE	207-08-9_bk	0.005			0.005					0.005			0.005				0.005						0.005			0.005				0.005							0.6415
BENZO[A]PYRENE	50-32-8	0.008			0.008					0.008			0.008				0.008						0.008			0.008				0.008							0.9573
BENZO[E]PYRENE	192-97-2	0.005			0.005					0.005			0.005				0.005						0.005			0.005				0.005							0.9008
DIBENZO[A,H]ANTHRACENE	53-70-3	0.002			0.002					0.002			0.002				0.002						0.002			0.002				0.002							0.2825
INDENO[1,2,3-CD]PYRENE	193-39-5	0.001			0.001					0.001			0.001				0.001						0.001			0.001				0.001							0.275
BENZO[G,H,I]PERYLENE	191-24-2	0.001			0.001					0.001			0.001				0.001						0.001			0.001				0.001							0.4391

calculation of chronic toxic units in sediment pore water samples																																					Benchmark
	FCV	OC-24/25	VQ	OC-23	OC-22	VQ	OC-18/19	OC-18	OC-16/17	OC-16	VQ	OC-15/16	OC-12/13	VQ	OC-11/12	OC-10-11	OC-9-10	VQ	OC-9-01	OC-8-9	OC-8	OC-7-8	OC-6/7(2)-01	VQ	OC-6/7(1)-01	OC-5A-01	VQ	OC-5	OC-4A-01	OC-4-01	VQ	OC-3A-01	OC-3	OC-2A	OC-2	OC-1A	FCV
NAPHTHALENE	193.5	0.00052			0.00052					0.00052			0.00057				0.00119						0.00052			0.00393				0.00450							
1-METHYLNAPHTHALENE	75.37	0.00066			0.00066					0.00066			0.00066				0.00066						0.00066			0.00876				0.03980							
2-METHYLNAPHTHALENE	72.16	0.00069			0.00069					0.00069			0.00069				0.00069						0.00069			0.00180				0.01192							
C2-NAPHTHALENES	30.24	0.00496			0.00496					0.00496			0.00496				0.00595						0.00496			0.11111				0.42626							
C3-NAPHTHALENES	11.1	0.00541			0.00991					0.02432			0.01802				0.11261						0.06667			0.71982				2.93964							
C4-NAPHTHALENES	4.048	0.03706			0.04200					0.14081			0.08399				0.96838						0.57312			1.23271				6.35375							
ACENAPHTHYLENE	306.9	0.00065			0.00065					0.00065			0.00065				0.00065						0.00065			0.00065				0.00072							
ACENAPHTHENE	55.85	0.00179			0.00179					0.00179			0.00179				0.00179						0.00179			0.00179				0.00645							
FLUORENE	39.3	0.00102			0.00102					0.00102			0.00102				0.00102						0.00102			0.00153				0.00560							
C1-FLUORENES	13.99	0.00143			0.00286					0.00286			0.00286				0.02359						0.00786			0.01930				0.08363							
C2-FLUORENES	5.305	0.00943			0.01131					0.02451			0.01320				0.20547						0.07917			0.10556				0.36192							
C3-FLUORENES	1.916	0.03132			0.03132					0.03132			0.03132				0.90814						0.49061			0.53758				1.26305							
PHENANTHRENE	19.13	0.00523			0.00523					0.00523			0.00523				0.00523						0.00523			0.00523				0.01202							
ANTHRACENE	20.73	0.00241			0.00241					0.00241			0.00241				0.00241						0.00241			0.00241				0.00338							
C1-PHENANTHRENES/ANTHRACENES	7.436	0.00269			0.00269					0.01076			0.00269				0.02286						0.00807			0.05648				0.15196							
C2-PHENANTHRENES/ANTHRACENES	3.199	0.01563			0.03439					0.04689			0.02501				0.31885						0.17818			0.45639				0.93467							
C3-PHENANTHRENES/ANTHRACENES	1.256	0.03185			0.03185					0.15924			0.05573				0.89172						0.81210			1.08280				1.97452							
C4-PHENANTHRENES/ANTHRACENES	0.5594	0.03575			0.03575					0.16089			0.03575				0.75080						1.64462			2.05577				3.25349							
FLUORANTHENE	7.109	0.00141			0.02673					0.00985			0.01547				0.01829						0.00703			0.00141				0.00141							
PYRENE	10.11	0.00099			0.01583					0.00989			0.01088				0.01978						0.00890			0.00791				0.01187							
C1-FLUORANTHENES/PYRENES	4.887	0.00205			0.00818					0.01023			0.00818				0.03479						0.02865			0.03274				0.06139							
Chrysene	2.024	0.00049			0.00494					0.00494			0.00494				0.00988						0.00988			0.00494				0.00988							
C1 CHRYSENES	0.8557	0.00584			0.00584					0.00584			0.00584				0.01169						0.01169			0.01169				0.02337							
C2 CHRYSENES	0.4827	0.02072			0.02072					0.02072			0.02072				0.02072						0.02072			0.02072				0.02072							
C3 CHRYSENES	0.1675	0.05970			0.05970					0.05970			0.05970				0.05970						0.05970			0.05970				0.05970							
C4 CHRYSENES	0.07062	0.14160			0.14160					0.14160			0.14160				0.14160						0.14160			0.14160				0.14160							
PERYLENE	0.9008	0.00444			0.00444					0.00444			0.00444				0.00444						0.00444			0.00444				0.00444							
BENZO[A]ANTHRACENE	2.227	0.00045			0.00449					0.00000			0.00000				0.00000						0.00449			0.00000				0.00000							
BENZO[B+K]FLUORANTHENE	0.6415	0.00779			0.00779					0.00779			0.00779				0.00779						0.00779			0.00779				0.00779							
BENZO[A]PYRENE	0.9573	0.00836			0.00836					0.00836			0.00836				0.00836						0.00836			0.00836				0.00836							
BENZO[E]PYRENE	0.9008	0.00555			0.00555					0.00555			0.00555				0.00555						0.00555			0.00555				0.00555							
DIBENZO[A,H]ANTHRACENE	0.2825	0.00708			0.00708					0.00708			0.00708				0.00708						0.00708			0.00708				0.00708							
INDENO[1,2,3-CD]PYRENE	0.275	0.00364			0.00364					0.00364			0.00364				0.00364						0.00364			0.00364				0.00364							
BENZO[G,H,I]PERYLENE	0.4391	0.00228			0.00228					0.00228			0.00228				0.00228						0.00228			0.00228				0.00228							
	SUM	0.46087			0.54717					0.92143			0.59303				4.57760						4.21013			6.72347				18.19634							1.00000

Benchmark is the pore water final chronic value from Table 3-4 of USEPA 2003.

Table H-28. Polycyclic Aromatic Hydrocarbon Concentrations (ug/kg wet wt and umole/g lipid) in Aquatic Invertebrate Tissue Samples from Urban Comparison Streams and Duck and Otter Creeks.

Chemistry data for composite benthic macroinvertebrate tissue samples (µg/kg wet weight)

Stream Segments			Urban				Duck D		Duck A		Otter C				Otter A			
CHEMICAL NAME	(ug/umol)	CAS #	AD-1T	VQ	GC-2T	VQ	DC-11/12T	VQ	DC-5T	VQ	OC-16T	VQ	OC-12/13T	VQ	OC-5AT	VQ	OC-4T	VQ
NAPHTHALENE	128	91-20-3	100	U	9.2	U	0.79	J	3.4		11	U	3	J	0.95	J	1.6	J
1-METHYLNAPHTHALENE	142	90-12-0	100	U	9.2	U	2.2	U	1.7	J	11	U	2.8	J	0.95	J	2.6	
2-METHYLNAPHTHALENE	142	91-57-6	100	U	9.2	U	2.2	U	3		11	U	3.3	J	1.3	J	2.7	
2,3,5-TRIMETHYLNAPHTHALENE	170	2245-38-7	100	U	9.2	U	2.2	U	0.97	J	11	U	2.1	J	1	J	6.6	
2,6-DIMETHYLNAPHTHALENE	156	581-42-0	100	U	9.2	U	2.2	U	1.9	J	11	U	3.4	J	1.5	J	4.7	
1,1-BIPHENYL	154	92-52-4	100	U	9.2	U	2.2	U	2	U	11	U	4	U	2	U	2.1	U
ACENAPHTHYLENE	152	208-96-8	100	U	9.2	U	2.2	U	2	U	11	U	4	U	2	U	2.1	U
ACENAPHTHENE	154	83-32-9	32	J	2.8	J	2.2	U	0.81	J	4.4	J	2.9	J	2	U	0.81	J
DIBENZOTHIOPHENE	184	132-65-0	46	J	6.8	J	2.2	U	1.1	J	7.1	J	3	J	0.58	J	1.3	J
FLUORENE	166	86-73-7	36	J	4.5	J	2.2	U	1.5	J	5.3	J	3.3	J	2	U	1.3	J
PHENANTHRENE	178	85-01-8	870		68		2.6		9.6		110		32		5		7.2	
ANTHRACENE	178	120-12-7	89	J	6.5	J	2.2	U	2.3		16		6.4		0.56	J	1.1	J
1-METHYLPHENANTHRENE	192	832-69-9	51	J	4.8	J	2.2	U	1.8	J	11		4.7		1.5	J	3.9	
FLUORANTHENE	202	206-44-0	3900		390		5		21		400		86		11		12	
PYRENE	202	129-00-0	2800		240		6.2		26		420		120		19		25	
CHRYSENE	228	218-01-9	2300		220		4.3		20		270		78		15		19	
PERYLENE	252	198-55-0	450		21		0.77	J	3.8		57		13		2.6		3.2	
BENZO[A]ANTHRACENE	228	56-55-3	1000		65		2.3		11		140		32		5.1		5.7	
BENZO[B]FLUORANTHENE	252	205-99-2	2100		110		2.7		13		180		49		10		11	
BENZO[K]FLUORANTHENE	252	207-08-9	2000		86		2.3		14		170		40		10		9.9	
BENZO[A]PYRENE	252	50-32-8	1700		90		2.6		14		200		44		8.5		9	
BENZO[E]PYRENE	252	192-97-2	1700		110		2.7		14		190		49		12		13	
DIBENZ(A,H)ANTHRACENE	278	53-70-3	420		23		0.73	J	3.7		55		11		2.2		2.9	
INDENO[1,2,3-CD]PYRENE	276	193-39-5	1500		84		2.2		10		180		37		7.4		8	
BENZO[G,H,I]PERYLENE	268	191-24-2	1600		100		3		13		190		45		11		11	
PERCENT LIPID (% wet weight)		LIPID	0.57		0.67		0.68		0.34		1.5		1.1		0.55		0.90	
g lipid/kg organism (wet weight)			0.0057		0.0067		0.0068		0.0034		0.0150		0.0110		0.0055		0.0090	

calculation of PAH body burdens (µg/g lipid)

	Urban		Duck D	Duck A	Otter C		Otter A		
CHEMICAL NAME	AD-1 (umol/ g lipid)	GC-2 (umol/ g lipid)	DC-11/12 (umol/ g lipid)	DC-5 (umol/ g lipid)	OC-16 (umol/ g lipid)	OC-12/13 (umol/ g lipid)	OC-5A (umol/ g lipid)	OC-4 (umol/ g lipid)	Benchmark (USEPA 2003)
NAPHTHALENE			0.000908	0.00781		0.00213	0.00135	0.00139	
1-METHYLNAPHTHALENE				0.00352		0.00179	0.00122	0.00203	
2-METHYLNAPHTHALENE				0.00621		0.00211	0.00166	0.00211	
2,3,5-TRIMETHYLNAPHTHALENE				0.00168		0.00112	0.00107	0.00431	
2,6-DIMETHYLNAPHTHALENE				0.00358		0.00198	0.00175	0.00335	
1,1-BIPHENYL									
ACENAPHTHYLENE									
ACENAPHTHENE	0.0365	0.00271		0.00155	0.00190	0.00171	0.00236	0.000584	
DIBENZOTHIOPHENE	0.0439	0.00552		0.00176	0.00257	0.00148	0.00057	0.000785	
FLUORENE	0.0380	0.00405		0.00266	0.00213	0.00181	0.00219	0.000870	
PHENANTHRENE	0.857	0.0570	0.00215	0.0159	0.0412	0.0163	0.00511	0.00449	
ANTHRACENE	0.0877	0.00545		0.00380	0.00599	0.00327	0.000572	0.000687	
1-METHYLPHENANTHRENE	0.0466	0.00373		0.00276	0.00382	0.00223	0.00142	0.00226	
FLUORANTHENE	**3.39**	0.288	0.00364	0.0306	0.132	0.0387	0.00990	0.00660	
PYRENE	**2.43**	0.177	0.00451	0.0379	0.139	0.0540	0.0171	0.0138	
CHRYSENE	1.77	0.144	0.00277	0.0258	0.0789	0.0311	0.0120	0.00926	
PERYLENE	0.313	0.0124	0.00045	0.00444	0.0151	0.00469	0.00188	0.00141	
BENZO[A]ANTHRACENE	0.769	0.0426	0.00148	0.0142	0.0409	0.0128	0.00407	0.00278	
BENZO[B]FLUORANTHENE	1.46	0.0652	0.00158	0.0152	0.0476	0.0177	0.00722	0.00485	
BENZO[K]FLUORANTHENE	1.39	0.0509	0.00134	0.0163	0.0450	0.0144	0.00722	0.00437	
BENZO[A]PYRENE	1.18	0.0533	0.00152	0.0163	0.0529	0.0159	0.00613	0.00397	
BENZO[E]PYRENE	1.18	0.0652	0.00158	0.0163	0.0503	0.0177	0.00866	0.00573	
DIBENZ(A,H)ANTHRACENE	0.265	0.0123	0.000386	0.00391	0.0132	0.0036	0.00144	0.00116	
INDENO[1,2,3-CD]PYRENE	0.953	0.0454	0.00117	0.0107	0.0435	0.0122	0.00487	0.00322	
BENZO[G,H,I]PERYLENE	1.05	0.0557	0.00165	0.0143	0.0473	0.0153	0.00746	0.00456	
sum	**17.3**	1.09	0.0251	0.257	0.763	0.274	0.107	0.0845	2.24

Benchmark is the body burden from Table 3-4 of USEPA 2003.

Chemistry data for composite fish tissue samples (µg/kg wet weight)										calculation of PAH_{34} body burdens (µg/g lipid)					
Chemical name	Duck Creek D		Duck Creek A		Otter Creek C		Otter Creek A		GMW		Duck Creek D	Duck Creek A	Otter Creek C	Otter Creek A	
	Creek Chub sample		Log Perch sample		Creek Chub sample		Log Perch sample				Creek Chub sample	Log Perch sample	Creek Chub sample	Log Perch sample	Benchmark
italics indicates not PAH_{34}	FWS1590-DCD-CCH1-C	VQ	FWS1632-DCA LP-1-C93	VQ	FWS1626-OCC-CCH2-C8	VQ	FWS1622-OCA-LP1-C	VQ	ug/umole		FWS1590-DCD-CCH1-C	FWS1632-DCA LP-1-C93	FWS1626-OCC-CCH2-C8	FWS1622-OCA-LP1-C	(USEPA 2003)
cis/trans-Decalin	ND	U	3.9	J	2.6	J	65		140			0.000196	0.000103	0.0031	
C1-Decalins	1.1	J	7.5		7		360		154		0.000061	0.00034	0.000253	0.0157	
C2-Decalins	ND	U	22		22		650		168			0.00092	0.00073	0.0260	
C3-Decalins	ND	U	27		24		590		182			0.00105	0.00073	0.0218	
C4-Decalins	ND	U	31		28		600		196			0.00111	0.00079	0.0206	
Benzo(b)thiophene	ND	U	0.73	J	0.18	J	0.98	J	134			0.000038	0.0000075	0.000049	
C1-Benzothiophenes	ND	U	3.1	J	1.6	J	17		148			0.000148	0.000060	0.00077	
C2-Benzothiophenes	ND	U	3	J	ND	U	17		162			0.000131		0.00071	
C3-Benzothiophenes	ND	U	2.4	J	1.9	J	16		176			0.000096	0.000060	0.00061	
C4-Benzo(b)thiophenes	ND	U	ND	U	ND	U	30		190					0.00106	
Naphthalene	1.7	J	12		1.9	J	7.6	J	128		0.000113	0.00066	0.000083	0.00040	
C1-Naphthalenes	2.2	J	16		3.2	J	13		142		0.000132	0.00079	0.000125	0.00062	
C2-Naphthalenes	2.3	J	17		12		110		156		0.000125	0.00077	0.00043	0.0047	
C3-Naphthalenes	1.6	J	13		14		220		170		0.000080	0.00054	0.00046	0.0087	
C4-Naphthalenes	ND	U	18		22		210		186			0.00068	0.00066	0.0076	
Biphenyl	0.52	J	3.9	J	3	J	4.6	J	154		0.000029	0.000179	0.000108	0.000201	
Dibenzofuran	1.6	J	3.6	J	9.9		21		184		0.000074	0.000138	0.00030	0.00077	
Acenaphthylene	ND	U	1.4	J	0.89	J	3.9	J	152			0.000065	0.000033	0.000172	
Acenaphthene	1.3	J	4.7	J	8.1		28		154		0.000072	0.000215	0.00029	0.00122	
Fluorene	1.8	J	6.6		7.8		24		166		0.000092	0.00028	0.000261	0.00097	
C1-Fluorenes	0.51	J	5.1		4.4	J	39		180		0.0000241	0.000200	0.000136	0.00146	
C2-Fluorenes	5	J	14		7.9		87		194		0.000219	0.00051	0.000226	0.0030	
C3-Fluorenes	12		ND	U	19		140		208		0.00049		0.00051	0.0045	
Anthracene	0.33	J	5.1		5.1		18		178		0.0000158	0.000202	0.000159	0.00068	
Phenanthrene	4.3	J	19		14		73		178		0.000206	0.00075	0.00044	0.00276	
C1-Phenanthrenes/Anthracenes	1.4	J	220		11		81		192		0.000062	0.0081	0.00032	0.00284	
C2-Phenanthrenes/Anthracenes	0.92	J	50		10		92		206		0.000038	0.00171	0.00027	0.0030	
C3-Phenanthrenes/Anthracenes	ND	U	31		11		120		220			0.00099	0.00028	0.0037	
C4-Phenanthrenes/Anthracenes	ND	U	27		11		77		234			0.00081	0.000261	0.00221	
Retene	0.69	J	9.9		ND	U	ND	U	234		0.000025	0.00030			
Dibenzothiophene	0.34	J	3.5	J	3.4	J	12		184		0.0000157	0.000134	0.000103	0.00044	
C1-Dibenzothiophenes	ND	U	7.5		4.4	J	25		198			0.000267	0.000124	0.00085	
C2-Dibenzothiophenes	2.8	J	16		5.8		39		212		0.000112	0.00053	0.000152	0.00124	
C3-Dibenzothiophenes	ND	U	38		ND	U	37		226			0.00119		0.00110	
C4-Dibenzothiophenes	ND	U	ND	U	ND	U	ND	U	240						
Benzo(b)fluorene	0.15	J	1.7	J	0.61	J	2.3	J	216		0.000006	0.000055	0.0000157	0.000072	
Fluoranthene	2.6	J	12	J	9.7	J	63	J	202		0.000110	0.00042	0.00027	0.00210	
Pyrene	1.5	J	8.6		6.6		41		202		0.000063	0.00030	0.000182	0.00136	
C1-Fluoranthenes/Pyrenes	1.1	J	12		5.5		57		216		0.000043	0.00039	0.000142	0.00177	
C2-Fluoranthenes/Pyrenes	ND	U	13		3.3	J	49		230			0.00040	0.000080	0.00143	
C3-Fluoranthenes/Pyrenes	ND	U	9.7		ND	U	32		244			0.00028		0.00088	
C4-Fluoranthenes/Pyrenes	ND	U	8.2		ND	U	14		258			0.000224		0.00036	
Naphthobenzothiophene	0.25	J	8.4		0.41	J	4	J	238		0.0000089	0.000249	0.0000096	0.000113	
C1-Naphthobenzothiophenes	ND	U	27		ND	U	16		252			0.00076		0.00043	
C2-Naphthobenzothiophenes	ND	U	23		ND	U	ND	U	266			0.00061			
C3-Naphthobenzothiophenes	ND	U	64		ND	U	ND	U	280			0.00161			
C4-Naphthobenzothiophenes	ND	U	ND	U	ND	U	ND	U	294						
Benz(a)anthracene	0.64	J	8.8		2.2	J	3.7	J	228		0.0000239	0.00027	0.000054	0.000109	
Chrysene	0.59	J	11		3.6	J	39		228		0.0000220	0.00034	0.000088	0.00115	
C1-Chrysenes	ND	U	25		1.6	J	16		242			0.00073	0.000037	0.00044	
C2-Chrysenes	ND	U	21		5	J	46		256			0.00058	0.000109	0.00121	
C3-Chrysenes	ND	U	7		ND	U	ND	U	270			0.000183			
C4-Chrysenes	ND	U	ND	U	ND	U	ND	U	284						
Benzo(b)fluoranthene	1.3	J	4.9	J	4.2	J	7	J	252		0.000044	0.000137	0.000093	0.000187	
Benzo(k)fluoranthene	0.35	J	0.68	J	1.5	J	1.3	J	252		0.0000118	0.0000190	0.000033	0.000035	
Benzo(a)fluoranthene	0.51	J	0.68	J	0.89	J	ND	U	252		0.0000172	0.0000190	0.0000196		
Benzo(e)pyrene	0.72	J	9.3		2.5	J	12		252		0.0000243	0.000260	0.000055	0.00032	
Benzo(a)pyrene	0.55	J	8.6		2.3	J	2.4	J	252		0.0000186	0.000241	0.000051	0.000064	
Perylene	ND	U	0.7	J	0.73	J	ND	U	252			0.0000196	0.0000161		
Indeno(1,2,3-cd)pyrene	0.71	J	2.5	J	2.5	J	1.7	J	276		0.0000219	0.000064	0.000050	0.000041	
Dibenz(a,h)anthracene	ND	U	0.8	J	0.6	J	1.2	J	278			0.0000203	0.0000120	0.000029	
Benzo(g,h,i)perylene	0.74	J	7.4		2.3	J	3.8	J	268		0.0000235	0.000195	0.000048	0.000095	
4-Methyldibenzothiophene	1.1	J	3.3	J	1.3	J	10	J	148		0.000063	0.000157	0.000049	0.00045	
2-Methyldibenzothiophene	ND	U	2	J	0.46	J	5.5	J	148			0.000095	0.0000173	0.000250	
1-Methyldibenzothiophene	ND	U	0.61	J	ND	U	3.1	J	148			0.000029		0.000141	
3-Methylphenanthrene	ND	U	7.6		0.63	J	8.8	J	192			0.00028	0.0000182	0.00031	
2-Methylphenanthrene	0.68	J	17		5.7		29		192		0.000030	0.00062	0.000165	0.00102	
2-Methylanthracene	ND	U	ND	U	1.7	J	5.9	J	192				0.000049	0.000207	
9-Methylphenanthrene	ND	U	ND	U	0.75	J	18		192				0.000022	0.00063	
1-Methylphenanthrene	ND	U	ND	U	2.1	J	7.5	J	192				0.000061	0.000263	
2-Methylnaphthalene	1.7	J	14		2.4	J	6.3	J	142		0.000102	0.00070	0.000094	0.00030	
1-Methylnaphthalene	1.2	J	8.7		2	J	9.3	J	142		0.000072	0.00043	0.000078	0.00044	
2,6-Dimethylnaphthalene	1.3	J	12		3.9	J	34		156		0.000071	0.00054	0.000139	0.00146	
2,3,5-Trimethylnaphthalene	ND	U	3.6	J	3.8	J	45		170			0.000149	0.000124	0.00178	
Carbazole	ND	U	ND	U	4.7	J	25		167				0.000156	0.00101	
solids (% wet weight)	24.6		27.0		26.4		28.7			Sum PAH_{34}	0.002100	0.022408	0.006280	0.060219	2.24
Lipids, Total (% wet wt)	2.89		3.83		4.75		4.27								
lipids (g/kg dry weight)	117		142		180		149			Sum all non-duplicate	0.002426	0.032403	0.009969	0.156757	2.24

Benchmark is the body burden from Table 3-4 of USEPA 2003.

Appendix I

Arsenic bioaccessibility by in vitro gastrointestinal (IVG) extraction Report

The Ohio State University School of Environment and Natural Resources
Soil Environmental Chemistry Laboratory
Analytical Results

Facility

The Soil Environmental Chemistry Laboratory is located at 2021 Coffey Rd., Columbus OH, 43210 in the School of Environment and Natural Resources. The Soil Environmental Chemistry Lab exists to meet the needs of research grants, individuals, companies, state and federal agencies in regard to physical and chemical analysis of soil, water, plant, and other environmental samples. Professor Nick Basta, Director.

Instrumentation

Arsenic (As) analysis was carried out on a Varian Vista-MPX ICP-OES.

Quality Control

Inductively Coupled Plasma (ICP) Detection Limits

Definitions:
Method Detection Limit (MDL): The MDL for each element is calculated on the basis of the analytical method used to prepare and analyze the sample.. For analysis via ICP, the method detection limit is based on the multiple of three times the standard deviation of the signal of 10 blank solutions.

Limit of Quantitation (LOQ): The LOQ is the lowest reportable concentration of an element at which accuracy of ± 20% is demonstrated with a check standard prepared from a certified ICP standard. The LOQ check standard is analyzed at a frequency up to one per 20 samples.

Sample Preparation QA/QC Procedures

Measures:
Laboratory Control Sample: A standard reference material (SRM) or certified reference material (CRM) that goes through the same extraction/preparation procedure as the samples. The analyte composition of the United States Environmental Protection Agency (USEPA) SW-846 Method 3051a laboratory control sample (RTC Corp, CRM059-050) is certified using the same or similar extraction procedure. NIST 2710 is used as a laboratory control sample for the Ohio State University In Vitro Gastrointestinal extraction method (Basta et al., 2007; Rodriguez et al., 1999). However, no certified value exists for in vitro extractions for As.

Preparation Blank: The Preparation Blank is a sample that contains only the reagents used in the extraction procedure. The preparation blank is processed through the same preparation procedures as the samples and therefore gives an indication of any contamination introduced to the sample during the preparation process.

Sample Duplicates: A sample split and prepared by the same procedure in order to evaluate the reproducibility of the preparation method.

QC Limits:

Laboratory Control Sample: ± 20% of the known value or within the 95% prediction interval of the certified value.

Preparation Blank: For elements with blank concentrations above the LOQ, the sample concentration must be ≥ 10x the blank concentration.

Sample Duplicates: The relative percent difference (RPD) must be no more than ±20%. Sample Duplicates not evaluated for elements below the LOQ.

$$RPD = 100 \times \frac{|S - D|}{\text{Avg.}(S,D)}$$

ICP QA/QC Procedures

Measures:

Initial and Continuing calibration verification (ICV and CCV): Performed using standards prepared at two concentrations from a certified check standard (SPEX CertiPrep Group LPC standard 1, Fisher Cat. No. LPC-1-100N). Both solutions are analyzed after calibration but before samples, then alternating every 10 samples thereafter.

Initial and Continuing calibration blank (ICB and CCB): Blank solution analyzed after calibration but before samples and every 10 samples thereafter.

LOQ check standard: Prepared from certified check standard (SPEX CertiPrep Group LPC standard 1, Fisher Cat. No. LPC-1-100N). The LOQ for each element is analyzed at a frequency no greater than every 20 samples.

Linear range verification (LRV): A check standard analyzed for each element concentration that exceed the highest calibration standard by more than 20%. The standard shall be analyzed at any point during the analytical run.

Matrix Spike: A composite sample from samples of similar matrix is spiked with a solution prepared from certified check standard (SPEX CertiPrep Group LPC standard 1, Fisher Cat. No. LPC-1-100N).

Serial Dilution: A composite sample from samples of similar matrix is diluted by a known factor.

QC Limits:

ICV and CCV: ± 10% of the known concentration.

ICB and CCB: Below the MDL.

LOQ check standard: ± 20% of the known concentration.

LRV: ± 10% of the known concentration.

Matrix Spike: ± 25% of the spike concentration.
Serial Dilution: % difference ≤10%. Not evaluated for elements in which the diluted concentration is less than the LOQ.

$$\%\text{Difference} = 100 * \frac{(\text{initial} - (\text{diluted} * \text{DilutionFactor}))}{\text{initial}}$$

The OSU *in vitro* gastrointestinal Extraction

The OSU IVG is a rapid, inexpensive and reliable screening tool for determining the potential bioavailability (i.e., bioaccessible) of soil contaminants including As (Basta et al., 2007; Rodriguez et al., 1999). The OSU IVG method simulates important parameters of the human GI tract under fasting conditions. The amount of contaminant extracted by the OSU IVG is assumed to be available for absorption across the intestinal membrane (i.e., bioaccessible) and incorporation into systemic circulation (Ruby et al., 1999).

Bioaccessible As results:

Sample	Result	Unit	QC Qualifier
DC-2	5.38	mg/kg	J
OC-15/16	5.06	mg/kg	J
OC-22	8.04	mg/kg	
OC-24/25	2.88	mg/kg	J
DC-11	12.0	mg/kg	
OC-2	6.25	mg/kg	

USEPA 3051a As

USEPA 3051a is a microwave-assisted extraction using aqua regia and HNO_3. This method is more aggressive in dissolving the sample matrix than methods using conventional heating with nitric acid (HNO_3), or alternatively, nitric acid and hydrochloric acid (HCl), according to EPA Methods 200.2 and 3050.

This method is intended to provide a rapid multi-element acid extraction or dissolution prior to analysis. Many types of samples will be dissolved by this method. A few refractory sample matrix compounds, such as quartz, silicates, titanium dioxide, alumina, and other oxides may not be dissolved and in some cases may sequester target analyte elements. These bound elements are considered non-mobile in the environment and are excluded from most aqueous transport mechanisms of pollution.

Analytical Results

3051a As results:

Sample	Result	Unit	QC Qualifier
DC-2	12.8	mg/kg	
OC-15/16	17.0	mg/kg	
OC-22	21.4	mg/kg	
OC-24/25	5.00	mg/kg	

DC-11	39.9	mg/kg	
OC-2	11.9	mg/kg	

Percent Bioaccessible As
% Bioaccessibile As = 100*(Bioaccessible As/3051a As)

%Bioaccessible As Results:

Sample	Result	Unit	QC Qualifier
DC-2	42.0	%	J
OC-15/16	29.8	%	J
OC-22	37.6	%	
OC-24/25	57.6	%	J
DC-11	30.1	%	
OC-2	52.5	%	

QC Measures

Laboratory Control Sample Results:

Sample	Method	Result	Unit	Certified Value	% Recovery
Montana 2710	OSU IVG	184	mg/kg	NA	NA
CRM059-050	3051a	160	mg/kg	149	107

Sample Duplicate Results:

Sample Result	Sample Dup Result	Unit	Method	% Difference
5.38	6.36	mg/kg	OSU IVG	17
21.4	20.1	mg/kg	3051a	6

ICP Matrix Spike:

Sample Result	Sample Spike Result	Spike Concentration	Unit	Matrix/Method	% Recover
0.0417	0.791	0.800	mg/L	OSU IVG	94
0.170	1.01	0.800	mg/L	3051a	105

QC Qualifiers
J- Above the method detection limit (MDL) but below the limit of quantitation (LOQ)

Blank (Blk) **11/9/2010, 1:41:28 PM** **Rack 1, Tube 1**

Label	Replicates Intensity (c/s)								
As 188.980	0.556	0.800	1.35	0.748	2.04	2.56	1.71	4.73	1.76
	0.847								

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.000000	mg/L	1.244	72.8	1.71

Standard 1 (Std) **11/9/2010, 1:48:05 PM** **Rack 1, Tube 2**

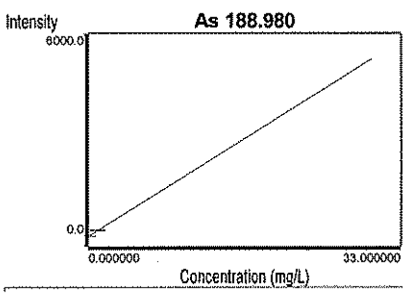
Label	Replicates Intensity (c/s)								
As 188.980	179	177	176	168	178	180	182	191	168
	170								

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	1.00	mg/L	6.930	3.9	177

As 188.980 Calibration (mg/L) **11/9/2010, 1:48:05 PM** **Correlation Coefficient: 1.000000**

Label	Flags	Int. (c/s)	Std Conc.	Calc Conc.	Error	%Error
Blank		1.71	0.000000	0.000000	-	-
Standard 1		177	1.00	1.00	0.000000	0.0

Curve Type: Linear Equation: y = 175.347 x + 1.70953



Blk (Samp) **11/9/2010, 1:54:44 PM** **Rack 1, Tube 3**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)								
As 188.980	1.13u	2.07	2.39	1.98	2.03	3.50	1.82	2.78	3.01
	1.09u								

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.00267u	mg/L	0.00440	164.3	2.18	0.00267 mg/L

Blank (Blk) **11/9/2010, 2:03:18 PM** **Rack 1, Tube 1**

Label	Replicates Intensity (c/s)		
As 188.980	1.8062	4.0225	2.5782

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.000000	mg/L	1.125	40.1	2.8023

Standard 1 (Std) **11/9/2010, 2:07:09 PM** **Rack 1, Tube 2**

Label	Replicates Intensity (c/s)		
As 188.980	4.1494	5.3162	5.6890

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.020000	mg/L	0.803	15.9	5.0515

Standard 2 (Std) **11/9/2010, 2:11:00 PM** **Rack 1, Tube 3**

Label	Replicates Intensity (c/s)		
As 188.980	11.470	10.898	9.4869

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.050000	mg/L	1.021	9.6	10.618

Standard 3 (Std) **11/9/2010, 2:14:51 PM** **Rack 1, Tube 4**

Label	Replicates Intensity (c/s)		
As 188.980	18.828	16.346	19.027

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.10000	mg/L	1.494	8.3	18.067

Standard 4 (Std) **11/9/2010, 2:18:42 PM** **Rack 1, Tube 5**

Label	Replicates Intensity (c/s)		
As 188.980	81.833	86.598	84.198

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.50000	mg/L	2.383	2.8	84.209

Standard 5 (Std) **11/9/2010, 2:22:33 PM** **Rack 1, Tube 6**

Label	Replicates Intensity (c/s)		
As 188.980	172.78	175.63	173.39

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	1.0000	mg/L	1.501	0.9	173.93

Standard 6 (Std) **11/9/2010, 2:26:24 PM** **Rack 1, Tube 7**

Label	Replicates Intensity (c/s)		
As 188.980	849.26	924.19	944.52

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	5.0000	mg/L	50.171	5.5	905.99

Standard 7 (Std) **11/9/2010, 2:30:16 PM** **Rack 1, Tube 8**

Label	Replicates Intensity (c/s)		
As 188.980	1889.1e	1942.5e	1938.7e

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	-----e	mg/L	0.000	-	0.000000

Standard 8 (Std) **11/9/2010, 2:34:09 PM** **Rack 1, Tube 9**

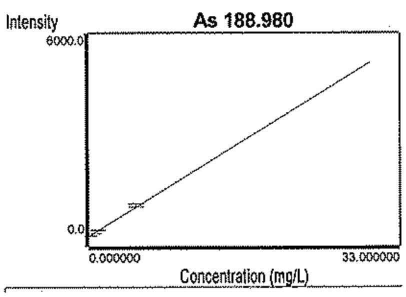
Label	Replicates Intensity (c/s)		
As 188.980	4313.4e	4140.1e	4270.0e

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	-----e	mg/L	0.000	-	0.000000

As 188.980 Calibration (mg/L) **11/9/2010, 2:34:09 PM** **Correlation Coefficient: 0.999926**

Label	Flags	Int. (c/s)	Std Conc.	Calc Conc.	Error	%Error
Blank		2.8023	0.000000	0.005834	-	-
Standard 1		5.0515	0.020000	0.018942	-0.001058	-5.3
Standard 2		10.618	0.050000	0.051385	0.001385	2.8
Standard 3		18.067	0.10000	0.094796	-0.005204	-5.2
Standard 4		84.209	0.50000	0.48026	-0.019738	-3.9
Standard 5		173.93	1.0000	1.0032	0.003159	0.3
Standard 6		905.99	5.0000	5.2695	0.26948	5.4
Standard 7	e	0.000000	-----	-0.010497	-10.010	-100.1
Standard 8	e	0.000000	-----	0.000000	-25.000	-100.0

Curve Type: Linear Equation: y = 171.59 x + 1.80123



Chk 0.04 (Samp) **11/9/2010, 3:03:46 PM** **Rack 1, Tube 10**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	10.001	7.7730	9.2747

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.042048	mg/L	0.006622	15.7	9.0163	0.042048 mg/L

Chk 0.40 (Samp) **11/9/2010, 3:07:37 PM** **Rack 1, Tube 11**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	69.090	67.233	72.957

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.39605	mg/L	0.017019	4.3	69.760	0.39605 mg/L

Chk 4.0 (Samp) **11/9/2010, 3:11:28 PM** **Rack 1, Tube 12**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	653.71	657.91	660.27

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	3.8201	mg/L	0.019351	0.5	657.30	3.8201 mg/L

Blk (Samp) **11/9/2010, 3:17:46 PM** **Rack 1, Tube 13**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	3.6571	1.5878u	3.2224

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.005951u	mg/L	0.006359	106.8	2.8224	0.005951 mg/L

BlkIVG (Samp) **11/9/2010, 3:21:37 PM** **Rack 1, Tube 14**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	1.9264	3.1668	3.8073

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.006793	mg/L	0.005573	82.0	2.9669	0.006793 mg/L

2710IVG (Samp) **11/9/2010, 3:25:27 PM** **Rack 1, Tube 15**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	209.86	212.86	213.17

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	1.2248	mg/L	0.010659	0.9	211.96	1.2248 mg/L

NERLIVG (Samp) **11/9/2010, 3:29:18 PM** **Rack 1, Tube 16**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	1542.8	1530.7	1526.6

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	8.9258	mg/L	0.049242	0.6	1533.4	8.9258 mg/L

DC-2 A (Samp) **11/9/2010, 3:33:10 PM** **Rack 1, Tube 17**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	7.7585	9.1260	6.9878

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.035878	mg/L	0.006311	17.6	7.9574	0.035878 mg/L

DC-2 B (Samp) **11/9/2010, 3:37:03 PM** **Rack 1, Tube 18**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	7.5660	8.9552	10.720

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.042422	mg/L	0.009212	21.7	9.0803	0.042422 mg/L

OC-15/16 (Samp) **11/9/2010, 3:40:54 PM** **Rack 1, Tube 19**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	6.7282	9.4182	6.6084

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.033707	mg/L	0.009259	27.5	7.5849	0.033707 mg/L

OC-22 (Samp) **11/9/2010, 3:44:46 PM** **Rack 1, Tube 20**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	10.986	12.040	9.9544

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.053572	mg/L	0.006077	11.3	10.994	0.053572 mg/L

OC-24/25 (Samp) **11/9/2010, 3:48:37 PM** **Rack 1, Tube 21**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	5.6545	4.7257	4.8940

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.019175	mg/L	0.002884	15.0	5.0914	0.019175 mg/L

DC-11 (Samp) **11/9/2010, 3:52:28 PM** **Rack 1, Tube 22**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	15.718	14.265	16.648

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.080090	mg/L	0.006999	8.7	15.544	0.080090 mg/L

OC-2 (Samp) **11/9/2010, 3:56:19 PM** **Rack 1, Tube 23**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	9.3020	9.1470	8.3961

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.041652	mg/L	0.002824	6.8	8.9484	0.041652 mg/L

Blk (Samp) **11/9/2010, 4:00:11 PM** **Rack 1, Tube 24**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	2.5359	4.2113	4.1678

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.010706	mg/L	0.005565	52.0	3.6383	0.010706 mg/L

chk 0.4 (Samp) **11/9/2010, 4:04:01 PM** **Rack 1, Tube 25**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	72.898	75.669	75.320

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.42443	mg/L	0.008795	2.1	74.629	0.42443 mg/L

chk 0.04 (Samp) **11/9/2010, 4:07:54 PM** **Rack 1, Tube 26**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	9.5195	9.3742	11.137

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.047841	mg/L	0.005703	11.9	10.010	0.047841 mg/L

Comp (Samp) **11/9/2010, 4:33:03 PM** **Rack 1, Tube 27**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	9.9852	9.0432	7.8350

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.041688	mg/L	0.006281	15.1	8.9545	0.041688 mg/L

Comp spk (Samp) **11/9/2010, 4:36:54 PM** **Rack 1, Tube 28**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	138.40	137.86	136.12

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.79058	mg/L	0.006938	0.9	137.46	0.79058 mg/L

Comp x5 (Samp) **11/9/2010, 4:40:46 PM** **Rack 1, Tube 29**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	4.0733	4.4118	4.1701

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.014087	mg/L	0.001016	7.2	4.2184	0.014087 mg/L

Blank (Blk) **11/10/2010, 2:27:38 PM** **Rack 1, Tube 1**

Label	Replicates Intensity (c/s)								
As 188.980	2.6074	2.7720	1.0795	1.5744	2.8316	1.9621	4.4657	2.8339	2.8909
	2.8402								

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.000000	mg/L	0.915	35.4	2.5858

Standard 1 (Std) **11/10/2010, 2:34:24 PM** **Rack 1, Tube 2**

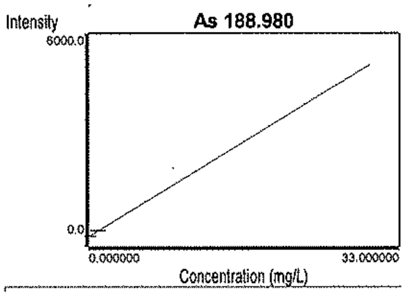
Label	Replicates Intensity (c/s)								
As 188.980	170.86	169.18	171.82	170.68	170.61	175.36	174.42	175.91	172.39
	171.59								

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	1.0000	mg/L	2.234	1.3	172.28

As 188.980 Calibration (mg/L) **11/10/2010, 2:41:08 PM** **Correlation Coefficient: 1.000000**

Label	Flags	Int. (c/s)	Std Conc.	Calc Conc.	Error	%Error
Blank		2.5858	0.000000	0.000000	-	-
Standard 1		172.28	1.0000	1.0000	0.000000	0.0

Curve Type: Linear Equation: y = 169.696 x + 2.58577



Blk (Samp) **11/10/2010, 2:47:53 PM** **Rack 1, Tube 4**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)								
As 188.980	3.6768	2.1721u	2.2424u	1.4123u	1.2985u	4.2722	1.3609u	3.0058	0.50563u
	0.71561u								

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	-0.003062u	mg/L	0.007391	241.4	2.0662	-0.003062 mg/L

Blank (Blk) **11/10/2010, 2:52:51 PM** **Rack 1, Tube 1**

Label	Replicates Intensity (c/s)		
As 188.980	5.4443	3.3705	2.0829

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.000000	mg/L	1.696	46.7	3.6326

Standard 1 (Std) **11/10/2010, 2:56:43 PM** **Rack 1, Tube 2**

Label	Replicates Intensity (c/s)		
As 188.980	4.6300e	6.4095e	2.5886e

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	-----e	mg/L	0.000	-	0.000000

Standard 2 (Std) **11/10/2010, 3:00:36 PM** **Rack 1, Tube 3**

Label	Replicates Intensity (c/s)		
As 188.980	11.056	10.479	11.486

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.050000	mg/L	0.505	4.6	11.007

Standard 3 (Std) **11/10/2010, 3:04:29 PM** **Rack 1, Tube 4**

Label	Replicates Intensity (c/s)		
As 188.980	20.304	20.788	18.606

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.10000	mg/L	1.146	5.8	19.900

Standard 4 (Std) **11/10/2010, 3:08:22 PM** **Rack 1, Tube 5**

Label	Replicates Intensity (c/s)		
As 188.980	82.667	83.845	82.853

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	0.50000	mg/L	0.634	0.8	83.122

Standard 5 (Std) **11/10/2010, 3:12:15 PM** **Rack 1, Tube 6**

Label	Replicates Intensity (c/s)		
As 188.980	175.81	176.13	177.48

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	1.0000	mg/L	0.883	0.5	176.47

Standard 6 (Std) **11/10/2010, 3:16:09 PM** **Rack 1, Tube 7**

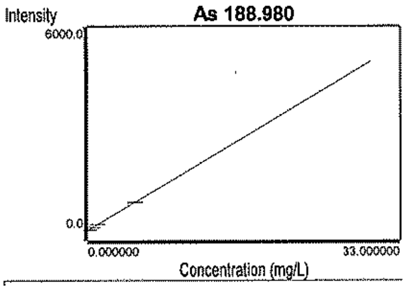
Label	Replicates Intensity (c/s)		
As 188.980	819.22	841.83	839.55

Label	Sol'n Conc.	Units	SD(Int)	%RSD(Int)	Int. (c/s)
As 188.980	5.0000	mg/L	12.450	1.5	833.53

As 188.980 Calibration (mg/L) **11/10/2010, 5:32:25 PM** **Correlation Coefficient: 0.999943**

Label	Flags	Int. (c/s)	Std Conc.	Calc Conc.	Error	%Error
Blank		3.6326	0.000000	-0.001158	-	-
Standard 1	e	0.000000	-----	-0.023024	-0.043024	-215.1
Standard 2		11.007	0.050000	0.043236	-0.006764	-13.5
Standard 3		19.900	0.10000	0.096764	-0.003236	-3.2
Standard 4		83.122	0.50000	0.47734	-0.022661	-4.5
Standard 5		176.47	1.0000	1.0393	0.039275	3.9
Standard 6		833.53	5.0000	4.9945	-0.005456	-0.1

Curve Type: Linear Equation: $y = 166.123 x + 3.82485$



Chk 0.04 (Samp) **11/10/2010, 3:38:03 PM** **Rack 1, Tube 14**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	10.793	9.5452	9.4581

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.036764	mg/L	0.004496	12.2	9.9322	0.036764 mg/L

Chk 0.40 (Samp) **11/10/2010, 3:41:57 PM** **Rack 1, Tube 15**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	73.131	72.696	71.481

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.41302	mg/L	0.005147	1.2	72.436	0.41302 mg/L

Chk 4.0 (Samp) **11/10/2010, 3:45:50 PM** **Rack 1, Tube 16**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	713.40	711.39	717.52

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	4.2756	mg/L	0.018798	0.4	714.10	4.2756 mg/L

Blk (Samp) **11/10/2010, 3:49:44 PM** **Rack 1, Tube 17**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	2.7697u	2.6615u	3.1630u

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	-0.005780u	mg/L	0.001589	27.5	2.8647	-0.005780 mg/L

CRM059-050-104 (Samp) **11/10/2010, 3:54:37 PM** **Rack 1, Tube 18**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	271.72	269.50	268.01

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	1.6007	mg/L	0.011218	0.7	269.74	1.6007 mg/L

Blk-104 (Samp) **11/10/2010, 4:17:45 PM** **Rack 1, Tube 19**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	2.1848u	3.0508u	1.1706u

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	-0.010170u	mg/L	0.005665	55.7	2.1354	-0.010170 mg/L

ICSA-104 (Samp) **11/10/2010, 4:21:40 PM** **Rack 1, Tube 20**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	5.0621	4.7153	5.5415

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.007714	mg/L	0.002497	32.4	5.1063	0.007714 mg/L

ICSB-104 (Samp) **11/10/2010, 4:25:33 PM** **Rack 1, Tube 21**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	20.521	19.495	17.751

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.092889	mg/L	0.008428	9.1	19.256	0.092889 mg/L

OC-22A (Samp) **11/10/2010, 4:29:25 PM** **Rack 1, Tube 22**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	39.973	38.166	39.842

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.21371	mg/L	0.006062	2.8	39.327	0.21371 mg/L

OC-22B (Samp) **11/10/2010, 4:33:17 PM** **Rack 1, Tube 23**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	35.525	39.089	36.838

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.20061	mg/L	0.010849	5.4	37.151	0.20061 mg/L

OC-15/16 (Samp) **11/10/2010, 4:37:11 PM** **Rack 1, Tube 24**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	32.413	32.002	31.978

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.17039	mg/L	0.001471	0.9	32.131	0.17039 mg/L

OC-24/25 (Samp) **11/10/2010, 4:41:04 PM** **Rack 1, Tube 25**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	13.709	11.083	11.624

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.050046	mg/L	0.008347	16.7	12.139	0.050046 mg/L

DC-11 (Samp) **11/10/2010, 4:44:58 PM** **Rack 1, Tube 26**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	67.903	71.568	70.761

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.39882	mg/L	0.011592	2.9	70.078	0.39882 mg/L

OC-2 (Samp) **11/10/2010, 4:48:52 PM** **Rack 1, Tube 27**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	23.365	24.295	23.036

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.11883	mg/L	0.003928	3.3	23.565	0.11883 mg/L

DC-2 (Samp) **11/10/2010, 4:52:45 PM** **Rack 1, Tube 28**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	24.129	25.146	26.137

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.12830	mg/L	0.006044	4.7	25.138	0.12830 mg/L

Blk (Samp) **11/10/2010, 4:56:37 PM** **Rack 1, Tube 29**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	1.5438u	1.8608u	2.3914u

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	-0.011394u	mg/L	0.002578	22.6	1.9320	-0.011394 mg/L

Chk 0.4 (Samp) **11/10/2010, 5:00:51 PM** **Rack 1, Tube 30**

Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	72.727	73.777	71.231

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.41387	mg/L	0.007700	1.9	72.578	0.41387 mg/L

BL 0.04 A (Samp) **11/10/2010, 5:04:44 PM** **Rack 1, Tube 31**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	79.512	78.704	79.042

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.45305	mg/L	0.002443	0.5	79.086	0.45305 mg/L

BL 0.04 B (Samp) **11/10/2010, 5:08:36 PM** **Rack 1, Tube 32**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	84.489	84.665	84.515

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.48598	mg/L	0.000573	0.1	84.556	0.48598 mg/L

BL 0.4 (Samp) **11/10/2010, 5:12:29 PM** **Rack 1, Tube 33**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	79.582	81.753	79.882

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.46099	mg/L	0.007080	1.5	80.406	0.46099 mg/L

BL 1.8 (Samp) **11/10/2010, 5:16:22 PM** **Rack 1, Tube 34**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	96.993	94.601	93.824

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.54968	mg/L	0.009942	1.8	95.140	0.54968 mg/L

Hcomp (Samp) **11/10/2010, 5:20:16 PM** **Rack 1, Tube 35**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	31.538	32.657	31.802

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.16960	mg/L	0.003519	2.1	31.999	0.16960 mg/L

Hcomp spk (Samp) **11/10/2010, 5:24:10 PM** **Rack 1, Tube 36**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	172.10	172.21	170.50

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	1.0100	mg/L	0.005752	0.6	171.60	1.0100 mg/L

Hcomp x5 (Samp) **11/10/2010, 5:28:04 PM** **Rack 1, Tube 37**
Weight: 1 Volume: 1 Dilution: 1

Label	Replicates Intensity (c/s)		
As 188.980	8.9125	7.6587	6.5414

Label	Sol'n Conc.	Units	SD	%RSD	Int. (c/s)	Calc Conc.
As 188.980	0.023352	mg/L	0.007141	30.6	7.7042	0.023352 mg/L

L

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638
Client No:
SDG No:

Date Shipped: 10/19/2010
Carrier Name: FedEx
Airbill: 7963 5822 1551
Shipped to: OSU - School of Environmental & Natural Resources
2021 Coffer Road
210 Kottman Hall
Columbus OH 43210

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/18/10 1600	[signature]	10/22/10 1200
2				
3				
4				

For Lab Use Only

Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME		FOR LAB USE ONLY Sample Condition On Receipt
DC-11	Sediment/ Matt Beer	L/C	AS Bioavai (21)	(Ice Only) (1)	DC-11	S: 10/18/2010	10:40	
OC-2	Sediment/ Mike Browning	L/G	AS Bioavai (21)	(Ice Only) (1)	OC-2	S: 10/6/2010	11:10	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 110174-110175
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact? ___ Shipment Iced? ___

AS Bioavai = As Bioavailability

TR Number: 5-350091276-101910-0006

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 15000 Conference Center Dr., Chantilly, VA. 20151-3819 Phone 703/818-4200; Fax 703/818-4602

F2V5.1.047

USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case 40638 L
Client No:
SDG No:

Date Shipped: 10/21/2010
Carrier Name: FedEx
Airbill: 7963 6329 0219
Shipped to: OSU - School of Environmental & Natural Resources, 2021 Coffer Road, 210 Kottman Hall, Columbus OH 43210

Chain of Custody Record

Sampler Signature: [signature] for Matt Beer

	Relinquished By	(Date / Time)	Received By	(Date / Time)
1	[signature]	10/21/10 1600	[signature]	10/22/10 12:00
2				
3				
4				

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	FOR LAB USE ONLY Sample Condition On Receipt
DC-2	Sediment/ Matt Beer	L/C	AS Bioavai (21)	(Ice Only) (1)	DC-2	S: 10/19/2010 17:10	
OC-15/16	Sediment/ Matt Beer	L/C	AS Bioavai (21)	(Ice Only) (1)	OC-15/16	S: 10/19/2010 14:50	
OC-22	Sediment/ Matt Beer	L/C	AS Bioavai (21)	(Ice Only) (1)	OC-22	S: 10/19/2010 10:35	
OC-24/25	Sediment/ Matt Beer	L/C	AS Bioavai (21)	(Ice Only) (1)	OC-24/25	S: 10/19/2010 9:25	

Shipment for Case Complete? N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s): [signature]	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number: 110195-6

Analysis Key: AS Bioavai = As Bioavailability
Concentration: L = Low, M = Low/Medium, H = High
Type/Designate: Composite = C, Grab = G
Custody Seal Intact? ___ Shipment Iced? ___

TR Number: 5-350091276-102110-0004

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 15000 Conference Center Dr., Chantilly, VA. 20151-3819 Phone 703/818-4200; Fax 703/818-4602

LABORATORY COPY

Appendix J

USFWS Fish Tissue Residue Work Plan and DRAFT ENTRIX Memo on Sample Selection for Chemical Analyses

ENTRIX, Inc.
1000 Hart Road, Suite 130
Barrington, IL 60010
(847) 277-2850 | Fax (847) 381-6679
www.entrix.com

Date: October 4, 2010

To: Duck and Otter Creek Industrial Partners

From: Jody Kubitz, Ph.D. and John Matousek, MS, ENTRIX, Inc.

Re: **DRAFT Recommendations for Chemical Analyses of Fish Tissues from Duck and Otter Creek**

On August 24 and 25, 2010 fish samples were collected from Duck and Otter Creeks in Northwest Ohio by the U.S. Fish and Wildlife Service (USFWS). Boat-based electroshocking equipment was used to collect fish from the lacustuarine sections of Duck and Otter Creeks and Hecklinger Pond. Backpack electroshocking equipment and seines were used to collect fish from upstream areas. The USFWS fish collection team was composed of Dave DeVault (project lead), Kevin Tloczynski (asst. project lead), Jeromy Applegate, Jennifer Finfera, and Dave Henry. Sampling support was also provided by John Matousek (ENTRIX) on behalf of the Duck and Otter Creek Industrial Partners (Partners). Fish were collected from three stream reaches of Duck Creek and three reaches of Otter Creek. The coordinates for the stream reaches that were sampled are presented in Table 1.

Table 1. Coordinates for the stream reaches of Duck and Otter Creeks where fish were sampled in August 2010.

Sample reach	Start coordinates	Stop coordinates
Duck Creek A	N 41 41.342, W 083 27.941	N41 41.290, W 083 28.021
Duck Creek D	-	-
Duck Creek E (Hecklinger Pond)	N 41 39.113, W 083 29.833 (launch/landing point)	
Otter Creek A	N 41 41.937, W 083 27.203	N41 41.044, W 083 27.486
Otter Creek C	N 41 39.778, W 083 28.372	N 41 39.663, W 083 28.438
Otter Creek D	N 41 37.748, W 083 29.910	N 41 37.664, W 083 29.924

Twenty-three species of fish were captured in Otter Creek and thirteen species of fish were captured in Duck Creek on August 24 and 25, 2010. Most of the species that were captured were native to the streams of Northwestern Ohio; however, six introduced species were observed (Table 2). Twenty-nine fish tissue samples were collected from Duck Creek; eleven were individual fish and eighteen were composites of several small individuals. Forty-nine fish tissue samples were collected from Otter Creek; seventeen were individual fish and thirty-two were composites. A total of seventy-eight fish tissue samples are available for chemical analysis from Duck and Otter Creek.

ENTRIX

Down to Earth. Down to Business.™

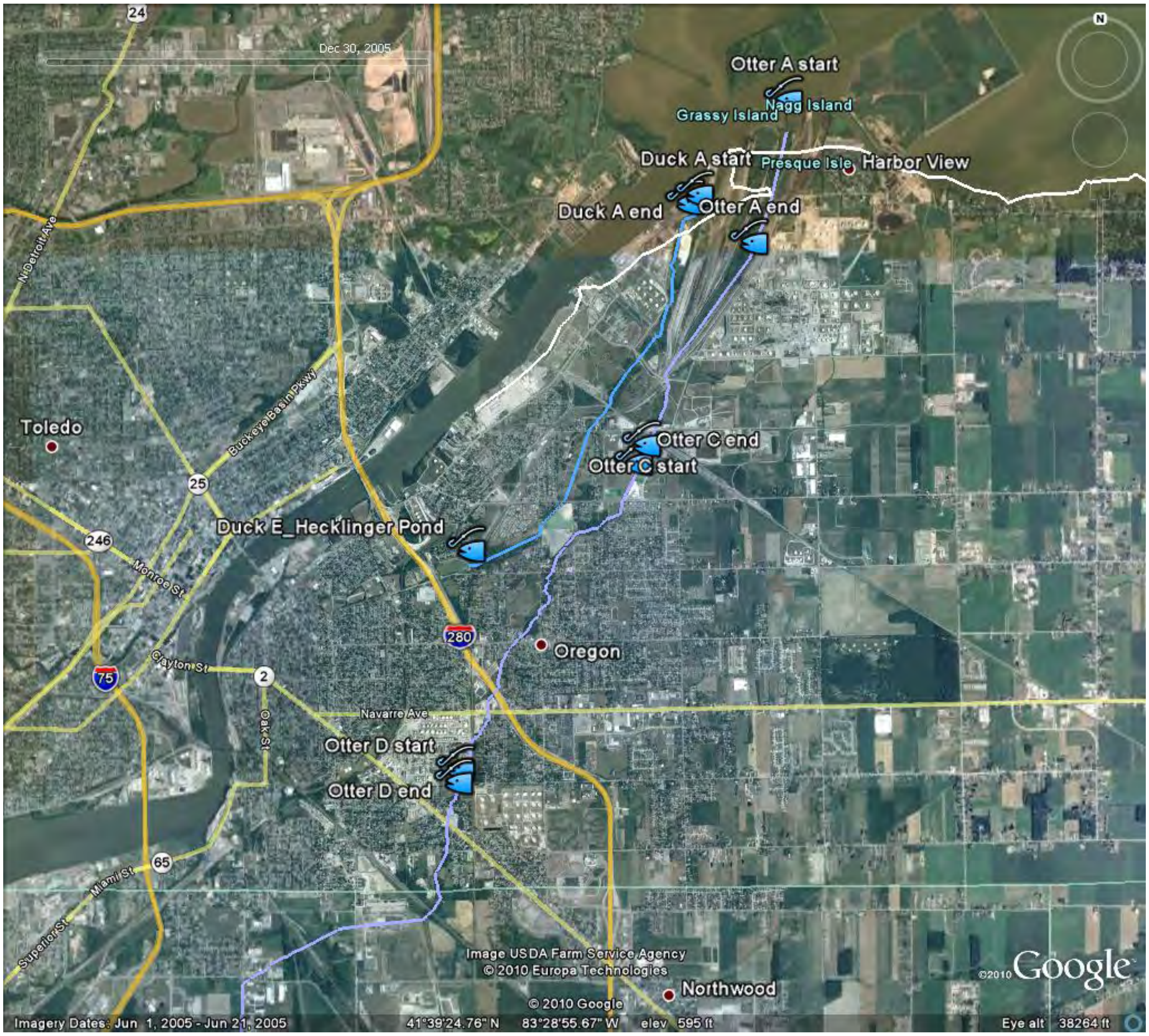


Figure 1. **Aerial photograph of Duck and Otter Creeks with USFWS sample location information. Duck Creek is represented by the blue line; Otter Creek is represented by the lavender line. The white line is the approximate shoreline of the Maumee River and Bay in 1900.**

Table 2. **Fish species observed (O) and sampled (S) in Duck and Otter Creeks in August 2010.**

Fish Species	**Duck Creek**	**Otter Creek**
Largemouth bass	S (n=13)	S (n=6)
Yellow perch	S (n=2)	S (n=5)
Northern pike	-	O
Freshwater drum	S (n=2)	S (n=6)
Emerald shiner	-	O
Brook silverside	O	O
Bluntnose minnow	O	O
Log perch	S (n=1)	S (n=1)
Creek chub	S (n=1)	S (n=7)
Bluegill	S (n=7)	S (n=2)
Pumpkinseed	S (n=3)	S (n=3)
Green sunfish	O	S (n=1)
Bluegill x green sunfish hybrid	-	S (n=1)
Longnose gar	-	O
Channel Catfish	-	S (n=1)
Yellow bullhead	-	S (n=2)
White sucker	O	S (n=4)
Spotted sucker	-	S (n=1)
White perch*	-	O
Golden shiner*	-	S (n=5)
Gizzard shad*	O	O
Common carp*	-	S (n=3)
Goldfish*	-	O
Round goby*	O	-

* These fish species are not believed to be native to Duck and Otter Creek.

Unique sample identification codes were created by USFWS staff in the field using the following convention:

- The first two letters indicate the stream where fish were collected; OC for Otter Creek or DC for Duck Creek;
- The third letter indicates the stream zone (i.e. zones A through Zone E);
- The fourth fifth and sixth letter when present indicate the fish species (e.g. CC = channel catfish, CCH = creek chub, PS = pumpkinseed);
- The number following the species code indicates the sample number for that combination of location and species (i.e. CC3, would be the third channel catfish sample collected from that location);

- The final letter that follows the dash indicates whether the sample was one individual fish (I) or a composite of several individual fish (C); and, in some cases a number was appended after the "C" indicating how many individuals were included in that composite sample.

Total lengths for each fish were recorded; for composite samples the range of lengths of sizes of the individuals that were included was recorded. The total weight of each sample was also recorded; for composites, the combined weight of all fish was recorded. All fish tissue samples where wrapped in aluminum foil, labeled with a loose paper scrap in bag, then and placed in a sealed plastic bag. Chain of custody forms were completed in the field. Bagged fish samples were placed in a cooler with loose “wet” ice (frozen H_2O) for shipment to the USFWS facility.

The *Fish Tissue Collection Work Plan for Duck and Otter Creeks* (USFWS 2010a) was published as a part of the NRDA that will be conducted by the Trustee (USFWS 2010b). The stated purposes of the USFWS fish tissue collection work plan are:

> “*1. Establish exposure of various fish species present in Duck and Otter Creeks to a range of hazardous substances released, or potentially released, by PRPs.*
>
> *2. Begin establishing the pathway by which hazardous substances have reached trust resources.*
>
> *3. Evaluate current fish tissue concentrations of select hazardous substances relative to various regulatory endpoints. Specifically, to determine whether concentrations of a hazardous substance exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342, in edible portions of organisms [43 CFR § 11.62(f)(1)(ii)] or exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of such organism [43 CFR § 11.62(f)(1)(iii)].*”

ENTRIX has identified three subsets of samples that can be used to meet the stated USFWS objectives, and to meet the objectives of the Great Lakes Legacy Act (GLLA) data gap investigation.

The first subset of data includes eighteen samples of fish that are either 1) within the general size range that represents common forage sizes for wildlife (< 6 inches or 152 mm) or 2) represent fish species that have a relatively close association with sediments (yellow bullhead, white sucker). These 18 fish are identified in Table 3 for chemical analysis. These relatively small fish tend to have small home ranges and they tend to have greater site tenacity than larger species that tend to migrate. Consequently, the small fish in Table 3 are suitable for addressing the site-specific relationships between constituents in sediments and fish tissues. The chemical analysis of forage-sized fish can also be used to assess the potential exposure of wildlife to chemical constituents in prey-sized fish, which is consistent with the USFWS objective 2.

Table 3. Recommended whole fish samples to submit for chemical analyses. These samples represent potential ecological and wildlife exposure and can be used to evaluate site-specific bioaccumulation factors.

Species	Duck Creek fish tissue samples	Otter Creek fish tissue samples
Yellow Perch	DCA YP1-C2; DCE YP1-I	OCA YP5-C
Log perch	DCA LP1-C93*	OCA LP1-C*
Creek chub	DCD-CCH1-C*	OCC CCH2-C8*; OCD CCH4-C14
White sucker	-	OCA WS3-C8; OCD WS1-C9
Yellow bullhead	-	OCA-YB1-I
Bluegill	DCA BG1-C4; DCE BLG1-C	OCA BG1-C; OCD BG1-C6
Pumpkinseed	DCA PS1-C2; DCE PS2-C	OCA PS1-C

* These samples are most suitable for fulfilling the objectives of the GLLA data gap investigation.

The second subset of data includes the four fish samples that were identified in the GLLA data gap investigation Quality Assurance Project Plan (Weston 2010). The four proposed samples can be used to evaluate site-specific accumulation of chemical constituents present in the sediments of Duck and Otter Creeks by fish. The four samples that best match the proposed GLLA data gap investigation work plan are identified with asterisks in Table 4. Two are samples of log perch from the "A" reaches of Duck and Otter Creeks, respectively. The other two samples proposed for the GLLA data gap investigation are creek chubs from the upstream reaches of the streams. By selecting the same species for each stream, these samples will minimize interspecies variability in constituent bioaccumulation. ENTRIX recommends that the Partners request split samples from these four samples from the USFWS and conduct the chemical analyses that are proposed in the *Quality Assurance Project Plan: Duck and Otter Creeks 2010 Data Gaps Investigation, Wood and Lucas Counties, Ohio* (Weston 2010). The list of GLLA analytes is included in Table 5.

Table 4. **Recommended whole fish sample splits to submit for the GLLA suite of chemical analyses. These samples represent potential ecological and wildlife exposure and can be used to evaluate site-specific bioaccumulation factors.**

Species	Duck Creek fish tissue samples	Otter Creek fish tissue samples
Log perch	DCA LP1-C93	OCA LP1-C
Creek chub	DCD-CCH1-C	OCC CCH2-C8

Table 5. **Biota tissue sample analysis rationale; excerpted from the GLLA data gap investigation (Weston 2010).**

Analysis	Method	Rationale
Metals	ILM05.4	Some metals in sediments can be accumulated by biota Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
PAH_{34}	1734.2	PAHs are organic molecules that can be accumulated and metabolized by aquatic life. Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
Aroclors	SOM01.2	PCBs are persistent organic compounds that can biomagnify in aquatic ecosystems. Tissue data can be interpreted based on residue-effects information from the literature to estimate the likelihood of adverse effects on fish and invertebrates. In addition, tissue data could support future evaluations of wildlife and potential human exposures.
Lipid content	Gravimetric	Organic molecules tend to partition into, and can be transferred through the food web with lipids. Lipid content can also be useful for estimating accumulation factors for other species or stream areas.

The third subset of data includes sixteen fish samples that are relevant to USFWS objective 3 regarding constituent concentrations in the consumable tissues of fish. Eight fish from Duck Creek and eight fish from Otter Creek are listed in Table 6. Chemistry data from these samples could be used to refine analyses of human health risks, evaluate whether fish consumption advisories are warranted, and/or evaluate whether the uptake of constituents is greater in large fish than in small fish. The large fish that were collected from the lacustuarine sections of Duck and Otter Creek also represent individuals that may migrate and their tissue concentrations may represent an integrated exposure to the streams where they were captured plus portions of the Maumee River and Bay. Given the potential migratory behavior of these large fish in Table 6, they are not as well-suited for evaluating the site-specific relationships between constituents in sediments and fish tissues as the small fish in Table 4. This subset also can be used to address the exposure of fish to chemical constituents that have been accumulated from the aquatic environment, which is consistent with the USFWS objective 1.

Table 6. Recommended fish samples to submit as fillet portions for chemical analyses. These samples represent potential human health exposure pathways.

Species	Duck Creek fish tissue samples	Otter Creek fish tissue samples
Yellow Perch	-	OCA YP1-I; OCA YP2-I
Largemouth bass	DCE LMB3-I[a]; DCE LMB4-I[a]; DCE LMB5-I[a]; DCA LMB1-I[b]; DCA LMB2-I[b]; DCA LMB3-I[b]	OCA LMB1-I[b]
Channel catfish	-	OCA CC1-I
Freshwater drum	DCA FD1-I; DCA FD2-I	OCA FD1-I; OCA FD6-I
Common carp	-	OCA CRP1-I; OCA CRP2-I

a The Partners do not have a history of potential discharges to Hecklinger Pond (Duck Creek E), and, therefore views these fish samples as being unrelated to their component of the NRDA case. Consequently, the GLLA list of analytes (Table 5) is recommended for these samples instead of the UFWS (2010a) list of analytes.

b these fish are smaller than the minimum legal size of 14 inches (356 mm) but are the largest individuals of this popular sport fish species available for edible tissue analysis from the lower reaches of the streams.

References

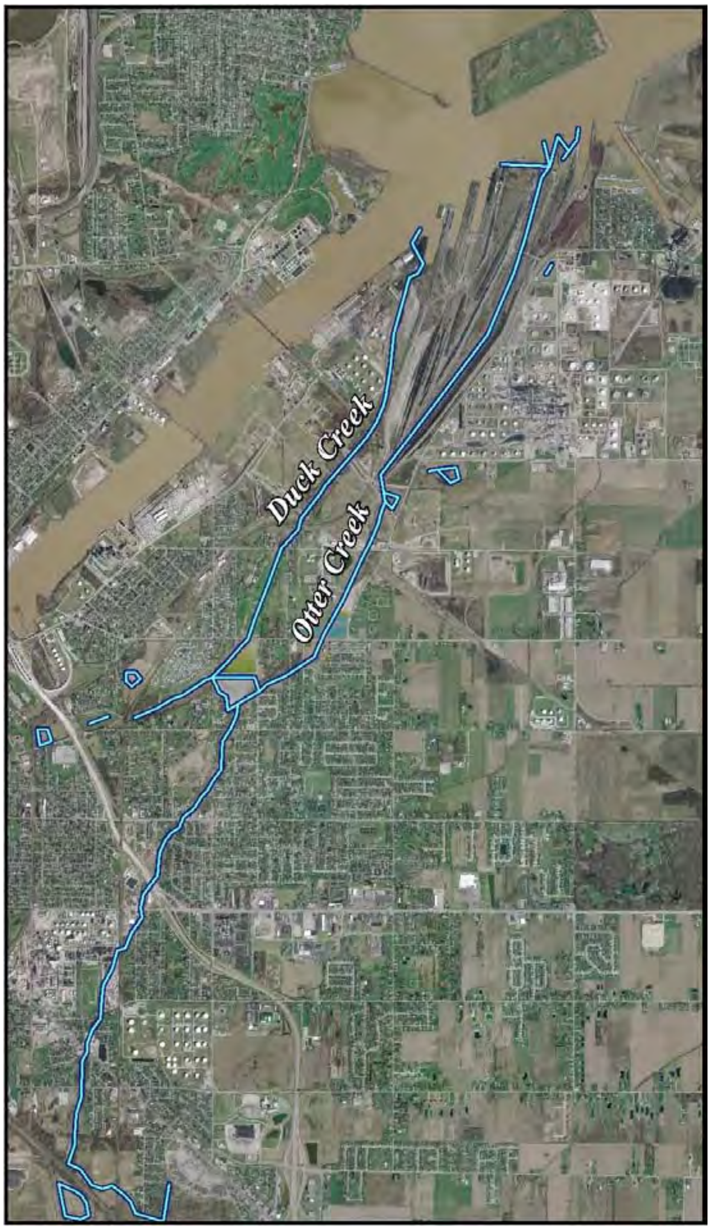
USFWS. 2010a. Duck and Otter Creek, Natural Resource Damage Assessment, Fish Tissue Residue Work Plan. Prepared by U.S. Fish and Wildlife Service, Columbus Ohio Field Office, 4625 Morse Road, Suite 104, Columbus, Ohio July 16, 2010. 5 pp.

USFWS 2010b. Duck and Otter Creek, Natural Resource Damage Assessment Plan. Prepared by U.S. Fish and Wildlife Service, Columbus Ohio Field Office, 4625 Morse Road, Suite 104, Columbus, Ohio August 6, 2010. 40 pp.

Weston 2010. Quality Assurance Project Plan: Duck and Otter Creeks 2010 Data Gaps Investigation, Wood and Lucas Counties, Ohio. Revision 0. prepared by Weston Solutions of Michigan, Inc. in preparation.

Duck & Otter Creeks

Natural Resource Damage Assessment Fish Tissue Residue Work Plan



Prepared by:

U.S. Fish and Wildlife Service
Columbus Ohio Field Office
4625 Morse Road, Suite 104
Columbus, Ohio 43230
614-416-8993
612-670-5530

16 July 2010

Fish Tissue Collection Work Plan for Duck and Otter Creeks

The United States Department of the Interior (DOI) represented by the U.S. Fish and Wildlife Service (FWS) (the Trustee) is conducting a natural resource damage assessment (NRDA) to address injuries to natural resources resulting from the release of hazardous substances from several Potentially Responsible Parties (PRPs) to Duck and Otter Creeks in Toledo, Ohio ("Duck and Otter Creeks Assessment Area" or the "Assessment Area"). The Assessment Area as defined in the Duck & Otter Creeks Natural Resource Damage Assessment Plan includes Duck Creek from its upstream terminus downstream four miles to its confluence with the Maumee River, Otter Creek from its upstream terminus seven miles downstream to its confluence with the Maumee Bay, and the entirety of Driftmeyer Ditch and the Duck and Otter Creek watersheds.

Decades of refining and manufacturing activity and improper waste disposal practices have resulted in the release of hazardous substances to both Duck and Otter Creeks and their watersheds, and potentially Driftmeyer Ditch. Hazardous substances have migrated to Duck and Otter Creeks from refineries and other industrial complexes along their banks, as well as through numerous spills and other releases from these facilities. Hazardous substances have potentially injured surface waters, sediments, fish and wildlife in the Duck and Otter Creeks Assessment Area.

The Fish Tissue Collection Work Plan for Duck and Otter Creeks (the "Work Plan" or "Study") is a part of the NRDA that will be conducted by the Trustee [1]. This Work Plan describes fish collection and analysis to be conducted by the FWS in August of 2010. The purposes of this Study are:

1. Establish exposure of various fish species present in Duck and Otter Creeks to a range of hazardous substances released, or potentially released, by PRPs.
2. Begin establishing the pathway by which hazardous substances have reached trust resources.
3. Evaluate current fish tissue concentrations of select hazardous substances relative to various regulatory endpoints. Specifically, to determine whether concentrations of a hazardous substance exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342, in edible portions of organisms [43 CFR § 11.62(f)(1)(ii)] or exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of such organism [43 CFR § 11.62(f)(1)(iii)].

The Screening and Baseline Ecological Risk Assessment prepared for Partners for Clean Streams (Tetra Tech EM, 2008) separated Duck and Otter Creeks each into five exposure areas (Duck Creek exposure areas A through E, and Otter Creek exposure areas A through E, collectively referred herein as "Exposure Areas"). For consistency with previous work at the Duck and Otter Creeks Assessment Area, the FWS will attempt to collect and analyze fish within each of these respective Exposure Areas. However, the Trustee recognizes that, based on collection success, it may be necessary to combine samples from one or more Exposure Areas for data analysis.

[1] The Trustee is preparing a comprehensive Natural Resource Damage Assessment Plan (the "Assessment Plan") for the Duck and Otter Creeks Site. The Assessment Plan will be noticed for public comment for a period of thirty (30) days.

A review of available data for the Assessment Area confirms that there are few historical datasets from Duck and Otter Creeks that provide either fish tissue hazardous substance concentrations or fish species community composition and abundance. It is, therefore, not possible to determine what species and numbers will be collected for analysis. However, both streams are Lake Erie tributaries and could be expected to contain fish species assemblages similar to other Lake Erie tributaries. This could include yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), pumpkinseed (*Lepomis gibbosus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), goldfish (*Carassius auratus*), emerald shiner (*Notropis atherinoides*), gizzard shad (*Dorosoma cepedianum*), carp (*Cyprinus carpio*), brown bullhead (*Ictalurus nebulosus*), yellow bullhead (*Ameirus natalis*), alewife (*Alosa pseudoharangus*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), rainbow smelt (*Osmerus mordax*), Johnny darter (*Etheostoma nigrum*), walleye (*Stizostedion vitreum*), rainbow trout (*Oncorhynchus mykiss*), spottail shiners (*Notropis hudsonius*), stone roller (*Campostoma anomalum*), blunt nose minnow (*Pimephales notatus*), creek chub (*Semotilus atromaculatus*), log perch (*Percina caprodes*), freshwater drum (*Aplodinotus grunniens*), lake sturgeon (*Acipenser fulvescens*), bowfin (*Amia calva*), and white suckers (*Catostomus commersoni).*

Within each Exposure Area, the Trustee will collect all available fish species using boat and/or backpack electro-shocking devices. If necessary, trap nets may also be deployed. The majority of fish will be analyzed as whole body samples. Selected samples of large bass (large and or small mouth) and common carp may be analyzed as skin on fillets for comparison to regulatory endpoints. The upstream and downstream ends of each zone will be recorded using a geographical positioning system.

Most fish will be identified to species, while some, such as minnows or hybrids may be identified to genus. All will be measured for length and weight, individually wrapped in aluminum foil and placed in Ziplock bags. Each fish sample will be labeled with a distinct sample number and stored on ice. Samples will be shipped overnight to the FWS, Columbus, Ohio Field Office the day they are collected. Upon arrival at the Field Office, the samples will be frozen and kept frozen until arrival at the analytical laboratory.

At the analytical laboratory, fish will be homogenized and analyzed for polychlorinated biphenyl congeners, chlorinated pesticides, heavy metals, polycyclic aromatic hydrocarbons and metabolites, and percent lipids (Table 1). Larger fish will be analyzed as individual fish, with small fishes being composited as necessary to achieve the biomass required by the analytical laboratory.

Table 1. Analytical Parameter List

Organochlorines including quantification of the following compounds:			
pp'-DDE	alpha BHC	gamma chlordane	
pp'-DDD	beta BHC	cis-nonachlor	
pp'-DDT	gamma BHC	trans-nonachlor	
op'-DDE	dieldrin	endrin	
op'-DDD	heptachlor epoxide	mirex	
op'-DDT	oxychlordane	toxaphene	
HCB	alpha chlordane	PCB – 209 congeners	
Aliphatic hydrocarbons including quantification of the following compounds:			
n-decane	n-undecane	n-dodecane	n-tridecane
n-tetradecane	n-pentadecane	n-hexadecane	n-heptadecane
n-octadecane	n-nonadecane	n-eicosane	n-heneicosane
n-docosane	n-tricosane	n-tetracosane	n-pentacosane
n-hexacosane	n-heptacosane	n-octacosane	n-nonacosane
n-triacontane	n-hentriacontane	n-dotriacontane	n-tritriacontane
n-tetratriacontane	pristine	phytane	
Aromatic hydrocarbons including quantification of the following compounds:			
naphthalene	C1-naphthalenes	C2-naphthalenes	
C3-naphthalenes	C4-naphthalenes	biphenyl	
acenaphthalene	acenaphthene	fluorene	
C1-fluorenes	C2-fluorenes	C3-fluorenes	
phenanthrene	anthracene	C1-phenanthrenes	
C2-phenanthrenes	C3-phenanthrenes	C4- phenanthrenes	
dibenzothiophene	C1-dibenzothiophenes	C2-dibenzothiophenes	
C3-dibenzothiophenes	fluoranthene	pyrene	
(C1-flouranthenes+C1-pyrenes)	benz(a)anthracene	chrysene	
C1-chrysenes	C2-chrysenes	C3-chrysenes	
C4-chrysenes	benzo(b)fluoranthene	benzo(k)fluoranthene	
benzo(e)pyrene	benzo(a)pyrene	perylene	
indeno(1,2,3-cd)pyrene	dibenz(a,h)anthracene	benzo(g,h,i)perylene	
2-methylnaphthalene	1-methylnaphthalene	2,6-dimethylnaphthalene	
2,3,5-trimethylnaphthalene	1-methylphenanthrene		
Metals:			
Arsenic, selenium, mercury, aluminum, boron, barium, beryllium, cadmium, chromium, copper, iron, magnesium, manganese, molybdenum, nickel, lead, strontium, vanadium, and zinc			

Standard U.S. Fish and Wildlife Service quality assurance protocols will be followed. See http://www.fws.gov/chemistry/acf_qaqc.html, http://www.fws.gov/chemistry/acf_org_sow.html and http://www.fws.gov/chemistry/acf_inorg_sow.html for details.

Public Review and Comment

The Trustee intends for this Work Plan to communicate the approach for this Study to the public, so that the public can become engaged and comment on, the proposed approach. The Trustee will soon publish and seek public comment on the "Natural Resource Damage Assessment Plan for Duck and Otter Creeks". This will describe the overall assessment process the Trustee intends to follow for Duck and Otter Assessment area. The current Work Plan is being released in advance of the broader "Natural Resource Damage Assessment Plan for Duck and Otter Creeks" to increase efficiency and reduce costs by coordinating with the “Great Lakes Legacy Act Data Gap Investigation For Duck and Otter Creeks in The Maumee River Area of Concern” being conducted by the U.S. Environmental Protection Agency – Great Lakes National Program Office and several local industry partners.

The Work Plan is available for public review and comment for 30 days, with reasonable extensions granted, if appropriate. The public comment period for this Work Plan begins on the day the notice of availability is published in newspapers in the northwest Ohio area and lasts for 30 calendar days. Comments may be submitted in writing or by email to:

Kevin Tloczynski
U.S. Fish and Wildlife Service
4625 Morse Road, Suite 104
Columbus, Ohio 43230
Kevin_Tloczynski@fws.gov

References:

Tetra Tech EM. 2008. Screening and Baseline Ecological Risk Assessment Duck and Otter Creeks, Toledo, Ohio

Appendix K

EPA Data Qualifiers

Ref Columbia Analytical

EPA Data Qualifiers

The following is a list of EPA Data Qualifiers by category. These are used to flag analytes in an analytical report, under the column labeled "Q" for qualifier. A contractor or client may use additional flags as needed, but the definition of such flags must be explicit, not contradict the qualifiers listed below, and be included in the accompanying SDG Narrative, according to EPA instructions. This information is from the EPA Contract Laboratory Program (CLP).

PCB Congeners, Dioxins and Furans

Qualifier (flag)	Definition
U	Indicates compound was analyzed for, but not detected. The "CONCENTRATION" column is left blank in this instance, and an Estimated Detection Limit (EDL) must be calculated based on the signal-to-noise (S/N) ratio, as described in Exhibit D. This calculation takes into account the sample weight/volume extracted, the volume of the most concentrated extract, the injection volume, and dilution of the most concentrated extract prior to analysis.
J	Indicates an estimated value. This flag is used when the mass spectral data indicate the presence of an analyte meeting all the identification criteria in Exhibit D, but the result is less than the Contract Required Quantitation Limit (CRQL), as listed in Exhibit C, but greater than zero.
B	This flag is used when the analyte is found in the associated blank, as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
E	This flag identifies analytes whose concentrations exceed the calibration range of the HRGC/HRMS instrument for that specific analysis. If one or more compounds have a response greater than fullscale, except as noted in Exhibit D, a smaller sample size must be extracted and analyzed according to the specifications in Exhibit D. All such compounds with a response greater than full scale should have the concentration flagged "E" on the Form I for the original analysis. If the dilution causes any compounds identified in the first analysis to be below the calibration range in the second analysis, the results of both analyses shall be reported on separate copies of Form I. The Form I for the diluted sample shall have the"DL" suffix appended to the EPA Sample

	Number.
D	This flag indicates all compounds identified in an analysis at a secondary dilution factor. If a smaller sample size is analyzed, as in the "E" flag above, the "DL" suffix is appended to the EPA Sample Number on the Form I for the diluted sample, and all concentration values reported on that Form I are flagged with the "D" flag. This flag alerts data users that any discrepancies between the concentrations reported may be due to dilution of the sample extract.
H	This flag indicates that the analyte in question was quantitated using peak heights rather than peak areas for both the analyte and its internal standard.
X	Other specific flags may be required to properly define the results. If used, they must be fully described, and such description must be attached to the Sample Data Package and the SDG Narrative. Begin using "X". If more than one flag is needed, use "Y" and "Z" as needed. The laboratory-defined flags are limited to the letters "X", "Y", and "Z".

Inorganics

Qualifier (flag)	Definition
	"C" Concentration qualifier
J	The reported value was obtained from a reading that was less than the CRQL but greater than or equal to the MDL (Method Detection Limit).
U	If the reading was less than the MDL.
	"Q" qualifier
E	The reported value is estimated due to the presence of interference. An explanatory note shall be included under “Comments” on the Cover Page (if the problem applies to all samples), or on the specific Form IA-IN or Form IB-IN (if it is an isolated problem).
N	Spiked sample recovery not within control limits.
*	Duplicate analysis not within control limits.
D	The reported value is from a dilution.
	"M" (Analysis Method) qualifier
P	ICP-AES
MS	ICP-MS
CV	Manual Cold Vapor Atomic Absorption (AA)
AV	Automated Cold Vapor AA
AS	Semi-Automated Spectrophotometric
C	Manual Spectrophotometric

" ":	Where no data have been entered
NR	The analyte is Not Required to be analyzed

Organics

Qualifier (flag)	Definition
U	This flag indicates the compound was analyzed for but not detected. The Contract Required Quantitation Limit (CRQL) shall be adjusted according to the equation listed in Exhibit D. CRQLs are listed in Exhibit C.
J	This flag indicates an estimated value. This flag is used when: 1. estimating a concentration for Tentatively Identified Compounds (TICs) where a 1:1 response is assumed; 2. the mass spectral and Retention Time (RT) data indicate the presence of a compound that meets the volatile and semivolatile GC/MS identification criteria, and the result is less than the adjusted CRQL but greater than zero 3. the RT data indicate the presence of a compound that meets the pesticide and/or Aroclor identification criteria, and the result is less than the adjusted CRQL but greater than zero. For example, if the sample's adjusted CRQL is 5.0 µg/L, but a concentration of 3.0 µg/L is calculated, report it as 3.0J.
N	This flag indicates presumptive evidence of a compound. This flag is only used for TICs, where the identification is based on a mass spectral library search and must be used in combination with the J flag. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, or for an "unknown" (no matches $ 85%), the "N" flag is not used.
P	This flag is used for pesticide and Aroclor target compounds when there is greater than 25% difference for detected concentrations between the two GC columns (see Form X). The lower of the two values is reported on Form I and flagged with a "P". The "P" flag is not used unless a compound is identified on both columns.
C	This flag applies to pesticide and Aroclor results when the identification has been confirmed by GC/MS. If GC/MS confirmation was attempted but was unsuccessful, do not apply this flag; use a laboratory-defined flag instead (see the X qualifier).
B	This flag is used when the analyte is found in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user to take appropriate action. This flag shall be used for a TIC as well

	as for a positively identified target compound.
E	This flag identifies compounds whose response exceed the response of the highest standard in the initial calibration range of the instrument for that specific analysis. If one or more compounds have a response greater than the response of the highest standard in the initial calibration, the sample or extract shall be diluted and reanalyzed according to the specifications in Exhibit D. Exceptions are also noted in Exhibit D. All such compounds with responses greater than the response of the highest standard in the initial calibration shall have the result flagged with an "E"on Form I for the original analysis. The results of both analyses shall be reported on separate copies of Form I. The Form I for the diluted sample shall have "DL" suffix appended to the Sample Number.
D	If a sample or extract is reanalyzed at a DF greater than 1 (e.g., when the response of an analyte exceeds the response of the highest standard in the initial calibration), the DL suffix is appended to the Sample Number on Form I for the more diluted sample, and all reported concentrations on that Form I are flagged with the "D" flag. This flag alerts data users that any discrepancies between the reported concentrations may be due to dilution of the sample or extract.

Other Abbreviations

symbol	Definition
MDL	Method Detection Limit
DL	Dilution
CRQL	Contract Required Quantitation Limit
TIC	Tentatively Identified Compounds
RT	Retention Time
GC/MS	Gas chromatograph / mass spectrometer

Appendix L

CAS Qualifiers

Inorganic Data Qualifiers

* The result is an outlier. See case narrative.
# The control limit criteria is not applicable. See case narrative.
B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E The result is an estimate amount because the value exceeded the instrument calibration range.
J The result is an estimated value that was detected outside the quantitation range.
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.1 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X See case narrative.
Q See case narrative. One or more quality control criteria was outside the limits.
H In accordance with the 2007 EPA Methods Update Rule published in the Federal Register, the holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

The control limit criteria is not applicable. See case narrative.
J The result is an estimated value that was detected outside the quantitation range.
E The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M The duplicate injection precision was not met.
N The Matrix Spike sample recovery is not within control limits. See case narrative.
S The reported value was determined by the Method of Standard Additions (MSA).
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.1 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X See case narrative.
+ The correlation coefficient for the MSA is less than 0.995.
Q See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

* The result is an outlier. See case narrative.
# The control limit criteria is not applicable. See case narrative.
A A tentatively identified compound, a suspected aldol-condensation product.
B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D The reported result is from a dilution.
E The result is an estimate amount because the value exceeded the instrument calibration range.
J The result is an estimated value that was detected outside the quantitation range.
N The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.1 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X See case narrative.
Q See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z The chromatographic fingerprint does not resemble a petroleum product.

Appendix M

SulTRAC 2007 Data

TABLE 23
SUMMARY OF TOXICITY TESTING –
DUCK CREEK

Exposure Area/ Sample Location	Mean Percent Survival	Mean Percent Survival Statistically Different from Controls	Mean Dry Weight (grams)	Mean Dry Weight Statistically Different from Controls
Control	91.7	NA	1.3304	NA
Duck Creek Exposure Area A				
DC-01	43.3	Yes	NA	NA
DC-03	85	No	1.509	No
DC-05	40	Yes	NA	NA
Duck Creek Exposure Area B				
DC-05	40	Yes	NA	NA
DC-08	45	Yes	NA	NA
Duck Creek Exposure Area C				
DC-08	45	Yes	NA	NA
DC-10	83	No	1.5511	No
Duck Creek Exposure Area D				
DC-10	83	No	1.5511	No
DC-13	90	No	1.336	No
Duck Creek Exposure Area E				
DC-13	90	No	1.336	No
DC-14	86.7	No	1.474	No

Notes:

NA Not applicable

TABLE 24
SUMMARY OF TOXICITY TESTING –
OTTER CREEK

Exposure Area/ Sample Location	Mean Percent Survival	Mean Percent Survival Statistically Different from Controls	Mean Dry Weight (grams)	Mean Dry Weight Statistically Different from Controls
Control	91.7	NA	1.3304	NA
Otter Creek Exposure Area A				
OC-01	60	No	2.3783	No
OC-03	48.3	Yes	NA	NA
OC-05	16.7	Yes	NA	NA
OC-07	16.7	Yes	NA	NA
Otter Creek Exposure Area B				
OC-07	16.7	Yes	NA	NA
OC-11	43.3	Yes	NA	NA
Otter Creek Exposure Area C				
OC-11	43.3	Yes	NA	NA
OC-14	51.7	Yes	NA	NA
Otter Creek Exposure Area D				
OC-19	53.3	Yes	NA	NA
OC-22	30	Yes	NA	NA
Otter Creek Exposure Area E				
OC-22	30	Yes	NA	NA
OC-26	35	Yes	NA	NA

Notes:

NA Not applicable

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S01-DC-01 4/02/07	S02-DC-02 4/02/07	S03-DC-03 4/02/07	S04-DC-04 4/02/07	S05-DC-05 4/03/07	S06-DC-06 4/03/07		
Aldrin	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.029	NE
Alpha-BHC	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.09	NE
Beta-BHC	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.32	NE
Gamma-BHC	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.44	0.00237
Delta-BHC	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.09	NE
Alpha-Chlordane	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	1.6	0.00324
Gamma-Chlordane	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	1.6	0.00324
4,4'-DDD	*0.089*	*0.0721*	*0.0218*	*0.0912*	*0.136*	*0.161*	2.4	0.00488
4,4'-DDE	*0.0473*	*0.0367*	*0.0107*	*0.0417*	*0.0622*	*0.0566*	1.7	0.00316
4,4'-DDT	0.00483 U	0.0102 U	*0.0191*	0.0106 U	0.0104 U	0.00888 U	1.7	0.00416
Dieldrin	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	0.03	0.0019
Endosulfan I	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	370	NE
Endosulfan II	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	370	NE
Endosulfan Sulfate	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	370	NE
Endrin	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	18	0.00222
Endrin Aldehyde	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	18	NE
Endrin Ketone	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	18	NE
Heptachlor	0.00483 U	0.0102 U	0.00392 J	0.0106 U	0.0104 U	0.00888 U	0.11	NE
Heptachlor Epoxide	*0.0109*	*0.00786*	0.00521 U	*0.00907 J*	*0.0147*	0.00888 U	0.053	0.00247
Methoxychlor	0.00483 U	0.0102 U	0.00521 U	0.0106 U	0.0104 U	0.00888 U	310	NE

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S07-DC-07 4/02/07	S08-DC-08 4/02/07	S09-DC-09 4/02/07	S10-DC-10 4/0307	S11-DC-11 4/03/07	S12-DC-12 4/03/07		
Aldrin	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.029	NE
Alpha-BHC	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.09	NE
Beta-BHC	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.32	NE
Gamma-BHC	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.44	0.00237
Delta-BHC	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.09	NE
Alpha-Chlordane	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	1.6	0.00324
Gamma-Chlordane	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	1.6	0.00324
4,4'-DDD	*0.222*	*0.14*	*0.176*	*0.0783*	*0.388 H*	*0.277*	2.4	0.00488
4,4'-DDE	*0.0752*	*0.136*	*0.0727*	*0.061*	*0.201 H*	*0.285*	1.7	0.00316
4,4'-DDT	0.0121 U	*0.0372*	*0.0167*	*0.017*	*0.0502 H*	*0.0248*	1.7	0.00416
Dieldrin	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.03	0.0019
Endosulfan I	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	370	NE
Endosulfan II	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	370	NE
Endosulfan Sulfate	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	370	NE
Endrin	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	18	0.00222
Endrin Aldehyde	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	18	NE
Endrin Ketone	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	18	NE
Heptachlor	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.11	NE
Heptachlor Epoxide	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	0.053	0.00247
Methoxychlor	0.0121 U	0.0159 U	0.01 U	0.00801 U	0.0121 U, H	0.0224 U	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S13-DC-13 4/04/07	S14-DC-14 4/04/07	S15-DC-15 4/04/07	S16-DC-16 4/02/07	S17-DC-17 4/02/07	S18-DC-18 4/02/07		
Aldrin	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.029	NE
Alpha-BHC	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.09	NE
Beta-BHC	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.32	NE
Gamma-BHC	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.44	0.00237
Delta-BHC	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.09	NE
Alpha-Chlordane	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	1.6	0.00324
Gamma-Chlordane	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	1.6	0.00324
4,4'-DDD	*0.136*	*0.0707*	*0.00787*	*0.0179*	*0.0198*	*0.0174*	2.4	0.00488
4,4'-DDE	*0.0727*	*0.0175*	*0.00723*	*0.0194*	*0.0199*	*0.019*	1.7	0.00316
4,4'-DDT	*0.0349*	0.00954 U	0.00313 J	0.0112 U	0.0109 U	0.0104 U	1.7	0.00416
Dieldrin	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.03	0.0019
Endosulfan I	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	370	NE
Endosulfan II	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	370	NE
Endosulfan Sulfate	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	370	NE
Endrin	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	18	0.00222
Endrin Aldehyde	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	18	NE
Endrin Ketone	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	18	NE
Heptachlor	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.11	NE
Heptachlor Epoxide	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	0.053	0.00247
Methoxychlor	0.00616 U	0.00954 U	0.00609 U	0.0112 U	0.0109 U	0.0104 U	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S19-DC-19 4/04/07	S20-OC-01 4/02/07	S21-OC-02 4/02/07	S22-OC-03 4/02/07	S23-OC-04 4/02/07	S24-OC-05 4/02/07		
Aldrin	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.029	NE
Alpha-BHC	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.09	NE
Beta-BHC	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.32	NE
Gamma-BHC	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.44	0.00237
Delta-BHC	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.09	NE
Alpha-Chlordane	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	1.6	0.00324
Gamma-Chlordane	0.00539 U	0.0541 U, MS, LS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	1.6	0.00324
4,4'-DDD	*0.00764*	*0.0116 M, MS, LC*	*0.0252 LS, LC*	*0.0274 LS, LC*	*0.0152 LS, LC*	*0.0233 LS, LC*	2.4	0.00488
4,4'-DDE	*0.0044 J*	*0.00938 M, MS, LC*	*0.0178 LS, LC*	*0.0174 LS, LC*	*0.0138 LS, LC*	*0.0163 LS, LC*	1.7	0.00316
4,4'-DDT	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	1.7	0.00416
Dieldrin	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.03	0.0019
Endosulfan I	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	370	NE
Endosulfan II	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	370	NE
Endosulfan Sulfate	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	370	NE
Endrin	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	18	0.00222
Endrin Aldehyde	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	18	NE
Endrin Ketone	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	18	NE
Heptachlor	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.11	NE
Heptachlor Epoxide	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	0.053	0.00247
Methoxychlor	0.00539 U	0.0541 U, M, MS, LC	0.00743 U, LS, LC	0.00958 U, LS, LC	0.00798 U, LS, LC	0.00848 U, LS, LC	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S25-OC-06 4/02/07	S26-OC-07 4/03/07	S27-OC-08 4/03/07	S28-OC-09 4/04/07	S29-OC-10 4/04/07	S30-OC-11 4/03/07		
Aldrin	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.029	NE
Alpha-BHC	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.09	NE
Beta-BHC	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.32	NE
Gamma-BHC	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.44	0.00237
Delta-BHC	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.09	NE
Alpha-Chlordane	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	1.6	0.00324
Gamma-Chlordane	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	1.6	0.00324
4,4'-DDD	*0.0109 LS, LC*	*0.18 LS, LC*	*0.0157 LS, LC*	*0.0132 LS, LC*	*0.0153 LS, LC*	*0.0158 LS, LC*	2.4	0.00488
4,4'-DDE	*0.00972 LS, LC*	*0.00992 LS, LC*	*0.00843 LS, LC*	*0.00473 LS, LC*	*0.0102 LS, LC*	*0.00971 LS, LC*	1.7	0.00316
4,4'-DDT	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	1.7	0.00416
Dieldrin	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.03	0.0019
Endosulfan I	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	370	NE
Endosulfan II	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	370	NE
Endosulfan Sulfate	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	370	NE
Endrin	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	18	0.00222
Endrin Aldehyde	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	18	NE
Endrin Ketone	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	18	NE
Heptachlor	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.11	NE
Heptachlor Epoxide	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	0.053	0.00247
Methoxychlor	0.0071 U, LS, LC	0.00695 U, LS, LC	0.006 U, LS, LC	0.00521 U, LS, LC	0.00576 U, LC	0.00766 U, LC	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S31-OC-12 4/03/07	S32-OC-13 4/03/07	S33-OC-14 4/03/07	S34-OC-15 4/03/07	S35-OC-16 4/03/07	S36-OC-17 4/03/07		
Aldrin	0.006 U, LC	0.00487 U, LS, LC	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.029	NE
Alpha-BHC	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.09	NE
Beta-BHC	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.32	NE
Gamma-BHC	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.44	0.00237
Delta-BHC	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.09	NE
Alpha-Chlordane	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	1.6	0.00324
Gamma-Chlordane	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	1.6	0.00324
4,4'-DDD	*0.0133 LS, LC*	*0.0141 LS*	*0.0125 LS*	*0.011*	0.00538 U	*0.0279*	2.4	0.00488
4,4'-DDE	*0.00608 LS, LC*	*0.00615 LS*	*0.00573 LS*	*0.00439 J*	0.00538 U	*0.0155*	1.7	0.00316
4,4'-DDT	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	1.7	0.00416
Dieldrin	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.03	0.0019
Endosulfan I	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	370	NE
Endosulfan II	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	370	NE
Endosulfan Sulfate	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	370	NE
Endrin	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	18	0.00222
Endrin Aldehyde	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	18	NE
Endrin Ketone	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	18	NE
Heptachlor	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.11	NE
Heptachlor Epoxide	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	0.053	0.00247
Methoxychlor	0.006 U, LC	0.00487 U, LS	0.00537 U, LS	0.00617 U	0.00538 U	0.00502 U	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S37-OC-18 4/03/07	S38-OC-19 4/03/07	S39-OC-20 4/03/07	S40-OC-21 4/03/07	S41-OC-21A 4/04/07	S42-OC-22 4/03/07		
Aldrin	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.029	NE
Alpha-BHC	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.09	NE
Beta-BHC	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.32	NE
Gamma-BHC	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.44	0.00237
Delta-BHC	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.09	NE
Alpha-Chlordane	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	1.6	0.00324
Gamma-Chlordane	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	1.6	0.00324
4,4'-DDD	*0.0146*	*0.0101*	*0.0233*	*0.00708 J*	*0.00547*	0.00358	2.4	0.00488
4,4'-DDE	*0.00765*	*0.00666*	*0.0139*	*0.0066 J*	*0.00519 J*	*0.0209*	1.7	0.00316
4,4'-DDT	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	1.7	0.00416
Dieldrin	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.03	0.0019
Endosulfan I	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	370	NE
Endosulfan II	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	370	NE
Endosulfan Sulfate	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	370	NE
Endrin	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	18	0.00222
Endrin Aldehyde	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	18	NE
Endrin Ketone	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	18	NE
Heptachlor	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.11	NE
Heptachlor Epoxide	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	0.053	0.00247
Methoxychlor	0.00529 U	0.00427 U	0.00447 U, LS	0.00718 U	0.00539 U	0.00485 U	310	0.00141

TABLE B-2
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PESTICIDES
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S43-OC-23 4/03/07	S44-OC-24 4/03/07	S45-OC-25 4/03/07	S46-OC-26 4/03/07	S47-ER-EK-01 4/04/07 (milligrams per liter)	S48-ER-SH-02 4/04/07 (milligrams per liter)		
Aldrin	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	0.029	NE
Alpha-BHC	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	0.09	NE
Beta-BHC	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	0.32	NE
Gamma-BHC	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0336 U	0.0337 U	0.44	0.00237
Delta-BHC	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0336 U	0.0337 U	0.09	NE
Alpha-Chlordane	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0732 U	0.0674 U	1.6	0.00324
Gamma-Chlordane	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0732 U	0.0674 U	1.6	0.00324
4,4'-DDD	0.00485 U	0.00363 J	0.00586 U	0.00529 U	0.0732 U	0.0674 U	2.4	0.00488
4,4'-DDE	0.00485 U	0.00247 J	0.00586 U	0.00237 J	0.0366 U	0.0337 U	1.7	0.00316
4,4'-DDT	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.11 U	0.101 U	1.7	0.00416
Dieldrin	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	0.03	0.0019
Endosulfan I	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.07332 U	0.0674 U	370	NE
Endosulfan II	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	370	NE
Endosulfan Sulfate	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0732 U	0.0674 U	370	NE
Endrin	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	18	0.00222
Endrin Aldehyde	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	18	NE
Endrin Ketone	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0732 U	0.0674 U	18	NE
Heptachlor	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0336 U	0.0337 U	0.11	NE
Heptachlor Epoxide	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.0366 U	0.0337 U	0.053	0.00247
Methoxychlor	0.00485 U	0.00462 U	0.00586 U	0.00529 U	0.146 U	0.0135 U	310	0.00141

Notes:

[a] Human health reference limits taken from EPA Region 9 preliminary remediation goals (PRG) for residential soil exposure (EPA 2004c)

[b] Ecological reference limits were provided by EPA GLNPO (MacDonald and others 2000).

H = Estimated value. Holding time exceeded.
J = Estimated value. Greater than detection limit, but less than reporting limit.
LC = Estimated value. Lab control recoveries exceed upper or lower control limits.
LS = Estimated value. Batch quality control for laboratory surrogate exceeds upper or lower control limits.
M = Estimated value. Associated matrix spike/matrix spike duplicate recoveries exceed the upper or lower control limits.
MS = Estimated value. Relative percent difference between matrix spike/matrix spike duplicate exceeded specified criteria.
NE = Not established
U = Analyte not detected at or above reporting limit

Bold values exceed human health reference limits
Italicized values exceed ecological reference limits
All values are expressed in milligrams per kilogram unless otherwise noted

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S01-DC-01 4/02/07	S02-DC-02 4/02/07	S03-DC-03 4/02/07	S04-DC-04 4/02/07	S05-DC-05 4/03/07	S06-DC-06 4/03/07		
Aroclor 1016	0.145 U	0.306 U	0.156 U	0.317 U	0.312 U	0.266 U	3.90	NE
Aroclor 1221	0.0966 U	0.204 U	0.104 U	0.211 U	0.208 U	0.178 U	3.90	NE
Aroclor 1232	0.0966 U	0.204 U	0.104 U	0.211 U	0.208 U	0.178 U	3.90	NE
Aroclor 1242	0.0966 U	0.204 U	0.104 U	0.211 U	0.208 U	0.178 U	0.22	NE
Aroclor 1248	0.0966 U	0.204 U	0.104 U	0.211 U	0.208 U	0.178 U	0.22	NE
Aroclor 1254	0.193	0.141 J	0.104 U	0.186 J	0.15 J	0.11 J	0.22	NE
Aroclor 1260	**0.295**	0.137 J	0.125 U	0.253 U	0.25 U	0.213 U	0.22	NE
Total PCBs[c]	*0.488*	*0.278*	U	*0.186*	*0.15*	*0.11*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S07-DC-07 4/02/07	S08-DC-08 4/02/07	S09-DC-09 4/02/07	S10-DC-10 4/0307	S11-DC-11 4/03/07	S12-DC-12 4/03/07		
Aroclor 1016	0.362 U	0.476 U	0.3 U	0.24 U	0.363 U, H	0.673 U	3.90	NE
Aroclor 1221	0.242 U	0.317 U	0.2 U	0.16 U	0.242 U, H	0.449 U	3.90	NE
Aroclor 1232	0.242 U	0.317 U	0.2 U	0.16 U	0.242 U, H	0.449 U	3.90	NE
Aroclor 1242	0.242 U	0.317 U	0.2 U	0.16 U	0.242 U, H	0.449 U	0.22	NE
Aroclor 1248	0.242 U	0.317 U	0.2 U	0.16 U	0.242 U, H	0.449 U	0.22	NE
Aroclor 1254	0.164 J	0.317 U	0.2 U	0.16 U	0.242 U, H	0.449 U	0.22	NE
Aroclor 1260	0.29 U	0.381 U	0.24 U	0.192 U	0.291 U, H	0.538 U	0.22	NE
Total PCBs[c]	*0.164*	U	U	U	U	U	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S13-DC-13 4/04/07	S14-DC-14 4/04/07	S15-DC-15 4/04/07	S16-DC-16 4/02/07	S17-DC-17 4/02/07	S18-DC-18 4/02/07		
Aroclor 1016	0.185 U	0.286 U	0.183 U	0.335 U	0.327 U	0.312 U	3.90	NE
Aroclor 1221	0.123 U	0.191 U	0.122 U	0.223 U	0.218 U	0.208 U	3.90	NE
Aroclor 1232	0.123 U	0.191 U	0.122 U	0.223 U	0.218 U	0.208 U	3.90	NE
Aroclor 1242	0.123 U	0.191 U	0.122 U	0.223 U	0.218 U	0.208 U	0.22	NE
Aroclor 1248	0.123 U	0.191 U	0.122 U	0.223 U	0.218 U	0.208 U	0.22	NE
Aroclor 1254	0.123 U	0.195	0.122 U	**0.259**	**0.231**	**0.235**	0.22	NE
Aroclor 1260	0.148 U	0.145 J	0.146 U	0.268 U	0.262 U	0.249 U	0.22	NE
Total PCBs[c]	U	*0.34*	U	*0.259*	*0.231*	*0.235*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S19-DC-19 4/04/07	S20-OC-01 4/02/07	S21-OC-02 4/02/07	S22-OC-03 4/02/07	S23-OC-04 4/02/07	S24-OC-05 4/02/07		
Aroclor 1016	0.162 U	0.162 U	0.223 U	0.287 U	0.239 U	0.254 U	3.90	NE
Aroclor 1221	0.108 U	0.108 U	0.149 U	0.192 U	0.16 U	0.17 U	3.90	NE
Aroclor 1232	0.108 U	0.108 U	0.149 U	0.192 U	0.16 U	0.17 U	3.90	NE
Aroclor 1242	0.108 U	0.108 U	0.149 U	0.192 U	0.16 U	0.17 U	0.22	NE
Aroclor 1248	0.108 U	0.108 U	0.149 U	0.192 U	0.16 U	0.17 U	0.22	NE
Aroclor 1254	0.108 U	0.172	**0.484**	**0.468**	**0.458**	**0.332**	0.22	NE
Aroclor 1260	0.129 U	0.13 U	0.178 U	0.23 U	0.192 U	0.204 U	0.22	NE
Total PCBs[c]	U	*0.172*	*0.484*	*0.468*	*0.458*	*0.332*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S25-OC-06 4/02/07	S26-OC-07 4/03/07	S27-OC-08 4/03/07	S28-OC-09 4/04/07	S29-OC-10 4/04/07	S30-OC-11 4/03/07		
Aroclor 1016	0.213 U	0.209 U	0.18 U	0.156 U	0.173 U	0.23 U	3.90	NE
Aroclor 1221	0.142 U	0.139 U	0.12 U	0.104 U	0.115 U	0.153 U	3.90	NE
Aroclor 1232	0.142 U	0.139 U	0.12 U	0.104 U	0.115 U	0.153 U	3.90	NE
Aroclor 1242	0.142 U	0.139 U	0.12 U	0.104 U	0.115 U	0.153 U	0.22	NE
Aroclor 1248	0.142 U	0.139 U	0.12 U	0.104 U	0.115 U	0.153 U	0.22	NE
Aroclor 1254	**0.403**	**0.242**	0.201	0.0813 J	0.116	**0.247**	0.22	NE
Aroclor 1260	0.17 U	0.167 U	0.144 U	0.125 U	0.138 U	0.184 U	0.22	NE
Total PCBs[c]	*0.403*	*0.242*	*0.201*	*0.0813*	*0.116*	*0.247*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S31-OC-12 4/03/07	S32-OC-13 4/03/07	S33-OC-14 4/03/07	S34-OC-15 4/03/07	S35-OC-16 4/03/07	S36-OC-17 4/03/07		
Aroclor 1016	0.18 U	0.146 U	0.163 U	0.185 U	0.161 U	0.151 U	3.90	NE
Aroclor 1221	0.12 U	0.0974 U	0.109 U	0.123 U	0.108 U	0.1 U	3.90	NE
Aroclor 1232	0.12 U	0.0974 U	0.109 U	0.123 U	0.108 U	0.1 U	3.90	NE
Aroclor 1242	0.12 U	0.0974 U	0.109 U	0.123 U	0.108 U	0.1 U	0.22	NE
Aroclor 1248	0.12 U	0.0974 U	0.109 U	0.123 U	0.108 U	0.1 U	0.22	NE
Aroclor 1254	0.184	0.188	0.151	0.123 U	**11.3**	**0.524**	0.22	NE
Aroclor 1260	0.144 U	0.117 U	0.13 U	0.148 U	0.129 U	0.121 U	0.22	NE
Total PCBs[c]	*0.184*	*0.188*	*0.151*	U	*11.3*	*0.524*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S37-OC-18 4/03/07	S38-OC-19 4/03/07	S39-OC-20 4/03/07	S40-OC-21 4/03/07	S41-OC-21A 4/04/07	S42-OC-22 4/03/07		
Aroclor 1016	0.159 U	0.128 U	0.134 U	0.215 U	0.162 U	0.146 U	3.90	NE
Aroclor 1221	0.106 U	0.0855 U	0.0895 U	0.144 U	0.108 U	0.0971 U	3.90	NE
Aroclor 1232	0.106 U	0.0855 U	0.0895 U	0.144 U	0.108 U	0.0971 U	3.90	NE
Aroclor 1242	0.106 U	0.0855 U	0.0895 U	0.144 U	0.108 U	0.0971 U	0.22	NE
Aroclor 1248	0.106 U	0.0855 U	0.0895 U	0.144 U	0.108 U	0.0971 U	0.22	NE
Aroclor 1254	0.179	0.145	**0.257**	0.197	0.166	0.161	0.22	NE
Aroclor 1260	0.127 U	0.103 U	0.107 U	0.172 U	0.129 U	0.116 U	0.22	NE
Total PCBs[c]	*0.179*	*0.145*	*0.257*	*0.197*	*0.166*	*0.161*	NE	0.0598

TABLE B-3
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PCBs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S43-OC-23 4/03/07	S44-OC-24 4/03/07	S45-OC-25 4/03/07	S46-OC-26 4/03/07	S47-ER-EK-01 4/04/07 (micrograms per liter)	S48-ER-SH-02 4/04/07 (micrograms per liter)		
Aroclor 1016	0.145 U	0.138 U	0.176 U	0.159 U	1.22 U	1.12 U	3.90	NE
Aroclor 1221	0.097 U	0.0923 U	0.117 U	0.106 U	1.22 U	1.12 U	3.90	NE
Aroclor 1232	0.097 U	0.0923 U	0.117 U	0.106 U	1.22 U	1.12 U	3.90	NE
Aroclor 1242	0.097 U	0.0923 U	0.117 U	0.106 U	1.22 U	1.12 U	0.22	NE
Aroclor 1248	0.097 U	0.0923 U	0.117 U	0.106 U	1.22 U	1.12 U	0.22	NE
Aroclor 1254	**2.42**	0.0618 J	0.117 U	0.162	1.22 U	1.12 U	0.22	NE
Aroclor 1260	0.116 U	0.111 U	0.141 U	0.127 U	1.22 U	1.12 U	0.22	NE
Total PCBs[c]	*2.42*	*0.0618*	U	*0.162*	U	U	NE	0.0598

Notes:

a Human health reference limits taken from EPA Region 9 preliminary remediation goals (PRG) for residential soil exposure

b Ecological reference limits were provided by EPA GLNPO

c Non-detect results were counted as 0 when calculating total PCBs.

H = Estimated value. Holding time exceeded.

J = Estimated value. Greater than detection limit, but less than reporting limit.

NE = Not established

U = Not detected

Bold values exceed human health reference limits.

Italicized values exceed ecological reference limit for total PCBs

All values are expressed in milligrams per kilogram unless otherwise noted.

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S01-DC-01 4/02/07	S02-DC-02 4/02/07	S03-DC-03 4/02/07	S04-DC-04 4/02/07	S05-DC-05 4/03/07	S06-DC-06 4/03/07		
Acenaphthene	0.447 U	1.3 U	0.535 U	1.38 U	1.27 U	1.24 U	3,700	NE
Acenaphthylene	0.447 U	1.3 U	0.535 U	1.38 U	1.27 U	1.24 U	3,700	NE
Anthracene	*0.076 J*	1.3 U	*0.112 J*	1.38 U	1.27 U	*0.297 J*	22,000	0.0572
Benzo(a)anthracene	*0.218 J*	*0.517 J*	*0.427 J*	*0.292 J*	*0.31 J*	***1.3***	0.62	0.108
Benzo(a)pyrene	***0.183 J***	***0.449 J***	***0.305 J***	***0.201 J***	***0.201 J***	***1.05 J***	0.062	0.15
Benzo(b)fluoranthene	0.251 J	**0.658 J**	*0.567*	0.416 J	0.407 J	**1.58**	0.62	NE
Benzo(g,h,i)perylene	0.447 R, M, LC	1.3 R, M, LC	0.535 R, M, LC	1.38 R, M, LC	1.27 R, M, LC	1.24 R, M, LC	2,300	NE
Benzo(k)fluoranthene	0.0734 J	0.217 J	0.212 J	1.38 U	0.155 J	0.606 J	6.2	NE
Chrysene	*0.31 J*	*0.828 J*	*0.539*	*0.449 J*	*0.43 J*	*1.56*	62	0.166
Dibenz(a,h)anthracene	***0.0716 J***	***0.149 J***	***0.0707 J***	1.38 U	1.27 U	***0.163 J***	0.062	0.033
Fluoranthene	0.307 J	*0.974 J*	*1.08*	*0.923 J*	*0.771 J*	*2.53*	2,300	0.423
Fluorene	*0.0859 J*	1.3 U	0.0728 J	1.38 U	1.27 U	*0.178 J*	2,700	0.0774
Indeno(1,2,3-cd)pyrene	0.103 J	0.261 J	0.216 J	0.157 J	0.135 J	0.499 J	0.62	NE
Naphthalene	*0.384 J*	*0.694 J*	0.131 J	*0.51 J*	*0.692 J*	*0.655 J*	56	0.176
Phenanthrene	*0.322 J*	*0.833 J*	*0.574*	*0.496 J*	*0.514 J*	*1.38*	22,000	0.204
Pyrene	*0.414 J*	*1.08 J*	*0.86*	*0.761 J*	*0.593 J*	*2.24*	2,300	0.195
Total PAHs[c]	*2.80*	*6.66*	*5.17*	*4.21*	*4.21*	*14.0*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S07-DC-07 4-02-07	S08-DC-08 4-02-07	S09-DC-09 4/02/07	S10-DC-10 4/03/07	S11-DC-11 4/03/07	S12-DC-12 4/03/07		
Acenaphthene	0.23 J	2.25 U	1 U	0.719 U	1.41 U	2.88 U	3,700	NE
Acenaphthylene	1.16 U	2.25 U	1 U	0.719 U	1.41 U	2.88 U	3,700	NE
Anthracene	*0.374 J*	2.25 U	*0.275 J*	*0.214 J*	1.41 U	2.88 U	22,000	0.0572
Benzo(a)anthracene	***1.19***	***0.739 J***	***0.918 J***	***0.635 J***	*0.459 J*	2.88 U	0.62	0.108
Benzo(a)pyrene	***1.05 J***	***0.649 J***	***0.898 J***	***0.586 J***	***0.428 J***	2.88 U	0.062	0.15
Benzo(b)fluoranthene	**1.81**	**1.32 J**	**1.48**	**1.1**	**0.853 J**	0.306 J	0.62	NE
Benzo(g,h,i)perylene	1.16 R, M, LC	2.25 R, M, LC	1 R, M, LC	0.719 R, M, LC	1.41 R, M, LC	2.88 R, M, LC, CV	2,300	NE
Benzo(k)fluoranthene	0.599 J	0.419 J	0.519 J	0.394 J	0.293 J	2.88 U	6.2	NE
Chrysene	*1.53*	*1.1 J*	*1.24*	*0.949*	*0.693 J*	2.88 U	62	0.166
Dibenz(a,h)anthracene	***0.169 J***	2.25 U	***0.136 J***	***0.0907 J***	1.41 U	2.88 U	0.062	0.033
Fluoranthene	*2.81*	*2.6*	*2.76*	*2.23*	*1.41*	*0.473 J*	2,300	0.423
Fluorene	*0.234 J*	2.25 U	*0.136 J*	*0.132 J*	*0.217 J*	2.88 U	2,700	0.0774
Indeno(1,2,3-cd)pyrene	**0.627 J**	0.478 J	0.547 J	0.396 J	0.27 J	2.88 U	0.62	NE
Naphthalene	*0.928 J*	2.25 U	1 U	0.719 U	1.41 U	2.88 U	56	0.176
Phenanthrene	*1.26*	*1.25 J*	*1.15*	*1.1*	*1.55*	2.88 U	22,000	0.204
Pyrene	*2.26*	*1.79 J*	*2*	*1.64*	*1.08 J*	*0.317 J*	2,300	0.195
Total PAHs[c]	*15.07*	*10.3*	*12*	*9.5*	*7.25*	1.096	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S13-DC-13 4/04/07	S14-DC-14 4/04/07	S15-DC-15 4/04/07	S16-DC-16 4/02/07	S17-DC-17 4/02/07	S18-DC-18 4/02/07		
Acenaphthene	0.394 J	5.85	0.515 U	1.25 U	1.25 U	1.27 U	3,700	NE
Acenaphthylene	0.859 U	0.816 J	0.515 U	1.25 U	1.25 U	1.27 U	3,700	NE
Anthracene	*1.54*	*32.4*	0.515 U	*0.341 J*	*0.171 J*	1.27 U	22,000	0.0572
Benzo(a)anthracene	***5.3***	***87.2***	0.0712 J	***1.69***	***0.934 J***	***0.894 J***	0.62	0.108
Benzo(a)pyrene	***5.4***	***82.5***	**0.0712 J**	***1.7***	***1.02 J***	***0.894 J***	0.062	0.15
Benzo(b)fluoranthene	**7.65**	**10.7**	0.105 J	**2.75**	**1.68**	**1.47**	0.62	NE
Benzo(g,h,i)perylene	0.859 R, M, LC, CV	2.53 R, M, LC, CV	0.515 R, M, LC, CV	1.25 R, M, LC, CV	1.25 R, M, LC, CV	1.27 R, M, LC, CV	2,300	NE
Benzo(k)fluoranthene	2.63	**38.6**	0.515 U	0.964 J	0.583 J	0.531 J	6.2	NE
Chrysene	*5.1*	***80.9***	0.0898 J	*1.71*	*1.03 J*	*0.901 J*	62	0.166
Dibenz(a,h)anthracene	***0.659 J***	***9.74***	0.515 U	***0.208 J***	1.25 U	1.27 U	0.062	0.033
Fluoranthene	*10.8*	*190*	0.182 J	*4.1*	*2.3*	*2.09*	2,300	0.423
Fluorene	*0.619 J*	*8.72*	0.515 U	1.25 U	1.25 U	1.27 U	2,700	0.0774
Indeno(1,2,3-cd)pyrene	**2.35**	**32.9**	0.515 U	**0.811 J**	0.492 J	0.406 J	0.62	NE
Naphthalene	*0.253 J*	*1.93 J*	0.515 U	1.25 U	1.25 U	1.27 U	56	0.176
Phenanthrene	*4.31*	*68.4*	0.063 J	*1.13 J*	*0.595 J*	*0.584 J*	22,000	0.204
Pyrene	*8.99*	*150*	0.141 J	*2.96*	*1.67*	*1.63*	2,300	0.195
Total PAHs[c]	*56.0*	*801*	0.723	*18.4*	*10.5*	*9.40*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S19-DC-19 4/04/07	S20-OC-01 4/02/07	S21-OC-02 4/02/07	S22-OC-03 4/02/07	S23-OC-04 4/02/07	S24-OC-05 4/02/07		
Acenaphthene	0.578 U	0.646 U	0.744 U	1 U	0.725 U, H	0.785 U, H	3,700	NE
Acenaphthylene	0.578 U	0.646 U	0.744 U	1 U	0.725 U, H	0.785 U, H	3,700	NE
Anthracene	0.578 U	*0.142 J*	*0.336 J*	*0.227 J*	*0.277 J, H*	*0.329 J, H*	22,000	0.0572
Benzo(a)anthracene	*0.147 J*	***0.727***	***1.12***	***0.761** J*	***0.666 J, H***	***0.872 H***	0.62	0.108
Benzo(a)pyrene	**0.11 J**	***0.725***	***1.15***	***0.888** J*	***0.551 J, H***	***1.21 H***	0.062	0.15
Benzo(b)fluoranthene	0.186 J	**1.06**	**2.24**	**1.59**	**0.913 H**	**2.27 H**	0.62	NE
Benzo(g,h,i)perylene	0.578 R, M, LC, CV	0.646 R, M, LC, CV	0.744 R, LC, CV	1 R, M, LC, CV	0.373 R, H, LC	0.83 R, H, LC	2,300	NE
Benzo(k)fluoranthene	0.0717 J	0.202 J	0.472 J	0.442 J	0.297 J, H	0.745 J, H	6.2	NE
Chrysene	0.103 J	*1.92*	*2.5*	*1.77*	*1.31 H*	*1.76 H*	62	0.166
Dibenz(a,h)anthracene	0.578 U	***0.219 J***	***0.146 J***	***0.141 J***	***0.107 J, H***	***0.176 J, H***	0.062	0.033
Fluoranthene	0.25 J	*0.641 J*	*1.86*	*1.92*	*1.39 H*	*2.94 H*	2,300	0.423
Fluorene	0.578 U	*0.125 J*	*0.247 J*	*0.163 J*	*0.225 J, H*	*0.303 J, H*	2,700	0.0774
Indeno(1,2,3-cd)pyrene	0.578 U	0.233 J	0.293 J	0.311 J	0.29 J, H	**0.711 J, H**	0.62	NE
Naphthalene	0.578 U	0.173 J	*0.517 J*	*0.42 J*	*0.562 J, H*	*0.283 J, H*	56	0.176
Phenanthrene	0.0752 J	*0.862*	*1.45*	*1.13*	*1.13 H*	*1.13 H*	22,000	0.204
Pyrene	0.182 J	*1.14*	*2.7*	*2.02*	*1.99 H*	*2.57 H*	2,300	0.195
Total PAHs[c]	1.12	*8.17*	*15.0*	*11.78*	*9.71*	*15.30*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S25-OC-06 4/02/07	S26-OC-07 4/03/07	S27-OC-08 4/03/07	S28-OC-09 4/04/07	S29-OC-10 4/04/07	S30-OC-11 4/03/07		
Acenaphthene	0.628 U, H	0.662 U, H	0.513 U, H	*1.33 H*	0.539 U, H	0.571 U, H	3,700	NE
Acenaphthylene	0.628 U, H	0.662 U, H	0.513 U, H	0.44 U, H	0.539 U, H	0.571 U, H	3,700	NE
Anthracene	*0.151 J, H*	*0.208 J, H*	*0.351 J, H*	*3.8 H*	*0.326 J, H*	*0.344 J, H*	22,000	0.0572
Benzo(a)anthracene	*0.305 J, H*	***0.783 H***	***0.719 H***	***10.9 H***	***1.08 H***	***1.77 H***	0.62	0.108
Benzo(a)pyrene	***0.294 J, H***	***0.865 H***	***0.759 H***	***7.86 H***	***1.29 H***	***2.39 H***	0.062	0.15
Benzo(b)fluoranthene	0.427 J, H	**1.47 H**	**1.09 H**	**14 H**	**2.25 H**	**4.31 H**	0.62	NE
Benzo(g,h,i)perylene	0.148 R, H, LC	0.474 R, H, LC	0.325 R, H, LC	1.92 R, H, LC	0.495 R, H, LC, CV	0.91 R, H, LC, CV	2,300	NE
Benzo(k)fluoranthene	0.151 J, H	0.46 J, H	0.397 J, H	3.63 H	0.8 H	1.38 H	6.2	NE
Chrysene	*0.586 J, H*	*1.24 H*	*1.12 H*	*12.4 H*	*1.84 H*	*3.11 H*	62	0.166
Dibenz(a,h)anthracene	0.628 U, H	***0.124 J, H***	***0.0945 J, H***	***0.951 H***	***0.13 J, H***	***0.238 J, H***	0.062	0.033
Fluoranthene	*0.743 H*	*1.82 H*	*1.55 H*	*18 H*	*3.19 H*	*5.87 H*	2,300	0.423
Fluorene	*0.123 J, H*	*0.142 J, H*	*0.148 J, H*	*1.5 H*	*0.0799 J, H*	*0.146 J, H*	2,700	0.0774
Indeno(1,2,3-cd)pyrene	0.111 J, H	0.396 J, H	0.299 J, H	**2.11 H**	0.509 H, CV	**0.914 J, H, CV**	0.62	NE
Naphthalene	0.162 J, H	0.662 U, H	*0.176 J, H*	*0.311 J, H*	0.539 U, H	0.751 U, H	56	0.176
Phenanthrene	*0.501 J, H*	*0.824 H*	*0.709 H*	*13.1 H*	*2.81 H*	*4.84 H*	22,000	0.204
Pyrene	*1.16 H*	*1.89 H*	*1.93 H*	*17.4 H*	*4.55 H*	*3.82 H*	2,300	0.195
Total PAHs[c]	*4.71*	*10.22*	*9.34*	*107*	*18.9*	*29.13*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S31-OC-12 4/03/07	S32-OC-13 4/03/07	S33-OC-14 4/03/07	S34-OC-15 4/03/07	S35-OC-16 4/03/07	S36-OC-17 4/03/07		
Acenaphthene	0.726 U	0.532 U	0.586 U	0.121 J	0.748	1.15	3,700	NE
Acenaphthylene	0.726 U	0.532 U	0.11 J	0.527 U	0.5 U	0.235 J	3,700	NE
Anthracene	*0.295 J*	*0.291 J*	*0.29 J*	*0.316 J*	*1.34*	*2.6*	22,000	0.0572
Benzo(a)anthracene	***1.26***	***0.891***	***1.43***	***1.26***	***3.49***	***7.13***	0.62	0.108
Benzo(a)pyrene	***1.66***	***0.983***	***1.58***	***1.38***	***2.51***	***7.22***	0.062	0.15
Benzo(b)fluoranthene	**3.76**	**2.15**	**2.52**	**2.44**	**2.86**	**9.52**	0.62	NE
Benzo(g,h,i)perylene	0.726 R, M, LC, CV	0.532 R, M, LC, CV	0.586 R, M, LC, CV	0.527 R, LC	0.441 R, J, LC	2.22 R, LC	2,300	NE
Benzo(k)fluoranthene	1.26	0.695	0.969	0.789	0.788	3.09	6.2	NE
Chrysene	*2.22*	*1.57*	*2.26*	*1.83*	*4.37*	*8.81*	62	0.166
Dibenz(a,h)anthracene	0.726 U, CV	0.532 U, CV	***0.45 J, CV***	***0.191 J***	***0.0892 J***	***1.81***	0.062	0.033
Fluoranthene	*4.61*	*2.69*	*3.46*	*3.14*	*3.34*	*19.1*	2,300	0.423
Fluorene	*0.119 J*	0.532 U	*0.118 J*	*0.156 J*	*0.546*	*1.5*	2,700	0.0774
Indeno(1,2,3-cd)pyrene	0.469 J, CV	0.245 J, CV	**1.73 CV**	**0.787**	**1.28**	**5.58**	0.62	NE
Naphthalene	0.726 U	0.113 J	0.109 J	*0.495 J*	*0.313 J*	*1.45*	56	0.176
Phenanthrene	*1.53*	*0.668*	*1.41*	*1.69*	*1.85*	*13.6*	22,000	0.204
Pyrene	*3.09*	*2.33*	*3.87*	*2.59*	*13*	*17.8*	2,300	0.195
Total PAHs[c]	*20.27*	*12.63*	*20.31*	*17.19*	*37*	*100.6*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S37-OC-18 4/03/07	S38-OC-19 4/03/07	S39-OC-20 4/03/07	S40-OC-21 4/03/07	S41-OC-21A 4/04/07	S42-OC-22 4/03/07		
Acenaphthene	0.643 J	0.18 J	0.723	0.846 U	0.692 U	1.63	3,700	NE
Acenaphthylene	1.08 U	0.416 U	0.203 J	0.846 U	0.692 U	1.25 U	3,700	NE
Anthracene	*2.05*	*0.297 J*	*1.81*	*0.232 J*	*0.123 J*	*4.84*	22,000	0.0572
Benzo(a)anthracene	***3.46***	***1.02***	***6.79***	***1.38***	*0.598 J*	***18.4***	0.62	0.108
Benzo(a)pyrene	***3.27***	***1.13***	***6.95***	***1.84***	***0.773***	***20***	0.062	0.15
Benzo(b)fluoranthene	**4.08**	**1.67**	**9.88**	**2.67**	**1.32**	**24.7**	0.62	NE
Benzo(g,h,i)perylene	0.879 R, J, LC	0.144 R, J, LC	1.04 R, LC	0.648 R, J, LC	0.114 R, J, LC	8.39 R, LC	2,300	NE
Benzo(k)fluoranthene	1.4	0.585	3.08	0.911	0.425 J	**7.88**	6.2	NE
Chrysene	*3.95*	*1.34*	*7.84*	*2.27*	*0.969*	*22.9*	62	0.166
Dibenz(a,h)anthracene	***0.855 J***	***0.174 J***	***1.01***	***0.581 J***	***0.136 J***	***4.53***	0.062	0.033
Fluoranthene	*8.79*	*2.92*	*19.5*	*3.58*	*1.9*	*51.8*	2,300	0.423
Fluorene	*0.859 J*	*0.231 J*	*0.982*	0.846 U	0.692 U	*2.39*	2,700	0.0774
Indeno(1,2,3-cd)pyrene	**2.5**	**0.679**	**3.74**	**1.81**	0.517 J	**17.7**	0.62	NE
Naphthalene	*0.459 J*	*0.824*	*0.288 J*	0.846 U	0.692 U	*0.265 J*	56	0.176
Phenanthrene	*6.93*	*1.67*	*12.4*	*1.34*	*0.645 J*	*26.3*	22,000	0.204
Pyrene	*8.59*	*2.25*	*17.3*	*3.54*	*1.54*	*44.8*	2,300	0.195
Total PAHs[c]	*47.8*	*14.97*	*92.5*	*20.15*	*8.9*	*248*	NE	1.61

TABLE B-4
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - PAHs
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]
	S43-OC-23 4/03/07	S44-OC-24 4/03/07	S45-OC-25 4/03/07	S46-OC-26 4/03/07	S47-ER-EK-01 4/04/07 (micrograms per liter)	S47-ER-SH-02 4/04/07 (micrograms per liter)		
Acenaphthene	0.655 U	0.509 U	0.641 U	0.599 U	5.26 U, H	5.15 U, H	3,700	NE
Acenaphthylene	0.655 U	0.509 U	0.641 U	0.599 U	5.26 U, H	5.15 U, H	3,700	NE
Anthracene	*0.168 J*	*0.109 J*	*0.162 J*	*0.368 J*	5.26 U, H	5.15 U, H	22,000	0.0572
Benzo(a)anthracene	*0.539 J*	*0.375 J*	***0.704***	***1.47***	5.26 U, H	5.15 U, H	0.62	0.108
Benzo(a)pyrene	***0.46 J***	***0.364 J***	***0.672***	***1.62***	5.26 U, H	5.15 U, H	0.062	0.15
Benzo(b)fluoranthene	0.56 J	0.521	**1.09**	**2.64**	5.26 U, H	5.15 U, H	0.62	NE
Benzo(g,h,i)perylene	0.08 R, J, LC	0.125 R, J, LC	0.214 R, J, LC	0.173 R, J, LC	5.26 U, H	5.15 U, H	2,300	NE
Benzo(k)fluoranthene	0.142 J	0.198 J	0.373 J	0.865	5.26 U, H	5.15 U, H	6.2	NE
Chrysene	*1.15*	*0.478 J*	*0.922*	*2.01*	5.26 U, H	5.15 U, H	62	0.166
Dibenz(a,h)anthracene	***0.147 J***	***0.158 J***	***0.254 J***	***0.217 J***	5.26 U, H	5.15 U, H	0.062	0.033
Fluoranthene	*0.982*	*0.869*	*1.52*	*4.97*	5.26 U, H	5.15 U, H	2,300	0.423
Fluorene	*0.113 J*	*0.15 J*	0.641 U	*0.145 J*	5.26 U, H	5.15 U, H	2,700	0.0774
Indeno(1,2,3-cd)pyrene	0.388 J	0.382 J	**0.643**	**0.853**	5.26 U, H	5.15 U, H	0.62	NE
Naphthalene	0.655 U	0.136 J	0.168 J	0.599 U	5.26 U, H	5.15 U, H	56	0.176
Phenanthrene	*0.761*	*0.585*	*0.571 J*	*2.11*	5.26 U, H	5.15 U, H	22,000	0.204
Pyrene	*1.35*	*0.874*	*1.47*	*3.66*	5.26 U, H	5.15 U, H	2,300	0.195
Total PAHs[c]	*6.76*	*5.20*	*8.55*	*20.93*			NE	1.61

Notes:

[a] Human health reference limits taken from EPA Region 9 preliminary remediation goals (PRG) for residential soil exposure

[b] Ecological reference limits were provided by EPA GLNPO

[c] Non-detect results were counted as 0 when calculating total PAHs.

CV = Estimated value. Calibration verification results exceed upper or lower control limits.
H = Estimated value. Holding time exceeded.
J = Estimated value. Greater than detection limit, but less than reporting limit.
LC = Estimated value. Laboratory control recoveries exceed upper or lower control limits.
M = Estimated value. Associated matrix spike/matrix spike duplicate recoveries exceed the upper or lower control limits.
NE = Not established
R = Rejected value
U = Analyte not detected at or above reporting limit.

Bold values exceed human health reference limits
Italicized values exceed ecological reference limits
All values expressed in milligrams per kilogram unless otherwise noted

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S01-DC-01 4/02/07	S02-DC-02 4/02/07	S03-DC-03 4/02/07	S04-DC-04 4/02/07	S05-DC-05 4/03/07	S06-DC-06 4/03/07			
Arsenic	***45.5***	***46.8***	**5.48**	***102***	***132***	***42.2***	0.39	9.79	11
Barium	94.9	439	133	526	469	343	5,400	NE	210
Cadmium	0.83	*5*	0.49	*4.58*	*4.49*	*2.35*	37	0.99	0.96
Chromium	26	*81.9*	15.9	*77.4*	*76.2*	*66*	100,000	43.4	51
Lead	*112*	*292*	*83.6*	***402***	*290*	*240*	400	35.8	47
Mercury	0.05 U,B	*0.19 J*	*0.37*	*0.23*	*0.19*	0.13	23	0.18	0.12
Selenium	2.21 U	5.56	2.45 U	9.6	9.97	6.07	390	NE	1.4
Silver	1.4 U	2.9 U	1.4 U	3.1 U	2.9 U	2.6 U	390	NE	0.43
Total Organic Carbon (%)	8.56 H, LD	11.1 H, LD	4.86 H, LD	7.15 H, LD	12.2 H, LD	6.24 H, LD	NE	NE	NE
Oil & Grease	1,100 J	2,130 J	2,390 J	6,360 U	3,400 J	2,740 J	NE	NE	NE
Percent Solids	76.9	34.2	69.4	32.3	34.1	37.9	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S07-DC-07 4-02-07	S08-DC-08 4-02-07	S09-DC-09 4/02/07	S10-DC-10 4/03/07	S11-DC-11 4/03/07	S12-DC-12 4/03/07			
Arsenic	***72.2***	***65.1***	***41.3***	***29.5***	***140***	***82.3***	0.39	9.79	11
Barium	447	651	324	295	651	2,152	5,400	NE	210
Cadmium	*3.51*	*3.67*	*2.24*	*1.66*	*3.39*	*16.08*	37	0.99	0.96
Chromium	*72.2*	*74.4*	*44.2*	38.6	*65.1*	*190*	100,000	43.4	51
Lead	*309*	*363*	*186*	*173*	*277*	***1,076***	400	35.8	47
Mercury	*0.21 J*	*0.18 J*	*0.21 J*	0.12 J	0.13 J	*6.82*	23	0.18	0.12
Selenium	7.56	7.44 U	4.72 U	3.86 U	7.19	30.4	390	NE	1.4
Silver	*44.7*	4.6 U	2.9 U	2.3 U	3.4 U	*10.8*	390	NE	0.43
Total Organic Carbon (%)	15.8 H, LD	7.48 H, LD	28.7 H, LD	5.93 H, LD	7.33 H, LD	26.7 H, LD	NE	NE	NE
Oil & Grease	7,600 U	4,050 J	3,770 J	4,060 U	4,790 J	13,900 U	NE	NE	NE
Percent Solids	29.1	21.5	33.9	44.0	29.2	15.8	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S13-DC-13 4/04/07	S14-DC-14 4/04/07	S15-DC-15 4/04/07	S16-DC-16 4/02/07	S17-DC-17 4/02/07	S18-DC-18 4/02/07			
Arsenic	***22.9***	***86***	***52.1***	***129***	***125***	***121***	0.39	9.79	11
Barium	159	315	68.4	514	492	455	5,400	NE	210
Cadmium	0.88	*1.23*	0.37	*3.12*	*3.34*	*3.42*	37	0.99	0.96
Chromium	33.5	31.5	21.2	*109*	*121*	*100*	100,000	43.4	51
Lead	*108*	*226*	*78.2*	*354*	*393*	*333*	400	35.8	47
Mercury	0.03 U, B	0.08 J	0.02 U, B	0.11 J	0.12 J	0.11 J	23	0.18	0.12
Selenium	2.82 U	15.5	3.26	18	18.7	16.7	390	NE	1.4
Silver	1.8 U	2.9 U	1.6 U	3.2 U	3.3 U	3 U	390	NE	0.43
Total Organic Carbon (%)	5.09 H, LD	10.5 H, LD	2.96 H, LD	3.33 H, LD	4 H, LD	2.56 H, LD	NE	NE	NE
Oil & Grease	1,340 J	12,600	3,040 U	6,840 U	6,370 U	5,610 U	NE	NE	NE
Percent Solids	56.7	34.9	61.4	31.1	30.5	33.0	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S19-DC-19 4/04/07	S20-OC-01 4/02/07	S21-OC-02 4/02/07	S22-OC-03 4/02/07	S23-OC-04 4/02/07	S24-OC-05 4/02/07			
Arsenic	***54.1***	***12.9***	***32.5***	***43.1***	***29.4***	***35.7***	0.39	9.79	11
Barium	97.1	86.6	346	350	385	286	5,400	NE	210
Cadmium	0.4	0.9	*2.29*	*2.67*	*1.97*	*2.55*	37	0.99	0.96
Chromium	19.1	*56.2*	*177*	*224*	*385*	*162*	100,000	43.4	51
Lead	*68.5*	*89.7*	*260*	*350*	*294*	*333*	400	35.8	47
Mercury	0.04 U, B	0.1 J	*0.3*	*0.28*	*0.35*	*0.25*	23	0.18	0.12
Selenium	4.46	2.43 U	3.46 U	4.31 U	7.24 U	3.81 U	390	NE	1.4
Silver	1.6 U	1.5 U	2.2 U	2.7 U	2.3 U	2.4 U	390	NE	0.43
Total Organic Carbon (%)	2.72 H, LD	1.47 H, LD	7.44 H, LD	5.03 H, LD	4.81 H, LD	6.39 H, LD	NE	NE	NE
Oil & Grease	3,200 U	2,730 U	7,840	6,290	13,100	4,220 J	NE	NE	NE
Percent Solids	62.8	65.8	46.2	37.1	44.2	42.0	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S25-OC-06 4/02/07	S26-OC-07 4/03/07	S27-OC-08 4/03/07	S28-OC-09 4/04/07	S29-OC-10 4/04/07	S30-OC-11 4/03/07			
Arsenic	***26.5***	***38.1***	***27.3***	***22.5***	***39.5***	***52.5***	0.39	9.79	11
Barium	265	220	150	127	189	284	5,400	NE	210
Cadmium	*1.37*	*1.82*	0.87	0.9	*1.51*	*2.6*	37	0.99	0.96
Chromium	*186*	*220*	*121*	*89.8*	*127*	*160*	100,000	43.4	51
Lead	*204*	*321*	*187*	*165*	*206*	*306*	400	35.8	47
Mercury	*0.26*	*0.35*	*0.22*	*0.28*	*0.2*	*0.28*	23	0.18	0.12
Selenium	6.73 U	6.41 U	5.62 U	2.4 U	2.74 U	3.72 U	390	NE	1.4
Silver	2 U	2 U	1.7 U	1.5 U	1.7 U	2.2 U	390	NE	0.43
Total Organic Carbon (%)	4.56 H, LD	7.16 H, LD	2.94 H, LD	2.48 H, LD	10.1 H, LD	5.45 H, LD	NE	NE	NE
Oil & Grease	5,110	3,050 J	2,000 J	3,120 U	1,390 J	2,040 J	NE	NE	NE
Percent Solids	49.0	49.9	58.7	66.8	58.3	45.7	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S31-OC-12 4/03/07	S32-OC-13 4/03/07	S33-OC-14 4/03/07	S34-OC-15 4/03/07	S35-OC-16 4/03/07	S36-OC-17 4/03/07			
Arsenic	***54.1***	***42.1***	***55***	***83.5***	***46.3***	***58.5***	0.39	9.79	11
Barium	192	129	336	301	255	190	5,400	NE	210
Cadmium	*1.69*	*1.3*	*1.77*	*1.65*	*1.12*	*1.68*	37	0.99	0.96
Chromium	*279*	*323*	*153*	*184*	*399*	*237*	100,000	43.4	51
Lead	*262*	*196*	*397*	*267*	*191*	*237*	400	35.8	47
Mercury	*0.2*	0.15	0.11 J	0.14	*0.77*	0.17	23	0.18	0.12
Selenium	3.14	3.65	2.44 U	2.67	5.1 U	3.01	390	NE	1.4
Silver	1.7 U	1.4 U	1.5 U	1.7 U	1.6 U	1.6 U	390	NE	0.43
Total Organic Carbon (%)	5.46 H, LD	3.42 H, LD	2.48 H, LD	4.62 H, LD	4.12 H, LD	4.96 H, LD	NE	NE	NE
Oil & Grease	1,940 J	7,460	3,350	12,500	13,000	3,910	NE	NE	NE
Percent Solids	57.3	71.3	65.5	59.9	62.7	63.2	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S37-OC-18 4/03/07	S38-OC-19 4/03/07	S39-OC-20 4/03/07	S40-OC-21 4/03/07	S41-OC-21A 4/04/07	S42-OC-22 4/03/07			
Arsenic	***35.8***	***34.8***	***47.3***	***65.7***	***56.6***	***17.4***	0.39	9.79	11
Barium	156	94.2	143	318	137	155	5,400	NE	210
Cadmium	*1.06*	0.53	*1.23*	*1.48*	*1.09*	*2.39*	37	0.99	0.96
Chromium	*218*	*76.1*	*103*	*106*	*56.6*	*98.1*	100,000	43.4	51
Lead	*202*	*69.7*	*207*	*206*	*102*	*348*	400	35.8	47
Mercury	*0.25*	0.06 U, B	0.11	0.12 J	0.15	0.08 U, B	23	0.18	0.12
Selenium	2.65 U	2.06 U	2.36 U	3.39 U	2.92 U	5.22 U	390	NE	1.4
Silver	1.6 U	1.3 U	1.5 U	2.1 U	1.8 U	1.6 U	390	NE	0.43
Total Organic Carbon (%)	4.38 H, LD	1.39 H, LD	2.63 H, LD	5.51 H, LD	3.4 H, LD	5.51 H, LD	NE	NE	NE
Oil & Grease	2,470 J	1,550 J	2,740 J	1,720 J	1,750 J	9,120	NE	NE	NE
Percent Solids	64.2	77.5	67.7	47.2	54.8	63.2	NE	NE	NE

TABLE B-5
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - RCRA METALS, TOC, AND OIL AND GREASE
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected						Human Health Reference Limit for Soil[a]	Ecological Reference Limit for Sediment[b]	OEPA Sediment Reference Values[c]
	S43-OC-23 4/03/07	S44-OC-24 4/03/07	S45-OC-25 4/03/07	S46-OC-26 4/03/07	S47-ER-EK-01 4/04/07 (milligrams per liter)	S47-ER-SH-02 4/04/07 (milligrams per liter)			
Arsenic	***51***	**6.67**	***25.8***	***23.8***	0.02 U	0.02 U	0.39	9.79	11
Barium	117	62.4	207	221	0.003 U	0.003 U	5,400	NE	210
Cadmium	0.8	0.51	*1.46*	*1.48*	0.002 U	0.002 U	37	0.99	0.96
Chromium	42.5	28.4	34.4	*44.1*	0.005 U	0.005 U	100,000	43.4	51
Lead	*78.2*	*66.7*	*105*	*144*	0.015 U	0.015 U	400	35.8	47
Mercury	0.12 J	*0.21*	0.08 J	0.07 U,B	5E-04 U	0.0005 U	23	0.18	0.12
Selenium	2.72 U	2.27 U	2.75 U	2.72 U	0.03 U	0.03 U	390	NE	1.4
Silver	1.7 U	1.4 U	1.7 U	1.7 U	0.005 U	0.005 U	390	NE	0.43
Total Organic Carbon (%)	3.07 H, LD	1.85 H, LD	13.2 H, LD	2.61 H, LD	1.9 J	1.4 J	NE	NE	NE
Oil & Grease	4,160	2,900	1,560 J	2,530 J		1.8 U	NE	NE	NE
Percent Solids	58.8	70.5	58.1	58.9	NA	NA	NE	NE	NE

Notes:

[a] Human health reference limits taken from EPA Region 9 preliminary remediation goals (PRG) for residential soil exposure (EPA 2004c).

[b] Ecological reference limits were provided by EPA GLNPO (MacDonald and others 2000).

[c] Statewide or available local ecoregion sediment reference values taken from OEPA Guidance for Conducting Ecological Risk Assessments (OEPA 2003a).

% = Percent
B = Analyte detected in laboratory method blank.
H = Estimated value. Holding time exceeded.
J = Estimated value. Greater than detection limit, but less than reporting limit.
LD = Estimated value. Batch quality control for lab duplicate exceeds upper or lower control limits.
NE = Not established
OEPA = Ohio Environmental Protection Agency
R = Value is rejected
U = Analyte not detected at or above reporting limit.

Bold values exceed ecological and human health reference limits
Italicized values exceed ecological reference limits
All values expressed in milligrams per kilogram unless otherwise noted

TABLE B-6
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - FULL-SCAN PAHs[a]
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collectec							
	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported
	S01-DC-01 4/02/07	S01-DC-01[a] 4/02/07	S03-DC-03 4/02/07	S03-DC-03[a] 4/02/07	S05-DC-05 4/03/07	S05-DC-05[a] 4/03/07	S08-DC-08 4-02-07	S08-DC-08[a] 4-02-07
Acenaphthene	0.041 IS	0.447 U	0.028 J, IS	0.535 U	0.42 IS	1.27 U	0.099 J, IS	2.25 U
Acenaphthylene	0.015 J, IS	0.447 U	0.011 J, IS	0.535 U	0.026 J, IS	1.27 U	0.022 J, IS	2.25 U
Anthracene	0.1 IS	0.076 J	0.15 IS	0.112 J	0.15 IS	1.27 U	0.32 IS	2.25 U
Benzo(a)anthracene	0.45 IS	0.218 J	0.68 IS	0.427 J	0.63 IS	0.31 J	1.3 IS	0.739 J
Benzo(a)pyrene	0.55 IS	0.183 J	0.69 IS	0.305 J	0.61 IS	0.201 J	1.3 IS	0.649 J
Benzo(b)flouranthene	0.57 IS	0.251 J	0.77 IS	0.567	0.81 IS	0.407 J	2.1 IS	1.32 J
Benzo(e)pyrene	0.52 IS	NA	0.47 IS	NA	0.52 IS	NA	1.1 IS	NA
Benzo(g,h,i)perylene	0.54 IS	0.447 R, M, LC	0.55 IS	0.535 R, M, LC	0.49 IS	1.27 R, M, LC	1.2 IS	2.25 R, M, LC
Benzo(k)flouranthene	0.24 IS	0.0734 J	0.64 IS	0.212 J	0.66 IS	0.155 J	1.4 IS	0.419 J
C1-Chrysene	1.2 IS	NA	0.45 IS	NA	0.94 IS	NA	1 IS	NA
C1-Fluorenes	0.15 IS	NA	0.038 J, IS	NA	0.66 IS	NA	0.05 J, IS	NA
C1-Fluoranthenes/pyrene	0.8 IS	NA	0.59 IS	NA	0.61 IS	NA	1 IS	NA
C1-Naphthalenes	0.55 IS	NA	0.09 IS	NA	0.3 IS	NA	0.079 J, IS	NA
C1-Phenanthrenes/anthracenes	0.9 IS	NA	0.39 IS	NA	0.52 IS	NA	0.66 IS	NA
C2-Chrysene	1 IS	NA	0.28 IS	NA	0.74 IS	NA	0.34 IS	NA
C2-Fluorenes	0.28 IS	NA	0.064 IS	NA	0.14 IS	NA	0.052 J, IS	NA
C2-Naphthalenes	1.9 IS	NA	0.35 IS	NA	0.89 IS	NA	0.25 IS	NA
C2-Phenanthrenes/anthracenes	0.79 IS	NA	0.25 IS	NA	0.46 IS	NA	0.29 IS	NA
C3-Chrysene	0.42 IS	NA	0.12 IS	NA	0.51 IS	NA	0.11 J, IS	NA
C3-Fluorenes	0.53 IS	NA	0.12 IS	NA	0.35 IS	NA	0.088 J, IS	NA
C3-Naphthalenes	1.6 IS	NA	0.37 IS	NA	0.74 IS	NA	0.16 IS	NA
C3-Phenanthrenes/anthracenes	0.6 IS	NA	0.18 IS	NA	0.47 IS	NA	0.15 IS	NA
C4-Chrysene	0.17 IS	NA	0.055 IS	NA	0.35 IS	NA	0.048 J, IS	NA
C4-Naphthalenes	1.3 IS	NA	0.25 IS	NA	0.62 IS	NA	0.12 IS	NA
C4-Phenanthrenes/anthracenes	0.24 IS	NA	0.064 IS	NA	0.35 IS	NA	0.049 J, IS	NA
Chrysene	0.67 IS	0.31 J	0.84 IS	0.539	0.83 IS	0.43 J	1.9 IS	1.1 J
Dibenz(a,h)anthracene	0.19 IS	0.0716 J	0.15 IS	0.0707 J	0.15 IS	1.27 U	0.31 IS	2.25 U
Fluoranthene	0.63 IS	0.307 J	2 IS	1.08	1.2 IS	0.771 J	4.4 IS	2.6
Fluorene	0.081 IS	0.0859 J	0.063 IS	0.0728 J	0.71 IS	1.27 U	0.19 IS	2.25 U
Indeno(1,2,3-cd)pyrene	0.28 IS	0.103 J	0.48 IS	0.216 J	0.46 IS	0.135 J	1.1 IS	0.478 J
Naphthalene	0.22 IS	0.384 J	0.067 IS	0.131 J	0.27 IS	0.692 J	0.066 J, IS	2.25 U
Perylene	0.12 IS	NA	0.17 IS	NA	0.17 IS	NA	0.33	NA
Phenanthrene	0.43 IS	0.322 J	0.73 IS	0.574	0.48 IS	0.514 J	1.4	1.25 J
Pyrene	0.82 IS	0.414 J	1.5 IS	0.86	1.1 IS	0.593 J	3.2 IS	1.79 J
TOTAL PAHs[b]	18.9	2.80	14	5.17	18.3	4.21	26	10.3

TABLE B-6
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - FULL-SCAN PAHs[a]
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Full Scan S10-DC-10 4/03/07	Regularly Reported S10-DC-10[a] 4/03/07	Full Scan S13-DC-13 4/04/07	Regularly Reported S13-DC-13[a] 4/04/07	Full Scan S14-DC-14 4/04/07	Regularly Reported S14-DC-14[a] 4/04/07	Full Scan S20-OC-01 4/02/07	Regularly Reported S20-OC-01[a] 4/02/07
Acenaphthene	0.12 U	0.719 U	0.19 U	0.394 J	10	5.85	0.079 U	0.646 U
Acenaphthylene	0.12 U	0.719 U	0.19 U	0.859 U	9.5 U	0.816 J	0.079 U	0.646 U
Anthracene	0.24	0.214 J	0.59	1.54	57	32.4	0.11	0.142 J
Benzo(a)anthracene	1.1	0.635 J	2.1	5.3	180	87.2	1.3	0.727
Benzo(a)pyrene	1.2	0.586 J	2.1	5.4	140	82.5	1.4	0.725
Benzo(b)flouranthene	1.9	1.1	2.4	7.65	150	10.7	1.8	1.06
Benzo(e)pyrene	0.95	NA	1.2	NA	77	NA	2.1	NA
Benzo(g,h,i)perylene	1	0.719 R, M, LC	1.4	0.859 R, M, LC, CV	76	2.53 R, M, LC, CV	1.4	0.646 R, M, LC, CV
Benzo(k)flouranthene	1.3	0.394 J	2	2.63	130	38.6	0.46	0.202 J
C1-Chrysene	0.76	NA	1	NA	61	NA	4	NA
C1-Fluorenes	0.12 U	NA	0.19 U	NA	9.5 U	NA	0.36	NA
C1-Fluoranthenes/pyrene	0.91	NA	1.4	NA	100	NA	2.9	NA
C1-Naphthalenes	0.12 U	NA	0.19 U	NA	9.5 U	NA	0.2	NA
C1-Phenanthrenes/anthracenes	0.39	NA	0.88	NA	61	NA	2	NA
C2-Chrysene	0.29	NA	0.31	NA	17	NA	3.2	NA
C2-Fluorenes	0.12 U	NA	0.19	NA	9.5 U	NA	0.77	NA
C2-Naphthalenes	0.13	NA	1.3	NA	16	NA	1.7	NA
C2-Phenanthrenes/anthracenes	0.21	NA	0.39	NA	19	NA	2.2	NA
C3-Chrysene	0.12 U	NA	0.19 U	NA	9.5 U	NA	1.4	NA
C3-Fluorenes	0.12 U	NA	0.19	NA	9.5 U	NA	1.6	NA
C3-Naphthalenes	0.12 U	NA	1.5	NA	16	NA	3.6	NA
C3-Phenanthrenes/anthracenes	0.12 U	NA	0.19 U	NA	9.5 U	NA	2	NA
C4-Chrysene	0.12 U	NA	0.19 U	NA	9.5 U	NA	7	NA
C4-Naphthalenes	0.12 U	NA	1.1	NA	12	NA	3.1	NA
C4-Phenanthrenes/anthracenes	0.12 U	NA	0.19 U	NA	9.5 U	NA	1.1	NA
Chrysene	1.5	0.949	2.2	5.1	160	80.9	3	1.92
Dibenz(a,h)anthracene	0.28	0.0907 J	0.31	0.659 J	18	9.74	0.72	0.219 J
Fluoranthene	3.4	2.23	5.3	10.8	440	190	1	0.641 J
Fluorene	0.12 U	0.132 J	0.2	0.619 J	15	8.72	0.13	0.125 J
Indeno(1,2,3-cd)pyrene	1	0.396 J	1.3	2.35	78	32.9	0.76	0.233 J
Naphthalene	0.12 U	0.719 U	0.19 U	0.253 J	9.5 U	1.93 J	0.079 U	0.173 J
Perylene	0.32	NA	0.57	NA	35	NA	0.25	NA
Phenanthrene	0.99	1.1	1.5	4.31	140	68.4	0.71	0.862
Pyrene	2.5	1.64	4	8.99	330	150	2	1.14
TOTAL PAHs[b]	20	9.5	35	56.0	2338	801	54	8.17

Note: the header "Sample Number and Date Collected" spans all sample columns.

TABLE B-6

SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - FULL-SCAN PAHs[a]

DUCK AND OTTER CREEKS

TOLEDO, OHIO

	Sample Number and Date Collected							
	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported
Parameter	S22-OC-03 4/02/07	S22-OC-03[a] 4/02/07	S24-OC-05 4/02/07	S24-OC-05[a] 4/02/07	S26-OC-07 4/03/07	S26-OC-07[a] 4/03/07	S30-OC-11 4/03/07	S30-OC-11[a] 4/03/07
Acenaphthene	0.079 J	1 U	0.12 U	0.785 U, H	0.14	0.662 U, H	0.19 U	0.571 U, H
Acenaphthylene	0.03 J	1 U	0.12 U	0.785 U, H	0.12 U	0.662 U, H	0.19 U	0.571 U, H
Anthracene	0.23	0.227 J	0.14	0.329 J, H	0.24	0.208 J, H	0.33	0.344 J, H
Benzo(a)anthracene	2.6	0.761 J	1.2	0.872 H	1.8	0.783 H	2	1.77 H
Benzo(a)pyrene	3.2	0.888 J	1.7	1.21 H	1.9	0.865 H	2.6	2.39 H
Benzo(b)flouranthene	3.7	1.59	2.6	2.27 H	1.9	1.47 H	3.8	4.31 H
Benzo(e)pyrene	3.7	NA	1.6	NA	2	NA	2.1	NA
Benzo(g,h,i)perylene	3	1 R, M, LC, CV	1.8	0.83 R, H, LC	1.5	0.474 R, H, LC	2.4	0.91 R, H, LC, CV
Benzo(k)flouranthene	3	0.442 J	2.1	0.745 J, H	1.8	0.46 J, H	2.7	1.38 H
C1-Chrysene	7.8	NA	1.8	NA	6.6	NA	2	NA
C1-Florenes	0.35	NA	0.45	NA	0.45	NA	0.27	NA
C1-Flouran/Pyrenes	7.7	NA	2.2	NA	7.1	NA	3	NA
C1-Naphthalenes	0.39	NA	0.21	NA	0.17	NA	0.19 U	NA
C1-Phenan/Anthracenes	3.1	NA	1.7	NA	3	NA	1.3	NA
C2-Chrysene	9.8	NA	1.8	NA	8.3	NA	1.6	NA
C2-Florenes	1.3	NA	1.4	NA	1.7	NA	0.6	NA
C2-Naphthalenes	1.7	NA	1.7	NA	1.7	NA	0.53	NA
C2-Phenan/Anthracenes	5.8	NA	2.7	NA	7.2	NA	2.5	NA
C3-Chrysene	5.5	NA	1.2	NA	5.2	NA	0.88	NA
C3-Florenes	3.9	NA	2.8	NA	5.1	NA	1.6	NA
C3-Naphthalenes	2.4	NA	3.4	NA	4.3	NA	1.5	NA
C3-Phenan/Anthracenes	8.5	NA	2.9	NA	9.3	NA	3.3	NA
C4-Chrysene	2.1	NA	0.43	NA	2.8	NA	0.46	NA
C4-Naphthalenes	3	NA	4.1	NA	5	NA	1.7	NA
C4-Phenan/Anthracenes	5.6	NA	1.6	NA	5.5	NA	1.9	NA
Chrysene	5.1	1.77	2.1	1.76 H	2.9	1.24 H	3.3	3.11 H
Dibenz(a,h)anthracene	0.72	0.141 J	0.27	0.176 J, H	0.43	0.124 J, H	0.58	0.238 J, H
Flouranthene	4.2	1.92	3.5	2.94 H	3	1.82 H	6.4	5.87 H
Fluorene	0.15	0.163 J	0.2	0.303 J, H	0.2	0.142 J, H	0.19 U	0.146 J, H
Indeno(1,2,3-cd)pyrene	2.3	0.311 J	1.6	0.711 J, H	1.3	0.396 J, H	2.3	0.914 J, H, CV
Naphthalene	0.19	0.42 J	0.12 U	0.283 J, H	0.12 U	0.662 U, H	0.19 U	0.751 U, H
Perylene	0.92	NA	0.42	NA	0.64	NA	0.6	NA
Phenanthrene	1.2	1.13	0.84	1.13 H	0.98	0.824 H	1.7	4.84 H
Pyrene	4.9	2.02	3.3	2.57 H	4	1.89 H	5.3	3.82 H
TOTAL PAHs[b]	108	11.78	53.8	15.30	98	10.22	59	29.13

TABLE B-6
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - FULL-SCAN PAHs[a]
DUCK AND OTTER CREEKS
TOLEDO, OHIO

Parameter	Sample Number and Date Collected							
	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported	Full Scan	Regularly Reported
	S33-OC-14 4/03/07	S33-OC-14[a] 4/03/07	S38-OC-19 4/03/07	S38-OC-19[a] 4/03/07	S42-OC-22 4/03/07	S42-OC-22[a] 4/03/07	S46-OC-26 4/03/07	S46-OC-26[a] 4/03/07
Acenaphthene	0.12 U	0.586 U	0.22	0.18 J	1.5 U	1.63	0.18 U	0.599 U
Acenaphthylene	0.12 U	0.11 J	0.12 U	0.416 U	1.5 U	1.25 U	0.18 U	0.599 U
Anthracene	0.27	0.29 J	0.76	0.297 J	3.8	4.84	0.36	0.368 J
Benzo(a)anthracene	1.6	1.43	2.1	1.02	17	18.4	1.7	1.47
Benzo(a)pyrene	1.8	1.58	2	1.13	19	20	1.7	1.62
Benzo(b)flouranthene	2.7	2.52	2.4	1.67	26	24.7	2.5	2.64
Benzo(e)pyrene	1.5	NA	1.3	NA	13	NA	1.2	NA
Benzo(g,h,i)perylene	1.6	0.586 R, M, LC, CV	1.4	0.144 R, J, LC	15	8.39 R, LC	1.4	0.173 R, J, LC
Benzo(k)flouranthene	2	0.969	1.8	0.585	18	7.88	1.8	0.865
C1-Chrysene	1.3	NA	0.98	NA	7.2	NA	0.75	NA
C1-Florenes	0.12	NA	0.12 U	NA	1.5 U	NA	0.18 U	NA
C1-Flouran/Pyrenes	1.7	NA	1.6	NA	9.9	NA	1	NA
C1-Naphthalenes	0.12 U	NA	0.12 U	NA	1.5 U	NA	0.18 U	NA
C1-Phenan/Anthracenes	0.7	NA	0.85	NA	4.6	NA	0.52	NA
C2-Chrysene	0.82	NA	0.45	NA	2.7	NA	0.29	NA
C2-Florenes	0.29	NA	0.15	NA	1.5 U	NA	0.18 U	NA
C2-Naphthalenes	0.34	NA	0.36	NA	1.5 U	NA	0.18 U	NA
C2-Phenan/Anthracenes	0.74	NA	0.48	NA	1.6	NA	0.2	NA
C3-Chrysene	0.4	NA	0.18	NA	1.5 U	NA	0.18 U	NA
C3-Florenes	0.75	NA	0.38	NA	1.5 U	NA	0.18 U	NA
C3-Naphthalenes	0.59	NA	0.29	NA	1.5 U	NA	0.18 U	NA
C3-Phenan/Anthracenes	1.1	NA	0.54	NA	1.5 U	NA	0.18 U	NA
C4-Chrysene	0.18	NA	0.12 U	NA	1.5 U	NA	0.18 U	NA
C4-Naphthalenes	0.72	NA	0.39	NA	1.5 U	NA	0.18 U	NA
C4-Phenan/Anthracenes	0.62	NA	0.3	NA	1.5 U	NA	0.18 U	NA
Chrysene	2.4	2.26	2.3	1.34	19	22.9	2.1	2.01
Dibenz(a,h)anthracene	0.26	0.45 J, CV	0.34	0.174 J	2.9	4.53	0.32	0.217 J
Flouranthene	4.8	3.46	6	2.92	48	51.8	5.3	4.97
Fluorene	0.12	0.118 J	0.37	0.231 J	1.7	2.39	0.18 U	0.145 J
Indeno(1,2,3-cd)pyrene	1.6	1.73 CV	1.4	0.679	15	17.7	1.4	0.853
Naphthalene	0.12 U	0.109 J	0.12 U	0.824	1.5 U	0.265 J	0.18 U	0.599 U
Perylene	0.47	NA	0.49	NA	4.5	NA	0.42	NA
Phenanthrene	1.4	1.41	3.2	1.67	19	26.3	1.9	2.11
Pyrene	3.7	3.87	4.4	2.25	36	44.8	3.7	3.66
TOTAL PAHs[b]	37	20.31	37	14.97	284	248	29	20.93

Notes:

a EPA Central Regional Laboratory analytical results for 16 regularly reported PAHs (not full-scan) are also presented for comparison purposes. These results are also presented for all sampling locations in Table B-4.
b Non-detect results were counted as 0 when calculating total PAHs.

CV = Estimated value. Calibration verification results exceed upper or lower control limits.
H = Estimated value. Holding time exceeded.
IS = Estimated value. Internal standard recoveries exceed the upper or lower control limits.
J = Estimated value. Greater than detection limit, but less than reporting limit.
LC = Estimated value. Laboratory control recoveries exceed upper or lower control limits.
M = Estimated value. Associated matrix spike/matrix spike duplicate recoveries exceed the upper or lower control limits.
NA = Not analyzed
R = Rejected value
U = Analyte not detected at or above reporting limit.

All values expressed in milligrams per kilogram unless otherwise noted

TABLE B-7
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - AVS/SEM
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Parameter	Sample Number and Date Collected					
	DC-SED-01 4/05/07	DC-SED-03 4/05/07	DC-SED-05 4/05/07	DC-SED-08 4/05/07	DC-SED-10 4/05/07	DC-SED-13 4/05/07
Cadmium	0.0058 B	0.0085 B	0.011	0.0088	0.0049	0.0077
Copper	0.094 B	0.05 B	0.035	0.087	0.074	0.099
Lead	0.08	0.097	0.21	0.14	0.082	0.83
Nickel	0.1 B	0.065 B	0.24 B	0.18 B	0.09 B	0.14 B
Silver	0.012 M, MS	0.011 M, MS	0.023 M, MS	0.039 M, MS	0.019 M, MS	0.014 M, MS
Zinc	1 SD	0.79 SD	2.9 SD	1.7 SD	0.77 SD	0.83 SD
Mercury	0.00018 M	0.00016 M	0.00035 M	0.0006 M	0.00028 M	0.00021 M
Total SEM	1.29198	1.02166	3.41935	2.1554	1.04018	1.92091
Acid Volatile Sulfide	8.7 M	10.3 M	59.3 M	76.4 M	11.3 M	20.3 M
Ratio of SEM*/AVS	0.15	0.097	0.057	0.027	0.088	0.094
Acid Volatile Sulfide (mg/kg)	279	329	1900	2450	361	652

TABLE B-7
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - AVS/SEM
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Parameter	Sample Number and Date Collected					
	DC-SED-14 4/05/07	OC-SED-01 4/05/07	OC-SED-03 4/05/07	OC-SED-05 4/05/07	OC-SED-07 4/05/07	OC-SED-11 4/05/07
Cadmium	0.0038	0.0028 B	0.0071 B	0.0072	0.006	0.0073
Copper	0.025 U	0.23	0.67	0.62	0.33	0.052
Lead	0.14	0.09	0.31	0.31	0.32	0.33
Nickel	0.055 B	0.087 B	0.22 B	0.22 B	0.21 B	0.25 B
Silver	0.019 M, MS	0.013 M, MS	0.02 M, MS	0.019 M, MS	0.019 M, MS	0.019 M, MS
Zinc	0.99 SD	0.76 SD	2.6 SD	2.7 SD	1 SD	2.9 SD
Mercury	0.00029 M	0.00019 M	0.00031 M	0.00029 M	0.00029 M	0.00029 M
Total SEM	1.23309	1.18299	3.82741	3.87649	1.88529	3.55859
Acid Volatile Sulfide	21.9 M	2.5 M	17.6 M	14 M	23.4 M	32.1 M
Ratio of SEM*/AVS	0.055	0.48	0.22	0.28	0.12	0.11
Acid Volatile Sulfide (mg/kg)	702	80.1	565	450	749	1030

TABLE B-7
SUMMARY OF SEDIMENT SAMPLE ANALYTICAL RESULTS - AVS/SEM
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Parameter	Sample Number and Date Collected			
	OC-SED-14 4/05/07	OC-SED-19 4/05/07	OC-SED-22 4/05/07	OC-SED-26 4/05/07
Cadmium	0.006	0.0028	0.0062	0.0043
Copper	0.27	0.18	0.016 U	0.17
Lead	0.36	0.13	0.22	0.17
Nickel	0.24 B	0.11 B	0.12 B	0.22 B
Silver	0.014 M, MS	0.0093 M, MS	0.012 M, MS	0.015 F, MS
Zinc	2.1 SD	1.3 SD	2.6 SD	1.1 F, CV
Mercury	0.0002 M	0.00014 M	0.00018 M	0.00022 F, MS
Total SEM	2.9902	1.73224	2.97438	1.67952
Acid Volatile Sulfide	16.9 M	8.7 M	39 M	7.2 M
Ratio of SEM*/AVS	0.18	0.2	0.074	0.24
Acid Volatile Sulfide (mg/kg)	543	280	1250	231

Notes:

AVS = Acid volatile sulfide
B = Result is less than reporting limit but greater than instrument detection limit.
CV = Estimated value. Calibration verification results exceed upper or lower control limits.
F = Estimated value. Relative Percent Difference of field duplicates/replicates exceeds criteria.
mg/kg = Milligrams per kilogram
M = Estimated value. Associated MS/MSD recoveries exceed the upper or lower control limits.
MS = Estimated value. RPD between MS/MSD exceeded specified criteria.
SD = Estimated value. Serial dilution exceeds specified criteria.
SEM = Simultaneously extracted metals

All results expressed in micromoles per gram unless otherwise noted

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S01-DC-01	Sieve 3/8	25.9	Gravel
S01-DC-01	Sieve 4	11.1	Sand
S01-DC-01	Sieve 10	9.3	Sand
S01-DC-01	Sieve 16	5.7	Sand
S01-DC-01	Sieve 35	11.0	Sand
S01-DC-01	Sieve 50	7.3	Sand
S01-DC-01	Sieve 100	9.0	Sand
S01-DC-01	Sieve 200	1.1	Silt and Clay
S01-DC-01	Pan and Wash through 200 Sieve	19.6	Silt and Clay
S02-DC-02	Sieve 3/8	2.3	Gravel
S02-DC-02	Sieve 4	0.7	Sand
S02-DC-02	Sieve 10	1.2	Sand
S02-DC-02	Sieve 16	0.8	Sand
S02-DC-02	Sieve 35	1.3	Sand
S02-DC-02	Sieve 50	1.7	Sand
S02-DC-02	Sieve 100	3.4	Sand
S02-DC-02	Sieve 200	4.7	Silt and Clay
S02-DC-02	Pan and Wash through 200 Sieve	83.9	Silt and Clay
S03-DC-03	Sieve 3/8	0.0	Gravel
S03-DC-03	Sieve 4	1.5	Sand
S03-DC-03	Sieve 10	8.6	Sand
S03-DC-03	Sieve 16	5.7	Sand
S03-DC-03	Sieve 35	14.6	Sand
S03-DC-03	Sieve 50	12.7	Sand
S03-DC-03	Sieve 100	34.7	Sand
S03-DC-03	Sieve 200	9.8	Silt and Clay
S03-DC-03	Pan and Wash through 200 Sieve	12.4	Silt and Clay
S04-DC-04	Sieve 3/8	0.2	Gravel
S04-DC-04	Sieve 4	0.6	Sand
S04-DC-04	Sieve 10	1.1	Sand
S04-DC-04	Sieve 16	1.1	Sand
S04-DC-04	Sieve 35	1.9	Sand
S04-DC-04	Sieve 50	1.4	Sand
S04-DC-04	Sieve 100	3.4	Sand
S04-DC-04	Sieve 200	1.4	Silt and Clay
S04-DC-04	Pan and Wash through 200 Sieve	88.9	Silt and Clay
S05-DC-05	Sieve 3/8	0.0	Gravel
S05-DC-05	Sieve 4	0.2	Sand
S05-DC-05	Sieve 10	0.9	Sand
S05-DC-05	Sieve 16	0.8	Sand
S05-DC-05	Sieve 35	1.0	Sand
S05-DC-05	Sieve 50	1.2	Sand
S05-DC-05	Sieve 100	1.5	Sand
S05-DC-05	Sieve 200	1.8	Silt and Clay
S05-DC-05	Pan and Wash through 200 Sieve	92.6	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S06-DC-06	Sieve 3/8	2.1	Gravel
S06-DC-06	Sieve 4	2.4	Sand
S06-DC-06	Sieve 10	3.3	Sand
S06-DC-06	Sieve 16	2.5	Sand
S06-DC-06	Sieve 35	6.5	Sand
S06-DC-06	Sieve 50	4.6	Sand
S06-DC-06	Sieve 100	9.9	Sand
S06-DC-06	Sieve 200	13.4	Silt and Clay
S06-DC-06	Pan and Wash through 200 Sieve	55.3	Silt and Clay
S07-DC-07	Sieve 3/8	2.6	Gravel
S07-DC-07	Sieve 4	1.4	Sand
S07-DC-07	Sieve 10	2.1	Sand
S07-DC-07	Sieve 16	1.7	Sand
S07-DC-07	Sieve 35	2.5	Sand
S07-DC-07	Sieve 50	2.8	Sand
S07-DC-07	Sieve 100	3.9	Sand
S07-DC-07	Sieve 200	3.5	Silt and Clay
S07-DC-07	Pan and Wash through 200 Sieve	79.5	Silt and Clay
S08-DC-08	Sieve 3/8	0.0	Gravel
S08-DC-08	Sieve 4	0.3	Sand
S08-DC-08	Sieve 10	1.1	Sand
S08-DC-08	Sieve 16	0.9	Sand
S08-DC-08	Sieve 35	-0.8	Sand
S08-DC-08	Sieve 50	1.1	Sand
S08-DC-08	Sieve 100	1.6	Sand
S08-DC-08	Sieve 200	1.3	Silt and Clay
S08-DC-08	Pan and Wash through 200 Sieve	94.5	Silt and Clay
S09-DC-09	Sieve 3/8	0.0	Gravel
S09-DC-09	Sieve 4	2.0	Sand
S09-DC-09	Sieve 10	3.7	Sand
S09-DC-09	Sieve 16	3.1	Sand
S09-DC-09	Sieve 35	5.6	Sand
S09-DC-09	Sieve 50	6.2	Sand
S09-DC-09	Sieve 100	9.2	Sand
S09-DC-09	Sieve 200	10.9	Silt and Clay
S09-DC-09	Pan and Wash through 200 Sieve	59.3	Silt and Clay
S10-DC-10	Sieve 3/8	0.0	Gravel
S10-DC-10	Sieve 4	0.2	Sand
S10-DC-10	Sieve 10	0.7	Sand
S10-DC-10	Sieve 16	0.6	Sand
S10-DC-10	Sieve 35	1.6	Sand
S10-DC-10	Sieve 50	1.1	Sand
S10-DC-10	Sieve 100	2.4	Sand
S10-DC-10	Sieve 200	1.4	Silt and Clay
S10-DC-10	Pan and Wash through 200 Sieve	92.0	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S11-DC-11	Sieve 3/8	0.0	Gravel
S11-DC-11	Sieve 4	0.0	Sand
S11-DC-11	Sieve 10	0.2	Sand
S11-DC-11	Sieve 16	0.3	Sand
S11-DC-11	Sieve 35	0.3	Sand
S11-DC-11	Sieve 50	0.3	Sand
S11-DC-11	Sieve 100	0.6	Sand
S11-DC-11	Sieve 200	1.4	Silt and Clay
S11-DC-11	Pan and Wash through 200 Sieve	96.9	Silt and Clay
S12-DC-12	Sieve 3/8	0.1	Gravel
S12-DC-12	Sieve 4	2.1	Sand
S12-DC-12	Sieve 10	4.4	Sand
S12-DC-12	Sieve 16	3.2	Sand
S12-DC-12	Sieve 35	6.1	Sand
S12-DC-12	Sieve 50	3.1	Sand
S12-DC-12	Sieve 100	4.0	Sand
S12-DC-12	Sieve 200	0.3	Silt and Clay
S12-DC-12	Pan and Wash through 200 Sieve	76.7	Silt and Clay
S13-DC-13	Sieve 3/8	9.0	Gravel
S13-DC-13	Sieve 4	6.3	Sand
S13-DC-13	Sieve 10	4.8	Sand
S13-DC-13	Sieve 16	3.1	Sand
S13-DC-13	Sieve 35	4.6	Sand
S13-DC-13	Sieve 50	6.5	Sand
S13-DC-13	Sieve 100	11.1	Sand
S13-DC-13	Sieve 200	14.0	Silt and Clay
S13-DC-13	Pan and Wash through 200 Sieve	40.6	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S14-DC-14	Sieve 3/8	4.0	Gravel
S14-DC-14	Sieve 4	12.5	Sand
S14-DC-14	Sieve 10	15.5	Sand
S14-DC-14	Sieve 16	7.2	Sand
S14-DC-14	Sieve 35	13.7	Sand
S14-DC-14	Sieve 50	10.4	Sand
S14-DC-14	Sieve 100	17.8	Sand
S14-DC-14	Sieve 200	3.4	Silt and Clay
S14-DC-14	Pan and Wash through 200 Sieve	15.5	Silt and Clay
S15-DC-15	Sieve 3/8	4.9	Gravel
S15-DC-15	Sieve 4	9.5	Sand
S15-DC-15	Sieve 10	9.1	Sand
S15-DC-15	Sieve 16	5.0	Sand
S15-DC-15	Sieve 35	8.0	Sand
S15-DC-15	Sieve 50	11.0	Sand
S15-DC-15	Sieve 100	14.7	Sand
S15-DC-15	Sieve 200	13.3	Silt and Clay
S15-DC-15	Pan and Wash through 200 Sieve	24.5	Silt and Clay
S16-DC-16	Sieve 3/8	0.1	Gravel
S16-DC-16	Sieve 4	0.0	Sand
S16-DC-16	Sieve 10	0.0	Sand
S16-DC-16	Sieve 16	0.0	Sand
S16-DC-16	Sieve 35	0.1	Sand
S16-DC-16	Sieve 50	0.2	Sand
S16-DC-16	Sieve 100	0.3	Sand
S16-DC-16	Sieve 200	0.0	Silt and Clay
S16-DC-16	Pan and Wash through 200 Sieve	99.4	Silt and Clay
S17-DC-17	Sieve 3/8	0.0	Gravel
S17-DC-17	Sieve 4	0.0	Sand
S17-DC-17	Sieve 10	0.0	Sand
S17-DC-17	Sieve 16	0.0	Sand
S17-DC-17	Sieve 35	0.0	Sand
S17-DC-17	Sieve 50	0.0	Sand
S17-DC-17	Sieve 100	0.1	Sand
S17-DC-17	Sieve 200	0.1	Silt and Clay
S17-DC-17	Pan and Wash through 200 Sieve	99.8	Silt and Clay
S18-DC-18	Sieve 3/8	0.0	Gravel
S18-DC-18	Sieve 4	0.0	Sand
S18-DC-18	Sieve 10	0.0	Sand
S18-DC-18	Sieve 16	0.0	Sand
S18-DC-18	Sieve 35	0.0	Sand
S18-DC-18	Sieve 50	0.0	Sand
S18-DC-18	Sieve 100	0.5	Sand
S18-DC-18	Sieve 200	0.3	Silt and Clay
S18-DC-18	Pan and Wash through 200 Sieve	99.2	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S19-DC-19	Sieve 3/8	0.4	Gravel
S19-DC-19	Sieve 4	3.3	Sand
S19-DC-19	Sieve 10	6.9	Sand
S19-DC-19	Sieve 16	4.0	Sand
S19-DC-19	Sieve 35	9.4	Sand
S19-DC-19	Sieve 50	9.1	Sand
S19-DC-19	Sieve 100	17.9	Sand
S19-DC-19	Sieve 200	0.3	Silt and Clay
S19-DC-19	Pan and Wash through 200 Sieve	48.7	Silt and Clay
S20-OC-01	Sieve 3/8	3.4	Gravel
S20-OC-01	Sieve 4	2.3	Sand
S20-OC-01	Sieve 10	1.0	Sand
S20-OC-01	Sieve 16	0.5	Sand
S20-OC-01	Sieve 35	0.0	Sand
S20-OC-01	Sieve 50	2.6	Sand
S20-OC-01	Sieve 100	17.1	Sand
S20-OC-01	Sieve 200	32.6	Silt and Clay
S20-OC-01	Pan and Wash through 200 Sieve	40.5	Silt and Clay
S21-OC-02	Sieve 3/8	0.0	Gravel
S21-OC-02	Sieve 4	0.1	Sand
S21-OC-02	Sieve 10	0.9	Sand
S21-OC-02	Sieve 16	0.5	Sand
S21-OC-02	Sieve 35	0.6	Sand
S21-OC-02	Sieve 50	0.9	Sand
S21-OC-02	Sieve 100	0.6	Sand
S21-OC-02	Sieve 200	0.1	Silt and Clay
S21-OC-02	Pan and Wash through 200 Sieve	96.4	Silt and Clay
S22-OC-03	Sieve 3/8	-0.5	Gravel
S22-OC-03	Sieve 4	0.9	Sand
S22-OC-03	Sieve 10	0.9	Sand
S22-OC-03	Sieve 16	1.1	Sand
S22-OC-03	Sieve 35	3.1	Sand
S22-OC-03	Sieve 50	2.6	Sand
S22-OC-03	Sieve 100	1.7	Sand
S22-OC-03	Sieve 200	8.4	Silt and Clay
S22-OC-03	Pan and Wash through 200 Sieve	81.8	Silt and Clay
S23-OC-04	Sieve 3/8	0.0	Gravel
S23-OC-04	Sieve 4	0.0	Sand
S23-OC-04	Sieve 10	0.1	Sand
S23-OC-04	Sieve 16	0.1	Sand
S23-OC-04	Sieve 35	0.1	Sand
S23-OC-04	Sieve 50	0.1	Sand
S23-OC-04	Sieve 100	0.3	Sand
S23-OC-04	Sieve 200	0.5	Silt and Clay
S23-OC-04	Pan and Wash through 200 Sieve	98.9	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S24-OC-05	Sieve 3/8	0.0	Gravel
S24-OC-05	Sieve 4	0.0	Sand
S24-OC-05	Sieve 10	0.1	Sand
S24-OC-05	Sieve 16	0.2	Sand
S24-OC-05	Sieve 35	0.8	Sand
S24-OC-05	Sieve 50	0.5	Sand
S24-OC-05	Sieve 100	0.1	Sand
S24-OC-05	Sieve 200	4.5	Silt and Clay
S24-OC-05	Pan and Wash through 200 Sieve	93.8	Silt and Clay
S25-OC-06	Sieve 3/8	-0.4	Gravel
S25-OC-06	Sieve 4	0.0	Sand
S25-OC-06	Sieve 10	-0.1	Sand
S25-OC-06	Sieve 16	0.2	Sand
S25-OC-06	Sieve 35	0.3	Sand
S25-OC-06	Sieve 50	0.1	Sand
S25-OC-06	Sieve 100	0.3	Sand
S25-OC-06	Sieve 200	2.2	Silt and Clay
S25-OC-06	Pan and Wash through 200 Sieve	97.4	Silt and Clay
S26-OC-07	Sieve 3/8	2.0	Gravel
S26-OC-07	Sieve 4	6.3	Sand
S26-OC-07	Sieve 10	6.0	Sand
S26-OC-07	Sieve 16	4.1	Sand
S26-OC-07	Sieve 35	7.7	Sand
S26-OC-07	Sieve 50	14.9	Sand
S26-OC-07	Sieve 100	14.0	Sand
S26-OC-07	Sieve 200	6.5	Silt and Clay
S26-OC-07	Pan and Wash through 200 Sieve	38.5	Silt and Clay
S27-OC-08	Sieve 3/8	0.0	Gravel
S27-OC-08	Sieve 4	0.7	Sand
S27-OC-08	Sieve 10	2.2	Sand
S27-OC-08	Sieve 16	3.1	Sand
S27-OC-08	Sieve 35	13.9	Sand
S27-OC-08	Sieve 50	11.3	Sand
S27-OC-08	Sieve 100	5.2	Sand
S27-OC-08	Sieve 200	25.5	Silt and Clay
S27-OC-08	Pan and Wash through 200 Sieve	38.1	Silt and Clay
S28-OC-09	Sieve 3/8	0.0	Gravel
S28-OC-09	Sieve 4	1.8	Sand
S28-OC-09	Sieve 10	5.3	Sand
S28-OC-09	Sieve 16	5.5	Sand
S28-OC-09	Sieve 35	9.5	Sand
S28-OC-09	Sieve 50	15.1	Sand
S28-OC-09	Sieve 100	15.3	Sand
S28-OC-09	Sieve 200	11.8	Silt and Clay
S28-OC-09	Pan and Wash through 200 Sieve	35.7	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S29-OC-10	Sieve 3/8	0.6	Gravel
S29-OC-10	Sieve 4	5.0	Sand
S29-OC-10	Sieve 10	8.7	Sand
S29-OC-10	Sieve 16	7.5	Sand
S29-OC-10	Sieve 35	13.3	Sand
S29-OC-10	Sieve 50	15.0	Sand
S29-OC-10	Sieve 100	12.7	Sand
S29-OC-10	Sieve 200	9.5	Silt and Clay
S29-OC-10	Pan and Wash through 200 Sieve	27.7	Silt and Clay
S30-OC-11	Sieve 3/8	0.0	Gravel
S30-OC-11	Sieve 4	0.5	Sand
S30-OC-11	Sieve 10	3.4	Sand
S30-OC-11	Sieve 16	3.8	Sand
S30-OC-11	Sieve 35	5.2	Sand
S30-OC-11	Sieve 50	6.1	Sand
S30-OC-11	Sieve 100	15.0	Sand
S30-OC-11	Sieve 200	18.6	Silt and Clay
S30-OC-11	Pan and Wash through 200 Sieve	47.4	Silt and Clay
S31-OC-12	Sieve 3/8	0.0	Gravel
S31-OC-12	Sieve 4	3.0	Sand
S31-OC-12	Sieve 10	4.1	Sand
S31-OC-12	Sieve 16	5.7	Sand
S31-OC-12	Sieve 35	21.6	Sand
S31-OC-12	Sieve 50	12.9	Sand
S31-OC-12	Sieve 100	1.8	Sand
S31-OC-12	Sieve 200	20.4	Silt and Clay
S31-OC-12	Pan and Wash through 200 Sieve	30.5	Silt and Clay
S32-OC-13	Sieve 3/8	0.0	Gravel
S32-OC-13	Sieve 4	0.9	Sand
S32-OC-13	Sieve 10	4.8	Sand
S32-OC-13	Sieve 16	5.7	Sand
S32-OC-13	Sieve 35	17.6	Sand
S32-OC-13	Sieve 50	12.5	Sand
S32-OC-13	Sieve 100	8.9	Sand
S32-OC-13	Sieve 200	19.3	Silt and Clay
S32-OC-13	Pan and Wash through 200 Sieve	30.3	Silt and Clay
S33-OC-14	Sieve 3/8	0.0	Gravel
S33-OC-14	Sieve 4	3.2	Sand
S33-OC-14	Sieve 10	6.6	Sand
S33-OC-14	Sieve 16	5.0	Sand
S33-OC-14	Sieve 35	9.2	Sand
S33-OC-14	Sieve 50	13.7	Sand
S33-OC-14	Sieve 100	15.8	Sand
S33-OC-14	Sieve 200	9.5	Silt and Clay
S33-OC-14	Pan and Wash through 200 Sieve	37.0	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S34-OC-15	Sieve 3/8	0.3	Gravel
S34-OC-15	Sieve 4	3.7	Sand
S34-OC-15	Sieve 10	15.1	Sand
S34-OC-15	Sieve 16	11.5	Sand
S34-OC-15	Sieve 35	21.7	Sand
S34-OC-15	Sieve 50	9.0	Sand
S34-OC-15	Sieve 100	0.7	Sand
S34-OC-15	Sieve 200	13.6	Silt and Clay
S34-OC-15	Pan and Wash through 200 Sieve	24.4	Silt and Clay
S35-OC-16	Sieve 3/8	0.0	Gravel
S35-OC-16	Sieve 4	8.5	Sand
S35-OC-16	Sieve 10	11.3	Sand
S35-OC-16	Sieve 16	7.3	Sand
S35-OC-16	Sieve 35	13.8	Sand
S35-OC-16	Sieve 50	10.1	Sand
S35-OC-16	Sieve 100	1.2	Sand
S35-OC-16	Sieve 200	17.9	Silt and Clay
S35-OC-16	Pan and Wash through 200 Sieve	29.9	Silt and Clay
S36-OC-17	Sieve 3/8	1.2	Gravel
S36-OC-17	Sieve 4	1.6	Sand
S36-OC-17	Sieve 10	6.8	Sand
S36-OC-17	Sieve 16	8.2	Sand
S36-OC-17	Sieve 35	19.2	Sand
S36-OC-17	Sieve 50	25.0	Sand
S36-OC-17	Sieve 100	17.4	Sand
S36-OC-17	Sieve 200	7.1	Silt and Clay
S36-OC-17	Pan and Wash through 200 Sieve	13.5	Silt and Clay
S37-OC-18	Sieve 3/8	3.5	Gravel
S37-OC-18	Sieve 4	0.9	Sand
S37-OC-18	Sieve 10	3.0	Sand
S37-OC-18	Sieve 16	1.9	Sand
S37-OC-18	Sieve 35	10.6	Sand
S37-OC-18	Sieve 50	24.4	Sand
S37-OC-18	Sieve 100	4.2	Sand
S37-OC-18	Sieve 200	33.8	Silt and Clay
S37-OC-18	Pan and Wash through 200 Sieve	17.7	Silt and Clay
S38-OC-19	Sieve 3/8	3.0	Gravel
S38-OC-19	Sieve 4	1.9	Sand
S38-OC-19	Sieve 10	11.7	Sand
S38-OC-19	Sieve 16	13.5	Sand
S38-OC-19	Sieve 35	23.4	Sand
S38-OC-19	Sieve 50	12.6	Sand
S38-OC-19	Sieve 100	16.2	Sand
S38-OC-19	Sieve 200	1.9	Silt and Clay
S38-OC-19	Pan and Wash through 200 Sieve	15.8	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S39-OC-20	Sieve 3/8	2.4	Gravel
S39-OC-20	Sieve 4	2.1	Sand
S39-OC-20	Sieve 10	9.2	Sand
S39-OC-20	Sieve 16	10.5	Sand
S39-OC-20	Sieve 35	22.8	Sand
S39-OC-20	Sieve 50	13.0	Sand
S39-OC-20	Sieve 100	7.1	Sand
S39-OC-20	Sieve 200	8.9	Silt and Clay
S39-OC-20	Pan and Wash through 200 Sieve	24.0	Silt and Clay
S40-OC-21	Sieve 3/8	0.3	Gravel
S40-OC-21	Sieve 4	2.5	Sand
S40-OC-21	Sieve 10	4.4	Sand
S40-OC-21	Sieve 16	5.9	Sand
S40-OC-21	Sieve 35	12.9	Sand
S40-OC-21	Sieve 50	16.7	Sand
S40-OC-21	Sieve 100	17.5	Sand
S40-OC-21	Sieve 200	15.3	Silt and Clay
S40-OC-21	Pan and Wash through 200 Sieve	24.5	Silt and Clay
S41-OC-21A	Sieve 3/8	0.0	Gravel
S41-OC-21A	Sieve 4	0.5	Sand
S41-OC-21A	Sieve 10	1.5	Sand
S41-OC-21A	Sieve 16	1.7	Sand
S41-OC-21A	Sieve 35	5.1	Sand
S41-OC-21A	Sieve 50	4.5	Sand
S41-OC-21A	Sieve 100	4.8	Sand
S41-OC-21A	Sieve 200	19.8	Silt and Clay
S41-OC-21A	Pan and Wash through 200 Sieve	62.1	Silt and Clay
S42-OC-22	Sieve 3/8	0.0	Gravel
S42-OC-22	Sieve 4	1.6	Sand
S42-OC-22	Sieve 10	7.3	Sand
S42-OC-22	Sieve 16	7.1	Sand
S42-OC-22	Sieve 35	9.4	Sand
S42-OC-22	Sieve 50	12.3	Sand
S42-OC-22	Sieve 100	37.6	Sand
S42-OC-22	Sieve 200	10.0	Silt and Clay
S42-OC-22	Pan and Wash through 200 Sieve	14.7	Silt and Clay
S43-OC-23	Sieve 3/8	16.6	Gravel
S43-OC-23	Sieve 4	5.0	Sand
S43-OC-23	Sieve 10	4.2	Sand
S43-OC-23	Sieve 16	3.7	Sand
S43-OC-23	Sieve 35	10.3	Sand
S43-OC-23	Sieve 50	8.1	Sand
S43-OC-23	Sieve 100	7.6	Sand
S43-OC-23	Sieve 200	16.1	Silt and Clay
S43-OC-23	Pan and Wash through 200 Sieve	28.4	Silt and Clay

TABLE B-8
SEDIMENT GRAIN SIZE ANALYSIS
DUCK AND OTTER CREEKS
TOLEDO AND OREGON, OHIO

Sample Name	Sieve No.	Percent Retained	Soil Classification
S44-OC-24	Sieve 3/8	0.0	Gravel
S44-OC-24	Sieve 4	0.3	Sand
S44-OC-24	Sieve 10	1.1	Sand
S44-OC-24	Sieve 16	1.0	Sand
S44-OC-24	Sieve 35	1.6	Sand
S44-OC-24	Sieve 50	2.6	Sand
S44-OC-24	Sieve 100	13.4	Sand
S44-OC-24	Sieve 200	36.0	Silt and Clay
S44-OC-24	Pan and Wash through 200 Sieve	44.0	Silt and Clay
S45-OC-25	Sieve 3/8	5.7	Gravel
S45-OC-25	Sieve 4	12.8	Sand
S45-OC-25	Sieve 10	12.8	Sand
S45-OC-25	Sieve 16	5.4	Sand
S45-OC-25	Sieve 35	10.5	Sand
S45-OC-25	Sieve 50	8.2	Sand
S45-OC-25	Sieve 100	14.8	Sand
S45-OC-25	Sieve 200	0.5	Silt and Clay
S45-OC-25	Pan and Wash through 200 Sieve	29.3	Silt and Clay
S46-OC-26	Sieve 3/8	0.0	Gravel
S46-OC-26	Sieve 4	0.0	Sand
S46-OC-26	Sieve 10	1.7	Sand
S46-OC-26	Sieve 16	3.6	Sand
S46-OC-26	Sieve 35	8.2	Sand
S46-OC-26	Sieve 50	9.9	Sand
S46-OC-26	Sieve 100	10.5	Sand
S46-OC-26	Sieve 200	10.2	Silt and Clay
S46-OC-26	Pan and Wash through 200 Sieve	55.9	Silt and Clay

Appendix N

Summary of Statistical Test Results

Descriptive Statistics: Friday, February 17, 2012, 7:43:19 PM

Data source: scaled biomass Data 1 in growth data_no Planaria

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
AD-1 scaled biomass	8	1	1.020	0.350	0.132	0.324
GC-1 scaled biomass	10	0	0.815	0.333	0.105	0.238
DC-3 scaled biomass	8	1	0.897	0.300	0.114	0.278
DC-5 scaled biomass	8	1	0.786	0.127	0.0481	0.118
DC-6/7 scaled biomass	8	0	0.690	0.171	0.0604	0.143
DC-11/12 scaled biomass	8	0	0.542	0.142	0.0502	0.119

Column	Range	Max	Min	Median	25%	75%
AD-1 scaled biomass	1.020	1.549	0.529	1.090	0.677	1.247
GC-1 scaled biomass	1.086	1.278	0.192	0.824	0.576	1.081
DC-3 scaled biomass	0.775	1.176	0.400	1.015	0.568	1.140
DC-5 scaled biomass	0.314	0.954	0.639	0.763	0.674	0.952
DC-6/7 scaled biomass	0.522	1.055	0.533	0.689	0.543	0.746
DC-11/12 scaled biomass	0.421	0.737	0.316	0.504	0.456	0.694

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
AD-1 scaled biomass	0.0128	-0.613	0.152	0.736	0.979	0.954
GC-1 scaled biomass	-0.391	-0.0974	0.0898	0.802	0.977	0.946
DC-3 scaled biomass	-0.980	-0.605	0.224	0.333	0.863	0.162
DC-5 scaled biomass	0.496	-1.453	0.191	0.537	0.893	0.293
DC-6/7 scaled biomass	1.508	2.868	0.238	0.199	0.829	0.058
DC-11/12 scaled biomass	0.0468	-0.534	0.217	0.309	0.939	0.599

Column	Sum	Sum of Squares
AD-1 scaled biomass	7.137	8.011
GC-1 scaled biomass	8.150	7.639
DC-3 scaled biomass	6.278	6.172
DC-5 scaled biomass	5.499	4.417
DC-6/7 scaled biomass	5.518	4.011
DC-11/12 scaled biomass	4.335	2.491

Descriptive Statistics: Friday, February 17, 2012, 8:16:27 PM

Data source: scaled biomass Data 1 in growth data_no Planaria

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
OC-4 scaled biomass	8	1	0.0853	0.0317	0.0120	0.0293
OC-5A-01 scaled biomass	8	0	0.196	0.116	0.0411	0.0972
OC-6/7 scaled biomass	8	1	0.877	0.170	0.0641	0.157
OC-9-10 scaled biomass	8	1	0.492	0.125	0.0471	0.115
OC-12/13 scaled biomass	8	1	0.893	0.0793	0.0300	0.0734
OC-16 scaled biomass	7	0	0.841	0.182	0.0687	0.168
OC-22 scaled biomass	8	0	0.855	0.223	0.0790	0.187
OC-24/25 scaled biomass	8	0	0.807	0.318	0.112	0.266

Column	Range	Max	Min	Median	25%	75%
OC-4 scaled biomass	0.0907	0.120	0.0294	0.0912	0.0676	0.118
OC-5A-01 scaled biomass	0.374	0.418	0.0442	0.220	0.0921	0.233
OC-6/7 scaled biomass	0.502	1.137	0.635	0.905	0.688	0.960
OC-9-10 scaled biomass	0.355	0.597	0.242	0.526	0.458	0.596
OC-12/13 scaled biomass	0.224	1.025	0.801	0.865	0.834	0.973
OC-16 scaled biomass	0.562	1.175	0.613	0.831	0.714	0.948
OC-22 scaled biomass	0.674	1.150	0.476	0.836	0.698	1.076
OC-24/25 scaled biomass	1.039	1.239	0.200	0.806	0.653	1.046

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
OC-4 scaled biomass	-0.753	0.408	0.145	0.757	0.935	0.591
OC-5A-01 scaled biomass	0.680	1.009	0.249	0.152	0.911	0.363
OC-6/7 scaled biomass	-0.130	-0.134	0.231	0.293	0.936	0.602
OC-9-10 scaled biomass	-1.573	2.718	0.249	0.209	0.829	0.079
OC-12/13 scaled biomass	0.789	-0.403	0.213	0.397	0.930	0.547
OC-16 scaled biomass	0.940	1.286	0.203	0.460	0.949	0.717
OC-22 scaled biomass	-0.300	-0.157	0.182	0.534	0.954	0.751
OC-24/25 scaled biomass	-0.745	1.065	0.173	0.594	0.957	0.781

Column	Sum	Sum of Squares
OC-4 scaled biomass	0.597	0.0570
OC-5A-01 scaled biomass	1.569	0.402
OC-6/7 scaled biomass	6.138	5.555
OC-9-10 scaled biomass	3.444	1.788
OC-12/13 scaled biomass	6.254	5.625
OC-16 scaled biomass	5.887	5.149
OC-22 scaled biomass	6.840	6.197
OC-24/25 scaled biomass	6.458	5.922

t-test Friday, February 17, 2012, 7:37:22 PM

Data source: scaled biomass Data 1 in growth data_no Planaria

Normality Test (Shapiro-Wilk) Passed (P = 0.951)

Equal Variance Test: Passed (P = 0.579)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
AD-1 scaled biomass	8	1	1.020	0.350	0.132
GC-1 scaled biomass	10	0	0.815	0.333	0.105

Difference 0.205

t = 1.222 with 15 degrees of freedom.

95 percent two-tailed confidence interval for difference of means: -0.152 to 0.561

Two-tailed P-value = 0.241

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.241).

One-tailed P-value = 0.120

The sample mean of group AD-1 scaled biomass does not exceed the sample mean of the group GC-1 scaled biomass by an amount great enough to exclude the possibility that the difference is due to random sampling variability. The hypothesis that the population mean of group GC-1 scaled biomass is greater than or equal to the population mean of group AD-1 scaled biomass cannot be rejected. (P = 0.120).

Power of performed two-tailed test with alpha = 0.050: 0.208

The power of the performed test (0.208) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

Power of performed one-tailed test with alpha = 0.050: 0.316

The power of the performed test (0.316) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

One Way Analysis of Variance Friday, February 17, 2012, 7:38:56 PM

Data source: scaled biomass Data 1 in growth data_no Planaria

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Friday, February 17, 2012, 7:38:56 PM

Data source: scaled biomass Data 1 in growth data_no Planaria

Group	N	Missing	Median	25%	75%
AD-1 scaled biomass	8	1	1.090	0.677	1.247
GC-1 scaled biomass	10	0	0.824	0.576	1.081
OC-4 scaled biomass	8	1	0.0912	0.0676	0.118
OC-5A-01 scaled biomass	8	0	0.220	0.0921	0.233
OC-6/7 scaled biomass	8	1	0.905	0.688	0.960
OC-9-10 scaled biomass	8	1	0.526	0.458	0.596
OC-12/13 scaled biomass	8	1	0.865	0.834	0.973
OC-16 scaled biomass	7	0	0.831	0.714	0.948
OC-22 scaled biomass	8	0	0.836	0.698	1.076
OC-24/25 scaled biomass	8	0	0.806	0.653	1.046
DC-3 scaled biomass	8	1	1.015	0.568	1.140
DC-5 scaled biomass	8	1	0.763	0.674	0.952
DC-6/7 scaled biomass	8	0	0.689	0.543	0.746
DC-11/12 scaled biomass	8	0	0.504	0.456	0.694

H = 58.920 with 13 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

All Pairwise Multiple Comparison Procedures (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
AD-1 scaled b vs OC-4 scaled b	73.500	4.473	Yes
AD-1 scaled b vs OC-5A-01 scal	67.188	4.223	Yes
AD-1 scaled b vs OC-9-10 scale	50.714	3.086	No
AD-1 scaled b vs DC-11/12 scal	45.375	2.852	Do Not Test
AD-1 scaled b vs DC-6/7 scaled	30.000	1.885	Do Not Test
AD-1 scaled b vs DC-5 scaled b	17.714	1.078	Do Not Test
AD-1 scaled b vs GC-1 scaled b	15.000	0.990	Do Not Test
AD-1 scaled b vs OC-24/25 scal	14.375	0.903	Do Not Test
AD-1 scaled b vs OC-16 scaled	12.429	0.756	Do Not Test
AD-1 scaled b vs OC-22 scaled	11.375	0.715	Do Not Test
AD-1 scaled b vs OC-6/7 scaled	7.429	0.452	Do Not Test
AD-1 scaled b vs DC-3 scaled b	6.429	0.391	Do Not Test
AD-1 scaled b vs OC-12/13 scal	4.143	0.252	Do Not Test
OC-12/13 scal vs OC-4 scaled b	69.357	4.221	Yes
OC-12/13 scal vs OC-5A-01 scal	63.045	3.962	Yes

OC-12/13 scal vs OC-9-10 scale	46.571	2.834	Do Not Test
OC-12/13 scal vs DC-11/12 scal	41.232	2.591	Do Not Test
OC-12/13 scal vs DC-6/7 scaled	25.857	1.625	Do Not Test
OC-12/13 scal vs DC-5 scaled b	13.571	0.826	Do Not Test
OC-12/13 scal vs GC-1 scaled b	10.857	0.717	Do Not Test
OC-12/13 scal vs OC-24/25 scal	10.232	0.643	Do Not Test
OC-12/13 scal vs OC-16 scaled	8.286	0.504	Do Not Test
OC-12/13 scal vs OC-22 scaled	7.232	0.455	Do Not Test
OC-12/13 scal vs OC-6/7 scaled	3.286	0.200	Do Not Test
OC-12/13 scal vs DC-3 scaled b	2.286	0.139	Do Not Test
DC-3 scaled b vs OC-4 scaled b	67.071	4.081	Yes
DC-3 scaled b vs OC-5A-01 scal	60.759	3.819	Yes
DC-3 scaled b vs OC-9-10 scale	44.286	2.695	Do Not Test
DC-3 scaled b vs DC-11/12 scal	38.946	2.448	Do Not Test
DC-3 scaled b vs DC-6/7 scaled	23.571	1.481	Do Not Test
DC-3 scaled b vs DC-5 scaled b	11.286	0.687	Do Not Test
DC-3 scaled b vs GC-1 scaled b	8.571	0.566	Do Not Test
DC-3 scaled b vs OC-24/25 scal	7.946	0.499	Do Not Test
DC-3 scaled b vs OC-16 scaled	6.000	0.365	Do Not Test
DC-3 scaled b vs OC-22 scaled	4.946	0.311	Do Not Test
DC-3 scaled b vs OC-6/7 scaled	1.000	0.0609	Do Not Test
OC-6/7 scaled vs OC-4 scaled b	66.071	4.021	Yes
OC-6/7 scaled vs OC-5A-01 scal	59.759	3.756	Yes
OC-6/7 scaled vs OC-9-10 scale	43.286	2.634	Do Not Test
OC-6/7 scaled vs DC-11/12 scal	37.946	2.385	Do Not Test
OC-6/7 scaled vs DC-6/7 scaled	22.571	1.419	Do Not Test
OC-6/7 scaled vs DC-5 scaled b	10.286	0.626	Do Not Test
OC-6/7 scaled vs GC-1 scaled b	7.571	0.500	Do Not Test
OC-6/7 scaled vs OC-24/25 scal	6.946	0.437	Do Not Test
OC-6/7 scaled vs OC-16 scaled	5.000	0.304	Do Not Test
OC-6/7 scaled vs OC-22 scaled	3.946	0.248	Do Not Test
OC-22 scaled vs OC-4 scaled b	62.125	3.904	Yes
OC-22 scaled vs OC-5A-01 scal	55.813	3.631	Yes
OC-22 scaled vs OC-9-10 scale	39.339	2.472	Do Not Test
OC-22 scaled vs DC-11/12 scal	34.000	2.212	Do Not Test
OC-22 scaled vs DC-6/7 scaled	18.625	1.212	Do Not Test
OC-22 scaled vs DC-5 scaled b	6.339	0.398	Do Not Test
OC-22 scaled vs GC-1 scaled b	3.625	0.249	Do Not Test
OC-22 scaled vs OC-24/25 scal	3.000	0.195	Do Not Test
OC-22 scaled vs OC-16 scaled	1.054	0.0662	Do Not Test
OC-16 scaled vs OC-4 scaled b	61.071	3.716	Yes
OC-16 scaled vs OC-5A-01 scal	54.759	3.442	No
OC-16 scaled vs OC-9-10 scale	38.286	2.330	Do Not Test
OC-16 scaled vs DC-11/12 scal	32.946	2.071	Do Not Test
OC-16 scaled vs DC-6/7 scaled	17.571	1.104	Do Not Test
OC-16 scaled vs DC-5 scaled b	5.286	0.322	Do Not Test
OC-16 scaled vs GC-1 scaled b	2.571	0.170	Do Not Test
OC-16 scaled vs OC-24/25 scal	1.946	0.122	Do Not Test
OC-24/25 scal vs OC-4 scaled b	59.125	3.716	Yes
OC-24/25 scal vs OC-5A-01 scal	52.813	3.436	Do Not Test
OC-24/25 scal vs OC-9-10 scale	36.339	2.284	Do Not Test
OC-24/25 scal vs DC-11/12 scal	31.000	2.017	Do Not Test
OC-24/25 scal vs DC-6/7 scaled	15.625	1.016	Do Not Test
OC-24/25 scal vs DC-5 scaled b	3.339	0.210	Do Not Test
OC-24/25 scal vs GC-1 scaled b	0.625	0.0429	Do Not Test
GC-1 scaled b vs OC-4 scaled b	58.500	3.861	Yes

GC-1 scaled b vs OC-5A-01 scal	52.188	3.579	Do Not Test
GC-1 scaled b vs OC-9-10 scale	35.714	2.357	Do Not Test
GC-1 scaled b vs DC-11/12 scal	30.375	2.083	Do Not Test
GC-1 scaled b vs DC-6/7 scaled	15.000	1.029	Do Not Test
GC-1 scaled b vs DC-5 scaled b	2.714	0.179	Do Not Test
DC-5 scaled b vs OC-4 scaled b	55.786	3.395	No
DC-5 scaled b vs OC-5A-01 scal	49.473	3.109	Do Not Test
DC-5 scaled b vs OC-9-10 scale	33.000	2.008	Do Not Test
DC-5 scaled b vs DC-11/12 scal	27.661	1.738	Do Not Test
DC-5 scaled b vs DC-6/7 scaled	12.286	0.772	Do Not Test
DC-6/7 scaled vs OC-4 scaled b	43.500	2.734	Do Not Test
DC-6/7 scaled vs OC-5A-01 scal	37.188	2.419	Do Not Test
DC-6/7 scaled vs OC-9-10 scale	20.714	1.302	Do Not Test
DC-6/7 scaled vs DC-11/12 scal	15.375	1.000	Do Not Test
DC-11/12 scal vs OC-4 scaled b	28.125	1.768	Do Not Test
DC-11/12 scal vs OC-5A-01 scal	21.813	1.419	Do Not Test
DC-11/12 scal vs OC-9-10 scale	5.339	0.336	Do Not Test
OC-9-10 scale vs OC-4 scaled b	22.786	1.387	Do Not Test
OC-9-10 scale vs OC-5A-01 scal	16.473	1.035	Do Not Test
OC-5A-01 scal vs OC-4 scaled b	6.313	0.397	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

Descriptive Statistics: Monday, June 27, 2011, 5:59:19 AM

Data source: taxa richness Data 1 in initial metrics

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
AD-1	5	0	7.400	1.949	0.872	2.420
GC-1	5	0	8.800	1.924	0.860	2.388
DC-6/7	5	0	7.000	2.345	1.049	2.912
DC-5	5	0	7.600	1.140	0.510	1.416
DC-3	5	0	8.000	2.550	1.140	3.166
OC-24/25	5	0	12.400	2.302	1.030	2.859
OC-22	5	0	6.000	2.345	1.049	2.912
OC-16	5	0	4.800	1.924	0.860	2.388
OC-12/13	5	0	4.600	2.191	0.980	2.720
OC-9/10	5	0	4.600	1.140	0.510	1.416
OC-6/7(2)	5	0	2.200	0.837	0.374	1.039
OC-5A	5	0	4.600	0.548	0.245	0.680
OC-4	5	0	4.200	0.447	0.200	0.555

Column	Range	Max	Min	Median	25%	75%
AD-1	5.000	10.000	5.000	8.000	5.750	8.500
GC-1	5.000	11.000	6.000	9.000	7.500	10.250
DC-6/7	6.000	11.000	5.000	6.000	5.750	8.000
DC-5	3.000	9.000	6.000	8.000	6.750	8.250
DC-3	7.000	12.000	5.000	8.000	6.500	9.000
OC-24/25	5.000	15.000	10.000	13.000	10.000	14.250
OC-22	5.000	9.000	4.000	5.000	4.000	8.250
OC-16	5.000	8.000	3.000	4.000	3.750	5.750
OC-12/13	6.000	8.000	2.000	4.000	3.500	5.750
OC-9/10	3.000	6.000	3.000	5.000	3.750	5.250
OC-6/7(2)	2.000	3.000	1.000	2.000	1.750	3.000
OC-5A	1.000	5.000	4.000	5.000	4.000	5.000
OC-4	1.000	5.000	4.000	4.000	4.000	4.250

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
AD-1	0.0810	-0.817	0.221	0.497	37.000	289.000
GC-1	-0.590	-0.0219	0.141	0.746	44.000	402.000
DC-6/7	1.744	3.322	0.300	0.149	35.000	267.000
DC-5	-0.405	-0.178	0.237	0.414	38.000	294.000
DC-3	0.905	2.000	0.300	0.149	40.000	346.000
OC-24/25	-0.197	-2.716	0.251	0.343	62.000	790.000
OC-22	0.581	-2.628	0.265	0.280	30.000	202.000
OC-16	1.517	2.608	0.261	0.297	24.000	130.000
OC-12/13	0.846	1.745	0.228	0.463	23.000	125.000
OC-9/10	-0.405	-0.178	0.237	0.414	23.000	111.000
OC-6/7(2)	-0.512	-0.612	0.231	0.448	11.000	27.000
OC-5A	-0.609	-3.333	0.367	0.026	23.000	107.000
OC-4	2.236	5.000	0.473	<0.001	21.000	89.000

Descriptive Statistics: Sunday, February 19, 2012, 7:36:52 AM

Data source: %EATData 2 in initial metrics v2.SNB

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
AD-1	5	0	0.614	0.187	0.0837	0.232
GC-1	5	0	0.000593	0.000963	0.000431	0.00120
DC-3	5	0	0.180	0.120	0.0537	0.149
DC-5	5	0	0.167	0.152	0.0679	0.189
DC-6/7	5	0	0.185	0.158	0.0706	0.196
OC-4	5	0	0.000	0.000	0.000	0.000
OC-5A	5	0	0.000	0.000	0.000	0.000
OC-6/7(2)	5	0	0.000	0.000	0.000	0.000
OC-9/10	5	0	0.0135	0.0228	0.0102	0.0283
OC-12/13	5	0	0.000	0.000	0.000	0.000
OC-16	5	0	0.00294	0.00658	0.00294	0.00817
OC-22	5	0	0.00909	0.0141	0.00631	0.0175
OC-24/25	5	0	0.0293	0.0245	0.0110	0.0305

Column	Range	Max	Min	Median	25%	75%
AD-1	0.476	0.894	0.419	0.631	0.443	0.775
GC-1	0.00221	0.00221	0.000	0.000	0.000	0.00148
DC-3	0.299	0.345	0.0463	0.150	0.0755	0.301
DC-5	0.376	0.396	0.0200	0.148	0.0330	0.309
DC-6/7	0.363	0.375	0.0116	0.130	0.0472	0.351
OC-4	0.000	0.000	0.000	0.000	0.000	0.000
OC-5A	0.000	0.000	0.000	0.000	0.000	0.000
OC-6/7(2)	0.000	0.000	0.000	0.000	0.000	0.000
OC-9/10	0.0526	0.0526	0.000	0.000	0.000	0.0338
OC-12/13	0.000	0.000	0.000	0.000	0.000	0.000
OC-16	0.0147	0.0147	0.000	0.000	0.000	0.00735
OC-22	0.0321	0.0321	0.000	0.000	0.000	0.0227
OC-24/25	0.0594	0.0594	0.000	0.0376	0.00420	0.0502

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
AD-1	0.746	0.263	0.211	0.548	0.933	0.614
GC-1	1.698	2.585	0.331	0.077	0.737	0.022
DC-3	0.495	-1.176	0.201	0.593	0.961	0.818
DC-5	0.880	0.157	0.186	0.654	0.929	0.587
DC-6/7	0.337	-2.515	0.236	0.419	0.905	0.440
OC-4	0.000	-4.000	0.000	<0.001	0.000	<0.001
OC-5A	0.000	-4.000	0.000	<0.001	0.000	<0.001
OC-6/7(2)	0.000	-4.000	0.000	<0.001	0.000	<0.001
OC-9/10	1.844	3.289	0.323	0.095	0.716	0.014
OC-12/13	0.000	-4.000	0.000	<0.001	0.000	<0.001
OC-16	2.236	5.000	0.473	<0.001	0.552	<0.001
OC-22	1.484	1.502	0.341	0.059	0.758	0.035
OC-24/25	-0.136	-1.895	0.233	0.436	0.931	0.605

Column	Sum	Sum of Squares
AD-1	3.068	2.022
GC-1	0.00297	0.00000547
DC-3	0.902	0.220
DC-5	0.833	0.231
DC-6/7	0.926	0.271

OC-4	0.000	0.000
OC-5A	0.000	0.000
OC-6/7(2)	0.000	0.000
OC-9/10	0.0676	0.00299
OC-12/13	0.000	0.000
OC-16	0.0147	0.000216
OC-22	0.0455	0.00121
OC-24/25	0.146	0.00670

Descriptive Statistics: Sunday, February 19, 2012, 7:43:46 AM

Data source: %OCData 3 in initial metrics v2.SNB

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
AD-1	5	0	0.236	0.168	0.0752	0.209
GC-1	5	0	0.812	0.120	0.0538	0.149
DC-3	5	0	0.434	0.201	0.0900	0.250
DC-5	5	0	0.739	0.155	0.0693	0.193
DC-6/7	5	0	0.705	0.200	0.0895	0.248
OC-4	5	0	0.773	0.182	0.0814	0.226
OC-5A	5	0	0.908	0.0692	0.0310	0.0859
OC-6/7(2)	5	0	0.954	0.0872	0.0390	0.108
OC-9/10	5	0	0.764	0.125	0.0561	0.156
OC-12/13	5	0	0.713	0.259	0.116	0.322
OC-16	5	0	0.828	0.0738	0.0330	0.0916
OC-22	5	0	0.833	0.109	0.0488	0.135
OC-24/25	5	0	0.191	0.111	0.0496	0.138

Column	Range	Max	Min	Median	25%	75%
AD-1	0.420	0.465	0.0453	0.255	0.0730	0.388
GC-1	0.280	0.935	0.655	0.853	0.686	0.917
DC-3	0.552	0.734	0.183	0.452	0.264	0.595
DC-5	0.344	0.897	0.554	0.820	0.573	0.865
DC-6/7	0.409	0.895	0.486	0.826	0.488	0.861
OC-4	0.467	0.954	0.486	0.806	0.605	0.923
OC-5A	0.176	0.968	0.792	0.939	0.847	0.954
OC-6/7(2)	0.200	1.000	0.800	1.000	0.886	1.000
OC-9/10	0.322	0.947	0.625	0.743	0.655	0.884
OC-12/13	0.668	0.941	0.273	0.815	0.494	0.882
OC-16	0.197	0.930	0.733	0.821	0.764	0.896
OC-22	0.284	0.963	0.679	0.818	0.739	0.935
OC-24/25	0.297	0.356	0.0588	0.204	0.0935	0.282

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
AD-1	0.277	-1.065	0.189	0.645	0.961	0.816
GC-1	-0.512	-2.163	0.235	0.427	0.912	0.482
DC-3	0.542	1.295	0.258	0.312	0.954	0.767
DC-5	-0.477	-2.830	0.299	0.153	0.852	0.202
DC-6/7	-0.518	-3.173	0.327	0.086	0.781	0.056
OC-4	-1.094	1.094	0.194	0.622	0.931	0.601
OC-5A	-1.640	2.819	0.272	0.249	0.834	0.148
OC-6/7(2)	-2.135	4.599	0.381	0.017	0.641	0.002
OC-9/10	0.661	-0.167	0.167	0.714	0.970	0.878
OC-12/13	-1.708	3.274	0.302	0.144	0.825	0.127
OC-16	0.213	0.107	0.137	0.746	0.996	0.997
OC-22	-0.375	-0.189	0.178	0.684	0.971	0.881
OC-24/25	0.606	0.840	0.241	0.393	0.956	0.780

Column	Sum	Sum of Squares
AD-1	1.178	0.391
GC-1	4.060	3.355
DC-3	2.169	1.103
DC-5	3.696	2.828
DC-6/7	3.524	2.643

OC-4	3.863	3.117
OC-5A	4.541	4.143
OC-6/7(2)	4.772	4.585
OC-9/10	3.820	2.982
OC-12/13	3.566	2.811
OC-16	4.141	3.452
OC-22	4.167	3.520
OC-24/25	0.954	0.231

Descriptive Statistics: Sunday, February 19, 2012, 10:07:58 AM

Data source: Data 1 in habitat benthos

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
QHEI	14	2	33.125	5.633	1.626	3.579
median tolerant	14	1	0.719	0.251	0.0696	0.152
median sensitive	14	1	0.0844	0.175	0.0486	0.106
median total taxa	14	1	6.231	2.891	0.802	1.747
substrate	14	2	3.000	0.826	0.238	0.525
cover	14	2	8.250	3.793	1.095	2.410
morph	14	2	7.000	1.537	0.444	0.977
banks	14	2	5.292	1.287	0.372	0.818
riffle pool	14	2	5.000	2.558	0.739	1.626
gradient	14	2	4.583	1.505	0.434	0.956

Column	Range	Max	Min	Median	25%	75%
QHEI	19.000	42.000	23.000	33.250	31.375	36.875
median tolerant	0.796	1.000	0.204	0.818	0.598	0.839
median sensitive	0.631	0.631	0.000	0.000	0.000	0.139
median total taxa	11.000	13.000	2.000	5.000	4.000	8.000
substrate	2.000	4.500	2.500	2.500	2.500	3.750
cover	11.000	13.000	2.000	7.000	5.250	12.750
morph	4.000	10.000	6.000	6.000	6.000	8.750
banks	4.000	7.500	3.500	5.750	4.000	6.000
riffle pool	9.000	11.000	2.000	4.000	3.000	6.000
gradient	3.000	6.000	3.000	5.000	3.000	6.000

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
QHEI	-0.504	0.337	0.206	0.170	0.915	0.247
median tolerant	-1.340	0.640	0.327	<0.001	0.777	0.004
median sensitive	2.913	9.203	0.315	<0.001	0.550	<0.001
median total taxa	0.951	1.183	0.203	0.148	0.917	0.225
substrate	1.308	-0.0929	0.394	<0.001	0.640	<0.001
cover	0.0802	-1.339	0.212	0.139	0.892	0.125
morph	1.081	-0.592	0.409	<0.001	0.681	<0.001
banks	-0.0958	-0.986	0.209	0.155	0.914	0.240
riffle pool	1.251	1.528	0.235	0.065	0.879	0.085
gradient	-0.0956	-2.323	0.327	<0.001	0.694	<0.001

Column	Sum	Sum of Squares
QHEI	397.500	13516.250
median tolerant	9.352	7.484
median sensitive	1.097	0.461
median total taxa	81.000	605.000
substrate	36.000	115.500
cover	99.000	975.000
morph	84.000	614.000
banks	63.500	354.250
riffle pool	60.000	372.000
gradient	55.000	277.000

Spearman Rank Order Correlation Sunday, February 19, 2012, 10:10:20 AM

Data source: Data 1 in habitat benthos

Cell Contents:
Correlation Coefficient
P Value
Number of Samples

	median tolerant	**median sensitive**	**median total taxa**	**substrate**	**cover**
QHEI	0.225 0.470 12	-0.172 0.572 12	-0.0303 0.921 12	0.213 0.484 12	0.737 0.00540 12
median tolerant		-0.479 0.0934 13	-0.397 0.173 13	0.538 0.0663 12	0.255 0.415 12
median sensitive			0.637 0.0180 13	-0.135 0.667 12	-0.0355 0.904 12
median total taxa				0.174 0.572 12	0.0540 0.852 12
substrate					0.410 0.173 12
cover					
morph					
banks					
riffle pool					
gradient					

	morph	**banks**	**riffle pool**	**gradient**
QHEI	0.358 0.243 12	0.298 0.329 12	0.602 0.0359 12	0.0176 0.939 12

median tolerant	0.238 0.442 12	0.464 0.123 12	0.229 0.456 12	-0.401 0.189 12
median sensitive	-0.223 0.470 12	-0.323 0.295 12	-0.486 0.105 12	-0.234 0.442 12
median total taxa	0.159 0.603 12	-0.147 0.635 12	-0.563 0.0547 12	0.0553 0.852 12
substrate	-0.0597 0.834 12	-0.0810 0.783 12	-0.162 0.603 12	-0.313 0.306 12
cover	0.0507 0.869 12	-0.0868 0.783 12	0.318 0.295 12	-0.406 0.181 12
morph		0.345 0.263 12	0.128 0.683 12	0.111 0.716 12
banks			0.292 0.340 12	0.229 0.456 12
riffle pool				0.0715 0.817 12
gradient				

The pair(s) of variables with positive correlation coefficients and P values below 0.050 tend to increase together. For the pairs with negative correlation coefficients and P values below 0.050, one variable tends to decrease while the other increases. For pairs with P values greater than 0.050, there is no significant relationship between the two variables.

Descriptive Statistics: Thursday, March 01, 2012, 4:50:52 PM

Data source: TPH metals TU Data 2 in habitat benthos

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
survival	27	13	0.783	0.136	0.0362	0.0782
scaled biomass	27	13	0.700	0.275	0.0736	0.159

Column	Range	Max	Min	Median	25%	75%
survival	0.516	0.929	0.413	0.821	0.700	0.882
scaled biomass	0.935	1.020	0.0853	0.811	0.530	0.881

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
survival	-1.624	3.490	0.159	0.410	0.858	0.028
scaled biomass	-1.329	0.949	0.266	0.008	0.834	0.014

Column	Sum	Sum of Squares
survival	10.963	8.824
scaled biomass	9.796	7.841

Descriptive Statistics: Thursday, March 01, 2012, 4:05:30 PM

Data source: Data 1 in habitat benthos

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
ammonia	27	13	4.831	3.856	1.030	2.226
PAH 34 SumTU	27	13	2.796	4.873	1.302	2.813

Column	Range	Max	Min	Median	25%	75%
ammonia	12.353	12.700	0.347	4.265	0.921	7.258
PAH 34 SumTU	17.740	18.196	0.456	0.562	0.461	4.302

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
ammonia	0.689	-0.191	0.137	0.605	0.924	0.255
PAH 34 SumTU	2.797	8.480	0.364	<0.001	0.560	<0.001

Column	Sum	Sum of Squares
ammonia	67.628	519.950
PAH 34 SumTU	39.147	418.131

Spearman Rank Order Correlation Thursday, March 01, 2012, 4:17:56 PM

Data source: TPH metals TU Data 2 in habitat benthos

Cell Contents:
Correlation Coefficient
P Value
Number of Samples

	PAH 34 SumTU	survival	scaled biomass	taxa richness	sensitive	tolerant
ammonia	-0.368 0.189 14	-0.0728 0.797 14	-0.238 0.399 14	0.0532 0.849 13	0.279 0.404 10	0.179 0.541 13
PAH 34 SumTU		-0.271 0.340 14	-0.150 0.594 14	-0.732 0.00373 13	-0.433 0.199 10	0.143 0.629 13
survival			0.209 0.463 14	-0.257 0.382 13	0.214 0.535 10	0.0138 0.949 13
scaled biomass				0.0615 0.835 13	0.433 0.199 10	-0.220 0.458 13
taxa richness					0.506 0.126 10	-0.397 0.173 13
sensitive						-0.575 0.0736 10
tolerant						

The pair(s) of variables with positive correlation coefficients and P values below 0.050 tend to increase together. For the pairs with negative correlation coefficients and P values below 0.050, one variable tends to decrease while the other increases. For pairs with P values greater than 0.050, there is no significant relationship between the two variables.