Phase II Property Assessment

for

Summit Lake, Akron, Ohio

Prepared for:

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PARTNERS
AN ENVIRONMENTAL, ENGINEERING & SURVEYING FIRM

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EXECUTIVE SUMMARY

EnviroScience, Inc. (EnviroScience), working with Partners Environmental, LLC, conducted a Phase II Assessment of water and sediment quality within Summit Lake and adjacent segments of the Ohio & Erie Canal within the City of Akron, Ohio to assess potential risks to human and ecological receptors. EnviroScience previously completed a Phase I Assessment of historical data regarding the environmental conditions of the lake and canal that reviewed the state of knowledge regarding this resource. The Phase II property assessment was conducted to provide background information and assessment data suitable for the development of long-range plans for community development, water quality management, and recreational uses of the waterbodies. The study area consisted of Summit Lake in its entirety and approximately 320 linear meters (0.2 miles) of the Ohio & Erie Canal, with a portion to the south and a longer segment to the north of Summit Lake.

Summit Lake is a 97.4-acre natural lake that has been historically altered to facilitate the passage of the Ohio & Erie Canal in the 1800's. For many decades the lake has been a focal point of economic and recreational activity in the City of Akron, including not only the connection of Lake Erie and the Ohio River to central Ohio via the canal, but later as a source of water for the industrial growth of the city, including the rubber industry which was critical to the prosperity of the City of Akron in the 20th Century. Summit Lake was also the site of one of the recreational hubs of the region during the 1900's as the home of Summit Beach Park, an amusement park that thrived along the northern shore of the lake from 1917 to 1958.

The Phase II Assessment included water quality monitoring and sediment sampling. The water quality in Summit Lake was studied intensively by the Ohio Environmental Protection Agency (Ohio EPA) in 2012-2013. Therefore, the water quality sampling for the 2017 Phase II Assessment was conducted to verify if the results from the previous study were still valid. Water samples were also collected from the Ohio & Erie Canal on both the south and north ends of the lake to measure the quality of the water flowing into and out of Summit Lake.

Sediment sampling was limited to the top sediment layer (30 cm or 1 ft) from shallow areas of the lake (less than 5 ft in depth) to evaluate areas with the highest potential for direct contact exposures by people using the lake. This sampling fills a data gap with respect to potential human health risks since previous studies by Ohio EPA and other entities focused upon sediment quality in the deepest portions of the lake. The Phase II study design for sediment sampling used both a randomized design for a general assessment and targeted sampling to evaluate sediments in the lake near locations where pollutants are likely to enter the lake such as storm drain outlets and the Ohio & Erie Canal. Therefore, the study provided a thorough evaluation of the upper layer of the sediments within the shallow areas of the lake and portions of the Ohio & Erie Canal within the study area.

Water quality data collected from Summit Lake and the Ohio & Erie Canal during the 2017 assessment were consistent with the results of the Ohio EPA study in 2012 and 2013. No significant changes in water quality or the limnological condition of the lake have occurred since that time. Other observations made from the water quality sampling include the following:

1. All applicable Ohio Water Quality Standards for chemical constituents were met in the water samples collected from the surface layer of Summit Lake and the Ohio & Erie Canal in 2017.

2. The Ohio Recreational Use Primary Contact Recreation criteria for *Escherichia coli* were exceeded in the Ohio & Erie Canal at the lake inlet (Kenmore Blvd.). The sources of pollutants causing this condition are unknown, but may include inputs of poorly managed sewage, or runoff from streets, paved areas and lawns that is contaminated with feces from wildlife or pets.

3. An oil release to the Ohio & Erie Canal was documented at the Kenmore Blvd. sampling location upstream of Summit Lake. The release affected the water quality of the inflow as well as the lake in July 2017. The release prompted a response by state and local agencies to contain it and remove the oil to alleviate the problem. The cause of this incident is unknown.

4. Measurements used as indicators of productivity of algae and the concentrations of algal nutrients in the water samples from Summit Lake all indicate that the lake is nutrient enriched. These conditions result in high algal abundance in Summit Lake, with a predominance of cyanobacteria in the summer algae community, and anoxia (lack of oxygen) in the bottom waters. Sources of these nutrients include the water flowing into the lake via the Ohio & Erie Canal and other routes as well as the release of phosphorus from the lake sediments.

5. Analyses for algal toxins in water samples from the lake identified the presence of Saxitoxin, but at very low concentrations below levels of concern for public health. Three other algal toxins included in the testing, including Microcystin, were not detected in the water samples.

There are no regulatory standards for sediment quality in Ohio lakes and streams. Sediment assessments are conducted to determine potential impacts on water quality, potential toxicity to aquatic life and for the protection of human health. The Phase II Assessment of Summit Lake sediment chemistry results used procedures developed by the Ohio Voluntary Action Program to assess the potential risks to human health and ecological receptors.

Chemical analysis of the sediments covered a broad range of parameters to provide a comprehensive evaluation of sediment quality. Testing included analyses for metals, petroleum hydrocarbons, volatile and semi-volatile organic compounds, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Analysis of the data obtained identified several constituents of interest for screening assessment to determine the potential for the sediments to have adverse effects on human and ecological receptors.

1. Multiple-chemical exposure screening was conducted to identify if there is a potential for human health effects from sediments from Summit Lake and the Ohio & Erie Canal. Although this procedure does not constitute a complete human health risk assessment, the screening is based upon conservative assumptions and is an indicator of whether a complete risk assessment may be needed. Based upon the results of the screening level analyses it is concluded that incidental recreational exposures to the sediments in Summit Lake and the Ohio & Erie Canal within the study area are unlikely to represent an unacceptable risk to the public.

2. Petroleum hydrocarbons were observed and detected in most of the Summit Lake sediment samples and were present in the top-most layers of the sediments. These results indicate that the loading of these compounds is ongoing from the surrounding watershed. The

presence of oils in the surficial sediment layer represents an aesthetic challenge with respect to recreational contact but does not represent a risk to human health.

3. Spatial analysis of the sediment data did not find predictable patterns of higher concentrations for any chemical parameters. However, statistical analysis of the results from risk screening for potential toxicity of PAHs to aquatic organisms found that the potential risk was higher at sites targeted to assess the impacts from flows to the lake from storm sewers and the Ohio & Erie Canal.

4. Statistical comparison of metals concentrations in the sediments of Summit Lake to Ohio benchmark values for inland lakes and streams found that the results for arsenic, barium, cadmium, nickel, selenium, and strontium were not significantly higher than the background concentrations.

5. Concentrations of copper, lead, mercury and zinc were found to be elevated in Summit Lake as compared to Ohio background thresholds for sediments. However, concentrations of these metals were well below screening values for potential risks to human health. In addition, subsequent screening analyses using ecological risk analysis procedures for metals mixtures predict that the bioavailability of cadmium, copper, lead, nickel, and zinc is very low in Summit Lake sediments. Therefore, these metals are unlikely to be negatively affecting the lake biota in the shallow water sediments of the lake.

6. Analyses of PAH concentrations in the sediments of Summit Lake and the Ohio & Erie Canal were conducted using Equilibrium Sediment Benchmark procedures to determine the potential for toxic effects upon the lake biota. Based upon these analyses, the concentrations of PAHs were considered potentially toxic to aquatic organisms at more than half of the sampling locations. Statistical analysis found that the potential for PAH toxicity is higher at sites targeted towards lake inflows, including sites in the Ohio & Erie Canal, than in other areas of the lake. This finding illustrates the importance of pollutant loadings from the lake watershed in determining the concentrations found in the Summit Lake sediments.

7. Equilibrium Sediment Benchmark analysis for dibenzofuran found that concentrations of this compound are unlikely to be toxic to aquatic life in Summit Lake.

8. Single-chemical comparisons for several organic compounds and mercury indicate that they are present above the ecological screening levels and may cause sediment toxicity to aquatic life in Summit Lake and the Ohio & Erie Canal. Further evaluation of the potential risks to ecological receptors was beyond the scope of the Phase II Assessment.

9. Site-specific investigation of the sediments is recommended in localized areas of interest prior to the implementation of plans for concentrated recreational activity or construction projects to ensure the protection of human health and the environment.

Based upon the Phase II assessment, it is concluded that there is little risk to human health from recreational exposures to chemicals within the water and sediments in Summit Lake and the Ohio & Erie Canal within study area. However, the potential for ecological impairments from exposures to lake and canal sediments does exist that would require further study to be fully understood.

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LIST OF ACRONYMS/ABBREVIATIONS

AVS	Acid Volatile Sulfide
AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
BEHP	bis (2-ethylhexyl) phthalate
BTAG	USEPA Region 3 Biological Technical Assistance Group
CIDARS	Chemical Information Database and Applicable Regulatory Standards
COI	Contaminant of Interest
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DERR	Ohio EPA Division of Environmental Response and Revitalization
DO	Dissolved Oxygen
DQO	Data Quality Objective
DRO	Diesel Range Organic
E. coli	*Escherichia Coli*
ERIE	Division of Environmental Response, Investigation and Enforcement
EnviroScience	EnviroScience Inc.
ESB	Equilibrium Partitioning Sediment Benchmark
ESL	Ecological Screening Level
ESQG	Ecological Sediment Quality Guideline
EWH	Exceptional Warmwater Habitat
GDCSS	Generic Direct-Contact Soil Standards
HAB	Harmful Algal Bloom
LH	Lake Habitat
MCS	Multiple Chemical Standard
MDL	Method Detection Limit
NEFCO	Northeast Ohio Four County Regional Planning and Development Organization
OAC	Ohio Administrative Code
Ohio EPA	Ohio Environmental Protection Agency
ORO	Oil Range Organic
Ortho P	Orthophosphate
PAH	Polycyclic Aromatic Hydrocarbon
PCB	PolyChlorinated Biphenyl
PCR	Primary Contact Recreation
PEC	Probable Effect Concentration
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control

RL	Reporting Limit
RM	River Mile
SAP	Sampling Analysis Plan
SEM	Simultaneously Extracted Metal
SRV	Sediment Reference Value
STV	Statistical Threshold Value
SVOC	Semi-Volatile Organic Compound
TEC	Threshold Effect Concentration
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TSI	Trophic State Index
UCL	Upper Confidence Limit
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VAP	Voluntary Action Program
VOC	Volatile Organic Compound
WQS	Water Quality Standards

1.0 INTRODUCTION
[3745-300-07(J)(1)]

EnviroScience, Inc. (EnviroScience), on behalf of Partners Environmental, LLC (Partners), performed a Phase II property assessment for Summit Lake and adjacent properties located in the vicinity of 380 West Crosier St., Akron, Ohio in the County of Summit. This project is part of a larger community development and revitalization effort and focuses upon the potential to enhance and promote recreational use of Summit Lake and surrounding areas. Funding for this project was provided through a grant from the Summit Brownfields Revitalization Program administered by the Northeast Ohio Four County Regional Planning and Development Organization (NEFCO). The grant was provided to The Trust for Public Land acting in collaboration with local stakeholders including the John S. and James L. Knight Foundation (Knight Foundation), the City of Akron, and the Ohio and Erie Canalway Coalition.

The project area is located within the City of Akron, Summit County, Ohio and bounded by Kenmore Blvd. to the south, and South St. to the north. The study area encompasses the entirety of Summit Lake and approximately 320 linear meters (0.2 linear miles) of the Ohio & Erie Canal (Figure 1). Summit Lake has a surface area of 39.43 ha (97.43 acres), a mean depth of 5.51 m (18.1ft), and a volume of 2,175,348 m^3 (1,763.6 acre-feet). A Phase I property assessment report was prepared by EnviroScience on February 28, 2017 (EnviroScience, 2017a). A property inspection for the lake was not required as part of the Phase I study. A site-specific sampling and analysis plan (SAP) was prepared for completion of Phase II sampling activities to characterize the sediment and water quality within the lake (EnviroScience, 2017b). The SAP was reviewed by Ohio EPA staff and was accepted for use in the study. All Phase II Assessment procedures were included in a site-specific Quality Assurance Project Plan (QAPP) (Partners, 2017) that was reviewed and approved by the United States Environmental Protection Agency (USEPA) on May 26, 2017.

Sampling of environmental media for the Phase II property assessment was performed between the dates of May 30 and July 19, 2017. This report was finalized on March 30, 2018.

Both the Phase I and Phase II assessments completed by EnviroScience are limited to Summit Lake and certain portions of the Ohio & Erie Canal within the study area. Additional assessment of the surrounding land areas surrounding the lake were completed by Partners as independent activities and are described in separate reports.

The Phase II property assessment was conducted by the following project staff members:

Paul Anderson, Senior Scientist, EnviroScience
Alex Valigosky, Biologist II, EnviroScience
Rick Vince, Associate Director, Brownfield and Remediation Services, Partners

The Phase II property assessment report was prepared by:

Paul Anderson, Senior Scientist, EnviroScience
Yakuta Bhagat Ph.D., Senior Environmental Scientist, EnviroScience

1.1 Data Quality Objectives

The data quality objectives (DQOs) for the Phase II Assessment of Summit Lake were selected to provide data sufficient to determine attainment status with respect to applicable water quality standards and to determine the degree and nature of any sediment contamination present in the lake and canal with a special emphasis on shoreline areas that have a high potential for recreational contact. The specific DQOs for the study were as follows:

1. To determine the sediment quality of the shallow areas of Summit Lake and the Ohio Canal within the study area and to compare the data to human health and ecological screening benchmarks;

2. To collect sufficient water quality data to determine if similar data collected by the Ohio Environmental Protection Agency (Ohio EPA) in 2012 and 2013 is still representative of the water quality conditions in Summit Lake and to assess any long-term water quality trends in the lake; and

3. To comprehensively compare water quality data for Summit Lake to applicable Ohio Water Quality Standards (WQS) for the protection of human health, recreational uses, aquatic life uses, and the protection of wildlife as promulgated in Ohio Administrative Code (OAC) Chapter 3745-1.

1.2 Study Design

1.2.1 Water Quality Assessment

Sites were selected for the sampling of water quality to match historical Ohio EPA sampling locations so that current conditions could be compared to historical data and the Ohio WQS. The locations selected for this study are depicted in Figure 2 and listed in Table 1.

Previous limnological measurements and water chemistry samples collected by Ohio EPA were primarily collected from the deepest point in the lake, identified with the Ohio EPA site number, F01A14 and otherwise known as Summit Lake Station L-1. This location was used to assess the water quality of the lake. Water grab samples were collected from river mile (RM) 3.62 of the Ohio & Erie Canal at Kenmore Blvd. to the south (Station R06P13) and at South Ave. (Station 200119, RM 2.66) to the north of Summit Lake to characterize the water flowing in and out of the lake.

Bacteriological samples for quantification of *Escherichia coli* (*E. coli*) were collected from the surface at Station L-1, from the canal monitoring locations, and from the dock at the boat ramp located near the City of Akron Community Center (Boat Ramp). The bacteriological assessment provide data necessary to determine whether recreational beneficial uses are supported by comparison to the WQS.

1.3 Sediment Assessment

Sediment sampling conducted for the Phase II Assessment focused upon the littoral (shallow water) areas where the probability of ecological and recreational use exposures to sediments are high. Sampling was therefore confined to the top 30 cm (~1 foot) of sediment within areas associated with the shoreline and littoral zone with water depths between 0.1 m and 2.0 m (~0.3 to 6.6 ft). Target sediments for sampling included fine-grained material with predominant particle size distribution less than 2 mm (sand or smaller) with a high organic content. This sediment type has a higher proclivity to contain environmental contaminants and presents a reasonable worst-case exposure scenario for both ecological and human health exposures.

In order to provide a sufficiently robust data set for the comparison of sediment data to applicable ecological and human health sediment benchmarks, two approaches were used to assess these areas: the first used a randomized site selection approach to define the overall sediment quality of the shallow littoral margin of the lake (designated herein as “Selected Sites”); the second approach was biased toward locations with a high potential for contamination and/or a higher probability of recreational use exposures (designated herein as “Targeted Sites”). The actual locations where sediment samples were collected are depicted in Figure 2 and listed in Tables 2 and 3. The protocol for selecting the sampling sites is fully described in the SAP.

1.3.1 Selected Sites

Selected Sites were randomly chosen from a 20 X 20 m (400 m^2) grid overlay of Summit Lake prepared using ArcGIS software (ESRI, 2012) to encompass the lake area between the shoreline and the 15-ft (~4.5 m) bathymetric depth contour. Depth contours used in this process were derived from a 1978 bathymetric map of Summit Lake found in Glaus, Pyle, Schomer, Burns, & Dehaven, Inc. (1978). The 15-ft depth contour was chosen to ensure that all areas of the lake less than or equal to 2.0 m in depth were included in the grid pattern since the accuracy of the 1978 map is unknown. Using this procedure, a grid with 961 cells was created around the periphery of the lake (Figure 2). This grid was sub-divided into four zones associated with the south (Zone A), west (Zone B), north (Zone C), and east (Zone D) shorelines of the lake. The average area encompassed by each zone is 32,435 ± 890 m^2. Since the cells on the periphery of each zone were bounded by either the shoreline or the 15-ft depth contour, these cells were not all 400 m^2 in area. The entire gridded area was equivalent to 32.9 percent of the lake surface area.

Each cell in the grid was assigned a unique identifier in the format of ‘Zn’, where ‘Z’ is the zone and ‘n’ is the grid number within the zone (e.g. “Grid_A34”). Three cells within each zone were selected to be sampled using the random number function in Microsoft Excel. These twelve cells constituted the population of Selected Sites. Five additional sites were also randomly selected in each zone to serve as alternative sampling locations. These “Alternate Sites” were available for use when the initial location of the Selected Site did not meet the DQOs for sampling (depth $\leq$ 2.0

m, sediment sand size or smaller). The coordinates of the Selected Sites sampled during the Phase II Assessment field study are provided in Table 2.

The analytical regime used for Selected and Targeted Sites differed in that the testing for Targeted sites used a reduced analyte list that was a subset of that conducted for Selected Sites. This procedure was used to reduce analytical costs while providing sufficient data to provide an indication of whether specific inputs to the lake were contributing disproportionately to the sediment contaminant load. Specific differences in the analytical regime are detailed in Section 5.3, the SAP, and the site-specific QAPP.

1.3.2 Targeted Sites

Targeted Sites were included in the study for two purposes: 1) to document the sediment quality within Summit Lake and sections of the Ohio & Erie Canal in areas likely to be utilized by canoeing and kayaking; and 2) to determine if the sediments near potential sources of contaminant loading to the lake such as storm culvert outlets contain elevated levels of contaminants as compared to the randomly-chosen Selected Sites. Analysis of these data were used to determine whether there are specific inputs to Summit Lake that merit further investigation in order to control or eliminate pollutant sources. Coordinates of the sediment sampling locations for the Targeted Sites sampled during the study are provided in Table 3.

2.0 PHASE I PROPERTY ASSESSMENT AMENDMENT

[3745-300-07(J)(2), 3745-300-07(E)(1)]

The Phase I property assessment (EnviroScience, 2017a) was not required for Summit Lake and as such, no amendments to an assessment are applicable as part of the Phase II report.

3.0 STATEMENT OF LIMITATIONS OR QUALIFICATIONS

[3745-300-07(J)(3)]

Summit Lake is a publicly-owned lake and is not under the ownership or control of the Trust for Public Land. Therefore, there is no intent to submit a letter of ‘No Further Action’ for Summit Lake or the assessed portions of the Ohio & Erie Canal under the provisions of OAC 3745-300-13 based upon the overall assessments conducted under this project. Rather, the assessments have been conducted to guide future planning with respect to public utilization of these waterbodies and for the determination of potential effects upon human health and environment.

Specifications for conducting the sampling associated with this Phase II Assessment are fully described in the site-specific SAP for conducting field activities (EnviroScience, 2017b). Qualifications identified during the Phase II Property Assessment included specifications within the SAP for water quality and sediment sampling. For example, criteria for minimum and maximum water depths of 0.1m and 2.0m, respectively, and a target sediment thickness of 30 cm (~ 1 foot) were set *a priori* for sediment sampling in areas associated with the shoreline and littoral zone to adequately evaluate the probability of ecological and recreational use exposures.

Furthermore, the target for sediment composition for sampling included sampling of fine-grained material with predominant particle size distribution less than 2 mm (i.e., sand or smaller) with a high organic content.

Limitations and qualifications identified during the Phase II Property Assessment included the following adjustments to the SAP:

- The SAP states that water samples at Station L-1 (F01A14) would be collected from the bottom layer of the lake (hypolimnion) at a depth 0.5 m above the sediment surface. This procedure was adjusted in the field to a depth of 1.0 m above the sediment surface to prevent potential contamination of the water sample caused from disturbance of the lake bottom.
- Three Selected Sites (randomly-selected) were replaced with Alternate Sites on June 1, 2017 following the procedures outlined in the SAP. Water depths at four primary Selected Sites, 'Grid_B16', 'Grid_B35', 'Grid_C33' and 'Grid_C36', had overlying water depths greater than 2.0 m, and therefore did not meet the DQOs for characterization of potential exposures to sediments by recreational users of the lake. The aforementioned sites were replaced with Alternate Sites, 'Grid_B12', 'Grid_B5', 'Grid_C52', and 'Grid_C75', respectively. Site replacement followed the procedures outlined in the SAP.
- The SAP specifies the collection of two sediment samples from the northern segment of the Ohio & Erie Canal within the study area. Based upon field reconnaissance, it was determined that a single sediment sample from this reach of the canal would be representative of the conditions in this area.
- The SAP listed Grid B71 as a Targeted Site for the collection of sediments to characterize potential effects associated with the storm sewer outlet location at the end of Indian Trail Ave. However, it proved impossible to collect sediments that met the specified DQOs from this location (water levels were too high and the sediment too coarse). Therefore, the sampling location was adjusted to Grid B61 to characterize this Targeted Site.
- The SAP indicates that analysis would be conducted for deeper sediments (>30 cm) collected in the cores if field observations concluded that they might be grossly contaminated in comparison to the surficial sediments. This condition was not observed during the collection of the sediment samples. Therefore, all sediment samples were collected exclusively from the 0-30 cm horizon.
- The SAP indicates that bacteria samples would be collected from storm drains discharging into the lake if it was deemed useful for identifying sources of sewage entering the lake directly via this pathway. Conditions meeting this criterion were not observed during the field study. Therefore, no additional bacteriological samples were collected for this purpose.

4.0 CONCEPTUAL SITE MODEL

[3745-300-07(J)(4), 3745-300-07(C)]

A conceptual site model (CSM) has been prepared to illustrate the relationships between contaminants, transport media and receptors associated with human and ecological exposures to water and sediment within Summit Lake (Figure 3). The CSM has been prepared in accordance with OAC 3745-300-07 (C)(7) and (J). The human health exposure pathway via the consumption of sport fish is not included in the project CSM because this issue is assessed by the State of Ohio through the Sport Fish Consumption Advisory process (see Section 7.4.3.4).

5.0 SAMPLING PROCEDURES

[3745-300-07(J)(5), 3745-300-07(D)]

All field characterization and sampling procedures and laboratory analytical methods used in this study are described in the SAP and in the site-specific QAPP. Sampling consisted of the collection of field readings and general observations, characterizations of sediment characteristics, photographic documentation, the collection of water samples, and the collection of sediment samples. There were no deviations from the procedures outlined in the approved SAP or QAPP for the project other than those described in Section 3.0.

5.1 Field Measurements and Observations

Methods for conducting field measurements are described in Section 5.1 of the SAP and are summarized in Table 4. All field measurements were recorded using standardized field data sheets to ensure consistency of data recording associated with sample collection (see Appendices C and D of the SAP). Photographs were taken of the lake and shoreline during each sampling event, and representative photographs were taken of each sediment core sample after retrieval and following compositing. Water clarity was measured using a Secchi disk for each lake sampling event.

5.2 SAMPLING METHODS

5.2.1 Water Sampling

Sampling for water quality parameters was conducted to develop a data set for comparison to applicable Ohio WQS found in OAC Chapter 3745-1 for the protection of aquatic life, human health, and recreational uses. Additional samples were also collected for chlorophyll *a*, algal species identification and algal toxins to characterize the lake trophic state (ecological condition) and the potential for harmful algal blooms (HABs) that might impair the ability of the lake to support recreational uses or result in unacceptable risks to human receptors. Although targeted storm sewer outlet sampling was described in the study plan, no conditions arose warranting the need for collection of water samples from these locations during the study.

Except for bacteriological samples (Section 5.2.1.5), water samples were collected with a Wildco® Beta™ style Van Dorn water sampler capable of collecting discrete water samples at specified depths. The sampler was lowered to the specified depth using the attached line, and the mechanism to collect the water sample was actuated by sending a weighted messenger down the deployment line. Several discrete samples were collected from each location and depth to obtain sufficient water to fill all sample containers. At Station L-1, samples were collected from the surface (0.5 m depth) and bottom (1.0 m above the lake bottom) layers of the lake, while at all other stations, samples were collected from a depth of 0.5m.

Upon retrieval, water for the analysis of organic compounds was emptied directly into precleaned glass sample containers provided by the laboratory. Water for the analysis of chlorophyll *a* and inorganic analytes was transferred to a 5-gal low density polyethylene Cubitainer® for compositing prior to dispensing the water samples to individual containers for preservation and delivery to the laboratory. Compositing of the sample was necessary to ensure that the water sample was uniform across analytical methods since the total volume of water needed was greater than the capacity of the sampler. Prior to collection of a composite sample, the Cubitainer® was rinsed three times with water from the designated sampling location and depth. Composite samples were mixed by closing the lid of the Cubitainer® and inverting it while ensuring that there was a sufficient sized air bubble to allow for complete mixing. Following mixing, the individual sample containers were filled, preserved, and immediately placed on ice to chill to 4°C for delivery to the laboratory in accordance with the approved SAP.

Clean nitrile sampling gloves were worn while handling sampling containers and filling containers. Care was taken to prevent contamination of the inside of the sample container or lid. For bacteriological sampling (Section 5.2.1.5), sterile techniques were used to ensure that the inside of the containers and lids were not contaminated during the sampling process.

5.2.1.1 Organics

A single round of sample collection for organic compounds was conducted during the study. Samples were collected from the surface (0.5 m) and bottom (1.0 m above the bottom) depths at Station L-1 and from the surface (0.5 m) at the Canal Sites. Sampling followed the procedures described in Section 5.2.1.

5.2.1.2 Chlorophyll a and Pheophytin a

A minimum of 500 ml of lake water was collected at a depth of 0.5m at Station L-1 (F01A14) during each sampling event for the analysis of chlorophyll *a*. On July 19, 2017, water was also collected at the Canal Sites and the Boat Ramp for chlorophyll *a* analysis in conjunction with sample collection for algal toxin analyses. Water samples were collected directly into dark sample bottles (protected from sunlight) and were placed on ice without preservatives for delivery to the EnviroScience laboratory. Water samples were filtered immediately upon receipt and were either analyzed or preserved by freezing the filtered samples within 24 hours of collection.

5.2.1.3 Algal Toxins

Water samples for algal toxin analysis (microcystin, saxitoxin, cylindrospermopsin, and anatoxin-a) were collected from the surface (0.5 m) at Station L-1, canal sites, and at the Boat Ramp on July 19, 2017. A portion of the composite sample was dispensed into a 250-mL container composed of polyethylene terephthalate glycol for algal toxin analysis following Ohio EPA (2016a) protocols. Samples were placed on ice and in the dark and submitted to the EnviroScience laboratory for freezing or analysis within 24 hours of collection.

5.2.1.4 Qualitative Phytoplankton

The species of phytoplanktonic algae present in the algal toxin water samples were identified to the lowest practical taxonomic level using light microscopy at the EnviroScience Laboratory. An aliquot of the composite water sample was used to collect a whole water sample at a depth of 0.5 m. Samples were preserved with 2 mL of 3% glutaraldehyde solution prior to the analysis.

5.2.1.5 Bacteriological Sampling

Bacteria *(E. coli)* samples were collected directly into sterile polypropylene containers provided by Adams Water Laboratory following the procedures outlined in Section 5.3.1.6 of the SAP. Samples were delivered to the Adams Laboratory for testing within 6 hours of collection.

5.2.2 Sediment Sampling

Target criteria for collection of all sediment samples called for the collection of the top 30 cm of sediment consisting of fine-grained material (i.e., sand or smaller) from locations that had a minimum of 0.1 m of water above the sediment-water interface and a maximum water depth of 2.0 m. The minimum sediment thickness for a valid sample was established as 10 cm. Sediment sample collection procedures are described in Section 5.3.2 and Appendix A of the approved SAP, and were based upon the Ohio EPA document *Surface Water Field Sampling Manual for Water Quality Parameters and Flows, Appendix III - Sediment Sampling* (Ohio EPA, 2015b).

Prior to the collection of sediment samples, the field team first evaluated the site with respect to water depth, sediment deposition, and sediment type to ensure that the DQOs were met with respect to the SAP. Detailed descriptions of the field evaluation procedures to determine site suitability and the materials and procedures that were used to properly collect sediment samples are provided in Appendix A of the SAP.

All sediment samples were collected using an Aquatic Research Instruments Universal Percussion Corer equipped with pre-cleaned thin-wall (68mm I.D., 71 mm O.D.) clear polycarbonate tubing. The core tubes were approximately 50 cm in length to allow for the collection of an undisturbed 30 cm sediment core.

Samples for acid volatile sulfides (AVS)/simultaneously extracted metals (SEM) and volatile organic compound (VOC) analyses were collected from undisturbed core samples and transferred directly into pre-cleaned sample containers provided by TestAmerica Laboratories in a manner that provided no air in the closed container (zero headspace). The remaining samples were composited in a pre-cleaned stainless-steel bowl and thoroughly mixed (a minimum of 5 minutes of mixing) prior to filling the sample containers. Sediment samples were placed into pre-cleaned containers provided by TestAmerica and were immediately stored on wet ice at 4°C for delivery to the laboratory.

Approximately 1.8 L of sediment was required to fill the sediment containers for laboratory analyses. This equates to a total of 50 cm of core sample to provide the requisite sample volume.

The target sample quantity was obtained through the collection of multiple cores (maximum = 30 cm) to provide a minimum of 1.9 L of sediment at each sampling location. The number of discrete core samples collected at a given site were adjusted as necessary to provide a sufficient quantity of composite sample. In cases where samples were collected for matrix spike duplicate analyses, approximately, 5.7 L of sediment sample was collected to obtain sufficient sample volume.

5.3 LABORATORY ANALYTICAL METHODS

Laboratory analysis of water and sediment samples were conducted by the following companies:

- TestAmerica Laboratories, Adams Water Laboratory, North Canton, Ohio;
- Adams Water Laboratory, Akron, Ohio; and
- EnviroScience Inc., Stow, Ohio.

To the extent applicable, all the laboratories are certified for the types of analyses conducted for the Summit Lake Phase II assessment. Documentation of the various certifications held by the project laboratories are detailed in the project-specific QAPP.

The analytical methods used for the project are listed in Tables 5 and 6 for water samples and sediment samples, respectively. Container requirements, field preservation methods, and holding times for the samples that were delivered for laboratory analysis are provided in the approved SAP. The laboratory used for the various test procedures to analyze the water samples is also listed in Table 5. All sediment analyses were conducted by TestAmerica Laboratories. Details regarding the specific laboratories used for each test method, the analytical method detection limits, reporting limits, and laboratory control limits for all analyses conducted are listed in the project-specific QAPP.

Analyses for AVS/SEM and VOC constituents were conducted for sediment samples from Selected Sites only. Semi-volatile organic compound (SVOC) analyses were limited to polycyclic aromatic hydrocarbon (PAH) compounds at Targeted Sites, while a full SVOC scan was conducted from sediments collected at Selected Sites (and/or Alternate Sites, where necessary).

6.0 DATA COLLECTION ACTIVITIES

[3745-300-07(J)(6), 3745-300-07(E)]

6.1 Water Sampling

The dates of sample collection and the types of water samples collected at each site surveyed during the study are summarized in Table 7. Copies of the completed field observation forms for water sample collection are provided in Appendix A. All water sampling was performed in accordance with the approved SAP except for the changes described in Section 3.0.

Two notable observations were made during the collection of water samples for the study:

1. On June 29, 2017 a persistent oil sheen was discovered on the water entering Summit Lake via the Ohio & Erie Canal at Kenmore Blvd. during a sampling event for collection of bacteria samples (Figure 4). EnviroScience staff immediately reported the incident to the Ohio EPA emergency spill number. The incident was promptly investigated by the Ohio EPA Division of Environmental Response, Investigation and Enforcement (ERIE). ERIE staff worked in collaboration with the Akron Fire Department and staff from the ODNR Ohio & Erie Canal Hydraulics Division, to contain the oil with booms (Figure 5). and initiate an investigation of the potential source of the spill. Although the subsequent transport of oil to Summit Lake was stopped by these actions, the agencies involved could not identify the source of the spill. The City of Akron Sewer Maintenance Division conducted a cleanup of the collected oil on July 7, 2017. Two additional inspections of the canal were conducted by Ohio EPA ERIE staff in July 2017 and no further problems were noted. A copy of the Ohio EPA incident report and the associated photo logs are provided in Appendix B.

2. During the month of July 2017, clearing and construction activity was initiated along the eastern shoreline of Summit Lake near the Summit Lake Community Center as part of a park improvement program. However, the construction work did not include any sediment or erosion control best management practices (Figure 6). This issue was brought to the attention of the Summit Lake stakeholder’s group and was rectified later in late July. No apparent water quality impacts were noted because of this problem.

6.2 Sediment Sampling

Sediment samples were collected from Summit Lake on May 30, June 1, and June 7, 2017. All sediment sample collection activities conformed with the SAP except as reported in Section 3.0. It was possible to retrieve undisturbed core samples from all sampling locations. A total of 24 sediment samples were collected from 22 different locations in the lake. Section 1.3 provides details regarding the study design and the locations where sediment samples were collected. Section 3.0 provides information of the methods used to replace sediment sampling locations that did not meet the DQOs of the study. Details of the water depths, sediment thickness, and core sample retrieval for each of the of the samples is provided in Table 8. Copies of the completed field observation forms associated with each sediment sample are provided in Appendix C.

Water depths ranged from 0.7 m to 1.8 m at the sediment sampling sites, with a mean depth of 1.3 m. Sediment thickness, as measured as depth to refusal using a USGS gaging rod, ranged from 36.6 cm to greater than 294 cm, with a mean refusal depth of 131.3 cm. There was no significant difference between mean sediment refusal depths at Selected vs. Targeted sampling locations ($p>0.25$ using the Student’s t test).

Overall, sediment sample retrieval thickness ranged from 18.5 cm to 58.5 cm using 60 cm long core tubes. Average sediment core sample retrieval thickness was significantly higher ($t = 3.298$, p = 0.002, df = 20) at Selected Sites as compared to Targeted Sites, averaging 40.2 cm at the former and 26.9 at the latter. The difference can be attributed to larger grain size sediments at the Targeted Sites, as is described in Section 7.2.1 below. Core sample thickness ranged from 18.5 to 30 cm at the Targeted sites and from 26 to 30 cm at the Selected Sites, with the pooled average being 27.7 cm. It was possible to obtain the full 30 cm target core thickness at 10 of the 13 Selected Sites (77%), while the full 30 cm thickness was only obtainable at 1 of the 9 Targeted Sites sampled for the study (11% of the sites).

7.0 DETERMINATIONS

[3745-300-07(J)(7), 3745-300-07(F)(1) to (F) (10)]

The main purpose of the Phase II Assessment of Summit Lake is to expand the quantity and quality of existing data to assess potential risks to human health and the biota associated with the lake and linked canal areas with respect to water quality and the lake sediments in the shallow areas of the lake.

The following sections summarize the results from the analyses conducted for water and sediment samples collected during the assessment. Copies of the analytical reports for water and sediment samples conducted by TestAmerica are provided in their entirety in Appendices D, E, F, and G. Affadavits from TestAmerica Laboratories attesting to the results for the analyses conducted pursuant to their VAP certification are provided in Appendix H. Reports from the other laboratories used for testing are also provided in the appendices to this report as referenced in the sections below.

7.1 Water Quality

Water quality data are used to assess potential risks associated with likely recreational uses of the lake using comparisons to the Ohio WQS and appropriate recreational use guidelines as promulgated in OAC Chapter 3745-1. The WQS applicable to Summit Lake are those established for the Lake Erie Basin. Ohio EPA provides a summary of these criteria within a Table published on their website at the following URL: http://www.epa.ohio.gov/Portals/35/rules/Erieval14.pdf. The version of this table summarized in this report is dated February 3, 2017 and was accessed on October 1, 2017.

It should be noted that Ohio EPA only assesses the results obtained from the epilimnion (surface layer) of inland lakes for making determinations regarding attainment of the chemical water criteria (Ohio EPA, 2016b). Water quality results are also used to assess the ecological condition of the lake through comparisons to lake trophic state indicators as well as draft Ohio EPA nutrient criteria for inland lakes (Ohio EPA, 2010a).

7.1.1 Attainment of Ohio Water Quality Standards

The designated beneficial uses for Summit Lake and the Ohio & Erie Canal assigned under the provisions of OAC Chapter 3745-1 are summarized in Table 9. Water quality criteria applicable to the water bodies are those established to protect these designated beneficial uses and serve as the basis for the comparison of water quality data collected during this assessment.

7.1.1.1 Field Water Quality Measurements

Field readings for water clarity (measured as Secchi Disk transparency), water temperature, dissolved oxygen, pH, and specific conductance are provided in Appendix I. Summary statistics for field readings collected from the various categories of sampling stations are summarized in Table 10. Field readings were collected in conjunction with both water and sediment samples. Readings for water samples were taken at depths corresponding with the sample collection depth. Readings taken at sediment sampling locations were made at a depth approximately 0.5 m above the lake bottom prior to the collection of sediment samples. There were no exceedances of the Ohio WQS noted during the Phase II Assessment study based upon field measurements for temperature, dissolved oxygen, pH, and specific conductance.

Results for the profiles for field parameters collected at Station L-1 in Summit Lake are provided in Figures 7 and 8. Secchi disk transparency, a measurement of water clarity,was 1.25 m on June 7 and 1.09 m on July 19, 2017. Doubling the Secchi disk transparency depth is often used as a rough estimate of the depth of the euphotic zone, the depth to which algae can utilize sunlight for photosynthesis (Ohio EPA, 2016a). Therefore, the euphotic depth in Summit Lake is estimated to extend to between 2.2 and 2.5 meters in depth during the summer.

Summit Lake was thermally stratified throughout the study period with a warmer surface layer (epilimnion) and a colder bottom layer (hypolimnion) that resulted in the stratification of water chemistry characteristics as well. Temperatures of both layers increased as the summer progressed, with the average epilimnion temperature warming from 20.6°C on June 7 to 28.1°C on July 19, 2017. The average temperature in the hypolimnion increased from 8.3°C to 11.5°C during the same period.

The layering of the lake resulting from thermal stratification also creates a chemical stratification thus isolating the bottom waters from interactions with the atmosphere. This condition produces anoxia (a lack of oxygen) in the hypolimnion resulting from the decay of organic matter in the water column and the lake sediments. Dissolved oxygen concentrations in the hypolimnion were very low throughout the study period, ranging from 0.1 to 0.3 mg/L. Very low dissolved oxygen concentrations (less than 4.0 mg/L, the minimum value deemed necessary for fish) existed at depths below 5.0 m (~16 ft) for both sampling events.

In contrast, dissolved oxygen values in the epilimnion (surface layer) were at saturation on June 7, 2017 (100.0 – 104.3 percent saturation) and were super-saturated (111.5 – 176.3 percent saturation) on July 19, 2017). These values are indicative of high algal productivity, as the process of photosynthesis adds oxygen to the water column during the daylight periods. High algal productivity also explains the elevated pH values observed in the epilimnion, where values were approximately 1.0 SU higher than those in the hypolimnion. The process of photosynthesis removes carbon dioxide from the surrounding water, resulting in a higher pH in the surface waters where sunlight can penetrate.

Specific conductance readings are a measurement of the concentrations of dissolved salts in the water column. Summertime specific conductivity readings in the hypolimnion of Summit Lake are 35 percent higher than those from the epilimnion, with average values of 1,115 µS/cm on June 7 and 919 µS/cm on July 19. Specific conductivity readings taken in the epilimnion averaged 831 µS/cm and 686 µS/cm for these dates.

The potential mechanism for this phenomenon is higher rates of loading of dissolved salts from the Summit Lake watershed during the winter months as the result of road deicing and subsequent runoff to the lake. Since temperate lakes in the northeast Ohio region tend to have uniform temperatures with depth during the winter months, the higher concentrations of dissolved salts likely become distributed equally with depth during this period. Loading of dissolved salts to the lake decreases in the spring simultaneous with increasing temperatures of the surface waters of the lake. When the lake becomes thermally stratified in the spring, the higher concentrations of dissolved salts would become trapped in the hypolimnion, producing the phenomenon observed during this study.

Readings for field parameters at the water quality sampling locations on the Ohio & Erie Canal showed very similar water temperatures on both dates. Similar to the results at Station L-1 in the lake, temperatures in the canal rose from approximately 20°C on June 7 to 27.4°C and 28.9°C on July 19, 2017 at Kenmore Blvd. (R06P13) and South Ave. (200119), respectively. Dissolved oxygen concentrations were lower at the Kenmore Blvd. sampling site compared to Station L-1 or South Ave. for both sampling events. The dissolved oxygen concentration at the lake inlet at Kenmore Blvd. ranged from 5.49 mg/L to 5.90 mg/L while the readings at South Ave., the lake outlet, ranged from 7.84 mg/L to 13.67 mg/L on June 7 and July 19, 2017, respectively. The values observed at the South Ave. sampling site reflected the concentrations observed in the open water areas of the lake.

The characteristics of the water overlying the lake bottom at the shallow-water sediment sampling locations used in the study were very similar to the results obtained from sampling at Station L-1 on June 7, 2017. Water temperatures just above the lake bottom at the sediment sampling sites ranged from 20.3°C to 24.0°C, pH readings ranged from 7.9 to 8.9 SU, and specific conductance ranged from 769 µS/cm to 881 µS/cm. Dissolved oxygen concentrations ranged from 7.0 to 14.8 mg/L, equivalent to 80 to 140 percent saturation. These results indicate that the shallow water areas have moderate to high primary productivity for algae and aquatic plants, and that these areas are accessible to aquatic fauna, including benthic (bottom-dwelling) organisms and fish throughout the summer.

7.1.1.2 Water Chemistry Results

Analytical reports for testing of inorganic and organic constituents conducted by TestAmerica are provided in Appendices D, E, F, and G. The following sections provide summaries of the results and a discussion of their implications with respect to the Ohio WQS and the support of designated beneficial uses of the waterbodies in the study area.

Inorganic Constituents

The results for inorganic constituents from the two rounds of water sampling conducted during the study are summarized in Table 11. The laboratory analyses included testing for 31 inorganic parameters including 13 general chemistry parameters. General chemistry parameters included alkalinity, total suspended solids, total dissolved solids, hardness, chemical oxygen demand. Compounds considered to be nutrients important in controlling algal growth in aquatic ecosystems were also included in the analysis, including total phosphorus (TP), orthophosphate (ortho P), and nitrogen compounds. The nitrogen parameters included ammonia (NH_3-N), nitrate+nitrite (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN). Analyses for metals in the water column were conducted for 18 constituents including major cations (calcium, potassium, sodium, and magnesium) and 14 other metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, selenium, strontium, and zinc). The results from the laboratory analyses are also compared to the applicable Ohio WQS listed in OAC Chapter 3745-1 in Table 11.

The only exceedance of an applicable WQS was a single result for manganese in the L-1 surface (0.5 m) sample collected on June 7, 2017. The epilimnetic concentration of manganese was 74 and 75 µg/L in two duplicate samples collected on that date, and exceeded the Public Water Supply (PWS) criterion of 50 µg/L. The result from the second sampling event conducted on July 19, 2017 for the surface sample collected at Station L-1 was 35 µg/L, well below the criterion. However, the average of the two samples is 54.25 µg/L, slightly higher than the 50 µg/L water quality criterion for the PWS use. It is possible that the elevated result for manganese on June 7, 2017 was related to the higher concentrations observed in the hypolimnion (2,100 µg/L) and that some mixing of the water column was occurring or had occurred. Manganese from lake sediments becomes highly soluble under anoxic conditions and is mobilized into the water column under those conditions. It should be noted that the PWS water quality criterion for manganese is based upon a secondary drinking water standard for the control of taste and odor problems in drinking water and does not reflect adverse risks for human health or ecological receptors (see the USEPA web site: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals for additional information regarding this criterion).

The concentrations of major cations (calcium, potassium, sodium, and magnesium) were slightly higher in the hypolimnion than in the epilimnion at Station L-1. This was also true for the Ohio & Erie Canal samples from the lake inflow (Station R06P13) as compared to the outflow station (200119). The cause of this phenomenon is uncertain except that on an average basis, the inflow water may be cooler than lake surface water and the inflow may affect the hypolimnion water quality according to the pattern also observed for specific conductance in the bottom waters of the lake (Section 7.1.1.1.1).

With respect to other metals in the water column, arsenic was detected in most of the samples, but the concentrations were all estimated and below the reporting limit (RL) of 10 µg/L. As discussed above, manganese concentrations were highly elevated in the hypolimnion of the lake on both sample dates, with concentrations 27 times and 50 times those measured in the epilimnion on the June 7 and July 19, 2017 sampling dates, respectively (Range 1,800-2,100 µg/L). These results are indicative of very low dissolved oxygen concentrations in the bottom waters and the mobilization of manganese from the sediments resulting from the reduction of this metal to a soluble ionic state.

For other metals, lead was detected at estimated concentrations below the RL (5 µg/L) in both canal sampling stations on June 7, 2017 but was not detected in any other water sample. Both results were below the Outside Mixing Zone Average WQS of 16 µg/L for lead (based on hardness of 200 mg/L). Nickel was detected at an estimated concentration below the RL in the hypolimnion on June 7, 2017 but was not detected in any of the other water samples. Both barium and strontium were detected in all the water samples collected for the study. Concentrations of both metals were well below the applicable WQS for both the protection of aquatic life and human health. All results for analyses for total recoverable cadmium, chromium, copper, mercury, and selenium were reported as non-detects. It should be noted that the reporting limits (RLs) for mercury and selenium were above their respective WQSs. Therefore, a determination as to attainment with respect to these WQSs cannot be made with the data at hand.

Nutrient concentrations were higher in the inflow to the lake (Station R06P13) and in the hypolimnion of the lake as compared to the epilimnion and the lake outflow (South Ave., Station 200119). This was true for both phosphorus and nitrogen analytes. Total phosphorus ranged from 0.021 to 0.041 mg/L in the lake epilimnion (Station L-1) but was 44 percent and 57 percent higher in the inflow and was 18 to 20 times higher in the hypolimnion than in the surface (0.5 m) sample from Station L-1. In addition, ortho P, a soluble form of phosphorus that can be readily used by algae, was not detected (<0.1 mg/L) in the epilimnion on either sampling date, but was detected at in the hypolimnion on both dates, ranging from 0.36 to 0.39 mg/L. Concentrations of phosphorus parameters at the lake outflow (Station 200119) were very similar to those observed in the surface sample from Station L-1 on both sampling dates.

The results for phosphorus constituents indicate that two factors are at work which affect the concentrations of phosphorus in Summit Lake available to stimulate algal growth: first, the input of TP via the Ohio & Erie Canal during the summertime is more than sufficient to replace any phosphorus that is lost to the hypolimnion via sedimentation while the lake is stratified. Therefore, any management plan developed for the lake designed to reduce summer algal abundance will need to focus in part on the reduction of TP loading via the canal. Second, the highly elevated concentrations of TP found in the hypolimnion indicate that the lake sediments are a significant source of internal phosphorus loading that may also stimulate and prolong algae blooms in Summit Lake.

The mechanism for the release of phosphorus from lake sediments is similar to that for manganese. Changes in the oxidation-reduction potential occur within the sediments and at the sediment-water interface when dissolved oxygen is depleted in the overlying water. This results in the transformation of phosphorus to a more soluble form which is then released to the water column. Evidence of this phenomenon occurring in Summit Lake is substantiated by the relatively higher concentrations of TP in the hypolimnion and the disproportionately higher percentage of TP that is present in the form of ortho P. In the June 7, 2017 hypolimnion water sample, 44 percent of the TP was in the form of ortho P. This increased to 100 percent of the TP in the July 19, 2017 sample from the hypolimnion. This phosphorus is readily available for algal uptake and likely exacerbates the presence of algae blooms in the lake throughout the summer. There is also a high potential for algae blooms in the late summer and fall in Summit Lake when the thermal stratification of the lake breaks down because of seasonally colder air temperatures. Mixing of the lake water in the fall will result in much higher concentrations of TP in the surface water and would stimulate algal growth.

The pattern for concentrations of inorganic nitrogen compounds in Summit Lake was similar to that observed for TP. Although concentrations of NO_3+NO_2-N were low in the epilimnion (range: <0.05 to 0.08 mg/L) and were not detectable in either of the hypolimnion samples, concentrations of NH_3-N were much higher in the hypolimnion (range: 1.4-1.6 mg/L) versus non-detectable (<0.02 mg/L) results for Station L-1 epilimnion samples on both dates. The water flowing into Summit Lake via the Ohio & Erie Canal (Station R06P13) had detectable concentrations of NH_3-N on both sampling dates (range: 0.10-0.16 mg/L). These values were similarly higher than those observed at the lake outlet (Station 200119), where concentrations ranged from 0.03-0.05 mg/L (average of 70 percent lower concentration at the outlet vs. the inlet).

Similarly, TKN, a measurement of NH_3-N plus organically-bound nitrogen compounds, was found at higher concentrations in the hypolimnion at Station L-1 as compared to the epilimnion. Concentrations ranged from 2.2 to 2.9 times the epiliminetic concentrations near the lake bottom. In addition, the makeup of TKN in the bottom samples was primarily composed of NH_3-N, which comprised 66 percent and 71 percent of the TKN in the hypolimnion on June 7 and July 19, 2017, respectively. In Station L-1 site surface samples, NH_3-N was not detected (<0.02 mg/L) on either sampling date, while TKN concentrations were 0.94 on June 7 and 0.73 mg/L on July 19, 2017. These results indicate that the majority of the TKN was associated with organic matter, likely within the algae in the water. For the canal sites, NH_3-N concentrations averaged 11.5 percent of the TKN, indicating that most of this nitrogen was bound in particulate matter or algae, similar to the observed condition at Station L-1. The implications for long-term lake management considerations is similar to that for phosphorus: the anoxic hypolimnion in Summit Lake has considerable potential to serve as a source for algal nutrients when events occur that cause surface and bottom waters in the lake to mix.

Organic Constituents

Testing was conducted for organic compounds in water samples collected on July 19, 2017 from the three water quality sampling locations as well as the hypolimnion at Station L-1. Analyses were conducted for 90 organic compounds including legacy pesticides and herbicides (23 compounds), PCBs (7 Arochlors), and SVOCs (60 compounds). The complete results from these analyses are provided in Appendix J. There were no detectable concentrations of any of the organic analytes reported for the water samples collected from Summit Lake and the Ohio & Erie Canal. Based on this data, Summit Lake and the Ohio & Erie Canal were in attainment with respect to these compounds at the time that the samples were taken. It should be noted that since the data set consists of the results from only one set of samples, it is possible that conditions are different on other dates and under different circumstances than those observed during the Phase II Study.

7.1.1.3 Algal Indicators

Three types of samples were collected to characterize the algal community in Summit Lake and the Ohio & Erie Canal within the study area: algal pigments (chlorophyll *a*), algal toxins, and the species composition of the phytoplanktonic (suspended) algae in the lake and canal water. The purpose of these analyses is to quantify algal abundance, and to assess the potential for risk to lake users from HABs.

Chlorophyll a

Chlorophyll *a* is the primary pigment involved with photosynthesis and as such, is used as an indicator of the total abundance of algae in lakes. The total algal abundance in freshwater lakes is most often limited by the concentration of nutrients, primarily phosphorus and nitrogen, in the water column. As lakes become nutrient enriched, the algal productivity and abundance increases with accompanying loss of water clarity and often with accelerated rates of oxygen depletion in the hypolimnion caused by the decay of dead algae sinking to the lake bottom. The nutrient enrichment of lakes and concomitant loss of water clarity, presence of algae blooms, and anoxia is described by the term “eutrophication”.

Chlorophyll *a* concentrations in Summit Lake from surface (0.5 m in depth) samples collected during the Phase II Assessment are provided in Table 12. The laboratory report for the analytical results is provided in Appendix K. The implications of the data are discussed in context with other indicators in Sections 7.1.2 and 7.1.3 of this report.

Algal Toxins

Samples collected from the surface (0.5 m depth) on July 19, 2017 were analyzed for the presence of four algal toxins as an indicator of the risks associated with HABs. The results of these analyses are presented in Table 13, and the report associated with the analyses is provided in Appendix L.

The only algal toxin detected in the July 19 samples was Saxitoxin, which was detected at concentrations ranging from 0.028 to 0.034 µg/L. Analysis for other potential algal toxins for which testing is available, Microcystin, Anatoxin-a, and Cylindrospermopsin, did not detect any of these compounds. Saxitoxin is a powerful neurotoxin that is produced by several freshwater algae, including cyanobacteria (blue-green algae) and dinoflagellates (Pearson et al., 2010). It is the primary component of a class of toxins known as "paralytic shellfish poisons" based upon incidents occurring in marine environments.

The State of Ohio has developed a response strategy for potential HABs based upon the concentrations of algal toxins found in surface water (State of Ohio, 2016). The strategy describes a progressive list of actions based upon the observed concentrations of these compounds. The thresholds for these responses are summarized in Table 14. Since the observed concentrations of Saxitoxin in Summit Lake are below the Recreational Public Health Advisory threshold of 0.8 µg/L, the response described in the strategy is the posting of an informational sign that includes general information regarding HABs and safe practices to avoid exposures.

The Phase I Report for the Summit Lake study area (EnviroScience, 2017a) summarizes the previous results for algal toxin analyses prior to the current study. Prior sampling was limited to testing for Microcystin, which was detected in Summit Lake in 2012 and 2013. Although none of the results from Summit Lake to date has shown concentrations of any algal toxin above the Public Health Advisory thresholds, the data that have been collected indicate that HABs are possible given that two different algal toxins have been detected. Given the limited data set, it is recommended that a regular surveillance program for HABs be developed for Summit Lake and the Ohio & Erie Canal, especially as plans are implemented to improve recreational opportunities for these water bodies and to encourage more use by the public.

Algae Species Composition

The species assemblage for algae was very similar among the four water quality sampling locations that were sampled on July 19, 2017. A total of 42 different planktonic (suspended) algal taxa were identified from the samples, with 12 taxa common to all the samples (Table 15, Appendix M). A total of 25 to 28 taxa were identified from each sample, with cyanobacteria accounting for 8 to 11 of these totals. Although the abundances of each taxon were not counted for the samples, the observations during the qualitative assessment indicated that cyanobacteria were the dominant algal group present in the samples. Six of the cyanobacteria taxa present in the samples are known to be potential producers of algal toxins based upon the scientific literature (Bláha et al., 2009; Graham et al., 2008; Mez et al., 1997; Pearson et al., 2010; Quiblier et al., 2013).

The presence of cyanobacteria taxa that can potentially produce algal toxins is common in Ohio inland lakes, and therefore the approach to management of Summit Lake with respect to this issue should be no different than that developed by the State of Ohio. If a reliable monitoring and public awareness program is followed to determine when and if HAB conditions may be present and proper precautions are taken, recreational activities associated with Summit Lake and the Ohio & Erie Canal can be supported into the future. Water quality and lake management approaches that will reduce the potential for the creation of HABs should be the focus as plans are implemented for the lake into the future.

7.1.1.4 Recreational Use Attainment

Recreational use attainment criteria for Ohio inland lakes are specified in OAC 3745-1-37. The criteria apply during the defined recreational season (May 1 – October 31) and are based upon the Outside Mixing Zone Maximum criteria for chemical pollutants, other aesthetic criteria, and the counts for the bacterium *Escherichia coli* (*E. coli*) in the water column.

Counts for *E. coli* are used as an indicator of the potential for the presence of pathogenic organisms in the water resulting from the presence of poorly treated wastewater or animal wastes in the water. The applicable recreational use criteria for Summit Lake are those set for the Primary Contact Recreation (PCR) beneficial use. This use is defined as "…waters that, during the recreation season, are suitable for one or more full body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving. …" [OAC 3845-1-07(B)(3)(b)]. Ohio EPA uses both statistical threshold values (STVs) and the geometric mean results from the collection of multiple samples over a 90-day period to evaluate attainment of the Recreational Use criteria.

Five rounds of samples were collected during the study period from the water quality sites on the Ohio & Erie Canal as it enters and leaves Summit Lake, as well as from the Boat Ramp site located near the Summit Lake Community Center to characterize potential recreational use exposures. Samples were collected during the period of June 7 – July 19, 2017. In addition, two samples were collected from Station L-1 for comparison purposes in conjunction with the collections of water samples at that location. Copies of the Adams Water Laboratory sample reports are provided in Appendix N.

Results for *E. coli* counts from samples collected during the assessment are summarized in Table 16. The results show that the water flowing into Summit Lake via the Ohio & Erie Canal (Station R06P13) exceeds both the geometric mean and the STV PCR criteria for *E. coli*. The Ohio & Erie Canal was therefore in non-attainment for the PCR Use at that location. The *E. coli* counts for samples collected within Summit Lake and in the Ohio & Erie Canal at the lake outlet (South Ave., Station 200119) were all well below the PCR criteria indicating that the PCR Use is in full attainment for these waters.

This study did not identify the sources of bacteria loads to the Ohio & Erie Canal south of Summit Lake. Potential sources include failing on-lot sewage systems, sanitary sewage overflows, releases of other untreated or poorly treated wastewater, and urban runoff affected by pet or wildlife feces. Additional monitoring of potential sources as well as other locations on the Ohio & Erie Canal would be necessary to develop a control strategy to correct the problem identified for this water body.

Water samples collected on July 19, 2017 did not detect any of the chemical compounds listed in Table 37-1 of OAC 3745-1-37 that are used to evaluate the support of recreational uses. However, as noted in Section 6.1, a visible oil sheen was noted on the Ohio & Erie Canal as it enters Summit Lake at Kenmore Blvd. (Station R06P13) on several occasions during the implementation of the Phase II Assessment study. The presence of a visible oil sheen is a violation of the Recreational Use Water Quality Standard (OAC 3745-1-37). Although the incident discovered during the present study was promptly investigated and cleaned up by Ohio EPA and local authorities, the source of the oil was not identified. In addition, Ohio EPA has responded to reports of visible oil sheens at this location on other occasions as well (Larry Antonelli, Ohio EPA, pers. comm.), indicating that this is an ongoing problem that has not yet been resolved. Given the widespread distribution of oils in the shallow sediments throughout Summit Lake (Section 7.2.1.1), monitoring and implementation to identify and eliminate sources of oils and greases to the Ohio & Erie Canal and Summit Lake is recommended.

7.1.2 Lake Trophic State Indicators and Trends

As described in the Phase I Report for Summit Lake (EnviroScience, 2017), the Trophic State Index (TSI) developed by Carlson (1977) can be used to quantify the condition of Summit Lake with respect to eutrophication. The TSI uses measurements for three parameters, Secchi disk transparency (TSISD), total phosphorus concentration (TSITP), and chlorophyll *a* concentration (TSIChl) to rate a lake on a scale of 1-100 to provide a standard method for comparison. Measurements for these parameters within the epilimnion of the lake are used to calculate the TSI values using standardized equations. Larger values for the TSI indicate more enriched, eutrophic conditions in the lake. Ohio EPA has informally set the following thresholds for determining the trophic state of inland lakes in Ohio (Ohio EPA, 1996): oligotrophic (TSI <38), mesotrophic (TSI 38-47), eutrophic (TSI 48-66), and hypereutrophic (TSI >66).

The historical measurements for the TSI parameters collected from Summit Lake and the resulting TSI values compiled for the Phase I Report have been updated to include data from this study (Figure 9) and are listed in Appendix O. The TSI scores for Summit Lake from the 2017 sampling events continue to fall within the eutrophic range for all three indicator parameters. However, the trend of total phosphorus concentrations and TSITP values (Figure 9) indicates that TP concentrations have remained stable in Summit Lake since the late 1990’s and are lower than those observed from earlier years. As discussed in the Phase I Report, the reduction in TP has not been accompanied by lower chlorophyll *a* concentrations, although average Secchi disk transparency has improved somewhat when compared to data from the 1980’s. The potential explanations for the apparent disconnect between total phosphorus concentrations and algal abundance include the possibility that the algae are limited more by nitrogen concentrations than by phosphorus. Also, it is possible that the internal availability of phosphorus from the hypolimnion is a source of sustained phytoplankton productivity in the epilimnion. The data collected from the Phase II Assessment of Summit Lake is only sufficient to confirm that the conditions in the lake have not changed since Ohio EPA last monitored the lake in 2012-2013. A detailed study of the cycling of nutrients and of the hydrology and mixing of the lake water would be needed to make definitive conclusions regarding the mechanisms at work in the lake that control phytoplankton growth.

7.1.3 Draft Ohio Lake Habitat Water Quality Criteria

Ohio EPA has developed draft water quality criteria for lakes based upon lake type and location that are being considered for adoption as water quality criteria within a new Lake Habitat (LH) beneficial use designation (Ohio EPA, 2010a; Ohio EPA, 2016b). Under this approach, numeric water quality criteria applicable to Summit Lake would be identical to those for the Exceptional Warmwater Habitat (EWH) Aquatic Life Use. In addition, criteria would be applied for the epilimnion layer of stratified lakes for concentrations of dissolved oxygen, chlorophyll *a*, total nitrogen, and TP as well as for water clarity measured as Secchi disk transparency.

The average for data collected from Summit Lake is compared to the draft LH criteria in Table 17. If these criteria were in force, Summit Lake would be in partial attainment for LH Use. The 2017 results from Summit Lake exceed the draft criteria for chlorophyll *a* and total nitrogen, while the draft criteria for dissolved oxygen and TP are met. The average Secchi disk transparency for 2017 is only slightly below the draft criterion, with one value below the criterion (not meeting expectations) and one value greater than the criterion. In addition, the average TP concentration is just below the draft criterion, with concentrations both above and below the LH Use target.

The comparison to the draft LH Use criteria is valuable in that it indicates that the condition of Summit Lake is not significantly degraded in relation to expectations for natural lakes in the Erie Ontario Lake Plain ecoregion. There is an opportunity to tangibly improve the lake trophic state and aesthetics through reductions in nutrient loading that could significantly improve recreational opportunities in Summit Lake. In addition to the potential to reduce algae abundance and improve water clarity, these reductions would also reduce the risk of HAB occurrences in the lake, thereby reducing the potential for exposures to algal toxins.

7.2 Sediment Quality

Ohio EPA guidance for evaluating sediment data (Ohio EPA, 2010b) is used in this assessment to screen and interpret the data for sediment quality from Summit Lake. Results are summarized for analytical parameters to describe the overall characteristics of the sediment in the lake (Section 7.2.1). Analytical results for sediments are also compared to appropriate screening criteria using both Tier I and Tier II assessment procedures outlined in the Ohio EPA guidance. The screening benchmarks used are those established under the Ohio EPA VAP program rules to identify potential risks to human health associated with exposures likely during typical recreational activities using the lake (Section 7.3). In addition, screening values for ecological risk as well as procedures to estimate sediment toxicity to aquatic life are also employed to identify potential impairments within the lake to the aquatic biota (7.4).

7.2.1 Sediment Characteristics and Analytical Results Summary

Complete analytical reports for the sediment samples collected from Summit Lake, including all laboratory and field QA/QC results are provided within the TestAmerica Analytical Reports in Appendices D, E, and F.

7.2.1.1 Sediment Characteristics

Field Observations

Information regarding encountered sediment thickness and sample collection success is described in Section 5.2.2. A summary of the field observations for sediment characteristics recorded for composition, color, layer thicknesses, and the presence of specific odors and oil sheens associated with the samples is provided in Table 18 for Selected Sites and Table 19 for Targeted Sites. Photographic logs of the sediment sample collection activities are provided in Appendix P. On average, each sediment core sample consisted of two distinct layers, although three layers were encountered at four of the twenty-two sampling locations and twelve of the sites had only a single discernable layer within the core sample. The average thickness of the of the top layer of the sediments at all sites was 24 cm. Therefore, the top layer of the sediment made up most of the volume of the samples sent to the laboratory for analysis. There was no significant difference for the thickness of the top layer of sediments at Selected vs. Targeted Sites (t=0.719, p=0.481, df=20).

Field observations noted qualitative differences between the top sediment layers at Selected Sites vs. Targeted Sites with respect to the composition of the deposits and the color of the material. Silt[1] and muck[2] dominated the top sediment layer at Selected Sites, with silt being a primary component of the material at 92 percent of the sites and muck recorded as a major component of the top layer at samples at 75 percent of the sites. The composition of the top sediment layer at the Ohio & Erie Canal Targeted Sites was very similar to that observed at the Selected Sites. However, muck was only recorded as a principal component at one of the seven other Targeted Sites, while sand was recorded as a major component of the samples at five of the other seven Targeted Sites (71 percent of the samples). With respect to the color of the top layer of the sediment, the qualitative color recorded for the top layer ranged from olive-brown to black at Selected Sites, with dark olive predominating (75 percent of the samples). In contrast, at Targeted Sites, the top layer was recorded as black in color at most of the locations (70% of the samples).

A common field observation at most of the sampling locations in Summit Lake was the presence of observable oil sheens and petroleum hydrocarbon odors in the sediment samples. Oil sheens were noted for 14 of the 22 (64 percent) sediment samples collected from the littoral areas of the lake. The presence of oil sheens was always accompanied by detectable petroleum hydrocarbon odors, and when present, the sheens were always noted for the top sediment layer. Oil sheens and petroleum odors were also noted for sub-surface layers for three of the four locations where multiple layers of sediments were noted and oil sheens were observed. Oil sheens were observed at a lower frequency at Selected Sites (46 percent of the samples) than at Targeted Sites (89 percent of the samples). Only one Targeted Site, Grid_B37 near the storm drain outlet at the end

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[1] Silt is defined as fine, non-plastic and non-cohesive particles, 4-60 µm in diameter, possessing a greasy or smooth texture when manipulated.

[2] Muck is defined as black, extremely fine, flocculent material composed entirely of decomposed organic matter that is most often anoxic and will heavily stain other materials when contacted.

of Leslie Ave. on the west shore of the lake, did not have an observable oil sheen or petroleum odor associated with the sample.

Geographic analysis of the distribution of the noted oil sheens and petroleum odors at the sediment sampling locations implicated both the flows from the Ohio & Erie Canal and those from storm sewer outlets entering Summit Lake as the sources for these contaminants. Selected sites where oil sheens and petroleum odors were noted are primarily those located in the southern portion of the lake that are likely affected by flows and from the Ohio & Erie Canal entering Summit Lake (i.e. samples SS1 – Grid_A50, SS2 – Grid_A27, SS4 – Grid_D77, and SS13 – Grid_D80). Accumulations of petroleum-derived contaminants are likely concomitant with the sedimentation that would occur in this portion of the lake from loadings associated with flows in the canal. The other Selected Site where oil-related sheen and odors was noted (sample SS-5, Grid_B65) is located along the western shore of the near the location of two storm sewer outlets to the lake along the western shore and is near the storm sewer outlets where two Targeted Sites were sampled (TS3, Grid_B51 adjacent to the Lagoon Ave. and TS4 – Grid_B_61 adjacent to Indian Trail).

It is not possible with the data gathered thus far to identify or quantify the sources of the petroleum hydrocarbon contaminant loadings to Summit Lake. However, the data from this assessment show that there are likely multiple sources that must be considered. In addition, the correlation of these contaminants to the top layer of the lake sediments indicates that these loadings are ongoing, and their presence cannot be attributed only to historical pollution of the lake.

An organic chemical odor was noted from the middle layer (sandy clay) in Selected Site sample SS11 from Grid_C75. This odor was very different than the petroleum hydrocarbon odor noted in other samples but was recorded as “moderate” on the field sample form. Since this layer of the sediment was within the top 30 cm of the core sample, a separate sample was not collected for this stratum. Other noted odors associated with the sediments collected during the assessment were hydrogen sulfide (rotten egg) odors associated with two of the samples collected from Selected Sites (samples SS3 and SS12). These types of odors are not unusual for lake sediments and reflect anaerobic respiration of detritus in the sediments.

Sediment Characteristics: Percent Solids, TOC, and Grain Size

Sediment characteristics with respect to percent solids, TOC, and grain size are summarized in Table 20, and are depicted graphically in Figure 10. Detailed results for these parameters are provided in Appendix Q. All sediment samples collected from Summit Lake met the DQO for sample characteristics, with sand size (2 mm) or smaller material making up the samples (range: 57 – 100 percent, average = 91.2 percent for all sites). No material was collected in any of the samples with grain sizes greater than the range for gravels (>2 - 19.2 mm).

The sediment samples from Targeted Sites had significantly higher average results for percent solids (t=-3.857, p=0.0005) and percent sand (t=-3.508, p=0.001) than Selected Sites based upon one-tailed Student’s t tests, while the percent silt was significantly higher at Selected Sites than Targeted Sites (t=1.938, p=0.033) (df=20 for all tests). These results make sense in that solids flowing into the lake will tend to be differentiated by size as they settle, with finer-grained material being carried farther into the lake prior to settling to the bottom, while larger-grained material will settle more quickly and thus be located closer to the source.

There was no significant difference between the average TOC content of the samples collected at Selected Sites and Targeted Sites. The fraction of organic carbon in the samples for all sites ranged from 0.005 to 0.600 and averaged 0.129. Additional statistical analysis for Selected Sites using single-factor ANOVA found that there are no significant differences between the delineated Areas within the lake for either percent solids (F=0.509, p=0.685) or TOC (F=1.811, p=0.215).

7.2.1.2 Sediment Chemistry

A summary of the results for each analyte group is provided in the sub-sections below.

Metals

Testing was conducted for 18 metals constituents in the sediment samples collected from both Selected and Targeted Sites. The results of these analyses are summarized in Table 21, and all results are compiled in Appendix R. Results were reported in all the sediment samples for 16 of the metal analytes. The exceptions were mercury, with three non-detect results (13.0 percent of the samples) and selenium with ten non-detects (43.5 percent of the samples). Results were estimated for some of the samples for five of the metal analytes: cadmium, mercury, potassium, selenium, and sodium. Estimated results are reported when an analyte is detected at concentrations above the method detection limit (MDL) but below the RL for the test method. For analytes where estimated results are reported, the number of samples involved ranged from five (21.7 percent of the samples) for cadmium to 100 percent of the samples for potassium and sodium.

Several metal analytes were detected in one or more laboratory method blanks associated with the testing of sediment samples from Summit Lake. These results affected the data reported for the following constituents: copper, iron, lead, manganese, magnesium, nickel, potassium, sodium, strontium, and zinc. Concentrations for these constituents were reported as detectable for all samples submitted for analysis. Of the 230 results reported for these constituents, 165, or 72 percent, were flagged as potentially affected by detection of the analyte in the associated laboratory blank. Results listed in the laboratory analytical reports (Appendix D) for the sediment samples from Summit Lake and the associated QA/QC samples were reviewed to determine the reliability of the data for conducting the Phase II assessment. Ohio EPA guidance (Ohio EPA, 2010) recommends that results be considered positive if the reported value is greater than five times the maximum blank sample concentration. All the flagged results for metals constituents in the Summit Lake data set met this criterion, and therefore are considered valid results for further assessment.

The data sets for all metal analytes were tested to determine if the values are normally distributed using the Shapiro-Wilk test (Shapiro and Wilk,1965) procedure prior to the calculation of averages and upper confidence limits (UCLs) for the concentrations in the sediments. The analyses found that only the data sets for iron, potassium, selenium, and sodium are normally distributed. The remainder of the data sets were log-transformed and re-tested and were then reanalyzed for normality. The log-transformed data sets were found to meet normality for the computation of the statistics presented in Table 21. Computations were conducted using ProUCL Software, ver. 5.1 (USEPA, 2014). This statistical software was created to provide tools for analyzing censored environmental data that may not be normally distributed.

Statistical comparisons were conducted between data from Selected vs. Target Sites using two-tailed Student's t tests to determine if there were differences between the average concentrations for each of the metal constituents. The statistical calculations used a concentration of one-half the RL for results reported as below the detection limit. The results of these evaluations found no significant differences for 15 of the 18 analyzed metal constituents. Significant differences were noted for average concentrations of barium ($p<0.03$), manganese ($p<0.0002$), and strontium ($p<0.03$). The concentrations of barium and strontium in the sediment were greater at Selected Sites, while manganese concentrations were higher at Targeted Sites. The relative percent differences between the concentration averages were 62 percent for barium, 175 percent for manganese, and 60 percent for strontium.

Mapping analysis found no pattern to the distribution of higher concentrations for the various metals constituents. In addition, exploratory analysis of the data using rankings for the concentrations of the various metals at the sampling sites did not detect a pattern of co-variance between the metal constituents in the samples. Based upon these results, it is difficult to assign causality for elevated metals concentrations at individual locations other than to infer that pollutant loadings via water inputs as well as transport and sedimentation patterns within the lake together result in the observed distributions. This issue would need to be investigated further in order to fully understand how metals become distributed in the sediments in Summit Lake.

Based upon the analytical results and the background determinations for metals presented in Section 8.0 of this report, the following metals are carried forward for screening analysis as contaminants of interest (COI) for screening level assessment for potential human health and ecological risk: copper, lead, mercury, and zinc. The metal constituents removed from the screening level analysis include metals that are also major cations within the dissolved solids in surface waters (calcium, magnesium, potassium and sodium), ubiquitous metals for which there is little or no concern regarding toxicity from the sediments (aluminum, iron and manganese), or are found at concentrations below background concentrations (arsenic, barium, cadmium, chromium, nickel, selenium, and strontium).

Acid Volatile Sulfides and Simultaneously Extracted Metals

Data from the analyses for AVS/SEM are used in the assessment of ecological risks for benthic organisms (see Section 7.4.2.1). Results for analyses of sediment grab samples for AVS/SEM analytes are summarized in Table 22. AVS/SEM analyses were limited to Selected Sites. Detailed results for each of the Selected Sites are provided in Appendix S. Concentrations of AVS in the sediments ranged from non-detect (<42 mg/kg) to 3,600 mg/kg. Although analyses were performed for SEM mercury, all the results from these tests were reported as non-detect, with RLs ranging from 0.001 to 0.580 mg/kg.

Single factor ANOVA analysis detected no significant differences between the areas of the lake with respect to sediment AVS or SEM concentrations for any of the metal analytes ($p>0.05$ for each analyte). Analyses for normality using the Shapiro-Wilk Test (Shapiro and Wilk, 1965) determined that the data sets were not normally distributed. Therefore, the data were log-transformed to produce normally distributed data prior to the ANOVA analyses.

Petroleum Hydrocarbons

Testing was conducted for the sediment samples from Selected Sites for oil-range and diesel-range organic compounds (ORO and DRO, respectively). The hydrocarbon chain for DRO compounds include those 10 to 20 carbon atoms long (C10-C20), while those for ORO are 20 to 34 carbon atoms in length (C20-C34). For purposes of this report, the sum of DRO and ORO is used as a surrogate for total petroleum hydrocarbons (TPH), although the data do not include gasoline-range organic compounds.

Concentrations of DRO, ORO and calculated values for TPH in the Selected Site Samples are listed in Table 23 and depicted in Figure 11. These compounds were detected at every sampling location in Summit Lake where testing was conducted, indicating the lake-wide effects of runoff and releases of petroleum-related contaminants from the watershed.

Total Peteroleum Hydrocarbon concentrations were statistically compared among the delineated areas of the lake to determine if their distribution in the surficial sediments are spatially concentrated. Summarized statistics for each lake area are provided in Table 24. Results from a Shapiro-Wilk's test showed that the data from each sampling area were normally distributed ($p>0.05$ for all sampling areas). A single-factor analysis of variance (ANOVA) showed that there were no significant differences in the mean TPH concentrations among the four areas of the lake ($F = 0.105$, $p = 0.955$, $df=20$). This analysis indicates that although random sampling identified presence of "hot-spots" within Summit Lake for TPH compounds, the presence of these more contaminated sites appears to be localized or random. Therefore, for the purposes of future management of the lake, the presence of TPH in the littoral sediments in the lake should be assumed from the outset. Additional investigation is recommended in portions of the lake where high frequency recreational contact with lake sediments is planned to ensure that exposures are within acceptable limits.

Volatile Organic Compounds

Testing for VOCs in Summit Lake sediments was limited to Selected Sites ($n=13$). Laboratory testing included analyses for 44 VOC constituents (Appendix T). Reportable results from the testing included 10 VOC constituents, as summarized in Table 25. Reported detections were limited to one to three samples for six of the VOCs, while four compounds, 2-butanone (MEK), acetone, carbon disulfide, and methylene chloride were detected in 11-12 of the samples. Of the 54 reported detections, only five results were above the RL for the associated compound. The remainder were qualified as being detected below the RL but above the MDL for the analyte.

It should be noted that five of the ten detected VOCs reported from Summit Lake are considered common laboratory contaminants (Ohio EPA, 2008). However, a review of the associated laboratory QA/QC documentation does not reveal a pattern for contamination of the laboratory control samples for these contaminants except for methylene chloride. Methylene chloride was detected in two of the laboratory method blanks associated with the analytical runs for the Summit Lake VOC samples. Only one of the reported detections for this compound was not qualified because of laboratory contamination. Of the estimated concentrations of methylene chloride, only one result, a value of 42 µg/kg from the sample collected at Grid D80, was reported at a concentration greater than 10 times the result found in the associated method blank. Ohio EPA Guidance (Ohio EPA, 2008) indicates that compounds should be considered present if it is detected at these levels when also found in the blank samples. Given the weight of evidence regarding the potential for false-positive methylene chloride results reported for Summit Lake sediments, it is reasonable to eliminate this compound as a COI for further screening characterization.

Three VOCs are carried forward for risk analysis as COIs for this assessment. They include 2-butanone (MEK), acetone and carbon disulfide. These compounds were detected in the majority of the samples that are likely to be encountered via recreational activities and their concentrations can be reliably predicted using descriptive statistics.

Semi-Volatile Organic Compounds

Samples for SVOC analyses were collected only at Selected Sites. The analyses included testing for 43 compounds, and complete results are tabulated in Appendix U. One compound reported with the SVOCs in the TestAmerica Analytical Reports, 2-methylnaphthalene is reported herein with results for PAHs, as this compound is within that chemical family.

The SVOC bis (2-ethylhexyl) phthalate (BEHP) was detected in one of the laboratory method blanks, resulting in qualification of eight of the twelve detectable results for this compound. Only two of the detectable results were reported at concentrations exceeding ten times the reported concentration of BEHP in the method blank. Based upon evaluation of the data, it appears that the reported concentrations of BEHP were the result of laboratory contamination and that reliable estimates of the presence of this compound in the sediments of Summit Lake were not obtained. This compound is also reported to be a common laboratory contaminant by Ohio EPA (Ohio EPA, 2008).

For the remaining SVOCs, detectable concentrations were reported for four compounds, only one of which was detected in more than two samples. Summary statistics for the detectable SVOCs is provided in Table 26. Dibenzofuran was detected in 46.2 percent of the sediment samples. For the other SVOC constituents where detectable results are limited in number, descriptive statistics such as averages and upper confidence limits are not provided in Table 26 since the data set is dominated by estimates of non-detectable concentrations, and the calculations would not be accurate. Of the 65 analytical results reported for SVOCs that were detected in one or more samples, 42 results were less than the detection limit (65 percent). For the 23 results with reported detections, 15 (65 percent) were reported as estimated values with concentrations below the RL but above the MDL. All detectable results reported for dibenzofuran were estimated values.

Dibenzofuran is the only SVOC carried forward as a COI for screening analysis regarding potential risks to human and ecological receptors. This decision is based upon the frequency of detection in the samples. The other three SVOC compounds detected in the samples are not carried forward for screening analysis, since reliable exposure concentration estimates cannot be developed for these constituents.

Polycyclic Aromatic Hydrocarbons

Analyses for PAH compounds consisted of testing for 17 of the 34 compounds in this chemical family at Selected Sites and for 16 compounds at Targeted Sites. This discrepancy is the result of the laboratory test method used for the analysis of 2-methylnaphthalene, which is included with the test method utilize for SVOC analysis and not for the PAH compound suite selected for the study. Samples were not collected for SVOC testing from Targeted Sites. Results from the analyses are summarized in Table 27 and complete results are compiled in Appendix U.

The distribution of PAHs in the sediments of Summit Lake is widespread, with detectable concentrations of multiple compounds at every sampling location. On average, 14 of the 17 PAH compounds were detected in each sample, with all analytes detected in 6 of the 23 samples collected. Of the 381 tests conducted for PAH compounds from the Summit Lake sediment samples, 85 percent were detectable results. Estimated results were reported for only 10 percent of the tests for PAH compounds. With respect to each constituent in the PAH analytical suite, detectable results occurred in 19 of the samples on an average. There were no results flagged for the presence of contaminants in the laboratory method blanks for PAHs.

Based upon the widespread distribution of PAHs in the sediments of Summit Lake, all of these compounds are carried forward as COIs for the assessment of potential risks to human and ecological receptors.

Total PAH concentrations were estimated by adding the individual results for each of the PAH analytes for each sample. For those PAH compounds that were reported as non-detect, a value equal to one-half of the reporting limit was substituted to provide a concentration estimate. Initial graphical and cursory analysis of the results from Selected and Targeted Sites (Figure 12, Table 28) led to an assumption that total PAH concentrations are higher at Targeted Sites. To confirm this apparent difference, a statistical test was conducted to compare the average total PAH concentrations at the two categories of sampling sites using the Student's t-test. Concentration data were log transformed to provide normally distributed data sets. Results from a Shapiro-Wilk test of log-transformed PAH concentration data showed that the transformed data sets from the site categories are normally distributed ($p > 0.05$). Comparison of the average concentrations found that there is no significant difference in the total PAH concentrations between Selected sites and Targeted sites ($t = -1.16$, $p = 0.257$, df=20).

Total PAH concentrations in the four delineated areas of the lake (Figure 2) were compared using a second statistical analysis to determine if there are specific portions of the lake that are more highly effected than others (Figure 13, Table 29). For this analysis, the Canal sites are excluded from the data set as they are not located within the lake proper. The data sets for this analysis were not all normally distributed based upon an evaluation using the Shapiro-Wilk test. Attempts to normalize all the data sets by transforming the data were not successful. Therefore, the data from the different areas were analyzed using the Kruskal-Wallis test (Siegel and Castellan, 1988), a non-parametric statistical procedure that does not require normally distributed data. The results of this analysis indicated that there is no statistical difference (Kruskal-Wallis Statistic = 3.078, $p = 0.380$) for total PAHs in the sediments between the delineated areas within Summit Lake. These results are very similar to those observed for TPH concentrations as described above, and reinforces the recommendations that additional investigation may be needed in portions of the lake where high frequency recreational contact with lake sediments is planned to ensure that exposures are within acceptable limits.

Polychlorinated Biphenyls

Polychlorinated biphenyls are bioaccumulative toxic compounds that are common persistent legacy pollutants in aquatic ecosystems. For the present study, analyses of sediment samples were conducted for seven different PCB formulations, known as Arochlors, for all sediment samples collected from Summit Lake (both Selected and Targeted Sites). A comprehensive listing of all results from the analyses for PCBs in the sediments is provided in Appendix V.

The only PCB Arochlor detected in the 2017 sediment survey of Summit Lake was Arochlor 1254, which was detected in 11 of the 23 samples (48%). Three of the detection results for Arochlor 1254 in the sediment samples were reported as estimated values, with concentrations below the RL but above the MDL. No other data qualifiers were reported for any of the PCB compounds in the analysis.

The average concentration calculated for Arochlor 1254 equaled 170 µg/kg, the maximum detected concentration was 630 µg/kg, and the 95 percent UCL was 240 µg/kg. The statistics for Arochlor 1254 concentrations in the sediment were calculated using Kaplan-Meier (1958) procedures using the ProUCL Software package developed by USEPA for analyzing data sets that contain numerous values reported as less than the detection limit (USEPA, 2014).

Given that PCBs are known carcinogens, are highly refractory in the environment, and are also bioaccumulative, Arochlor 1254 is carried forward as a COI for further analysis of potential for risks to human and ecological receptors from the sediments in Summit Lake.

Pesticides and Herbicides

Sediment samples from Selected sites were analyzed for three organochlorinated herbicide and twenty-one pesticide compounds. These compounds are considered as legacy contaminants in that they are persistent and do not readily break down in the environment. Many of these chemicals are now banned for use in the United States. Analyses were not conducted for herbicides and pesticides currently approved for use that are bio-degradable.

The results of the analyses are provided in Appendix V and the results for detected compounds are summarized in Table 30. No herbicide analytes were detected in the sediment samples collected from Summit Lake. Three pesticide compounds, alpha-chlordane, gamma-chlordane, and 4-4’-Dichlorodiphenyldichloroethylene (4-4’-DDE or p-p’-DDE) were detected in the samples. Chlordane was a commonly used insecticide for termite control, while 4-4’-DDE is a decomposition byproduct of DDT which was used widely for mosquito control.

Both forms of chlordane were detected in a single sample collected from Grid A50, while 4-4’-DDE was detected in four samples. Since the distribution of chlordane compounds so limited, application of these results to produce lake-wide statistics it is not reliable, and these contaminants are not carried forward as COIs for additional analyses. The other detected pesticide, 4-4’-DDE is a bioaccumulative chemical and is also a known carcinogen. Therefore, this compound is carried forward as a COI for screening analysis.

7.3 Screening of Sediment Data for Potential Human Health Risks

One of the principal DQOs for the Phase II Assessment of Summit Lake was to *"…determine the sediment quality of the shallow areas of Summit Lake and the Ohio Canal within the study area and to compare the data to human health and ecological screening benchmarks*" (SAP, Section 2.0). The purpose of this DQO is to provide a screening level assessment of the potential risks associated with incidental contact with the lake sediment associated with recreational uses of the lake and nearby portions of the Ohio & Erie Canal.

Unfortunately, screening benchmark values for human exposures to contaminants in lentic sediments do not exist. Therefore, screening values used for soils were substituted to provide a starting point for the basis of comparison. For this assessment, the Residential Generic Direct-Contact Soil Standards (GDCSS) developed for the Ohio VAP program are used for initial screening of the sediment data from Summit Lake. The values used below are taken from the Ohio EPA VAP Chemical Information Database and Applicable Regulatory Standards (CIDARS) listings and Supplemental Criteria, current as of February 9, 2017 modified to reflect updates to the USEPA Integrated Risk Information System (IRIS) for selected parameters. The updated CIDARS values were obtained from the Ohio EPA Division of Environmental Response and Revitalization (DERR) Northeast District Office. Procedures for conducting the screening followed the guidance provided in the Ohio EPA Technical Guidance Compendium VA30008.14.02 (Ohio EPA, 2009) "*How to Conduct Multiple Chemical Adjustments Under the Voluntary Action Program*".

It should be noted that the contaminant screening information provided herein does not constitute a comprehensive site-specific human health risk assessment. The screening procedures are intended to provide a framework for assessing the potential for risks to human receptors based upon comparisons to conservative benchmarks for exposure that can guide decision-makers in planning for long-term management of public uses of Summit Lake.

Comparisons of the sediment data to the Residential GDCSS are summarized in Table 31 for potential non-cancer and cancer-causing effects. It should be noted that exposures to lake sediments will be much less than those modeled by Ohio EPA to develop the Residential GDCSS. For example, the Residential GDCSS assume a contact frequency of 350 days per year and include other assumptions for exposure that would not be likely with lake sediments. Nevertheless, only two results from the sediments in Summit Lake exceeded any of the GDCSS for the COIs carried forward for the evaluation. Results for benzo(a)pyrene from Grids C52 (6,400 µg/kg) and D77 (2,900 µg/kg) were greater than the GDCSS Cancer screening value of 2,300 µg/kg. Both locations are Selected Sites. None of the 95% UCLs, means, or maxima for any of the other COIs exceeded the corresponding Non-Cancer or Cancer Residential DCSS screening values.

Because multiple COIs were detected in the sediments of Summit Lake, including naturally occurring metals constituents that are present in concentrations exceeding background concentrations, it is appropriate to conduct a multiple-contaminant screening (MCS) of the data to determine whether there is potential for synergistic toxicity risk to human receptors. Procedures in Ohio EPA guidance (Ohio EPA, 2009) recommend summing the ratios of the exposure concentrations to the corresponding GDCSS for COIs with similar modes of toxicity. For purposes of this assessment, it is assumed that metals and organic compounds exhibit different mechanisms of action for non-cancer disease endpoints. None of the metals included in the screening assessment are considered to be carcinogenic.

The MCS assessment conducted for the Summit Lake sediments in this report also adjusts the Residential GDCSS values reflective of recreational exposures 90 days per year for receptor populations rather than the 350 days per year assumed to develop the Residential GDCSS. The exposure assumption of 350 days per year for soils is generally used to assess direct contact with soil for residential land uses where frequent daily exposures are expected. However, direct contact exposures to aquatic sediments by the public is likely to occur less than 350 days per year since recreational exposures during activities including wading, swimming, fishing, etc. are highly seasonal and intermittent. As a result, exposures of 90 days per year is considered a conservative exposure assumption to ensure protection of human health from direct contact to sediment in a recreational setting. All other residential exposure assumptions were used to add to the conservative nature of the screening level assessment. This adjustment was made in consultation with Vanessa Steigerwald-Dick, Ohio EPA Northeast District Office.

The formula for calculating the adjusted Recreational Use GDCSS was as follows:

$$\text{GDCSS}_{\text{REC}} = \text{GDCSS} * \frac{90\ days}{350\ days} \qquad (eq.\ 1)$$

Where $\text{GDCSS}_{\text{REC}}$ is the adjusted Recreational Use soils screening value, and

GDCSS is the CIDARS Residential GDCSS.

The $\text{GDCSS}_{\text{REC}}$ adjustment provides a more realistic reasonable worst-case scenario for exposure, while still being protective of potential lake users. No other adjustments were made to the Residential GDCSS exposure model.

The results of the MCS procedure using $\text{GDCSS}_{\text{REC}}$ values are presented in Tables 32 and 33 for potential non-cancer and cancer risks, respectively. The results provide Risk Index quotients that are less than one for both potential risk categories. Based upon these results it can be concluded that incidental recreational exposures to the sediments in Summit Lake and the Ohio & Erie Canal within the study area are unlikely to represent an unacceptable risk to the public. However, it must be cautioned that the evaluation of the sediment data from Summit Lake is limited to the surficial layers of littoral sediments and that the data show varying concentrations of COIs within the lake and canal. Detailed site-specific investigation of the sediment quality in localized areas of interest within the lake and canal are recommended before implementation of concentrated recreational activity or construction projects to ensure the protection of human health and the environment. In addition, interaction with the sediments within the lake and canal may also pose aesthetic challenges, as the surficial sediments in portions of the lake might be objectionable with respect to the presence of oils, consistency of the material and odors.

7.4 Screening of Sediment Data for Potential Ecological Risks

Ohio EPA utilizes several evaluation tools for screening sediment data to determine whether exposures to sediments present potential risk to ecological receptors. The ecological-based sediment data screening tools use either indicators of background conditions or conservative toxicity-based screening limits to determine whether sediment exposures could create unacceptable ecological risk potential. Based upon the DQOs for the Phase II Assessment, sediment data from Summit Lake was compared to appropriate ecological screening levels (ESLs) to evaluate sediment conditions. The following sections describe and reference the ESLs that were used to evaluate sediment data from Summit Lake pursuant to the objectives for the study.

Procedures for screening the sediment data from Summit Lake for potential ecological risks was consistent with the Ohio EPA guidance documents including the *Ecological Risk Assessment Guidance Document* (Ohio EPA, 2008) and the *Guidance on Evaluating Sediment Contaminant Results* (Ohio EPA, 2010). These documents summarize steps for evaluating potential ecological impacts and describe several methodologies for conducting screening of sediment data developed by USEPA that are utilized in this report. The screening procedures for COIs varied dependent upon the chemical characteristics of the analytes. These characteristics included both single-contaminant, or “Tier I” (Section 7.4.1), and MCS, or “Tier II” (Section 7.4.2), screening procedures to evaluate the potential for sediment toxicity to ecological receptors.

7.4.1 Tier I Ecological Screening of Sediment Data

Single-contaminant screening procedures use specific values of contaminant concentration that have been derived from studies or models where the ecological risk to exposure would result in little or no risk of toxicity to aquatic life. These values neither consider synergistic interactions between multiple contaminants nor do they provide correction for bioavailability of the contaminant based on site-specific conditions. However, the conservative nature of derivation of these standards is deemed sufficient to use for elimination of individual contaminants from further study if they are met.

Single-contaminant ESL values used to evaluate the sediment data from Summit Lake for potential ecological effects are summarized in Table 34. Metal analytes were initially screened by comparing the concentration of each metal to its corresponding Sediment Reference Value (SRV) established by Ohio EPA (Appendix H of Ohio EPA, 2008) as well as calculated UCLs for Ohio Lakes (see Section 8.0) as representative of background conditions. The appropriate SRV concentrations for the metals in the COI analyte list are those listed for the EOLP Ecoregion or statewide values for lead and mercury. Where the concentrations of specific metals exceed the applicable background thresholds, the data are carried forward for screening against other applicable ESL benchmarks.

Sediment results for both metals and organic COIs identified for Summit Lake are compared to Ecological Sediment Quality Guidelines (ESQGs) developed by the USEPA Region 5 RCRA Program (USEPA, 2003a), freshwater ESQGs (USEPA, 2006) developed by the USEPA Region 3 Biological Technical Assistance Group (BTAG), and published consensus-based ESQGs (MacDonald et al., 2000) in Table 34. The consensus based ESQGs are based upon a literature review which was used to identify “Threshold Effect Concentrations” (TECs) and “Probable Effect Concentrations” (PECs) for evaluating the potential of toxicity to aquatic life from exposure to sediments for a range of compounds. The TECs identify contaminant concentrations below which harmful effects on benthic organisms are not expected, while the PECs identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are likely to occur (MacDonald, 2000). These single-contaminant screening values are based upon the lower range of potential toxic effects on aquatic organisms and therefore serve as suitable criteria for the comparison of data for several of the COIs for the Summit Lake sediment evaluation.

7.4.1.1 Metals

The Tier I single-contaminant comparisons for metals found that the 95% UCL for concentrations of copper, lead, mercury, and zinc in Summit Lake sediments all exceeded the USEPA TEC ESL for potential toxicity to aquatic life. Concentrations of lead and zinc also exceed the PEC, indicating a high likelihood for the presence of toxicity. The metal COIs are carried forward for Tier II MCS in Section 7.4.2.1.

7.4.1.2 VOCs

The 95% UCLs for concentrations of acetone and 2-butanone both exceeded their respective TEC ESLs. Acetone was found in the majority of the sediment samples, while 2-butanone was detected in only 30 percent of the samples. There is no Tier II evaluation procedure available for further evaluation of toxic effects from these compounds. Carbon disulfide concentrations in Summit Lake sediments are below the TEC ESL, and therefore, this compound is unlikely to exhibit toxicity to aquatic life, although it may contribute to additive effects with other contaminants.

7.4.1.3 SVOCs

Although the TEC ESLs for dibenzofuran and N-nitrosodiphenylamine were exceeded in two of the sediment samples, the 95% UCLs were below the thresholds for potential toxicity. A Tier II equilibrium sediment benchmark has been developed for dibenzofuran, and concentrations from the Summit Lake sediments are compared to this threshold in Section 7.5.

7.4.1.4 PAHs

All 17 of the PAHs that were analyzed in the sediment samples from Summit Lake exceeded the TEC ESLs. In addition, the PECs were exceeded in Summit Lake sediments for all of the PAH constituents that are published, with the exception of naphthalene. The 95% UCL for total PAHs, derived by adding the results for each PAH analyte, also exceeded the PEC. These results indicate a high potential for toxicity to aquatic life in the lake sediment associated with PAHs and that Tier II evaluation of the data set is appropriate.

7.4.1.5 PCBs

The TEC ESL screening benchmark is based upon the concentration of total PCBs. The evaluation process requires adding the concentrations of all detected PCB compounds to derive the total PCB concentration. For Summit Lake, the only PCB Arochlor detected was Arochlor 1254. Therefore, the comparison to the TEC ESL is based solely upon the concentration of this single Arochlor. The 95% UCL for Arochlor 1254 for Summit Lake exceeds the TEC ESL for total PCBs. A discussion of the interpretation of this result in the context of a Tier II evaluation is provided in Section 7.4.2.

7.4.1.6 Pesticides

The 95% UCL concentration of 4-4'-DDE also exceeded the corresponding TEC ESL, but the PEC was not exceeded. This COI was detected in four of the thirteen samples collected from Selected Sites. Given the relatively low concentrations in the samples, the potential effects on the biota of the lake is unknown, but it likely contributes to additive effects of the overall sediment contaminant burden within the lake. Further evaluation of this COI is beyond the scope of this assessment.

7.4.2 Tier II Ecological Screening of Sediment Data

The Summit Lake sediment data were also screened using MCS procedures for the evaluation of bioavailability of COIs to determine if predictive toxicity thresholds are exceeded. These models by themselves do not constitute a complete risk assessment but are included in the Ohio EPA guidance as a tool for evaluating sediment data (Ohio EPA, 2010).

Two MCS procedures were used to evaluate the sediment data from Summit Lake. Metals data were evaluated using an equilibrium partitioning sediment benchmark (ESB) protocol for SEM mixtures in relation to AVS as described in USEPA guidance (USEPA, 2005) (Section 7.4.2.1). The potential for toxicity from mixtures of PAHs is also evaluated using ESB procedures developed by USEPA to predict bioavailability of these compounds (USEPA, 2003b) (Section 7.4.2.2).

7.4.2.1 ESB Procedure to Determine Metals Bioavailability

The ESB procedure for screening analysis for SEM bioavailability in the presence of AVS developed by USEPA estimates the potential for toxicity from metals mixtures of cadmium, copper, lead, nickel, silver, and zinc by normalization of their concentrations through conversion to molar units. The resulting normalized concentrations are then added to estimate the total concentration of SEM, expressed as ∑SEM. The bioavailability of the metals, and hence the potential for sediment toxicity is reduced in the presence of AVS, which binds the metals and inhibits uptake. The ESB model therefore estimates bioavailability as the difference between the ∑SEM and the molar concentration of AVS. Where there is an excess of SEM in comparison to

AVS, the bioavailability of the metals is higher. The potential for toxicity of metals in sediments also varies dependent upon the fraction of organic carbon present. Therefore, the TOC concentration in the sediment is used to calculate the fraction of organic carbon and the following equation is used to predict the potential for sediment toxicity from the metals mixture:

$$(\sum SEM - AVS) / f_{OC} \qquad (eq.\ 2)$$

Where ∑SEM = the sum of concentration of simultaneously extracted metals (µmol/g);

AVS = the concentration of acid volatile sulfides (µmol/g); and

f_{OC} = the fraction of organic carbon in the sediments.

The resulting value is expressed as available SEM in units of µmol/ g_{oc}. USEPA (2005) provides the following benchmarks for screening the data for toxicity potential: where (∑SEM – AVS) / f_{OC} is less than 130 µmols/g_{oc}, there is little to no risk to aquatic life. Where (∑SEM – AVS) / f_{OC} is between 130 and 3,000 µmols/goc, further testing and/or more information is needed to determine the risk to aquatic life. Where (∑SEM – AVS)/ f_{OC} is greater than 3,000 µmols/g_{oc}, there is a likely risk of toxicity to aquatic life.

Concentration data for the analyses for AVS and the SEMs associated with the AVS testing are summarized in Table 22 and are described in Section 7.2.1.2. Tables detailing the steps taken to conduct the ESB AVS-SEM evaluation are provided in Appendix W. The results of the calculations are summarized in Table 35. The calculated values for (∑SEM – AVS)/ f_{OC} for sediments collected from Summit Lake are all negative, ranging from -1,797 to -2.07. These values are indicative of sediments with an excess of AVS relative to concentrations of SEM and are well below the screening thresholds for potential toxicity to aquatic life. It can be concluded that the bioavailability of SEM COIs is very low in Summit Lake and that there and that there is little potential for metals toxicity to aquatic life in the littoral sediments for these COIs despite the high concentrations present as compared to the Tier I ESL benchmarks. The presence of high levels of TOC in sediments also reduces the bioavailability of metals (USEPA, 2005) and likely contributes to the results observed for Summit Lake.

7.4.2.2 ESB Procedure to Determine PAH Bioavailability

Procedures have also been established by USEPA to analyze sediment data for equilibrium partitioning of PAH mixtures to determine the potential for toxicity to benthos by comparison of results to ESBs (USEPA, 2003b). The process uses PAH concentration data normalized to the TOC content of the sediment to determine the potential for exposure of benthos, followed by a comparison to published Final Chronic Value (FCV) toxicity thresholds to calculate ESBs in terms of Toxicity Units (TUs). The equilibrium partitioning sediment benchmark toxicity unit (ESBTU) for each PAH constituent is calculated and the results are summed to provide an overall estimate of the total PAH toxicity potential of the sample. This methodology is based upon the analysis of 34 PAH compounds. However, since there are different analytical protocols that may be used, a statistical uncertainty factor is applied in cases where less than 34 PAH compounds are analyzed to provide a reasonable worst-case prediction of the potential for PAH-related toxicity to benthic organisms.

The calculation procedure for the ESBTU PAH screening procedure is as follows:

$$\sum ESBTU = \sum(([PAH_n] / f_{OC}) / FCV_n) \times UF \qquad (eq.\ 3)$$

Where: $[PAH_n]$ = the concentration of the nth PAH compound (µg/g);

f_{OC} = the fraction of organic carbon in the sediments (g_{oc} / g_{sed});

FCV_n = the final chronic toxicity value for the nth PAH compound (µg/ g_{oc}); and

UF = uncertainty factor for PAH analyses conducted with fewer than the 34 analytes used to develop the methodology.

The various steps for the calculation of the ESB analysis for the PAH mixtures in Summit Lake sediments are summarized in the tables provided in Appendix X. The final values for ∑ESBTU estimates are provided in Table 36. For the uncertainty factor UF (*eq. 3*), an extrapolated value of 8.101 was used for samples from Selected Sites where 17 PAH compounds were analyzed instead of the 13 or 23 PAH compound analyses for which 95th percentile values are provided in the applicable guidance documents (USEPA, 2003b; Ohio EPA, 2010). For Targeted sites where results are not available for 2-methynapthalene and only 16 PAH compounds were analyzed, 8.893 is used for the value of UF. The uncertainty factors were derived using a polynomial regression of the published correction factors, as depicted in Figure 14.

The final ∑ESBTU values for Summit Lake exceeded 1.0 ESBTU for 13 of the 23 sediment sampling sites (6 Selected Sites and 7 Targeted Sites). Statistical comparison of log-transformed ∑ESBTU values between the site categories found that the values for Targeted Sites are significantly higher than those found at Selected Sites ($t = 1.983$, $p = 0.030$, $df = 21$). The geometric mean ∑ESBTU is 1.826 for Targeted Sites and 0.525 for Selected Sites. Secondary single-sample statistical tests found that the mean ∑ESBTU for Targeted Sites is significantly greater than 1.0 ($t = -7.635$, $p = 1.6E-05$, $df = 9$), while the mean ∑ESBTU for Selected Sites is significantly lower than 1.0 ($t = -5.649$, $p = 5.37E-5$, $df = 12$).

Higher ∑ESBTU values for sediments at Targeted Sites is likely associated to the proximity of flow inputs to the lake and the pollutant loads carried into the lake at these points. Both sampling sites in the Ohio & Erie Canal have ∑ESBTU values greater than 2.0, and the highest estimated value for the lake at Grid B37 is located near the Leslie Ave. storm sewer outlet on the west shore of the lake. Differences in the sediment composition and the fraction of organic carbon in the samples also affects the assumptions regarding bioavailability of sediment PAHs and likely plays a role in the difference in the estimates of potential toxicity.

Additional sampling of sediment PAHs accompanied by analysis of all 34 PAH compounds could provide sufficient data to reduce the uncertainty factor for the ∑ESBTU calculations to definitively determine the degree of potential toxicity of PAHs to the biota in Summit Lake. Other options, such as sediment bioassay testing and ecological community analyses also exist for verifying the degree of inhibition that the lake sediments may have upon ecological receptors (Ohio EPA, 2008). These methodologies are beyond the scope of the present assessment.

7.4.3 Tier II Evaluations for Other COIs in Summit Lake Sediments

7.4.3.1 Mercury

No Tier II evaluation procedure for mercury in sediments is readily available. However, the results from SEM analyses for Summit Lake contained no detectable SEM mercury in the sediments at any of the Selected Sites. This indicates that the mercury present may not be bioavailable and may not pose a risk to aquatic life. Mercury levels in fish tissue are monitored by state agencies in Ohio and advisories for the consumption of sport fish are routinely reviewed. There currently is no site-specific advisory for consumption of fish from Summit Lake or the Ohio & Erie Canal for mercury. However, there is statewide advisory to limit meals of fish of all species caught in inland waters to one meal per week based upon mercury in the fish tissue. Additional evaluation of the potential effects of this COI on aquatic life is beyond the scope of this assessment.

7.4.3.2 VOCs

No Tier II evaluation procedures for VOCs in sediments are readily available. Additional evaluation of the potential effects of these COIs on aquatic life is beyond the scope of this assessment.

7.4.3.3 SVOCs

An ESB Tier II evaluation value has been developed by USEPA for dibenzofuran (USEPA, 2008). The ESB toxicity target concentration in freshwater sediments for this COI is 37 $\mu g/g_{OC}$. Evaluation of the Summit lake sediment data for dibenzofuran results in a 95% UCL of 3.4 $\mu g/g_{OC}$. This result indicates that there is little likelihood of toxic effects from this compound upon aquatic life in the lake.

No Tier II evaluation procedure for N-nitrosodiphenylamine in sediments is readily available. Additional evaluation of the potential effects of this COI on aquatic life is beyond the scope of this assessment.

7.4.3.4 PCBs

Deleterious effects of PCBs in aquatic sediments are the result of bioaccumulation in the food chain that result in elevated fish tissue and wildlife PCB burden, with adverse impacts on top predators. Elevated levels of PCBs in sport fish tissue PCB are also a public health concern. Ohio EPA, the Ohio Department of Natural Resources Division of Wildlife and the Ohio Department of Health work cooperatively to test fish from Ohio waters for contaminants and to develop sport fish consumption advisories to protect public health. Information regarding this program is available via Ohio EPA’s website: http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx.

The State of Ohio advised the public to not eat any Common Carp or Channel Catfish caught from Summit Lake, Lake Nesmith, or the Ohio & Erie Canal from 1987 to 2017. This advisory was based upon past results from testing for the concentrations of PCB's in these species. However, based upon recent monitoring of fish tissue from these waterbodies, the advisory for Common Carp was relaxed to advise eating no more than one meal per month in 2017. The "do not eat" advisory remains for channel catfish since there were too few of these fish captured for analysis of the data to merit revision of the advisory (Gary Klase, Ohio EPA Division of Surface Water, pers. comm.).

Additional evaluation of the potential effects of this COI on aquatic life is beyond the scope of this assessment.

7.4.3.5 Pesticides

No Tier II evaluation procedure for 4-4'-DDE in sediments is readily available. Additional evaluation of the potential effects of this COI on aquatic life is beyond the scope of this assessment.

8.0 BACKGROUND DETERMINATIONS

[3745-300-07(J)(8), 3745-300-07(H)]

It is appropriate to determine whether the metal COIs carried forward for screening of sediment data from Summit Lake to determine potential risks to human and ecological receptors represent background concentrations or should be considered elevated in the sediments of Summit Lake. The use of background comparisons is commonly used in VAP property assessments as Applicable Standards COIs in accordance with OAC 3745-300-07 (H). Applicable background benchmarks for comparing results from sediment in Ohio are the SRVs published by Ohio EPA in the publication "*Ecological Risk Assessment Guidance Document*" (Ohio EPA, 2008). The values provided in this document provide both ecoregional and statewide benchmarks for concentrations of various metals using data collected from samples collected from rivers and streams that are considered representative background concentrations for metals in accordance with OAC 3745-300-07 (H)(2). However, the SRVs do not contain sample results collected from inland lakes, nor have the benchmarks been compared to data from lentic ecosystems.

To verify that the background comparisons for metals in Summit Lake to the SRVs are appropriate, EnviroScience obtained data from Ohio EPA for sediments collected from inland lakes in conjunction with water quality monitoring activities. Sediment analytical results from 99 inland lakes for the years 1986-2016 were obtained from the Ohio EPA Division of Surface Water in June 2016. The data was parsed for completeness and repetitive results to produce a data set encompassing 64 lakes that was analyzed for the calculation of average and UCL statistics for 16 metal analytes. A summary table of the complete Ohio EPA data set and relevant statistics from the analysis is provided in Appendix Y. The USEPA ProUCL Software, Ver. 5.1 (USEPA, 2014) was used to produce statistically valid estimates from the Ohio EPA statewide data set. The calculated 95% UCLs from inland lakes are compared to the SRVs in Table 37.

The data set for each metal COI for Summit Lake (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, strontium, and zinc) was analyzed statistically against the most conservative benchmark value to determine if the constituent exceeded background thresholds. These analyses compared the arithmetic mean for selenium, which has a normally distributed data set, and the geometric mean for the remaining metals since these results are log-transformed to produce normality. The results of these analyses are summarized in Table 38. Based upon the statistical tests, concentrations of copper, lead, mercury, and zinc are significantly greater than the most conservative benchmark, and therefore exceed the background conditions for lake sediments. Mean values for arsenic, barium, cadmium, chromium, nickel, selenium, and strontium were all less than the most conservative benchmarks, and therefore these COIs can be concluded to represent background concentrations for purposes of the screening level analyses for potential risks to human and ecological receptors.

9.0 MODELING

[3745-300-07(J)(9), 3745-300-07(G), 3745-300-07(G)(5)]

The use of modeling was not a component of the DQOs for the Phase II property assessment of Summit Lake. Therefore, no modeling was conducted as part of the study.

10.0 URBAN SETTING DESIGNATION

[3745-300-07(J)(11), 3745-300-10(C)(3)]

The groundwater exposure pathway is not part of the evaluated CSM for Summit Lake. The areas surrounding the lake are all served by a public water supply, and no pathways for transport of potential contaminants affecting either human health or ecological exposures to groundwater in the vicinity of the lake have been identified.

11.0 PROPERTY-SPECIFIC RISK ASSESSMENT

[3745-300-07(J)(12)]

This study presents a property-specific risk assessment for recreational exposures to water and sediment in Summit Lake and the Ohio & Erie Canal within the study area. As described in Section 7.3, the MCS assessment conducted for the Summit Lake sediments adjusts the Residential GDCSS values reflective of recreational exposures 90 days per year for receptor populations rather than the 350 days per year assumed to develop the Residential GDCSS. This assessment was conducted to determine the level of risk to human health associated with plans to enhance recreational opportunities in Summit Lake and the Ohio & Erie Canal. The assessment assumes that direct contact exposures to sediment by the public is likely to occur less than 350 days per year due to the seasonality of recreational exposure to sediment including wading, swimming, fishing, etc. As a result, exposures of 90 days per year is considered a conservative exposure assumption to ensure protection of human health from direct contact to sediment.

12.0 REMEDIAL ACTIVITIES PRIOR TO NFA LETTER

[3745-300-07(J)(13), 3745-300-07(I)(4)]

No remedial activities are presently planned for Summit Lake. In addition, the goals of this project do not envision the development of a no further action letter for Summit Lake or the Ohio & Erie Canal within the project area. The purpose of this Phase II Assessment is to provide information for planning purposes within the context of a larger-scale community development paradigm.

13.0 COMPLIANCE WITH APPLICABLE STANDARDS

[3745-300-07(J)(14), 3745-300-07(I)]

The data quality objectives of the Phase II Assessment of Summit Lake and the Ohio & Erie Canal within the study area are presented in Section 1.1. The study was conducted to provide background data and assessment data suitable for the development of long-range plans for community development, water quality management, and recreational uses of the waterbodies. The study area consisted of Summit Lake in its entirety and approximately 320 linear meters (0.2 miles) of the Ohio Canal, with a portion to the south and a longer segment to the north of Summit Lake.

Water quality assessment included sampling at three locations: the Ohio & Erie Canal at Kenmore Blvd where water generally flows into the lake, an open water site located at the deepest spot in the lake, designated as Station L-1, and the Ohio & Erie Canal at South Ave. where water flows out of the study area. All applicable Ohio WQS (OAC Chapter 3745-1) for chemical constituents were met in the lake surface samples and water samples collected from the Ohio & Erie Canal in 2017.

The Recreational Use Primary Contact Recreation criteria for *E. coli* were exceeded in the Ohio & Erie Canal at the Kenmore Blvd. sampling location. This sampling location represents the lake inlet as water primarily flows into the lake from the south and characterizes the water quality flowing into the study area.

An oil release to the Ohio & Erie Canal documented at the Kenmore Blvd. sampling location upstream of Summit Lake affected the water quality of the inflow as well as the lake in July 2017. Although small in quantity, the release prompted a response by state and local agencies to contain it and remove the oil to alleviate the problem. This condition represented a violation of the criterion applicable to all waters in OAC 3745-1-04(B) and the criterion for the protection of aesthetic conditions in OAC 37451-37.

There are currently no regulatory standards for sediment quality in Ohio. Sediment assessments are conducted in the context of protection of water quality to meet state WQS and for the protection of human health. The Summit Lake Phase II Assessment provides a thorough assessment of the upper layer of the sediments within the littoral zone of the lake and portions of the Ohio & Erie Canal within the study area. These results augment prior data collected from the deepest part of the lake, as summarized in the Phase I Assessment Report for Summit Lake (EnviroScience, 2017).

Based upon the results of the screening level analyses it is concluded that incidental recreational exposures to the sediments in Summit Lake and the Ohio & Erie Canal within the study area are unlikely to represent an unacceptable risk to the public. However, caution should be taken with respect to the findings regarding potential human health effects associated with the lake sediments since the characteristics of representative samples used for the Phase II Assessment may not have identified areas where higher concentrations of COIs exist within Summit Lake and the Ohio & Erie Canal. Site-specific investigation of the sediments is recommended in localized areas of interest prior to the implementation of plans for concentrated recreational activity or construction projects to ensure the protection of human health and the environment.

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15.0 FIGURES

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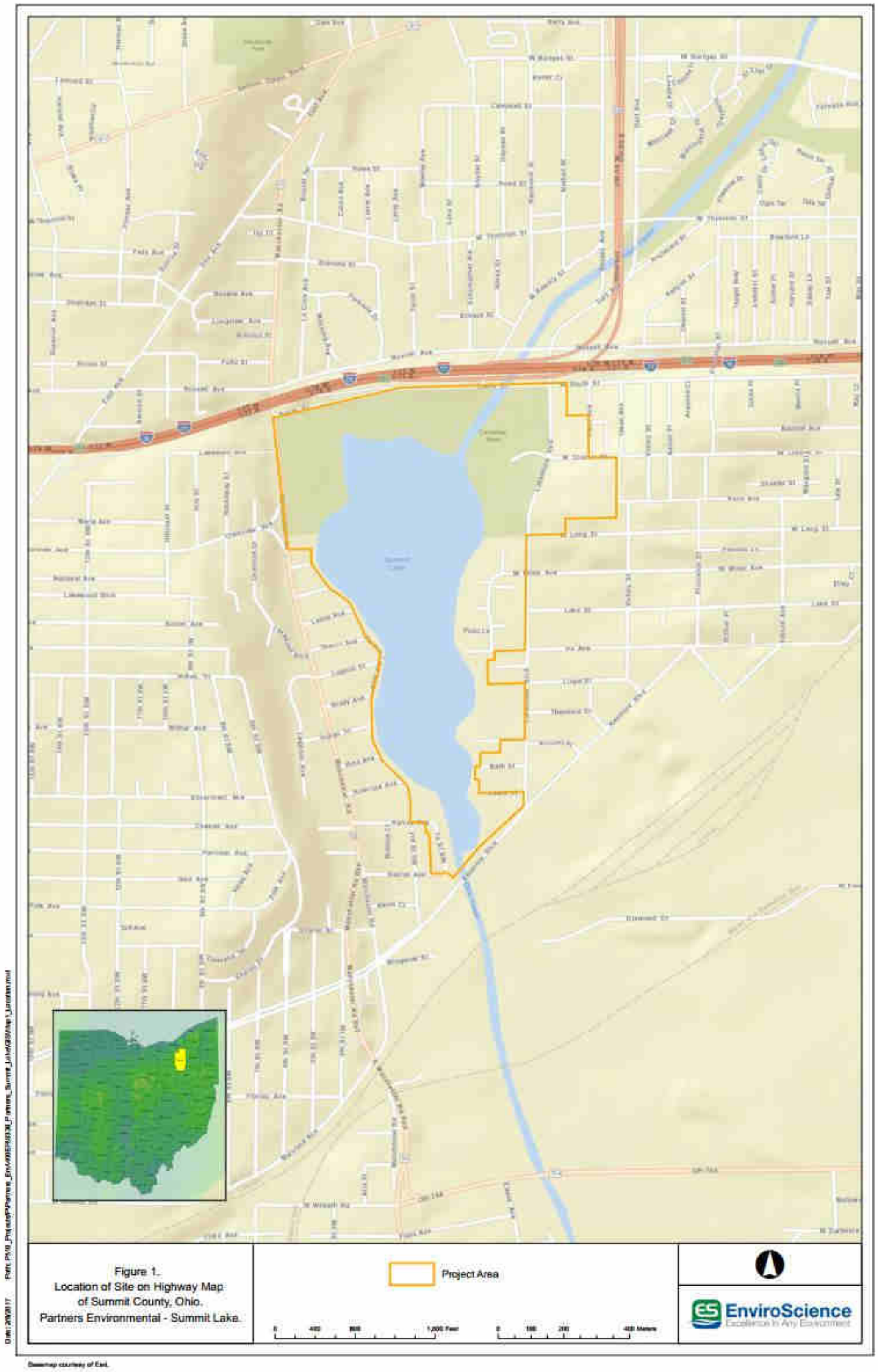


FIGURE 1. SUMMIT LAKE STUDY AREA

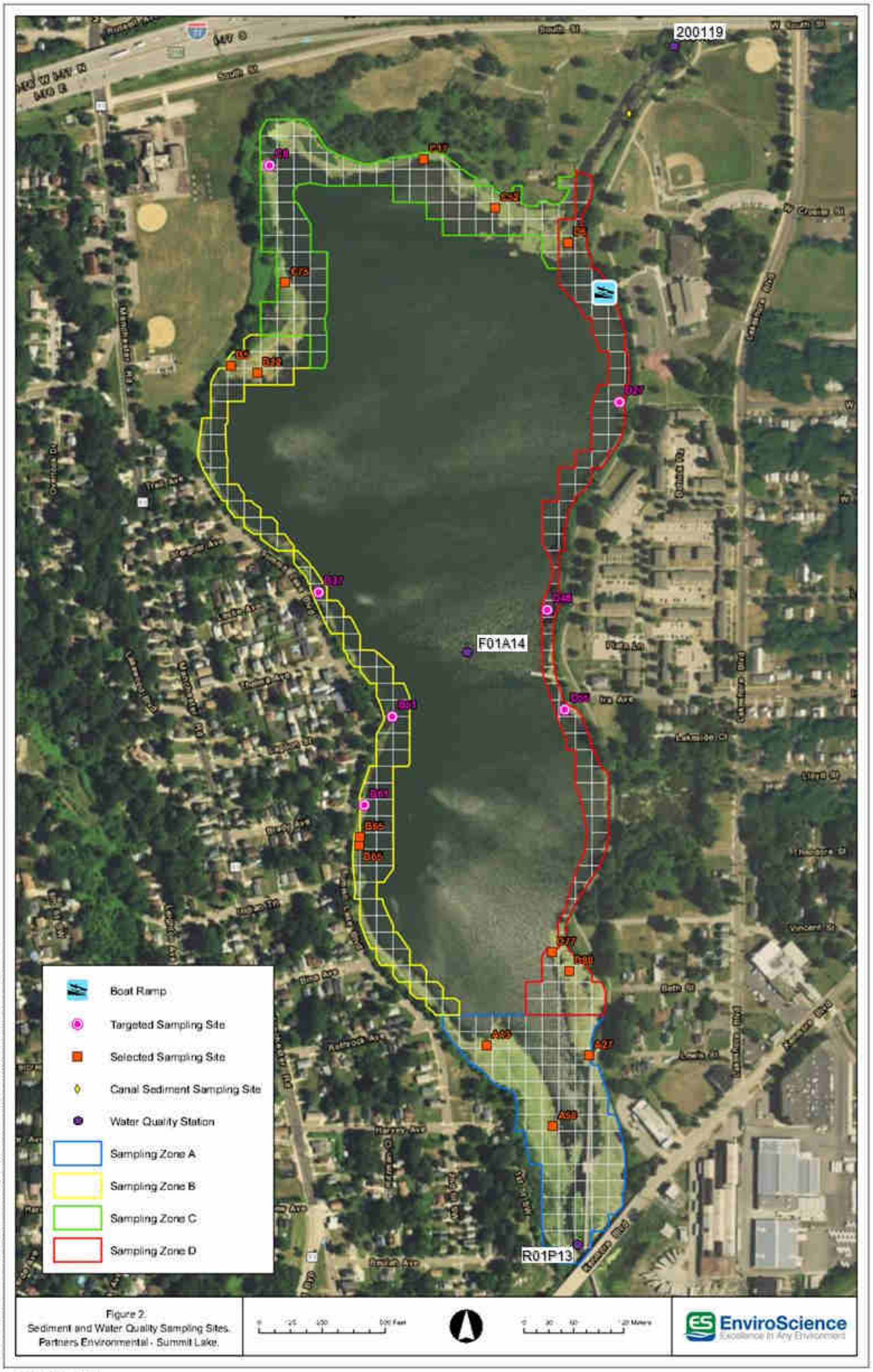
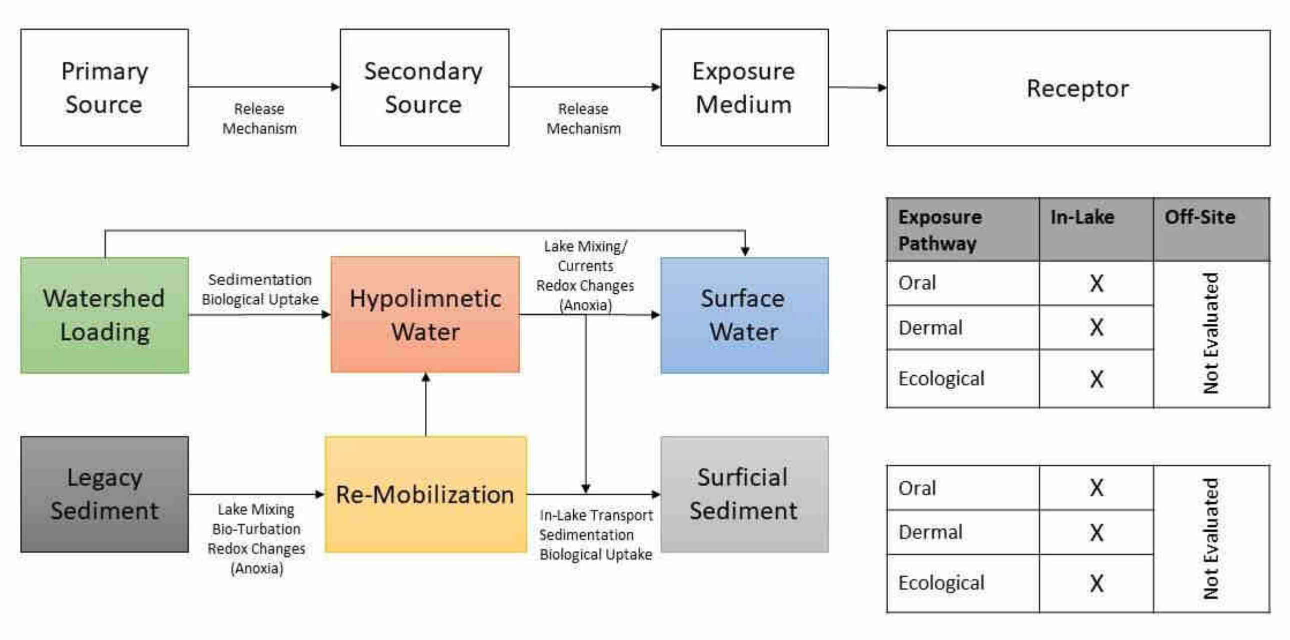


Figure 2.
Sediment and Water Quality Sampling Sites.
Partners Environmental - Summit Lake.

Basemap courtesy of Esri.



Exposure Pathway	In-Lake	Off-Site
Oral	X	Not Evaluated
Dermal	X	
Ecological	X	

Oral	X	Not Evaluated
Dermal	X	
Ecological	X	

FIGURE 3. CONCEPTUAL SITE MODEL FOR SUMMIT LAKE.

FIGURE 4. OIL SHEEN NOTED ON THE OHIO & ERIE CANAL AT KENMORE BLVD. IN JULY 5, 2017.

FIGURE 5. PHOTOS OF THE INLET OF THE OHIO & ERIE CANAL TO SUMMIT LAKE FOLLOWING THE OBSERVATION OF AN OIL RELEASE TO THE CANAL. A AND B: JULY 5, 2017 (NOTE CONTINUING RELEASE OF OIL AROUND BOOM); C: JULY 14, 2017; D: JULY 19, 2017.

FIGURE 6. SHORE CLEARING AND EARTH MOVING WORK CONDUCTED NEAR THE SUMMIT LAKE COMMUNITY CENTER, JULY 2017: A. JULY 5, 2017; B. JULY 14, 2017.

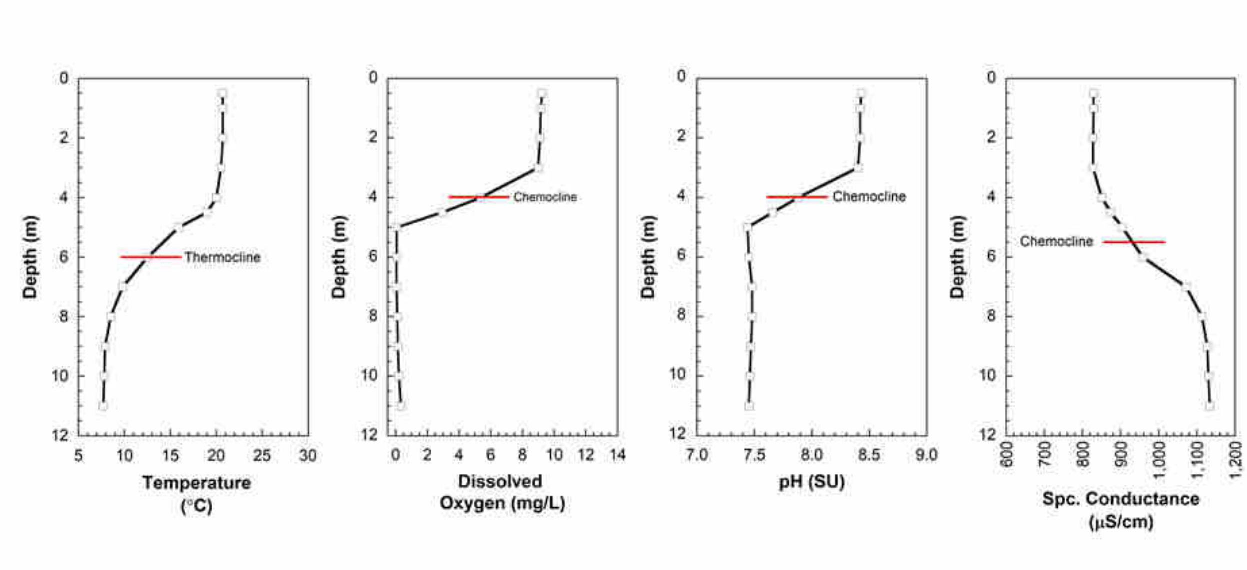


Figure 7. Depth Profiles of Field Measurements Collected from Station L-1 (F01A14) In Summit Lake on June 4, 2017.

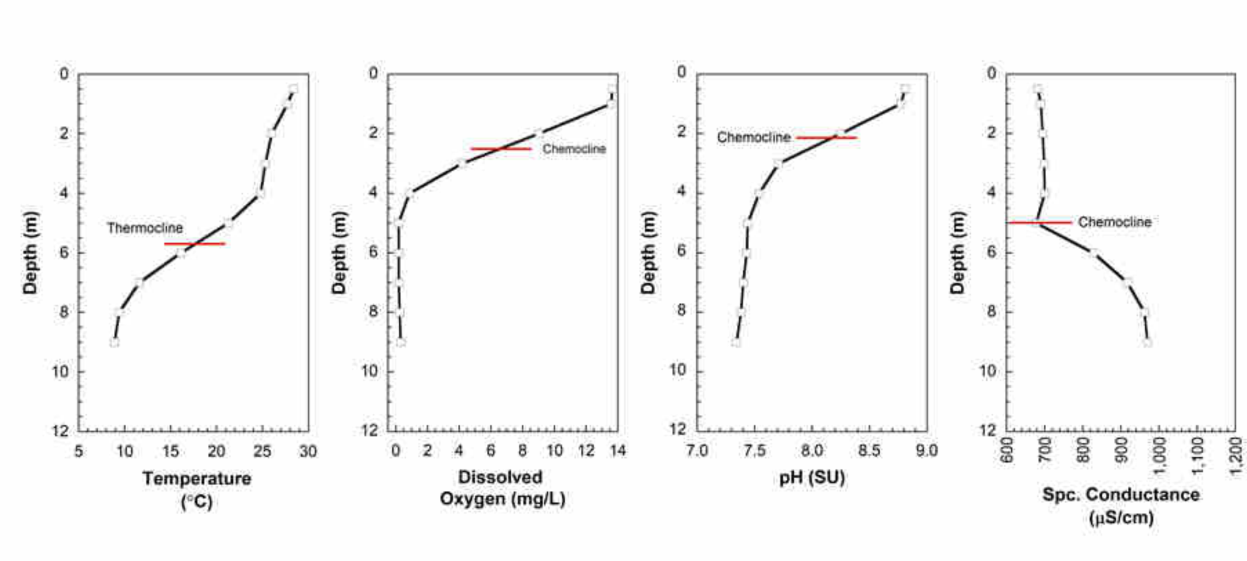


Figure 8. Depth Profiles of Field Measurements Collected from Station L-1 (F01A14) in Summit Lake on July 19, 2017.

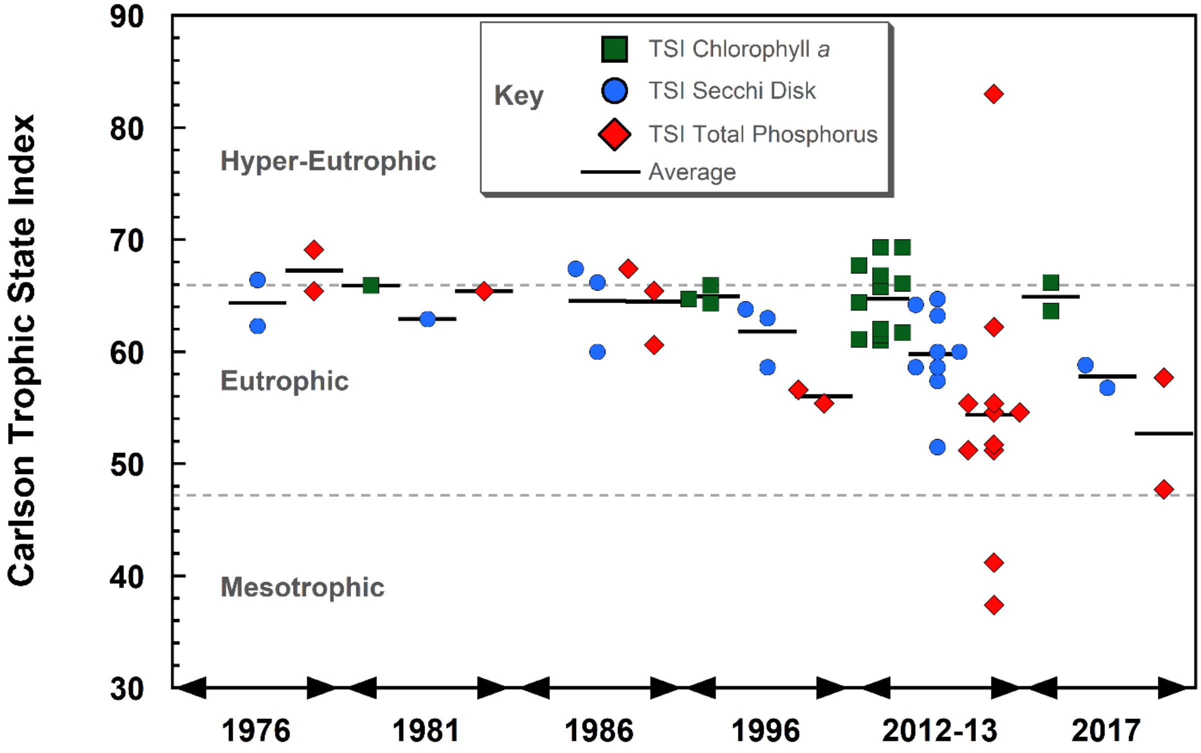


FIGURE 9. TRENDS FOR CARLSON'S TROPHIC STATE INDEX VALUES IN SUMMIT LAKE, 1976-2017.

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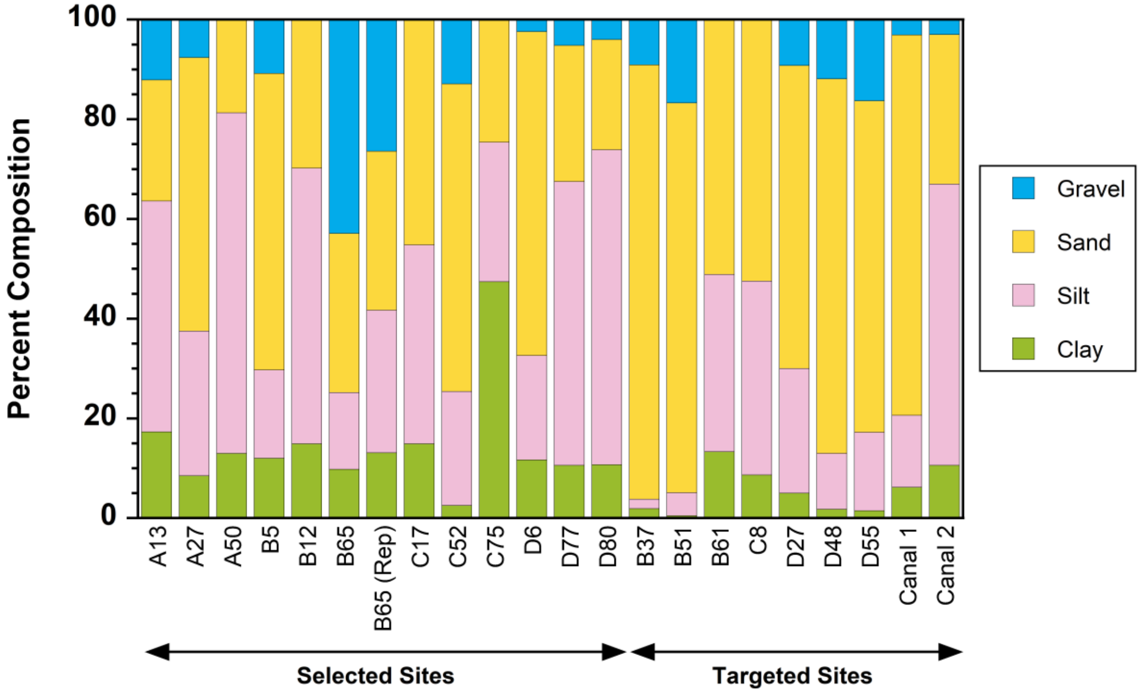


FIGURE 10. PARTICLE SIZE DISTRIBUTIONS FOR SEDIMENT SAMPLES FROM SUMMIT LAKE, 2017.

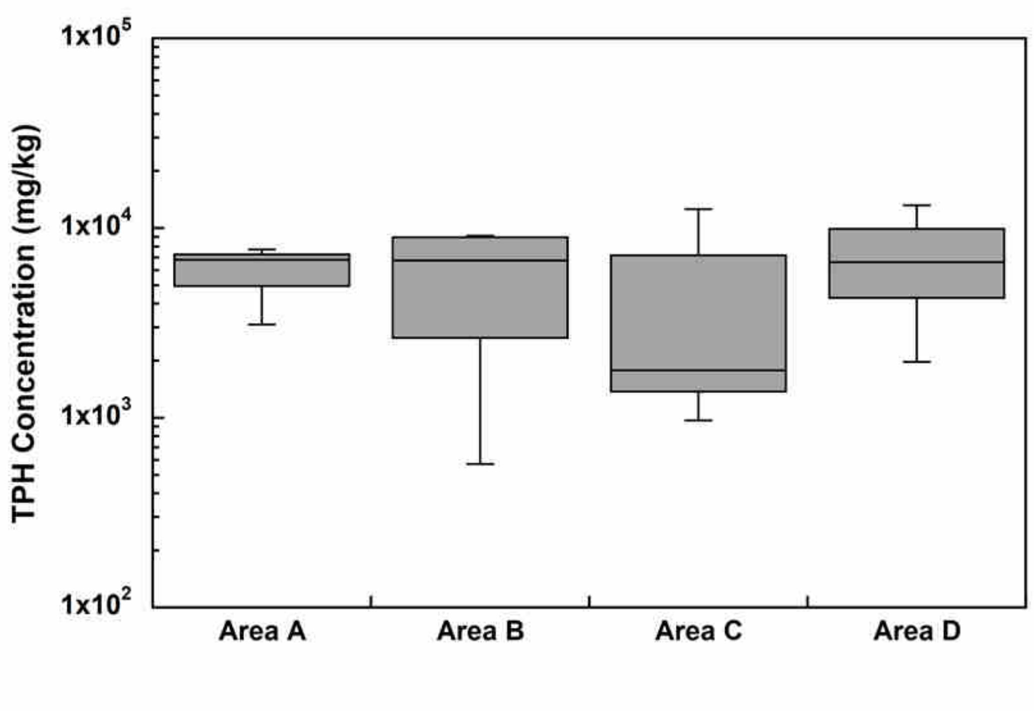


FIGURE 11. TPH (ORO+DRO) CONCENTRATIONS IN THE SURFICIAL SEDIMENTS OF SUMMIT LAKE, 2017.

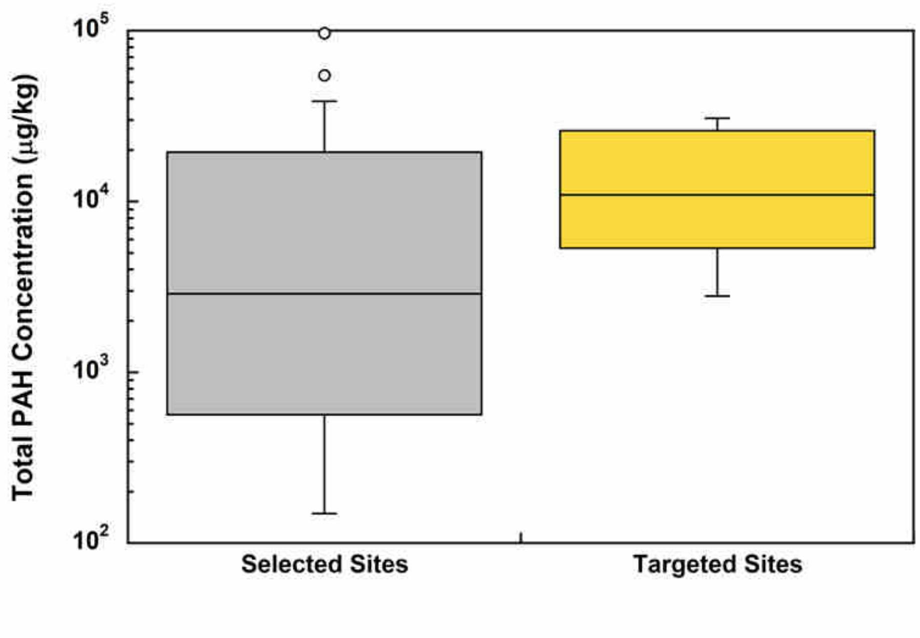


FIGURE 12. COMPARISON OF TOTAL PAH CONCENTRATIONS IN THE SEDIMENT AT SELECTED SITES TO TARGETED SITES FROM SUMMIT LAKE, 2017.

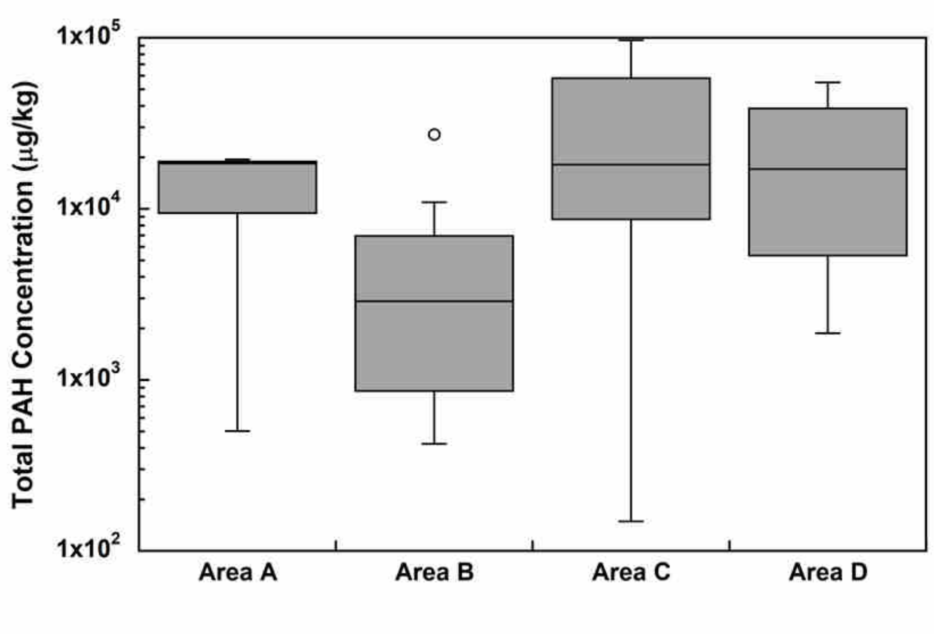
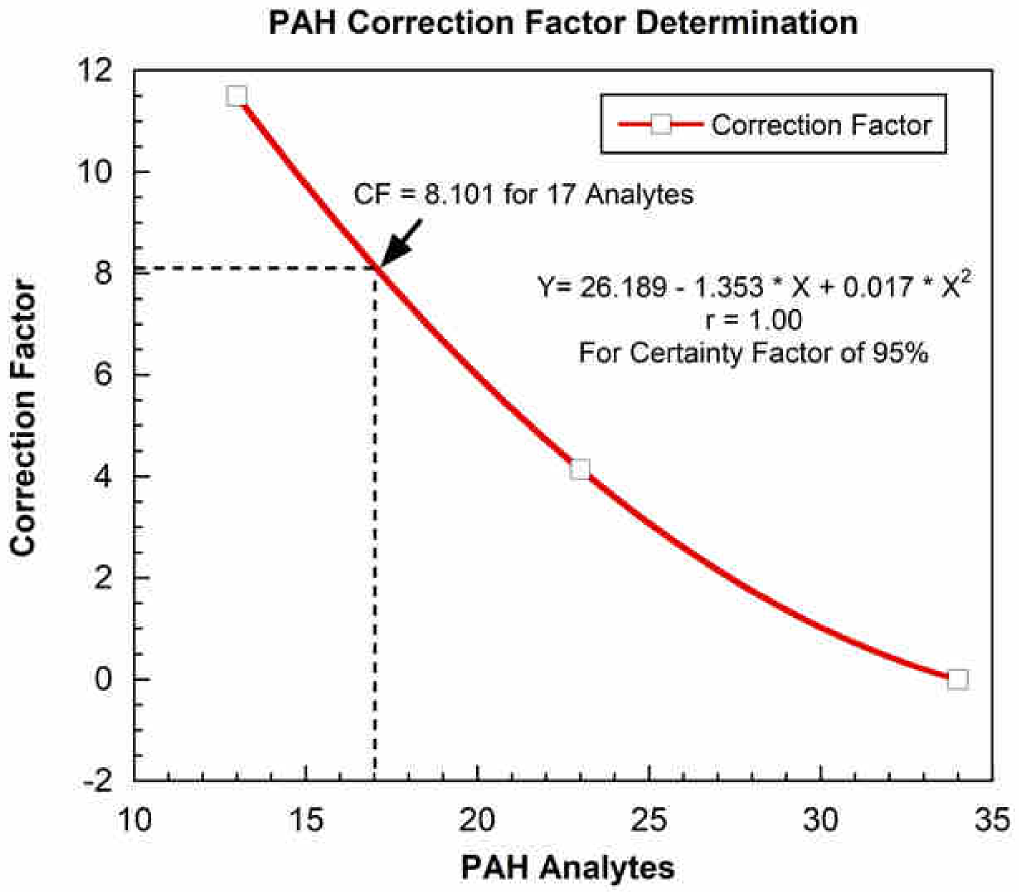


FIGURE 13. COMPARISON OF TOTAL PAH CONCENTRATIONS IN SURFICIAL SEDIMENTS FROM THE DELINEATED AREAS OF SUMMIT LAKE, 2017.



Correction Factors listed in Table 2 of Ohio EPA, 2010.

FIGURE 14. POLYNOMIAL REGRESSION ANALYSIS FOR EXTRAPOLATION OF ESB PAH CORRECTION FACTORS FOR DATA ANALYSIS

16.0 TABLES

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TABLE 1. WATER QUALITY MONITORING SITES FOR THE SUMMIT LAKE ASSESSMENT, 2017.

Ohio EPA Station Code	Location	River Mile	Latitude	Longitude
R06P13	Ohio Canal at Kenmore Blvd.	3.62	41.04818	-81.54375
F01A14	Summit Lake L-1	3.17	41.05490	-81.54556
NA	Summit Lake Boat Ramp	2.83	41.05865	-81.54325
200119	Ohio Canal at South Ave.	2.66	41.06135	-81.54206

TABLE 2. COORDINATES OF SELECTED SITES FOR SEDIMENT SAMPLES IN SUMMIT LAKE.

Zone	Cell ID	Latitude	Longitude
A	A13	41.05049	-81.5451
	A27	41.05037	-81.5436
	A50	41.04961	-81.5441
B	B12	41.05782	-81.5482
	B5	41.0579	-81.5486
	B65	41.05268	-81.5469
	B65_Rep	41.05277	-81.5468
C	C17	41.06012	-81.5458
	C52	41.05958	-81.5448
	C75	41.0588	-81.5478
D	D6	41.0592	-81.5438
	D77	41.0515	-81.5441
	D80	41.05129	-81.5439

TABLE 3. COORDINATES OF TARGETED SITES FOR SEDIMENT SAMPLES IN SUMMIT LAKE.

Zone	Cell ID	Latitude	Longitude	Site Description	Site Type
B	B37	41.05543	-81.54740	Leslie Ave. Storm Sewer	Targeted
B	B51	41.05407	-81.54636	Lagoon Ave. Storm Sewer	Targeted
B	B61	41.05311	-81.54678	Indian Tr. Storm Sewer	Targeted
C	C8	41.06007	-81.54804	NW Shoreline Storm Sewer	Targeted
D	D27	41.05746	-81.54305	Basketball Court Storm Sewer	Targeted
D	D48	41.05521	-81.54412	Plato Ln. Storm Sewer	Targeted
D	D55	41.05413	-81.54388	Ira Ave. Storm Sewer	Targeted
Canal_1	n/a	41.06059	-81.54286	North Reach Ohio & Erie Canal	Canal
Canal_2	A90	41.04835	-81.54375	Canal South (Kenmore Blvd.)	Canal

TABLE 4. FIELD MEASUREMENT SUMMARY FOR THE SUMMIT LAKE PHASE II ASSESSMENT.

Matrix	Locations	Parameter	Measurement	Method	Frequency
Sediment	All Sites (Targeted; Selected)	Water Depth	Total Water Depth to Sediment Surface (ft)	USGS Gaging Pole	Each Sampling Location Prior to Collection
		Sediment Thickness	Sediment Thickness to Refusal (ft)	USGS Gaging Pole	Each Sampling Location Prior to Sample Collection
			Sample Core Length (cm)	Ruler	Each Core Sample for Composite
		Sediment Color	Qualitative Evaluation	Visual Examination of Layers in Core	Each Core Prior to Compositing
			Color Classification	Musell Color Comparison	Each Composite Sample
		Sediment Odor	Qualitative Odor Description	Sampler Observation	Each Composite Sample
		Sheen	Qualitative Sheen Description	Sampler Observation	Each Composite Sample
Water	Open Water Site (F01A14)	Secchi Disk Transparency	Clarity (meters)	Visual estimate	Each Sampling Event
		Water Depth	Total Depth (ft)	Echo Sounder	Each Sampling Event
			Sample and Profile Depth (m)	YSI ProDSS Pressure Transducer	
	Open Water Site (F01A14) Canal Sites (F01A03, 200119) Sediment Locations (All)	Field Water Quality Parameters	Temperature Water Temp (°C)	YSI ProDSS Field Meter	Each sampling event: • F01A14: 0.5m Below Water Surface and 1.0m Depth Increments to 0.5m Above Bottom; • F01A03, 200119: 0.5m Below Surface • Sediment Sampling Locations: 0.5m Above Sediment Surface
			pH (SU)		
			Dissolved Oxygen (mg/L; % Saturation)		
			Specific Conductance (µS/cm)		

TABLE 5. LIST OF ANALYTICAL METHODS FOR WATER SAMPLES ASSOCIATED WITH THE SUMMIT LAKE PHASE II ASSESSMENT, 2016.

Laboratory/ *Analyte Group*	**Analysis**[a]	**Test Method**	**Reference**
TestAmerica Laboratory			
Inorganic Analytes			
	Alkalinity	SM 2320 B	1
	Chlorides	300.0_28D	2
	Sulfate	300.0_28D	2
	Total Dissolved Solids (TDS)	SM 2540 C	1
	TSS	SM 2540 D	1
Metals			
	Hardness (Ca + Mg)	SM 2340 C-1997	1
	Mercury	7470A	3
	Metals[b] (ICP)*	6010B	3
	Chemical Oxygen Demand (COD)	SM 5220 D-1997	1
	Total Organic Carbon (TOC)	SM 5310 D-2000	1
Nutrients			
	Ammonia Nitrogen (NH3-N)	353.2	4
	Nitrates + Nitrites (NO3+NO2)	350.1	5
	Total Kjeldahl Nitrogen (TKN)	351.2	6
	Phosphorus, Ortho	SM 4500 PE	1
	Phosphorus, Total	SM 4500 PE	1
Organics			
	Semi-Volatile Organics (SVOCs)[c]	8270C	3
	Polychlorinated Biphenyls (PCBs)[c]	8082	3
	Pesticides[c]	8081A	3
	Herbicides[c]	8151 A	3

References:

1. APHA (2012)
2. Pfaff, J.D. (1993)
3. USEPA SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*
4. USEPA (1993a)
5. USEPA (1993b)
6. USEPA (1993c)

* Inductively Coupled Plasma

[a] See Section 5.3.1 for a description of the applicability of tests at specific sampling locations.

[b] Al, As, Ba, Ca, Cd, Cr, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Na, Sr, Zn

[c] See Appendix Q for a complete analyte list for this method.

TABLE 5. CONTINUED.

Laboratory/ *Analyte Group*	Analysis	Test Method	Reference
Adams Water Laboratory			
Bacteria			
	E. coli	MMO-MUG, Quantitray	4
EnviroScience, Inc.			
Algae Related Parameters			
	Microcystin	Abraxis, Microcystins-ADDA ELISA (Microtiter Plate), Product 520011, R012215 OEPA DES 701.0 EnviroScience, 2017b	5 6 7
	Cylindrospermopsin	Abraxis, Cylindrospermopsin ELISA (Microtiter Plate), Product 522011, R090415 EnviroScience, 2017b	8 7
	Saxitoxin	Abraxis, Saxitoxin (PSP) ELISA, Microtiter Plate, Product 52255B, R071715 EnviroScience, 2017b	9 7
	Anatoxin a	Abraxis, Anatoxin-a ELISA Microtiter Plate, Product 520060, R053116 EnviroScience, 2017b	10 7
	Chlorophyll a	EPA 446 ES SOP 3006-0	11 12
	HAB Phytoplankton Screen	ES SOP 3009-1	13

References:

4. Ohio EPA (2014)
5. Abraxis R012215 (Undated 1)
6. Ohio EPA (2015c)
7. EnviroScience (2017c)
8. Abraxis R090415 (Undated 2)
9. Abraxis R071715 (Undated 3)
10. Abraxis R053116 (Undated 4)
11. Arar (1997)
12. EnviroScience (2015)
13. EnviroScience (2017d)

TABLE 6. LIST OF ANALYTICAL METHODS FOR SEDIMENT SAMPLES ASSOCIATED WITH THE SUMMIT LAKE PHASE II ASSESSMENT, 2016.

Analysis[a]	Test Method	Reference
% Solids (% Moisture)	2540	1
Particle Size Distribution	ASTM D422	2
Volatile Organic Compounds (VOCs)[b]	8260B	1
Semi-Volatile Organic Compounds (SVOCs)[b]	8270C	1
Polychlorinated Biphenyls (PCBs)[b]	8082	1
Pesticides[b]	8081A	1
Herbicides[b]	8151 A	1
Oil Range Organics (ORO)	8015 A (modified)	1
Diesel Range Organics (DRO)	8015 B	1
Metals[c] (ICP)*	6010B	1
Metals[d] (ICP/MS)**	6020	1
Mercury	7471A	1
Total Organic Carbon (TOC)	Lloyd Kahn	3
Acid Volatile Sulfides (AVS)	9034	1,
Simultaneously Extracted Metals (SEM)[e] (ICP)*	6010C	1
SEM Mercury (CVAA)***	7470A	1

References:

1. USEPA SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*
2. ASTM (2007)
3. Kahn (1988)

[a] See Section 5.3.2 for a description of the applicability of tests at specific sampling locations.

[b] See Appendix Q for a complete analyte list for this method.

[c] Al, Ca, K, Fe, Mg, Na, Se

[d] As, Ba, Cd, Cu, Cr, Pb, Zn, Ni, Mn, Sr

[e] Cd, Cu, Pb, Ni, Ag, Zn in extract generated in analysis for AVS

*Inductively Coupled Plasma

**ICP Mass Spectrometry

***Cold Vapor Atomic Absorption

TABLE 7. SUMMARY OF WATER SAMPLE COLLECTION DATES AND SAMPLE TYPES COLLECTED FOR THE SUMMIT LAKE PHASE II ASSESSMENT.

Sample Type	**Open Water Site (F01A14)**		**Ohio & Erie Canal Sites:** **1. Kenmore Blvd. (R06P13)** **2. South Ave. (200119)**	**Community Center Boat Ramp**
	Surface (0.5 m)	**Bottom**	**Surface (0.5 m)**	**Surface (0.5 m)**
Water Chemistry (Inorganic Analytes)	June 7, 2017 July 19, 2017	June 7, 2017 July 19, 2017	June 7, 2017 July 19, 2017	--
Water Chemistry (Organic Analytes)	July 19, 2017	July 19, 2017	July 19, 2017	--
Chlorophyll *a*	June 7, 2017 July 19, 2017	--	July 19, 2017	--
Algal Toxins	July 19, 2017	--	July 19, 2017	July 19, 2017
Algae for Identification	July 19, 2017	--	July 19, 2017	July 19, 2017
E. coli	June 7, 2017 July 19, 2017	--	June 7, 2017 June 29, 2017 July 5, 2017 July 14, 2017 July 19, 2017	June 7, 2017 June 29, 2017 July 5, 2017 July 14, 2017 July 19, 2017

TABLE 8. SUMMARY OF SEDIMENT SAMPLE CORE SAMPLE COLLECTION RESULTS FOR SUMMIT LAKE, 2017.

Site_Name	Sample Category	Sample_ID	Date	Time	Water Depth (m)	Refusal Thickness (cm)	Cores per Composite	Sediment Layers	Maximum Core Sample Thickness (cm)	Maximum Core Retrieval Thickness (cm)
Grid_A13	Selected	SS3	6/1/2017	11:30	1.2	184	2	3	28	28
Grid_A27	Selected	SS2	6/1/2017	10:40	1.2	131	4	1	30	40
Grid_A50	Selected	SS1	6/1/2017	9:50	1.2	291	4	1	30	45
Grid_B12	Selected	SS7	6/1/2017	14:55	1.8	219	2	2	30	58.5
Grid_B5	Selected	SS8	6/1/2017	15:30	1.2	55	2	2	26	26
Grid_B65	Selected	SS5	6/1/2017	13:55	1.2	122	2	2	29	29
Grid_B65	Selected	SS6	6/1/2017	16:35	1.8	79	2	1	30	48
Grid_C17	Selected	SS9	6/1/2017	17:20	1.5	>274	2	2	30	39
Grid_C52	Selected	SS10_DupA	6/1/2017	18:00	1.2	137	2	2	30	43.5
Grid_C52	Selected	SS10_DupB	6/1/2017	18:00	1.2	137	2	2	30	43.5
Grid_C75	Selected	SS11	6/1/2017	18:50	1.2	>274	1	3	30	35
Grid_D6	Selected	SS12	6/7/2017	10:00	1.3	40	3	3	30	30
Grid_D77	Selected	SS4	6/1/2017	12:10	1.4	119	2	1	30	57
Grid_D80	Selected	SS13	6/7/2017	11:10	1.5	>219	2	1	30	43.5
Canal_1	Targeted	TS9	5/30/2017	18:30	1.1	75	2	3	23	23
Canal_2	Targeted	TS5	5/30/2017	15:40	1.1	158	2	1	30	39
Grid_B37	Targeted	TS1	5/30/2017	10:28	1.7	91	2	2	28	28
Grid_B51	Targeted	TS3	5/30/2017	13:58	1.7	37	4	1	23	23
Grid_B61	Targeted	TS4	5/30/2017	15:00	0.9	116	3	1	22.5	22.5
Grid_C8	Targeted	TS2_DupA	5/30/2017	11:55	0.7	268	4	1	30	37.5
Grid_C8	Targeted	TS2_DupB	5/30/2017	11:55	0.7	268	4	1	30	37.5
Grid_D27	Targeted	TS8	5/30/2017	17:50	1.4	152	2	1	26	26
Grid_D48	Targeted	TS7	5/30/2017	17:10	0.8	49	2	1	25	25
Grid_D55	Targeted	TS6	5/30/2017	16:30	1.2	171	2	2	18.5	18.5

TABLE 9. BENEFICIAL USE DESIGNATIONS FOR SUMMIT LAKE AND THE OHIO & ERIE CANAL WITHIN THE 2017 SUMMIT LAKE PHASE II STUDY AREA.

Beneficial Use	**Ohio & Erie Canal, Summit Lake (RM 2.84) to Lock 1 (RM 1.25)**	**Summit Lake**	**Ohio & Erie Canal, South of Summit Lake (RM>3.6)**
Aquatic Life [Citation]	Modified Warmwater Habitat [OAC 3745-1-26]	Exceptional Warmwater Habitat [OAC 3745-1-07(B)(1)(c)]	General High Quality Waters [OAC 3745-1-05(A)(10)(a)]
Water Supply [Citation]	Agricultural and Industrial Water Supply [OAC 3745-1-26]	Public Water Supply [OAC 3745-1-07(B)(2)(a)(i)]	Not Designated
Recreation [Citation]	Primary Contact Recreation [OAC 3745-1-26]	Primary Contact Recreation [OAC 3745-1-07(B)(3)(b)]	Primary Contact Recreation [OAC 3745-1-07(B)(3)(b)]

TABLE 10. SUMMARIZED WATER QUALITY FIELD READING RESULTS FOR THE SUMMIT LAKE PHASE II ASSESSMENT, 2017.

L-1 Epilimnion, 6/4/2017

n=5

	Temperature (°C)	*pH (SU)*	*Dissolved Oxygen (mg/L)*	*Dissolved Oxygen Saturation (%)*	*Specific Conductance (µS/cm)*
Mean	20.6	8.3	8.5	18.2	831.3
Standard Error	0.11	0.09	0.64	17.23	4.01
Median	20.7	8.4	9.1	1.0	828.5
Range	0.7	0.55	3.97	103.709	27
Maximum	20.7	8.4	9.3	104.3	851.0
Minimum	20.0	7.9	5.4	0.6	824.0

L-1 Metalimnion, 6/4/2017

n=3

	Temperature (°C)	*pH (SU)*	*Dissolved Oxygen (mg/L)*	*Dissolved Oxygen Saturation (%)*	*Specific Conductance (µS/cm)*
Mean	15.8	7.5	1.0	11.03	912.0
Standard Error	1.88	0.07	0.96	10.38	24.58
Median	15.9	7.5	0.1	0.7	904.0
Range	6.5	0.22	2.88	31.2	84
Maximum	19.0	7.7	2.9	31.8	958.0
Minimum	12.5	7.4	0.1	0.6	874.0

L-1 Hypolimnion, 6/4/2017

n=5

	Temperature (°C)	*pH (SU)*	*Dissolved Oxygen (mg/L)*	*Dissolved Oxygen Saturation (%)*	*Specific Conductance (µS/cm)*
Mean	8.3	7.5	0.2	0.01	1115.0
Standard Error	0.39	0.01	0.05	0.00	11.28
Median	7.9	7.5	0.1	0.0	1127.0
Range	2.1	0.03	0.27	0.022	61
Maximum	9.8	7.5	0.3	0.0	1133.0
Minimum	7.7	7.5	0.1	0.0	1072.0

Table 10. Summarized Water Quality Field Reading Results for the Summit lake Phase II Assessment, 2017. (cont.)

**L-1
Metalimnion
7/19/2017
n=4**

	Temperature (°C)	pH (SU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Specific Conductance (µS/cm)
Mean	24.4	7.7	3.6	43.73	693.0
Standard Error	1.05	0.18	2.02	25.00	5.12
Median	25.1	7.6	2.5	30.7	697.0
Range	4.7	0.81	8.86	109.5	22
Maximum	26.0	8.3	9.0	111.5	700.0
Minimum	21.3	7.4	0.2	2.0	678.0

**L-1
Epilimnion,
7/19/2017
n=2**

	Temperature (°C)	pH (SU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Specific Conductance (µS/cm)
Mean	28.1	8.8	13.6	1.7	686.0
Standard Error	0.35	0.02	0.05	0.0175	4
Median	28.1	8.8	13.6	1.7	686.0
Range	0.7	0.04	0.1	0.035	8
Maximum	28.4	8.8	13.7	1.8	690.0
Minimum	27.7	8.8	13.6	1.7	682.0

**L-1
Hypolimnion
7/19/2017
n=4**

	Temperature (°C)	pH (SU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Specific Conductance (µS/cm)
Mean	11.5	7.4	0.2	0.02	919.3
Standard Error	1.64	0.02	0.02	0.00	32.58
Median	10.5	7.4	0.2	0.0	939.5
Range	7.2	0.09	0.11	0.007	142
Maximum	16.1	7.4	0.3	0.0	970.0
Minimum	8.9	7.3	0.2	0.0	828.0

Table 10. Summarized Water Quality Field Reading Results for the Summit lake Phase II Assessment, 2017. (cont.)

Canal Water
n=6

	Temperature (°C)	*pH (SU)*	*Dissolved Oxygen (mg/L)*	*Dissolved Oxygen Saturation (%)*	*Specific Conductance (µS/cm)*
Mean	24.1	8.1	8.2	1.0	783.5
Standard Error	2.34	0.23	1.89	0.27	44.59
Median	23.8	8.0	6.9	0.8	785.0
Range	8.9	1.02	8.18	1.176	204
Maximum	28.9	8.8	13.7	1.8	884.0
Minimum	20.0	7.7	5.5	0.6	680.0

Sediment Sites
n=20

	Temperature (°C)	*pH (SU)*	*Dissolved Oxygen (mg/L)*	*Dissolved Oxygen Saturation (%)*	*Specific Conductance (µS/cm)*
Mean	22.0	8.5	12.1	1.4	809.1
Standard Error	0.20	0.06	0.49	0.06	6.48
Median	22.0	8.6	13.0	1.5	812.5
Range	3.7	1	7.88	0.959	112
Maximum	24.0	8.9	14.8	1.7	881.0
Minimum	20.3	7.9	7.0	0.8	769.0

TABLE 11. WATER QUALITY RESULTS FOR INORGANIC ANALYTES FOR SUMMIT LAKE AND THE OHIO & ERIE CANAL, 2017.

Sample Date: June 7, 2017

Sampling Location[1]			Ohio Water Quality Standards (OAC Chapter 3745-1)				F01A14 (Surface, Dup A)	F01A14 (Surface, Dup B)	F01A14 (Bottom)	R06P13	200119
Depth (m)							**0.5**	**0.5**	**10.5**	**0.5**	**0.5**
PARAMETER	**CAS NUMBER**	**UNITS**	**OMZA[2]**	**OMZM[3]**	**Human Health (PWS)[4]**	**Human Health (Non-Drink)[5]**	**Results**	**Results**	**Results[6]**	**Results**	**Results**
Alkalinity		mg/L	--	--	--	--	130	130	150	160	130
Chemical Oxygen Demand		mg/L	--	--	--	--	24	23	19	21	23
Chloride	16887-00-6	mg/L	--	--	250	--	120	120	190	120	120
Hardness ($CaCO_3$)		mg/L	--	--	--	--	240	200	230	220	180
Ammonia N[7]	7664-41-7	mg/L	0.5	2.4	--	--	< 0.02	< 0.02	1.4	0.16	0.03
Nitrate-Nitrite as N		mg/L	--	--	10.0	--	0.083	0.077	< 0.05	0.35	0.057
Total Kjeldahl Nitrogen		mg/L	--	--	--	--	0.96	0.92	2.1	0.84	0.84
Orthophosphate as P		mg/L	--	--	--	--	< 0.1	< 0.1	0.39	0.081 J	< 0.1
Phosphorus, Total	7723-14-0	mg/L	--	--	--	--	0.015	0.026	0.37	0.048	0.015
Phosphorus as PO4		mg/L	--	--	--	--	0.046	0.08	1.1	0.15	0.046
Sulfate	14808-79-8	mg/L	--	--	250	--	40	40	40	41	38
Total Dissolved Solids		mg/L	1,500	--	750 (max) 500 (avg)	--	430	410	570	460	440
Total Suspended Solids		mg/L	--	--	--	--	8	8	6	7	4
Metals											
Aluminum	7429-90-5	µg/L	--	--	970	4,500	< 200	< 200	< 200	64 J	< 200
Arsenic	7440-38-2	µg/L	150	340	10	580	< 10	< 10	4.3 J	4 J	< 10
Barium	7440-39-3	µg/L	220	2,000	2,000	160,000	55 J	55 J	85 J	71 J	56 J
Cadmium[8]	7440-43-9	µg/L	4.2	9.9	14	730	< 2	< 2	< 2	< 2	< 2
Calcium	7440-70-2	µg/L	--	--	--	--	55,000	54,000	62,000	65,000	53,000
Chromium[8]	7440-47-3	µg/L	150	3,200	140	14,000	< 5	< 5	< 5	< 5	< 5
Copper[8]	7440-50-8	µg/L	17	27	790	64,000	< 25	< 25	< 25	< 25	< 25
Iron	7439-89-6	µg/L	--	--	--	--	100	98 J	280	310	69 J
Lead[8]	7439-92-1	µg/L	16	300	--	--	< 5	< 5	< 5	2.3 J	2.2 J
Magnesium	7439-95-4	µg/L	--	--	--	--	13,000	13,000	14,000	15,000	13,000
Manganese	7439-96-5	µg/L	--	--	50	61,000	**75**	**74**	2,100	160	74
Mercury[9]	7439-97-6	µg/L	0.91	1.7	0.0031	0.0031	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Nickel[8]	7440-02-0	µg/L	94	840	470	43,000	< 40	< 40	< 40	< 40	< 40
Potassium	7440-09-7	µg/L	--	--	--	--	3,000 J B	3,000 J B	3,300 J B	3,100 J B	2,900 J B
Selenium	7782-49-2	µg/L	5	--	130	3,100	< 15	< 15	< 15	< 15	< 15
Sodium	7440-23-5	µg/L	--	--	--	--	72,000 B	72,000 B	110,000 B	71,000 B	72,000 B
Strontium	7440-24-6	µg/L	21,000	40,000	18,000	1,400,000	180	180	200	170	180
Zinc[8]	7440-66-6	µg/L	220	220	5,000	35,000	< 50	< 50	< 50	< 50	< 50

TABLE 11. WATER QUALITY RESULTS FOR INORGANIC ANALYTES FOR SUMMIT LAKE AND THE OHIO & ERIE CANAL, 2017. (CONT.)

Sample Date: July 19, 2017

Sampling Location[1]			Ohio WQS (OAC Chapter 3745-1)				F01A14 (Surface)	F01A14 (Bottom)	R06P13	200119
Depth (m)							0.5	9.0	0.5	0.5
PARAMETER	CAS NUMBER	UNITS	OMZA[2]	OMZM[3]	Human Health (PWS)[4]	Human Health (Non-Drink)[5]	Results	Results[6]	Results	Results
Alkalinity		mg/L	--	--	--	--	120	170	140	120
Chemical Oxygen Demand		mg/L	--	--	--	--	25	22	29	26
Chloride	16887-00-6	mg/L	--	--	250	--	130	180	130	130
Hardness ($CaCO_3$)		mg/L	--	--	--	--	200	0	250	200
Ammonia N[7]	7664-41-7	mg/L	0.5	2.4	--	--	< 0.02	1.6	0.099	0.071
Nitrate-Nitrite as N		mg/L	--	--	10.0	--	< 0.05	< 0.05	0.16	< 0.05
Total Kjeldahl Nitrogen		mg/L	--	--	--	--	0.73	2.1	0.71	0.69
Orthophosphate as P		mg/L	--	--	--	--	< 0.1	0.36	0.06 J	< 0.1
Phosphorus, Total	7723-14-0	mg/L	--	--	--	--	0.041	0.3	0.072	0.043
Phosphorus as PO4		mg/L	--	--	--	--	0.13	0.9	0.22	0.13
Sulfate	14808-79-8	mg/L	--	--	250	--	36	35	38	36
Total Dissolved Solids		mg/L	1,500	--	750 (max) 500 (avg)	--	390	490	410	380
Total Suspended Solids		mg/L	--	--	--	--	5	4	10	4
Metals										
Aluminum	7429-90-5	µg/L	--	--	970	4,500	< 200	< 200	130 J B	< 200
Arsenic	7440-38-2	µg/L	150	340	10	580	3.3 J	4.4 J	4.2 J	4.6 J
Barium	7440-39-3	µg/L	220	2,000	2,000	160,000	50 J	89 J	66 J	49 J
Cadmium[8]	7440-43-9	µg/L	4.2	9.9	14	730	< 2	< 2	< 2	< 2
Calcium	7440-70-2	µg/L	--	--	--	--	48,000	63,000	56,000	45,000
Chromium[8]	7440-47-3	µg/L	150	3,200	140	14,000	< 5	< 5	< 5	< 5
Copper[8]	7440-50-8	µg/L	17	27	790	64,000	< 25	< 25	< 25	< 25
Iron	7439-89-6	µg/L	--	--	--	--	45 J	320	390	47 J
Lead[8]	7439-92-1	µg/L	16	300	--	--	< 5	< 5	< 5	< 5
Magnesium	7439-95-4	µg/L	--	--	--	--	14,000	14,000	15,000	14,000
Manganese	7439-96-5	µg/L	--	--	50	61,000	35	1800	110	52
Mercury[9]	7439-97-6	µg/L	0.91	1.7	0.0031	0.0031	< 0.2	< 0.2	< 0.2	< 0.2
Nickel[8]	7440-02-0	µg/L	94	840	470	43,000	< 40	1.6 J	< 40	< 40
Potassium	7440-09-7	µg/L	--	--	--	--	3,200 J B	3,300 J B	3,300 J B	3,100 J B
Selenium	7782-49-2	µg/L	5	--	130	3,100	< 15	< 15	< 15	< 15
Sodium	7440-23-5	µg/L	--	--	--	--	75,000	110,000	74,000	73,000
Strontium	7440-24-6	µg/L	21,000	40,000	18,000	1,400,000	180	210	170	170
Zinc[8]	7440-66-6	µg/L	220	220	5,000	35,000	< 50	< 50	< 50	< 50

TABLE 11. WATER QUALITY RESULTS FOR INORGANIC ANALYTES FOR SUMMIT LAKE AND THE OHIO & ERIE CANAL, 2017. (CONT.)

Key to Qualifiers:

J	Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.
B	Compound was also found in the laboratory blank sample.

Notes:

[1]Key to sampling Locations:

F01A14	SUMMIT LAKE L-1 SURFACE DUP A
F01A14	SUMMIT LAKE L-1 BOTTOM
R06P13	OHIO CANAL @ KENMORE BLVD
200119	OHIO CANAL @ SOUTH AVE

[2]Outside Mixing Zone Average criteria.

[3]Outside Mixing Zone Maximum criteria.

[4]Criteria applicable to Public Water Supplies established as OMZAs. Applicable to Summit Lake surface samples only.

[5]Human health criteria applicable to the Ohio & Erie Canal stations as OMZAs. Values presented are Lake Erie Basin Criteria.

[6]Ohio EPA does not apply the Water Quality Standards to samples collected from the bottom waters of stratified lakes.

[7]Criteria presented are for the EWH aquatic life use applicable to Summit Lake based upon the average surface temperature and pH.

[8]Hardness-based OMZA and OMZM criteria based upon an average hardness of 200 mg/L from Table 35-9 of OAC 3745-1-35.

[9]The OMZA presented for Mercury is the Lake Erie basin criterion for the protection of wildlife established in Table 35-12 of OAC 3745-1-35.

TABLE 12. CHLOROPHYLL A CONCENTRATIONS IN SAMPLES FROM SUMMIT LAKE, 2017.

Sampling Location	Sample Date	Depth (m)	Chlorophyll a (mg/L)
Summit Lake L-1 Surface	6/7/2017	0.5	0.037
Summit Lake L-1 Surface	7/19/2017	0.5	0.029
Ohio Canal @ Kenmore Blvd	7/19/2017	0.5	0.016
Ohio Canal @ South Ave	7/19/2017	0.5	0.016

TABLE 13. ALGAL TOXIN RESULTS FOR SAMPLES COLLECTED FROM SUMMIT LAKE, 2017.

Station	Site_ID	Anatoxin-a (µg/L)	Microcystin (µg/L)	Cylindrospermopsin (µg/L)	Saxitoxin (µg/L)
Summit Lake L-1	F01A13	<0.15	<0.15	<0.05	**0.034**
Ohio Canal @ Kenmore Blvd	R06Pxx	<0.15	<0.15	<0.05	<0.02
Ohio Canal @ South Ave	200119	<0.15	<0.15	<0.05	**0.029**
Summit Lake Boat Ramp (Dup A)		<0.15	<0.15	<0.05	**0.028**
Summit Lake Boat Ramp (Dup B)		<0.15	<0.15	<0.05	**0.029**

TABLE 14. STATE OF OHIO NUMERIC THRESHOLDS FOR CYANOTOXINS IN RECREATIONAL WATER.

Threshold	Microcystins* (µg/L)	Anatoxin-a (µg/L)	Cylindrospermopsin (µg/L)	Saxitoxin* (µg/L)
Post Informational Sign	<6	<80	<5	<0.8
Recreational Public Health Advisory	6 - <20	80 - <300	5 - <20	0.8 - <3
Elevated Recreational Public Health Advisory	≥20	≥300	≥20	≥3

*Microcystins and saxitoxin thresholds are intended to be applied to total concentrations of all reported congeners of those cyanotoxins.
(Source: State of Ohio, 2016)

TABLE 15. ALGAE TAXA OBSERVED IN SAMPLES COLLECTED FROM SUMMIT LAKE ON JULY 19, 2017.

Common Name (Phylum)/Order/Species	Potential for Algal Toxin Production	Ohio Canal @ Kenmore Blvd	Ohio Canal @ South Ave	Summit Lake Boat Ramp	Summit Lake L-1 Surface
Cyanobacteria (Cyanophyta)		8 Taxa	10 Taxa	8 Taxa	11 Taxa
Chroococcales					
Aphanocapsa incerta	Yes	X	X	X	X
Aphanocapsa nubilum	Yes		X		
Chroococcus minor					X
Merismopedia punctata		X	X	X	X
Merismopedia tenuissima		X	X	X	X
Microcystis wesenbergii	Yes		X	X	
Nostocales					
Dolichospermum (prev. Anabaena) flos-aquae	Yes	X	X	X	X
Dolichospermum (prev. Anabaena) sigmoideum	Yes				X
Oscillatoriales					
Glaucospira spp.		X	X	X	X
Komvophoron schmidlei					X
Leptolyngbya sp.		X	X	X	
Phormidium (prev. Oscillatoria) formosum	Yes	X	X	X	X
Pseudanabaena limnetica		X	X		X
Diatoms (Bacillariophyta)		3 Taxa	2 Taxa	3 Taxa	3 Taxa
Bacillariales					
Nitzschia spp.		X		X	X
Fragilariales					
Fragilaria spp.		X	X	X	X
Thalassiosirales					
Cyclotella spp.		X	X	X	X
Dinoflagellates (Pyrrhophyta)		0 Taxa	1 Taxon	1 Taxon	0 Taxa
Peridiniales					
Ceratium hirundinella			X	X	
Euglenoids (Euglenophyta)		1 Taxon	2 Taxa	1 Taxon	1 Taxon
Euglenales					
Lepocinclis sp.			X		
Trachelomonas hispida		X	X	X	X
Green Algae (Chlorophyta)		15 Taxa	11 Taxa	12 Taxa	9 Taxa
Chlorococcales					
Actinastrum hantzschii		X			
Ankistrodesmus falcatus		X	X		X
Chlorella vulgaris		X		X	X
Closteriopsis acicularis				X	X
Coelastrum astroideum		X		X	X
Crucigenia rectangularis			X		
Crucigenia tetrapedia		X			
Crucigeniella rectangularis		X		X	X
Dictyosphaerium pulchellum		X	X	X	X
Kirchneriella lunaris		X	X	X	X
Micractinium pusillum				X	
Oocystis parva			X		
Pediastrum simplex		X			
Scenedesmus acuminatus		X	X	X	
Scenedesmus denticulatus		X	X		
Scenedesmus ecornis			X	X	X
Scenedesmus granulatus		X			
Scenedesmus quadricauda		X	X		
Scenedesmus spinosus		X		X	
Volvocales					
Chlamydomonas spp.		X	X	X	X
Zygnematales					
Teilingia sp.			X	X	
Yellow-Green Algae (Chrysophyta)		1 Taxon	1 Taxon	1 Taxon	1 Taxon
Chrysomonadales					
Dinobryon bavaricum		X	X	X	X
Total Taxa Observed		28 Taxa	27 Taxa	26 Taxa	25 Taxa

TABLE 16. RECREATIONAL USE CRITERIA ANALYSIS FOR SUMMIT LAKE, 2017

Station	**Date**	**Time**	**Parameter**	**Result**	**Units[1]**
Ohio Canal @ Kenmore Blvd (F01A03)	6/7/2017	13:25	*E. coli*	228	CFU/100ml
	6/29/2017	13:55	*E. coli*	520	CFU/100ml
	7/5/2017	12:10	*E. coli*	121	CFU/100ml
	7/14/2017	8:30	*E. coli*	365	CFU/100ml
	7/19/2017	11:45	*E. coli*	28	CFU/100ml
Geometric Mean				**171.1***	
Percent>PCR[2] STV[3]				**20%†**	
Ohio Canal @ South Ave (200119)	6/7/2017	12:51	*E. coli*	80	CFU/100ml
	6/29/2017	14:15	*E. coli*	170	CFU/100ml
	7/5/2017	12:20	*E. coli*	49	CFU/100ml
	7/14/2017	8:50	*E. coli*	110	CFU/100ml
	7/19/2017	13:55	*E. coli*	79	CFU/100ml
Geometric Mean				**89.7**	
Percent>PCR STV				**0%**	
Summit Lake Boat Ramp	6/7/2017	14:40	*E. coli*	60	CFU/100ml
	6/29/2017	13:40	*E. coli*	200	CFU/100ml
	7/5/2017	11:55	*E. coli*	2	CFU/100ml
	7/14/2017	8:15	*E. coli*	44.1	CFU/100ml
	7/19/2017	14:30	*E. coli*	19	CFU/100ml
Geometric Mean				**28.9**	
Percent>PCR STV				**0%**	
Summit Lake L-1-Surface (F01A14)	6/7/2017	14:00	*E. coli*	16	CFU/100ml
	(6/7 Field Dup)	*14:00*	*E. coli*	*24*	*CFU/100ml*
	7/19/2017	13:15	*E. coli*	7	CFU/100ml
Geometric Mean				**13.5**	
Percent>PCR STV				**0%**	

Recreational Use Criteria (CFU/100ml)[4]:	**PCR**	**Bathing[5]**
90 Day Geometric Mean:	**126**	**126**
90 Day STV[6]:	**410**	**410**

Notes:

[1] CFU: Colony Forming Units

[2] PCR: Primary Contact Recreation

[3] STV: Statistical Threshold Value

[4] Ohio Administrative Code 3745-1-37

[5] A beach action value of 235 *E. coli* CFU/100 ml is used for issuing beach and bathing water advisories.

[6] These criteria cannot be exceeded in more than ten per cent of the samples taken during any ninety-day period.

*Exceeds the PCR 90-day geometric mean criterion.

†Exceeds the PCR STV 90-day criterion.

TABLE 17. COMPARISON OF SUMMIT LAKE WATER QUALITY RESULTS TO DRAFT OHIO EPA CRITERIA FOR PROTECTION OF THE PROPOSED LAKE HABITAT BENEFICIAL USE.

Parameter	**Units**	**Draft Lake Habitat Use Criterion[1]**	**Summit Lake 2017 Results (Epilimnion)[2]**
Dissolved Oxygen (Average)	mg/L	5.0	10.1
Dissolved Oxygen (Minimum)	mg/L	4.0	5.36
Chlorophyll *a*	µg/L	14.0	**33.0**
Total Nitrogen[3]	µg/L	638	**1,000**
Total Phosphorus	µg/L	34	31
Secchi Disk Transparency	meters	1.19	**1.17**

[1] Table I-1 from Ohio EPA, 2016a.

[2] Average results from the epilimnion for both 2017 sampling events. Values in **bold type** indicate exceedances of the draft Lake Habitat criteria.

[3] Sum of NO_3+NO_2-N and TKN.

TABLE 18. SUMMARY OF CHARACTERISTICS FOR SEDIMENT LAYERS COLLECTED IN SUMMIT LAKE CORE SAMPLES FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Site Name	Sample ID	Layer No	Color	Munsell Code[1]	Characteristics	Bottom Depth of Layer (cm)	Odor	Sheen?	Sheen Intensity	Notes
Selected Sites										
Grid_A13	SS3	1	Dark olive	5Y 3/2	Silty Muck	12.0	NO	NO	N/A	
		2	Dark olive		Silty muck with some sand	20.0	NO	NO	N/A	
		3	Red/Brown		Iron colored root material with silt and detritus	28.0	YES	NO	N/A	H2S Odor
Grid_A27	SS2	1	Olive	5Y 2.5/1	Silty muck with some sand and detritus	40.0	YES	YES	Moderate	Oil odor noted.
Grid_A50	SS1	1	Black/Dark Olive	Gley2 2.5/5B	Muck	45.0	YES	YES	Slight	Slight oil and H2S odor.
Grid_B12	SS7	1	Dark olive	5Y 3/2	Silty muck	18.0	NO	NO	N/A	
		2	Gray		Sand	58.5	NO	NO	N/A	
Grid_B5	SS8	1	Dark olive	5Y 3/2	Silt	14.0	NO	NO	N/A	
		2	Beige-Gray		Clayey sand	26.0	NO	NO	N/A	
Grid_B65	SS5	1	Black/Dark Olive	Not Collected	Silty muck with some sand and gravel	10.0	YES	YES	Moderate	Composite sample with consistency of wet cement
		2	Brown		Sand and plant roots	29.0	NO	NO	N/A	
Grid_B65	SS6	1	Dark olive	Not Collected	Clayey sand with silt and muck	48.0	NO	NO	N/A	Field Replicate. No layering as observed.
Grid_C17	SS9	1	Black/Dark Olive	Gley1 3/5G_1	Silty fine detritus	15.0	YES	YES	Heavy	Strong oil odor.
		2	Gray		Silty clay with some sand	39.0	YES	YES	Heavy	Strong oil odor.
Grid_C52	SS10 (Both Duplicates)	1	Gray/Black	5Y 4/2	Silty sand	16.0	NO	NO	N/A	Zebra mussel shells noted in sample
		2	Red/Brown		Iron colored silt and sand with heavy fine detritus	43.5	NO	NO	N/A	Munsell color is for composite sample
Grid_C75	SS11	1	Dark olive	5Y 4/4	Detritus and silt	11.0	NO	NO	N/A	Munsell color is for composite sample
		2	Gray		Sandy clay	24.0	YES	NO	N/A	Organic chemical odor
		3	Brown		Organic detritus	35.0	NO	NO	N/A	
Grid_D6	SS12	1	Black	5Y 2.5/1	Silt, fine detritus and sand with plant material	9.5	YES	NO	N/A	Slight H2S odor
		2	Gray Brown		Clay and sand with some silt	22.0	YES	NO	N/A	Slight H2S odor
		3	Gray		Clay and root material	30.0	YES	NO	N/A	Slight H2S odor
Grid_D77	SS4	1	Black/Dark Olive	Gley1 2.5/5GY	Muck with some sand and detritus	57.0	YES	YES	Heavy	Heavy gelatinous material with strong oil smell and sheen
Grid_D80	SS13	1	Gray/Black	5Y 3/1	Oily silty muck	43.5	YES	YES	Heavy	Strong oil odor

[1] Munsell Color codes refer to the composite sample.

TABLE 19. SUMMARY OF CHARACTERISTICS FOR SEDIMENT LAYERS COLLECTED IN SUMMIT LAKE CORE SAMPLES FROM TARGETED SITES IN SUMMIT LAKE, 2017.

Site Name	Sample ID	Layer No	Color	Munsell Code[1]	Characteristics	Bottom Depth of Layer (cm)	Odor	Sheen?	Sheen Intensity	Notes
Targeted Sites										
Canal_1	TS9	1	Black	Not Collected	Silt and Muck	11.0	YES	YES	Moderate	Moderate oil odor
		2	Brown		Sand	15.0	YES	YES	Moderate	Moderate oil odor
		3	Black		Sandy silt and muck	23.0	YES	YES	Moderate	Moderate oil odor
Canal_2	TS5	1	Black	Gley2 2.5/10B	Silt and Muck with sand and some detritus	39.0	YES	YES	Moderate	Slight oil odor
Grid B37	TS1	1	Olive	Not Collected	Silty Detritus	2.0	NO	NO	N/A	
		2	Gray/Black	Not Collected	Sand/Silt/Detritus	28.0	NO	NO	N/A	
Grid C8	TS2	1	Brown/Black	10YR/2/1	Silty Muck with Detritus	37.5	YES	YES	Heavy	Uniform consistency along core. Oil sheen on collection tube and water when sample collected. Moderate-strong oil odor.
Grid_B51	TS3	1	Black	Gley2 2.5/10B	Sand with some gravel, silt and detritus	23.0	YES	YES	Slight	Slight oil odor
Grid_B61	TS4	1	Black	Gley2 2.5/10B	Sandy silt with some gravel and detritus	22.5	YES	YES	Moderate	Slight oil odor
Grid_D27	TS8	1	Black/Dark Olive	Gley1 2.5/5G1	Sandy silt with some gravel and detritus	26.0	YES	YES	Moderate	Slight oil odor
Grid_D48	TS7	1	Black	Gley2 2.5/10B	Silty sand with some gravel and detritus	25.0	YES	YES	Slight	Oil odor noted
Grid_D55	TS6	1	Brown	Gley2 3/10B	Sand with some gravel	4.0	YES	YES	Slight	Slight oil odor
		2	Black	Gley2 3/10B	Sandy silt	18.5	YES	YES	Slight	

[1] Munsell Color codes refer to the composite sample.

TABLE 20. SUMMARY STATISTICS FOR PERCENT SOLIDS, TOTAL ORGANIC CARBON AND GRAIN SIZE FOR SUMMIT LAKE SEDIMENT SAMPLES, 2017.

Site Category	Statistic	Percent Solids	TOC mg/kg	Fraction Organic Carbon (f_{OC})	Percent Gravel (>2 - *19.2** mm)	Percent Sand (62.5 µm - 2 mm)	Percent Silt (3.9 - 62.5 µm)	Percent Clay (<3.9 µm)
All Sites (n=22)	Average	41.5	128,582	0.129	8.8	48.8	31.6	10.7
	Std Error	3.8	26,654	0.027	2.2	4.5	4.1	2.0
	Max	73.0	600,000	0.600	43.0	87.1	68.3	47.4
	Min	18.7	4,800	0.005	0.0	18.7	1.9	0.5
Selected Sites (n=13)	Average	**32.2**	159,908	0.160	9.6	**38.2**	**37.9**	**14.3**
	Std Error	3.3	42,152	0.042	3.5	4.6	5.1	2.9
	Max	58.4	600,000	0.600	43.0	65.0	68.3	47.4
	Min	18.7	4,800	0.005	0.0	18.7	15.4	2.6
Targeted Sites (n=9)	Average	**55.1**	83,333	0.083	7.7	**64.2**	**22.6**	**5.5**
	Std Error	5.4	16,607	0.017	2.2	5.9	6.0	1.5
	Max	73.0	150,000	0.150	16.7	87.1	56.4	13.3
	Min	29.1	17,000	0.017	0.0	30.0	1.9	0.5

Note: average values in **bold type** indicate values that are significantly different ($p<0.05$) based upon the Student's t Test.

TABLE 21. SUMMARY STATISTICS FOR METALS CONCENTRATIONS IN SUMMIT LAKE SEDIMENT SAMPLES, 2017.

Metal Analyte	Reporting Limit (mg/kg)	Non-Detect (Percent)	Samples>RL (Percent)	Estimated Values* (Percent)	Maximum (mg/kg)	Minimum (mg/kg)	Average[1] (mg/kg)	95% UCL[1,2] (mg/kg)
Aluminum	22 - 110	0.0%	100.0%	0.0%	16,000	1,900	5,787	7,129
Arsenic^	1.1 - 5.3	0.0%	100.0%	0.0%	41.0	4.9	16.4	22.6
Barium^	1.1 - 5.3	0.0%	100.0%	0.0%	290	23	101.6	162
Cadmium^	0.27 - 1.1	0.0%	78.3%	21.7%	5.50	0.22*	0.82	1.91
Calcium^	550 - 2,600	0.0%	100.0%	0.0%	260,000	4,700	32,079	66,139
Chromium^	0.44 - 2.1	0.0%	100.0%	0.0%	110.0	4.7	21.4	44.9
Copper^	0.44 - 2.1	0.0%	100.0%	0.0%	210.0	13.0	46.3	86.8
Iron	11 - 53	0.0%	100.0%	0.0%	32,000	7,800	20,387	23,511
Lead^	0.22 - 1.1	0.0%	100.0%	0.0%	340.0	30.0	112.3	192.2
Magnesium^	550 - 2,600	0.0%	100.0%	0.0%	10,000	820	3,391	5,173
Manganese^	1.1 - 5.3	0.0%	100.0%	0.0%	1,200	140	383	538
Mercury^	0.15 - 0.57	13.6%	38.5%	47.8%	1.400	<0.16	0.203	0.483
Nickel^	0.44 - 2.1	0.0%	100.0%	0.0%	42.0	6.9	18.6	26.2
Potassium	550 - 2,600	0.0%	0.0%	100.0%	1200	180*	564	668
Selenium	0.55 - 2.6	45.5%	37.2%	17.4%	2.20	<0.57	1.03	1.23
Sodium	550 - 2,600	0.0%	0.0%	100.0%	740	120*	399	484
Strontium^	2.2 - 11	0.0%	100.0%	0.0%	220.0	15.0	58.4	89.6
Zinc^	4.4 - 21	0.0%	100.0%	0.0%	2,900	97	389	947

Notes:

*Laboratory estimated values for constituents detected at concentrations below the RL but greater than the MDL.

[1] Values equivalent to one-half the RL are substituted for non-detect results for calculation of the statistic.

[2] The 95 percent upper confidence level for the data set using ProUCL Software, Ver. 5.1 (USEPA, 2015).

^Statistics based upon log-transformed data to ensure that the data are normally distributed. Average equals geometric mean.

TABLE 22. RESULTS SUMMARY FOR ACID VOLATILE SULFIDES AND SIMULTANEOUSLY EXTRACTED METALS CONCENTRATIONS IN SEDIMENTS FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Analyte/ Units	Solids (Percent)	AVS (mg/kg)	Cadmium SEM (mg/kg)	Copper SEM (mg/kg)	Lead SEM (mg/kg)	Nickel SEM (mg/kg)	Zinc SEM (mg/kg)
No. Samples / Estimated Results[1]	14 / 0	14 / 1	14 / 6	14 / 5	14 / 0	14 / 4	14 / 0
Median	28.0%	635	0.165	1.95	15.00	2.50	65.5
IQR[2]	16.2%	1,335	0.465	4.95	56.68	2.67	207.3
Average	27.5%	1,094	0.343	3.90	33.73	2.98	153.6
Standard Error	3.9%	297	0.108	1.22	9.00	0.67	54.0
Maximum	61.6%	3,600	1.400	15.00	93.00	8.70	760.0
Minimum	8.7%	<42	0.032	0.10	0.59	0.39	3.6

Notes:

[1] Laboratory estimated values for constituents detected at concentrations below the RL but greater than the MDL**.**

[2] Inter-Quartile Range.

TABLE 23. RESULTS FOR PETROLEUM HYDROCARBON ANALYSES FOR SEDIMENT SAMPLES COLLECTED AT SELECTED SITES IN SUMMIT LAKE, 2017.

Area	Location	ORO (mg/Kg)	DRO (mg/Kg)	TPH (mg/Kg)
A	SS3 - Grid A13	1,500	1,600	3,100
	SS2 - Grid A27	1,700	6,000	7,700
	SS1 - Grid A50	3,100	3,700	6,800
B	SS8 - Grid B5	260	310	570
	SS7 - Grid B12	5,600	3,200	8,800
	SS5 - Grid B65	2,300	2,400	4,700
	SS6 - Grid B65	5,500	3,600	9,100
C	SS9 - Grid C17	5,400	7,200	12,600
	SS10 - Grid C52	1,100	680	1,780
	SS11 - Grid C75	200	770	970
D	SS12 - Grid D6	1,100	870	1,970
	SS4 - Grid D77	2,200	11,000	13,200
	SS13 - Grid D80	2,100	4,500	6,600

TABLE 24. SUMMARY STATISTICS FOR TPH CONCENTRATIONS AT SELECTED SITES WITHIN THE AREAS OF SUMMIT LAKE, 2017.

	Area A	Area B	Area C	Area D
Number of Samples	3	4	3	3
Mean	5,867	5,793	5,117	7,257
Standard Deviation	2,438	4,019	6,493	5,644
Standard Error	1,408	2,009	3,749	3,258
Median	6,800	6,750	1,780	6,600
Maximum	7,700	9,100	12,600	13,200
Minimum	3,100	570	970	1,970

TABLE 25. SUMMARY OF RESULTS FOR DETECTED VOLATILE ORGANIC COMPOUNDS IN SAMPLES FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Parameter	CAS Number	No. of Samples	Number of Detections (%)	Number Detections J-Qualified (%)	Mean[#] (µg/kg)	Maximum (µg/kg)	95 % UCL[#] (µg/kg)
2-Butanone (MEK)	78-93-3	13	11 (84.6%)	10 (90.9%)	3.5	100	50.7
Acetone	67-64-1	13	11 (84.6%)	8 (72.7%)	139.3	450	264
Carbon disulfide	75-15-0	13	12 (92.3%)	12 (100.0%)	4.6	9.4 J	6.1
Chlorobenzene	108-90-7	13	1 (7.7%)	1 (100.0%)	n/a	1.5 J	n/a
cis-1,2-Dichloroethene	156-59-2	13	2 (15.4%)	2 (100.0%)	n/a	1.2 J	n/a
Ethylbenzene	100-41-4	13	1 (7.7%)	1 (100.0%)	n/a	0.84 J	n/a
Isopropylbenzene	98-82-8	13	1 (7.7%)	1 (100.0%)	n/a	1.7 J	n/a
Methylene Chloride	75-09-2	13	11 (84.6%)	11 (100.0%)	4.7	20 J B	11.8
Toluene	108-88-3	13	1 (7.7%)	1 (100.0%)	n/a	0.89 J	n/a
Xylenes, Total	1330-20-7	13	3 (23.1%)	2 (66.7%)	9.2	13 J	12.8

Notes:

[#] Statistic calculated using Kaplan-Meier (1958) procedures using USEPA ProUCL software (USEPA, 2014)

J: Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B: Compound was also found in the laboratory blank sample.

TABLE 26. SUMMARY OF RESULTS FOR DETECTED SEMI-VOLATILE ORGANIC COMPOUNDS IN SAMPLES FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Parameter	CAS Number	No. of Samples	Number of Detections (%)	Number Detections J-Qualified (%)	Mean[#] (µg/kg)	Maximum (µg/kg)	95 % UCL[#] (µg/kg)
Acetophenone	98-86-2	13	1 7.7%	1 (100%)	n/a	200 J	n/a
Dibenzofuran	132-64-9	13	6 46.2%	6 (100%)	625	1,100 J	436
N-Nitroso-diphenylamine	86-30-6	13	3 23.1%	2 (66.7%)	791	4,700	1,668
Phenol	108-95-2	13	1 7.7%	1 (100%)	n/a	61 J	n/a

Notes:

[#] 95% upper confidence limit calculated using USEPA ProUCL Software (USEPA, 2014)

J: Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

TABLE 27. SUMMARY OF RESULTS FOR DETECTED POLYCYCLIC AROMATIC HYDROCARBON COMPOUNDS IN SAMPLES FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Parameter	CAS Number	No. of Samples	Number of Detections (%)	Number Detections J-Qualified (%)	Mean[#] (µg/kg)	Maximum (µg/kg)	95 % UCL[#] (µg/kg)
Acenaphthene	83-32-9	23	15 (65.2%)	4 (17.4%)	255	1,900	450
Acenaphthylene	208-96-8	23	10 (43.5%)	4 (17.4%)	47	400	133
Anthracene	120-12-7	23	19 (82.6%)	4 (17.4%)	628	5,000	1,097
Benzo[a]anthracene	56-55-3	23	22 (95.7%)	1 (4.3%)	1,201	6,500	1,854
Benzo[a]pyrene	50-32-8	23	22 (95.7%)	0 (0%)	1,152	6,400	1,770
Benzo[b]fluoranthene	205-99-2	23	22 (95.7%)	0 (0%)	1,638	7,800	2,434
Benzo[g,h,i]perylene	191-24-2	23	22 (95.7%)	1 (4.3%)	676	2,800	985
Benzo[k]fluoranthene	207-08-9	23	20 (87.0%)	1 (4.3%)	635	3,200	964
Chrysene	218-01-9	23	22 (95.7%)	0 (0%)	1,421	6,000	2,088
Dibenz(a,h)anthracene	53-70-3	23	10 (43.5%)	1 (4.3%)	131	730	237
Fluoranthene	206-44-0	23	23 (100%)	0 (0%)	3,207	20,000	5,170
Fluorene	86-73-7	23	18 (78.3%)	4 (17.4%)	337	2,200	570
Indeno[1,2,3-cd]pyrene	193-39-5	23	22 (95.7%)	1 (4.3%)	545	2,400	800
2-Methylnaphthalene	91-57-6	13	11 (84.6%)	1 (7.7%)	513	2,000	862
Naphthalene	91-20-3	23	21 (91.3%)	6 (26.1%)	337	1,200	490
Phenanthrene	85-01-8	23	22 (95.7%)	1 (4.3%)	2,186	16,000	3,738
Pyrene	129-00-0	23	23 (100%)	0 (0%)	2,926	15,000	4,513
Total PAH's	**n/a**	**23**	**23 (100%)**	**n/a**	**17,247**	**96,400**	**28,154**

Notes:

[#] Statistics calculated using Kaplan-Meier (1958) procedures using USEPA ProUCL software (USEPA, 2014).

J: Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

TABLE 28. SUMMARY STATISTICS FOR TOTAL PAH CONCENTRATIONS FOR SELECTED AND TARGETED SITES WITHIN THE AREAS OF SUMMIT LAKE, 2017.

	Selected Sites	Targeted Sites
Number of Samples	13	9
Mean	19,598	14,590
Standard Deviation	28,836	11,009
Standard Error	7,998	3,670
Median	2,886	10,930
Maximum	96,870	30,700
Minimum	149	2,796

TABLE 29. SUMMARY STATISTICS FOR TOTAL PAH CONCENTRATIONS WITHIN THE AREAS OF SUMMIT LAKE, 2017.

	Area A	Area B	Area C	Area D
Count	3	7	4	6
Mean	12,785	6,591	33,334	22,461
Standard Deviation	10,650	9,787	43,207	21,159
Standard Error	6,149	3,699	21,603	8,638
Median	18,400	2,886	18,158	17,074
Maximum	19,453	27,209	96,870	54,770
Minimum	502	423	149	1,875

TABLE 30. SUMMARY OF RESULTS FOR DETECTED ORGANOCHLORINE PESTICIDE COMPOUNDS IN SAMPLES FROM SELECTED SITES IN SUMMIT LAKE, 2017.

Parameter	CAS Number	No. of Samples	Number of Detections (%)	Number Detections J-Qualified (%)	Mean[#] (µg/kg)	Maximum (µg/kg)	95 % UCL[#] (µg/kg)
4,4'-DDE	72-55-9	13	4 (31%)	4 (100%)	8.1	20 J	12.9
alpha-Chlordane	5103-71-9	13	1	0	n/a	18	n/a
gamma-Chlordane	5103-74-2	13	1	1	n/a	16 J	n/a

Notes:

[#] 95% upper confidence limit calculated using USEPA ProUCL Software (USEPA, 2014)

J: Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

TABLE 31. SCREENING ANALYSIS FOR POTENTIAL HUMAN HEALTH EFFECTS RELATED TO COIS IN THE SEDIMENTS OF SUMMIT LAKE.

Contaminant of Interest		CAS Number	Summit Lake Sediment Results				Residential Soils Direct-Contact Single-Contaminant Sceening Level Analyses					
							Non-Cancer Risk			Cancer Risk		
			Percent Detections	Max (ug/kg)	Mean[#] (ug/kg)	95% UCL[ʊ] (ug/kg)	Screening Value (ug/kg)	Number of Exceedances	Percent of Exceedances	Screening Value (ug/kg)	Number of Exceedances	Percent of Exceedances
Metals	Copper	7440-50-8	100.0%	210,000	46,300	86,800	6,300,000	0	0.0%	n/a	n/a	n/a
	Lead	7439-92-1	100.0%	340,000	112,300	192,200	400,000	0	0.0%	n/a	n/a	n/a
	Mercury	7439-97-6	86.4%	1,400	203	483	9,700	0	0.0%	n/a	n/a	n/a
	Zinc	744-66-6	100.0%	2,900	389,000	947,000	47,000,000	0	0.0%	n/a	n/a	n/a
VOCs	Acetone	67-64-1	84.6%	450	139	264	130,000,000	0	0.0%	n/a	n/a	n/a
	Butanone. 2- (MEK)	78-93-3	84.6%	100	4	51	48,000,000	0	0.0%	n/a	n/a	n/a
	Carbon disulfide	75-15-0	92.3%	9.4 J	4.6	6.1	2,000,000	0	0.0%	n/a	n/a	n/a
SVOCs	Dibenzofuran[†]	132-64-9	46.2%	3,000	577	436	160,000	0	0.0%	n/a	n/a	n/a
	N-Nitrosodiphenylamine*	86-30-6	23.1%	4,700	1,000	1,668	n/a	n/a	n/a	2,000,000	0	0.0%
PAHs	Acenaphthene*	83-32-9	65.2%	1,900	267	450	6,900,000	0	0.0%	n/a	n/a	n/a
	Acenaphthylene[†]	208-96-8	43.5%	400	91	133	7,200,000	0	0.0%	n/a	n/a	n/a
	Anthracene*	120-12-7	82.6%	5,000	626	1,097	34,000,000	0	0.0%	n/a	n/a	n/a
	Benzo[a]anthracene[ƚ]	56-55-3	95.7%	6,500	1,201	1,854	n/a	n/a	n/a	23,000	0	0.0%
	Benzo[a]pyreneƚ	50-32-8	95.7%	**6,400**	1,152	1,770	36,000	0	0.0%	**2,300**	**2**	**8.7%**
	Benzo[b]fluoranthene[ƚ]	205-99-2	95.7%	7,800	1,637	2,434	n/a	n/a	n/a	23,000	0	0.0%
	Benzo[g,h,i]perylene[†]	191-24-2	95.7%	2,800	676	985	3,600,000	0	0.0%	n/a	n/a	n/a
	Benzo[k]fluoranthene[ƚ]	207-08-9	87.0%	3,200	634	964	n/a	n/a	n/a	230,000	0	0.0%
	Chrysene[ƚ]	218-01-9	95.7%	6,000	1,420	2,088	n/a	n/a	n/a	2,300,000	0	0.0%
	Dibenz(a,h)anthracene[ƚ]	53-70-3	43.5%	730	160	237	n/a	n/a	n/a	2,300	0	0.0%
	Fluoranthene*	206-44-0	100.0%	20,000	3,207	5,170	4,600,000	0	0.0%	n/a	n/a	n/a
	Fluorene*	86-73-7	78.3%	2,200	337	570	4,600,000	0	0.0%	n/a	n/a	n/a
	Indeno[1,2,3-cd]pyrene[ƚ]	193-39-5	95.7%	2,400	545	800	n/a	n/a	n/a	23,000	0	0.0%
	Methylnapthalene, 2-	91-20-3	84.6%	2,000	512	862	460,000	0	0.0%	n/a	n/a	n/a
	Naphthalene*	91-57-6	91.3%	1,200	336	490	330,000	0	0.0%	90,000	0	0.0%
	Phenanthrene[†]	85-01-8	95.7%	16,000	2,186	3,738	36,000,000	0	0.0%	n/a	n/a	n/a
	Pyrene*	129-00-0	100.0%	15,000	2,926	4,513	3,400,000	0	0.0%	n/a	n/a	n/a
PCBs	Aroclor-1254*	11097-69-1	45.5%	630	176	240	4,400	0	0.0%	2,200	0	0.0%
Pesticides	4-4'-DDE	72-55-9	17.4%	20	8.1	12.9	n/a	n/a	n/a	29,000	0	0.0%

[#] One half of the Reporting Limit concentration substituted for non-detect values to generate statistic.

[ʊ] Upper confidence limit as derived using U.S.EPA ProUCL Software (see text).

*Screening values from Table 1, Appendix to OAC 3745-300-08

[†] Screening values from CIDARS Supplemental Criteria, to be used in accordance with OAC 3745-300-09; current as of May 2, 2017.

[ƚ] VAP property-specific standards reflecting IRIS updates since May 2016; current as of May 2, 2017.

TABLE 32. CUMULATIVE NON-CANCER RISK INDEX CALCULATIONS FOR COIS IN SUMMIT LAKE SEDIMENTS.

			Summit Lake Sediment Results				GDCSS$_{REC}$ (Adjusted 90-Day Recreation)	
							Non-Cancer Risk	
Contaminant of Interest		CAS Number	Percent Detections	Max (µg/kg)	Mean[#] (µg/kg)	95% UCL[ʊ] (µg/kg)	Screening Value (µg/kg)	Risk Index
Metals	Copper	7440-50-8	100.0%	210,000	46,300	86,800	24,500,000	3.54E-03
	Lead	7439-92-1	100.0%	340,000	112,300	192,200	1,555,556	1.24E-01
	Mercury	7439-97-6	86.4%	1,400	203	483	37,722	1.28E-02
	Zinc	744-66-6	100.0%	2,900	389,000	947,000	182,777,778	5.18E-03
							Cumulative Risk Index	1.45E-01

			Summit Lake Sediment Results				GDCSS$_{REC}$ (Adjusted 90-Day Recreation)	
							Non-Cancer Risk	
Contaminant of Interest		CAS Number	Percent Detections	Max (µg/kg)	Mean[#] (µg/kg)	95% UCL[ʊ] (µg/kg)	Screening Value (µg/kg)	Risk Index
VOCs	Acetone	67-64-1	84.6%	450	139	264	505,555,556	5.22E-07
	Butanone. 2- (MEK)	78-93-3	84.6%	100	4	51	186,666,667	2.72E-07
	Carbon disulfide	75-15-0	92.3%	9.4 J	5	6	7,777,778	7.84E-07
SVOCs	Dibenzofuran[†]	132-64-9	46.2%	3,000	577	436	622,222	7.00E-04
PAHs	Acenaphthene*	83-32-9	65.2%	1,900	267	450	26,833,333	1.68E-05
	Acenaphthylene[†]	208-96-8	43.5%	400	91	133	28,000,000	4.75E-06
	Anthracene*	120-12-7	82.6%	5,000	626	1,097	132,222,222	8.30E-06
	Benzo[a]pyreneƚ	50-32-8	95.7%	6,400	1,152	1,770	140,000	1.26E-02
	Benzo[g,h,i]perylene[†]	191-24-2	95.7%	2,800	676	985	14,000,000	7.04E-05
	Fluoranthene*	206-44-0	100.0%	20,000	3,207	5,170	17,888,889	2.89E-04
	Fluorene*	86-73-7	78.3%	2,200	337	570	17,888,889	3.19E-05
	Methylnapthalene, 2-	91-20-3	84.6%	2,000	512	862	1,788,889	4.82E-04
	Naphthalene*	91-57-6	91.3%	1,200	336	490	1,283,333	3.82E-04
	Phenanthrene[†]	85-01-8	95.7%	16,000	2,186	3,738	140,000,000	2.67E-05
	Pyrene*	129-00-0	100.0%	15,000	2,926	4,513	13,222,222	3.41E-04
PCBs	Aroclor-1254*	11097-69-1	45.5%	630	176	240	17,111	1.40E-02
							Cumulative Risk Index	2.90E-02

[#] One half of the Reporting Limit concentration substituted for non-detect values to generate statistic.

[ʊ] Upper confidence limit as derived using U.S.EPA ProUCL Software (see text).

*Screening values from Table 1, Appendix to OAC 3745-300-08

[†] Screening values from CIDARS Supplemental Criteria, to be used in accordance with OAC 3745-300-09; current as of May 2, 2017.

[ƚ] VAP property-specific standards reflecting IRIS updates since May 2016; current as of May 2, 2017.

TABLE 33. CUMULATIVE CANCER RISK INDEX CALCULATIONS FOR COIs IN SUMMIT LAKE SEDIMENTS.

			Summit Lake Sediment Results				GDCSS$_{REC}$ (Adjusted 90-Day Recreation)	
							Cancer Risk	
Contaminant of Interest		CAS Number	Percent Detections	Max (µg/kg)	Mean[#] (µg/kg)	95% UCL[℧] (µg/kg)	Screening Value (µg/kg)	Risk Index
SVOCs	N-Nitrosodiphenylamine*	86-30-6	23.1%	4,700	1,000	1,668	7,777,778	2.14E-04
PAHs	Benzo[a]anthracene[ǂ]	56-55-3	95.7%	6,500	1,201	1,854	89,444	2.07E-02
	Benzo[a]pyreneǂ	50-32-8	95.7%	6,400	1,152	1,770	8,944	1.98E-01
	Benzo[b]fluoranthene[ǂ]	205-99-2	95.7%	7,800	1,637	2,434	89,444	2.72E-02
	Benzo[k]fluoranthene[ǂ]	207-08-9	87.0%	3,200	634	964	894,444	1.08E-03
	Chrysene[ǂ]	218-01-9	95.7%	6,000	1,420	2,088	8,944,444	2.33E-04
	Dibenz(a,h)anthracene[ǂ]	53-70-3	43.5%	730	160	237	8,944	2.65E-02
	Indeno[1,2,3-cd]pyrene[ǂ]	193-39-5	95.7%	2,400	545	800	89,444	8.94E-03
	Naphthalene*	91-57-6	91.3%	1,200	336	490	350,000	1.40E-03
PCBs	Aroclor-1254*	11097-69-1	45.5%	630	176	240	8,556	2.80E-02
Pesticides	4-4'-DDE	72-55-9	17.4%	20	8.1	12.9	112,778	1.14E-04
							Cumulative Risk Index	3.12E-01

[#] One half of the Reporting Limit concentration substituted for non-detect values to generate statistic.

[℧] Upper confidence limit as derived using U.S.EPA ProUCL Software (see text).

*Screening values from Table 1, Appendix to OAC 3745-300-08

[†] Screening values from CIDARS Supplemental Criteria, to be used in accordance with OAC 3745-300-09; current as of May 2, 2017.

[ǂ] VAP property-specific standards reflecting IRIS updates since May 2016; current as of May 2, 2017.

TABLE 34. ECOLOGICAL SCREENING LEVEL (ESL) MATRIX FOR POTENTIAL RISKS TO ECOLOGICAL RECEPTORS ASSOCIATED WITH COIs IN SUMMIT LAKE SEDIMENTS.

Analyte	CAS Number	Units	Percent Detections	Mean	Max	95% UCL	USEPA Sediment TEC ESL[1]	Percent > USEPA TEC ESL	PEC[a]	Percent > PEC
Metals										
Copper	7440-50-8	mg/kg	100.0%	**46.3**	**210.0**	**61.9**	31.6	47.8%	149	8.7%
Lead	7439-92-1	mg/kg	100.0%	**112.3**	**340.0**	**150.7**	35.8	87.0%	128	52.2%
Mercury	7439-97-6	mg/kg	86.4%	**0.203**	**1.400**	**0.288**	0.174	56.5%	1.06	4.3%
Zinc	7440-66-6	mg/kg	100.0%	**389**	**2,900**	**555**	121	87.0%	459	43.5%
Volvatile Organic Compounds (VOCs)										
Acetone	67-64-1	µg/kg	84.6%	**139**	**450**	**264**	9.9	84.6%	--	--
Butanone. 2- (MEK)	78-93-3	µg/kg	84.6%	3.5	**100**	**50.7**	42.4	30.8%	--	--
Carbon disulfide	75-15-0	µg/kg	92.3%	4.6	9.4 J	6.1	23.9	0.0%	--	--
Semi-Volatile Organic Compounds (SVOCs)										
Dibenzofuran	132-64-9	µg/kg	46%	220	**1,100**	436	449	15.3%	--	--
N-Nitrosodiphenylamine	86-30-6	µg/kg	23%	791	**4,700**	1,668	2,680	15.3%	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)										
Acenaphthene	83-32-9	µg/kg	65.2%	**255**	**1,900**	**450**	6.7	65.2%	--	--
Acenaphthylene	208-96-8	µg/kg	43.5%	**47**	**400**	**133**	5.9	65.2%	--	--
Anthracene	120-12-7	µg/kg	82.6%	**628**	**5,000**	**1,097**	57.2	69.6%	845	21.7%
Benzo[a]anthracene	56-55-3	µg/kg	95.7%	**1,201**	**6,500**	**1,854**	108	78.3%	1,050	39.1%
Benzo[a]pyrene	50-32-8	µg/kg	95.7%	**1,152**	**6,400**	**1,770**	150	73.9%	1,450	30.4%
Benzo[b]fluoranthene	205-99-2	µg/kg	95.7%	**1,638**	**7,800**	**2,434**	27.2	95.7%	--	--
Benzo[g,h,i]perylene	191-24-2	µg/kg	95.7%	**676**	**2,800**	**985**	170	65.2%	--	--
Benzo[k]fluoranthene	207-08-9	µg/kg	87.0%	**635**	**3,200**	**964**	240	56.5%	--	--
Chrysene	218-01-9	µg/kg	95.7%	**1,421**	**6,000**	**2,088**	166	73.9%	1,290	47.8%
Dibenz(a,h)anthracene	53-70-3	µg/kg	43.5%	**131**	**730**	**237**	33	34.8%	--	--
Fluoranthene	206-44-0	µg/kg	100.0%	**3,207**	**20,000**	**5,170**	423	73.9%	2,230	43.5%
Fluorene	86-73-7	µg/kg	78.3%	**337**	**2,200**	**570**	77.4	52.2%	536	17.4%
Indeno[1,2,3-cd]pyrene	193-39-5	µg/kg	95.7%	**545**	**2,400**	**800**	17	95.7%	--	--
2-Methylnaphthalene	91-57-6	µg/kg	84.6%	**513**	**2,000**	**862**	20.2	84.6%	--	--
Naphthalene	91-20-3	µg/kg	91.3%	**337**	**1,200**	**490**	176	47.8%	561	17.4%
Phenanthrene	85-01-8	µg/kg	95.7%	**2,186**	**16,000**	**3,738**	204	65.2%	1,170	47.8%
Pyrene	129-00-0	µg/kg	100.0%	**2,926**	**15,000**	**4,513**	195	78.3%	1,520	52.2%
Total PAH's	n/a	µg/kg	100.0%	**17,247**	**96,400**	**28,154**	1,610	78.3%	22,800	26.1%
Polychlorinated Biphenyls (PCBs)										
Total PCB's	1336-36-3	µg/kg	47.8%	**170**	**630**	**240**	59.8	34.8%	676	0.0%
Pesticides										
4-4' DDE	77-55-9	µg/kg	30.8%	**8.1**	**20**	**12.9**	3.16	30.8%	31.3	0.0%

[1] ESL References:

TEC: Threshold Effect Concentration. USEPA, 2003 and McDonald (2000).

[a] PEC: Probable Effect Concentration from MacDonald et al., 2000

Environment Canada, 1994 as referenced in USEPA, 2003.

Ontario Ministry of the Environment, 1993; as referenced in USEPA, 2003.

USEPA Region III BTAG Freshwater Screening Benchmarks. 2004.

Notes:

UCL: 95% Upper Confidence Level calculated using ProUCL Software Ver. 5.1 (USEPA, 2015).

ESL: Ecological Screening Level (USEPA, 2003).

PEC: Probable Effects Concentration (McDonald, et al., 2000)

Values in **BOLD** font indicate results that exceed the ESL

Values in **BOLD Underlined** font indicate results that exceed the PEC

TABLE 35. METALS SEDIMENT EQUILIBRIUM SEDIMENT BENCHMARK ESTIMATES FOR SEM METALS TOXICITY IN RELATION TO ACID VOLATILE SULFIDES IN SUMMIT LAKE.

Location	Fraction Org. Carbon (f_{OC}) (g_{OC}/g_{sed})	Acid Volatile Sulfides (AVS) (µmol/g)	ΣSEM (µmol/g)	(∑SEM - AVS)/f_{OC} (µmol/g_{OC})
GRID A13	0.14	18.091	1.334	-119.69
GRID A27	0.073	84.217	4.096	-1,097.55
GRID A50	0.045	74.860	5.159	-1,548.90
GRID B5	0.0048	9.669	1.043	-1,797.11
GRID B12	0.09	21.522	0.843	-229.76
GRID B65 (SS5)	0.096	37.430	3.658	-351.79
GRID B65 (SS6)	0.12	10.293	0.326	-83.06
GRID C17	0.21	56.145	3.213	-252.06
GRID C52 (Dup A)	0.25	2.215	0.067	-8.59
GRID C52 (Dup B)	0.25	0.655*	0.087	-25.85
GRID C75	0.17	15.596	0.514	-88.72
GRID D6	0.05	0.655	0.180	-301.64
GRID D77	0.23	112.289	12.470	-2.07
GRID D80	0.6	28.384	3.800	-166.37

Key to Qualifiers:

*	One-half of the reporting limit substituted for non-detect result.

TABLE 36. EQUILIBRIUM SEDIMENT BENCHMARK SCREENING ESTIMATES FOR POTENTIAL TOXICITY RELATED TO PAHs IN SUMMIT LAKE SEDIMENTS.

Area	Sample Location	Sample ID	No. PAH Analytes	Adjusted ∑ESBTU
Selected Sites				
A	GRID A13	SS3	17	0.048
	GRID A27	SS2	17	**3.017**
	GRID A50	SS1	17	**4.769**
B	GRID B5	SS8	17	**2.737**
	GRID B12	SS7	17	0.064
	GRID B65 (Dup A)	SS5	17	0.313
	GRID B65 (Dup B)	SS6	17	0.058
C	GRID C17	SS9	17	**1.017**
	GRID C52	SS10	17	**4.329**
	GRID C75	SS11	17	0.028
D	GRID D6	SS12	17	0.402
	GRID D77	SS4	17	**2.788**
	GRID D80	SS13	17	0.763
Targeted Sites				
B	GRID B37	TS1	16	**6.610**
	GRID B51	TS3	16	0.575
	GRID B61	TS4	16	0.994
C	GRID C8 DUP A	TS2	16	**1.945**
	GRID C8 DUP B	TS2	16	**1.292**
D	GRID D27	TS8	16	**2.551**
	GRID D48	TS7	16	0.997
	GRID D55	TS6	16	**3.466**
Canal	CANAL_1	TS9	16	**2.064**
	CANAL_2	TS5	16	**2.395**

TABLE 37. BACKGROUND CONCENTRATIONS OF METALS IN SEDIMENTS FROM OHIO WATERBODIES.

Parameter	Ohio EPA Sediment Reference Value[1] (mg/kg)	Statewide Inland Lake[2] 95% UCL[3] (mg/kg)
Aluminum	29,000	18,325
Arsenic	25.0	15.4
Barium	190	207
Cadmium	0.79	0.92
Calcium	21,000	28,786
Chromium	29.0	26.5
Copper	32.0	35.1
Iron	41,000	37,791
Lead	47.0	29.4
Magnesium	7,100	5,943
Manganese	1,500	919
Mercury	0.120	0.074
Nickel	33.0	35.3
Potassium	6,800	2,795
Selenium	1.70	---
Sodium	---	---
Strontium	62.0	131.8
Zinc	160.0	168.1

[1] Source: Ohio EPA, 2008; values are for streams within the EOLP Ecoregion.

[2] Source: Ohio EPA Division of Surface Water.

[3] Statistic Calculated Using ProUCL Software, Ver. 5.1 (USEPA, 2015).

TABLE 38. SUMMARY OF STATISTICAL COMPARISONS OF CONCENTRATIONS OF SEDIMENT METALS COC'S FROM SUMMIT LAKE TO BACKGROUND SEDIMENT BENCHMARKS.

Parameter	Percent Samples > SRV	Percent Samples > Ohio Lakes 95% UCL	Data Transformation	Statistical Mean Compared	Mean Value (mg/kg)	SRV (mg/kg)	Ohio Lakes 95% UCL (mg/kg)	Benchmark Compared	Significance	t Statistic	Probability
Arsenic	21.7%	52.2%	Logarithmic	Geometric Mean	**16.4**	25.0	15.4	Ohio Lakes	No	0.544	0.296
Barium	21.7%	17.4%	Logarithmic	Geometric Mean	102	190	207	n/a	n/a	---	---
Cadmium	39.1%	39.1%	Logarithmic	Geometric Mean	0.82	0.79	0.92	SRV	No	0.185	0.427
Chromium	39.1%	39.1%	Logarithmic	Geometric Mean	21.5	29.0	26.5	n/a	n/a	---	---
Copper	47.8%	47.8%	Logarithmic	Geometric Mean	**46.3**	32.0	35.1	SRV	Yes[#]	2.182	0.020
Lead	78.3%	100.0%	Logarithmic	Geometric Mean	**112.3**	47.0	29.4	Ohio Lakes	Yes*	7.857	3.98E-08
Mercury	65.2%	82.6%	Logarithmic	Geometric Mean	**0.20**	0.12	0.07	Ohio Lakes	Yes[^]	4.576	7.39E-05
Nickel	21.7%	17.4%	Logarithmic	Geometric Mean	18.6	33.0	35.3	n/a	n/a	---	---
Selenium	8.7%	---	None	Arithmetic Mean	1.0	1.7	---	n/a	n/a	---	---
Strontium	56.5%	4.3%	Logarithmic	Geometric Mean	58.4	62.0	131.8	n/a	n/a	---	---
Zinc	73.9%	73.9%	Logarithmic	Geometric Mean	**389**	160	168	SRV	Yes[&]	4.279	2.00E-04

Key to Notations:

Values in **Bold** are greater than the 95% UCL for Ohio Lakes (see text).
Underlined values are greater than the Ohio SRV for the parameter.
[#] Value not significantly different than the Ohio Lakes UCL at p=0.058.
*Value also significantly greater than the SRV at p=2.06E-05.
[^] Value also significantly greater than the SRV at p=0.0134.
[&] Value also significantly greater than the Ohio Lakes UCL at p=0.0003.