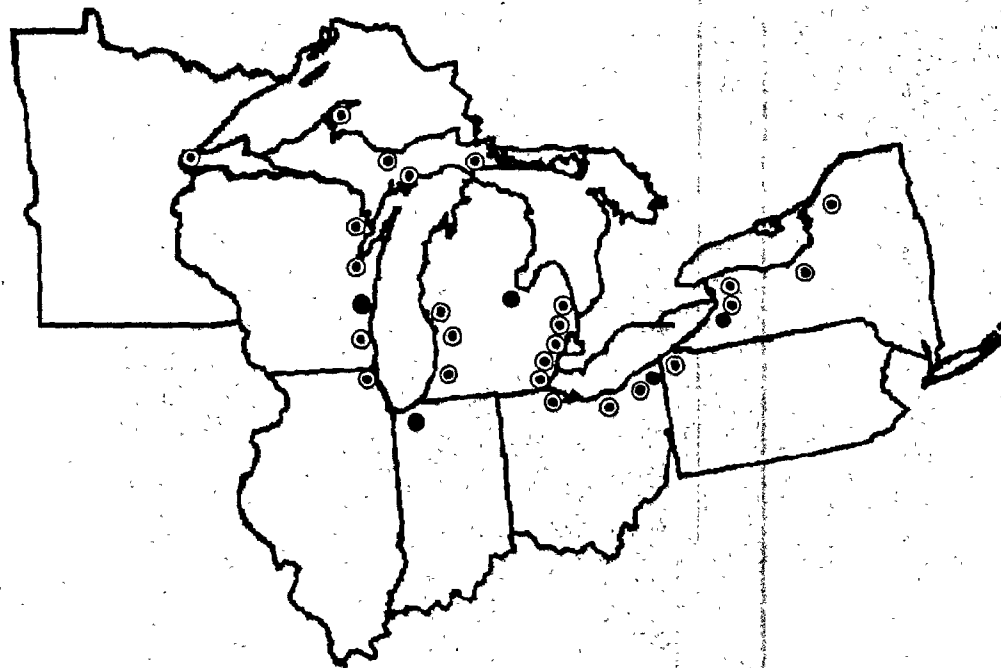




Assessment and Remediation of Contaminated Sediments (ARCS) Program



ASSESSMENT OF SEDIMENT IN THE INDIANA HARBOR AREA OF CONCERN



- United States Areas of Concern
- ARCS Priority Areas of Concern

ASSESSMENT AND REMEDIATION OF CONTAMINATED SEDIMENTS (ARCS)

**Assessment of Sediments in the
Indiana Harbor Area of Concern**

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Submitted to:

**U.S. Environmental Protection Agency
Great Lakes National Program Office
77 West Jackson Boulevard
Chicago, Illinois 60604**

Submitted by:

**Science Applications International Corporation
53 West Jackson Blvd.
Suite 1757
Chicago, Illinois 60604**

**U.S. Environmental Protection Agency
Region 5, Library (RL-12J)
77 West Jackson Boulevard, 12th Floor
Chicago, IL 60604-3550**

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1. INTRODUCTION

1.1 Overview of the ARCS Program

The 1987 amendments to the Clean Water Act, in Section 188(c)(3), authorized the U.S. Environmental Protection Agency's (EPA) Great Lakes National Program Office (GLNPO) to coordinate and conduct a 5-year study and demonstration project relating to the control and removal of toxic pollutants in the Great Lakes, with emphasis on removal of toxic pollutants from bottom sediments. Five areas were specified in the Clean Water Act as requiring priority consideration in locating and conducting demonstration projects: Saginaw Bay, Michigan; Sheboygan Harbor, Wisconsin; Grand Calumet River, Indiana; Ashtabula River, Ohio; and Buffalo River, New York (see Figure 1.1). In response, GLNPO undertook the Assessment and Remediation of Contaminated Sediments (ARCS) Program. ARCS was an integrated program for the development and testing of assessment and remedial action alternatives for contaminated sediments. Information from the ARCS Program activities is used to guide the development of Remedial Action Plans (RAPs) for the 42 Great Lakes Areas of Concern (AOCs, as identified by the International Joint Commission), as well as Lakewide Management Plans.

Although GLNPO is responsible for administering the ARCS Program, it is a multi-organization endeavor. Other participants in the ARCS program include the U.S. Army Corps of Engineers (ACE), the U.S. Fish and Wildlife Service (FWS), the National Oceanic and Atmospheric Administration (NOAA), EPA headquarters offices, EPA Regions 2, 3, and 5, Great Lakes State Agencies, numerous universities, and public interest groups.

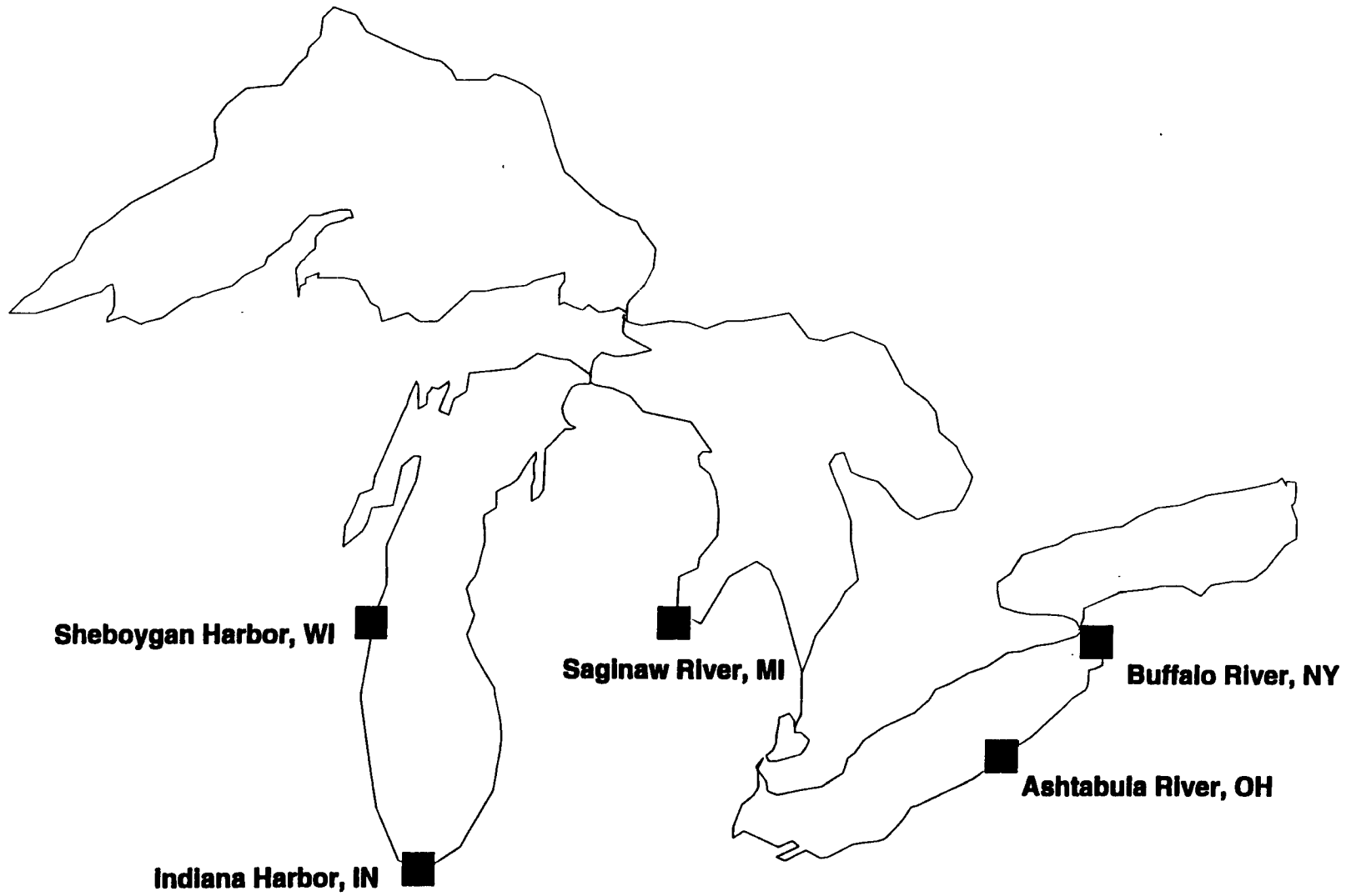
The Management Advisory Committee provides overall advice on ARCS Program activities. The Management Advisory Committee is made up of representatives from the organizations noted above. Three technical Work Groups identify and prioritize tasks to be accomplished in their areas of expertise. These are the Toxicity/Chemistry, Risk Assessment/Modeling, and the Engineering/Technology Work Groups. The Communication/Liaison Work Group oversees technology transfer, public information, and public participation activities. The Activities Integration Committee coordinates the technical aspects of the work groups' activities.

The overall objectives of the ARCS Program are:

- To assess the nature and extent of bottom sediment contamination at selected Great Lakes Areas of Concern;
- To evaluate and demonstrate remedial options, including removal, immobilization and advanced treatment technologies, as well as the "no action" alternatives; and
- To provide guidance on the assessment of contaminated sediment problems and the selection and implementation of necessary remedial actions in the Areas of Concern and other locations in the Great Lakes.

The primary aim of the ARCS Program is to develop guidelines that can be used at sites throughout the Great Lakes. Another goal of the ARCS Program is to develop and demonstrate sediment remediation procedures that are scientifically sound, and technologically and economically practical. The intent is to provide the environmental manager with methods for making cost-effective, environmentally sound decisions. As a result, application of existing techniques is stressed over basic research into new ones.

Figure 1.1 ARCS Program Demonstration Areas



It is important to stress that the ARCS Program is not a cleanup program, and will not solve the contaminated sediment problems at the five priority consideration areas. The Program will, however, provide valuable experience, methods, and guidance that could be used by other programs to actually solve the identified problems.

There are several important aspects of the management of contaminated sediments that will not be fully addressed by the ARCS Program. Regulatory requirements and socioeconomic factors in decision-making are two such aspects that will be critical in the choice of a remedial alternative (or whether to remediate at all). While not addressing such issues in depth, the ARCS Program will identify issues that need to be resolved before sediment cleanups can go forward.

1.2 Overview of the Indiana Harbor Area of Concern

This report will focus on the Indiana Harbor Area of Concern (see Figure 1.2). From the early 1900s through the 1960s, Indiana Harbor and its upstream feeders, the Indiana Harbor canal and the Grand Calumet River, were at the center of one of the most heavily industrialized corridors in the country. This industrial activity peaked from World War II until the early 1970s when the 13 miles of river and canal supported three major steel mills, three major publicly owned treatment works (POTWs), several chemical manufacturing facilities, a lead processing facility, oil refineries, metal finishers, and numerous other industries. During this time most of these facilities discharged wastewater of varying treatment levels directly and indirectly to the river and canal. Since discharge permits were first issued in the early 1970s, water quality has improved somewhat. However, numerous violations of discharge permits still occur for a number of dischargers, indicating that pollution of the harbor area is an ongoing problem.

Sediment quality throughout the reach is generally quite poor. The U.S. Army Corps of Engineers, which is responsible for maintenance of the federal navigation channel in the harbor and canal, has not been able to perform maintenance dredging in the area since 1972 due to the contaminated nature of the sediments. The toxic nature of the sediments makes them unfit for open water disposal in Lake Michigan and the selection of a suitable location for upland disposal has sparked public concern over the safety of such a site.

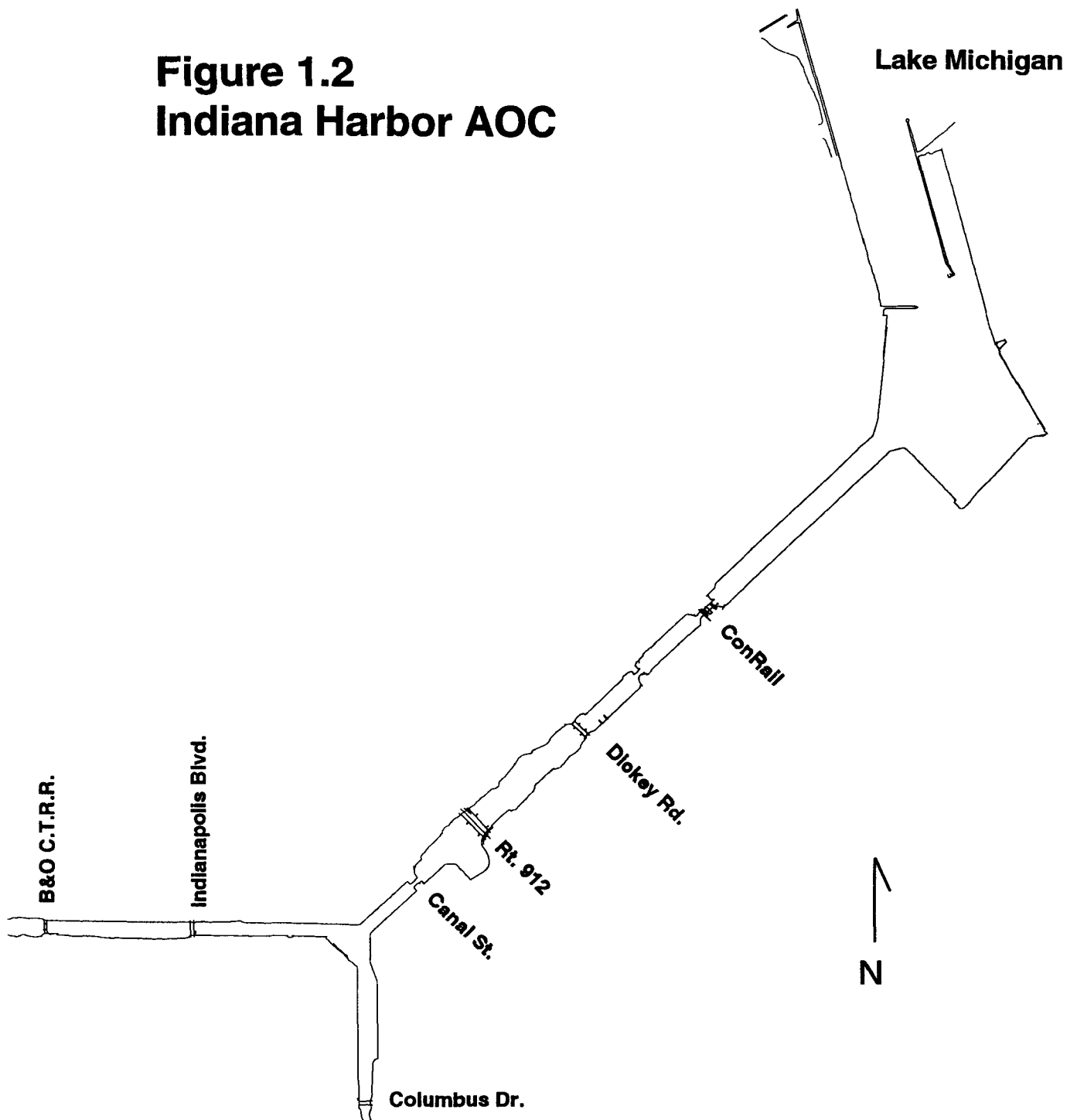
Due to the varied nature of the dischargers within the harbor area, a wide variety of contaminants are found within the sediments. Contaminants found at elevated levels include heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), oil and grease, and biological and chemical oxygen demand. The water table in the area is known to be covered with a layer of oil that is several feet thick in some areas.

1.3 Purpose and Organization of the Report

The purpose of this report is to summarize and analyze two ARCS sediment sampling surveys. Survey 1 was performed in August 1989 and consisted of grab samples taken at seven Master Stations, and Survey 2, sampled in November 1990, consisted of core samples taken at 37 locations.

Chapter 2 provides a complete description of the sampling and analytical methods used in the collection and analysis of sediment samples from Indiana Harbor and draws heavily from documents produced by the ARCS Toxicity/Chemistry Workgroup.

Figure 1.2
Indiana Harbor AOC



Chapter 3 contains a summary and analysis of the data from the two sampling surveys. The data are analyzed both by chemical and by location and includes a complete description of the guidelines and criteria used for the analysis.

Chapter 4 presents the general conclusions which can be drawn from the results of the analysis.

2. SAMPLING AND ANALYTICAL METHODOLOGY

This chapter summarizes the methodologies used to sample and analyze the sediments in the Indiana Harbor area of concern (AOC). The methodology is discussed only to allow for an understanding of the nature of the samples used to generate the data presented in this report. The majority of the material in this chapter was taken from the report entitled *ARCS Toxicity/Chemistry Work Group Sediment Assessment Guidance Document* (Filkins, et.al. 1993). The methodologies have been edited from this reference for the purposes of presenting only the highlights of the sampling methodology. More detailed information can be found in the original report.

Assessment of sediment quality must begin by locating deposits of polluted sediments and by collecting representative samples of them. The overall quality of the assessment depends on this, since investigations based on non-representative samples should not be used to support any decision-making processes.

In general, contaminants tend to be associated more with silty sediments of high organic content than with clay or sand. Silts originate in part from suspended organic particles that absorb various contaminants from the water column. Once they settle and are buried over time by newer sediments, the original link with pollutant sources and water quality in general may be broken.

Waters and sediments of each harbor in the Great Lakes possess a unique mosaic of chemical and physical characteristics that reflects the sum of all its historic, anthropogenic alterations. These mosaics of chemical and physical characteristics are sufficiently complex that conducting even a general inventory is very difficult. Complete accounts of historic waste compositions, treatment and disposal practices are seldom available. Changing industrial locations can sometimes be mapped, but provide little information on waste disposal practices. Almost no prior surveys of contaminated sediments include the third dimension of depth, since collecting long cores has been difficult until recently. Consequently, studies of contaminated sediments usually involve a limited number of chemical and toxicological assays performed on surficial samples. These conventional assays are usually expensive, time-consuming and require relatively large volumes of material.

In most urban-industrial harbors, like those studied in the ARCS Program, contaminant distribution in sediments may be highly variable and "patchy". In shipping channels or wherever navigational dredging occurs regularly, deposits of polluted sediments are likely to be thin. However, where dredging was once practiced and then ceased years ago, thick layers of contaminated material may accumulate. Sediment quality in these depositional areas can reflect a complex history of pollution events occurring over a span of decades. Consequently, it is unrealistic to think that a few grab samples of surficial sediment will accurately represent sediment quality. Too often, however, this approach to sampling has formed the only basis for sediment quality assessment. Significant laboratory resources have been spent analyzing sediment samples that may not adequately characterize the system.

The ARCS Program addressed this dilemma by conducting two suites of assays: a set of quick, less expensive assays ("indicator assays") at a large number of reconnaissance stations, and conventional chemical and toxicological assays, performed at a limited number of "Master" stations throughout the study area. Multivariate equations relating the indicator values to the conventional assays were then generated and used to predict endpoints for the conventional assays at the many stations at which only the indicator assays were conducted. The following sections provide details of the field, laboratory, and statistical procedures employed.

2.1 Collecting and Processing Sediment Samples

2.1.1 *Sampling Vessel*

The sampling vessel, the Research Vessel *Mudpuppy*, capable of operating in shallow waters of less than three feet (1 m), was needed for the ARCS work. It had a climate controlled cabin for electronic equipment and was capable of lifting a ton (900 kg) of weight and 20 foot (6 m) sediment cores onto the deck. Electronic instruments used in the vessel operations included: a marine radio, a fathometer, a Global Positioning System (GPS), computers for data logging and ship's navigation, and a Loran-C receiver serving as a backup for the ship's positioning system.

2.1.2 *Grab Samples*

Grab samples of surficial sediments were collected by steel Ponar or Van Veen grab samplers at each master station and at a few reconnaissance stations where coring was not possible. Benthos samples were collected prior to grab sampling for contaminants and bioassay analysis, to minimize disturbance of the organisms. Five replicate samples were collected at each of the master stations. For more details see EPA (1994).

2.1.3 *Core Samples*

Sediment cores were collected at each of the reconnaissance stations and at most of the master stations. The coring unit used in Indiana Harbor was a model P-4 Vibrocorer, manufactured by Rossfelder Corporation (La Jolla, California). This unit proved powerful enough to collect cores over 16 feet (5 meters) in length, even when they included several feet of clay. However, it should be noted that few cores longer than 16 feet were collected even when the 20 foot core tube fully penetrated the bottom. One obvious reason was that the cross-sectional area inside the core nose was about 10 percent less than that of the core tube inner diameter, reducing the collected sediment volume by that much. Another reason may be that friction inside the core tube can exceed the bearing strength of soft sediments, resulting in a plugged core tube that continues to penetrate without collecting more sediment. In addition, gaseous sediments may compress slightly when cored.

During the ARCS Program, each core was described and subsampled on board the sampling vessel. In subsequent, post-ARCS sediment surveys, cores were cut into 3 foot (1 meter) sections and transported to a shore-based facility where they were examined, described, and subsampled. This required a slightly larger field crew, but increased the number of cores that could be collected in a day and also facilitated in-field analyses of selected subsamples.

2.1.4 *Core Documentation*

Proper identification of individual cores and their subsamples was especially important in this project because of both the number of samples collected and the number of laboratories receiving splits of those samples. The visual characteristics of each sediment core total length, position of layers within the core, and color, texture, and composition of the material were recorded. Ancillary information collected in the field included percent fullness of the Ponar sampler and water chemistry information (dissolved oxygen, conductivity, temperature, and reduction potential) measured with a Hydrolab sonde positioned 3 feet (1 meter) above the bottom.

2.2 Characterizing Sediment by Remote Sensing

In larger areas, remote sensing or profiling as a supplement to coring provides a means to interpolate sediment quality between infrequent sampling points. Remote sensing ensured that the

locations of all principal sediment types were directly sampled for chemical analysis. Remote sensing also measured whether sediment chemical contamination was associated primarily or entirely with selected sediment deposits which have been geophysically mapped, or distributed in a fashion apparently independent of the mapped deposits. Seismic subbottom profiling and electrical resistivity are two geophysical profiling techniques used for remote sensing sediment characterization. Seismic subbottom profiling of sediments utilizes the reflection of sound waves from different subsurface sediment layers. These layers, exhibiting interfaces of different elasticity of density, are distinguished as distinct layers within the profile trace. Fine-grained sediments, such as clay, demonstrate high porosity, and are, if uncompacted, poor acoustical reflectors. Coarse-grained sediments, such as sand, exhibit lower porosity and tend to be good reflectors (Guigne' et al. 1991).

Electrical resistivity or conductivity profiling is the most common geophysical approach to pollution-related land studies. Despite a wide range of instrumentation and procedures, all of these techniques attempt to measure lateral and vertical variations in electrical resistivity or its reciprocal, electrical conductivity. With the exception of clay-rich material, the electrical resistivity of sediments is determined primarily by porosity, and pore fluid chemistry. For clay-rich sediments, the clay mineralogy is also a significant factor. While it is generally not possible to separate the effects of porosity, pore fluid chemistry, or mineralogy on resistivity measurements, the method is regularly used in land studies for the detection and mapping of clay units or inorganically contaminated groundwater. Thus, electrical resistivity surveys provide a reasonable supplement to the acoustic measurements. Comparison of the electrical properties with actual cores would then provide a basis for associating the electrical properties with sediment types.

In theory, the interpretation of the seismic trace is accomplished by "ground truthing" using sediment cores collected at selected points along the ship's track followed during the seismic survey. The visual description of core stratigraphy is compared to the seismic profile record for that position. A comparison of the core profile to the seismic record allows interpretation of seismic reflectors (layers) as sediment types, such as gravel, sand, silt and clay. The characterization of sediment stratigraphy between cores is mapped using the interpreted seismic profiles, providing a complete picture of sediment distribution in the study area.

2.2.1 *Geophysical Survey Design*

In portions of the study areas which were less than 100 meters wide, three equally spaced lines parallel to the shoreline were surveyed. In wider portions of the study areas, three parallel lines were utilized with an additional series of diagonal lines forming a diamond pattern overlying the parallel lines. In all cases, the intervals between survey lines were approximately one third of the channel width or finer resolution. This survey geometry was efficient while it provided adequate coverage and an acceptable number of tie-points (line intersections). The tie-points serve to evaluate the how reproducible of seismic measurements taken at the "same point". The reproducibility of these measurements is a function of the reproducibility of the acoustical profiler and the ship's positioning system. In a quality assurance sense, the number of tie-points used depends on the requirements established in the Quality Assurance Project Plan. It ensured the geophysical profiling of all sediment areas with linear dimensions equal to one quarter of the channel width.

The accuracy of sediment strata thickness and depth measured from the seismic record was limited by the extent to which subsurface velocities were known. Marker beds seen within the "ground truthing" cores were compared to the seismic record for depth correction. When using cores for "ground truthing" seismic records consideration must be given to core compaction which may occur during sample collection. Compaction can be variable throughout the core with greater compaction occurring in the

upper core containing less consolidated sediment. The sediment character, corrected depth and thickness of the strata were then mapped between core sites using seismic records.

2.3 Collecting, Storing and Handling Sediment Samples for Chemical Analyses and Bioassays

About 10 liters (L) of bulk sediment grab samples or 4 L of bulk core samples were collected from 10 stations in Indiana Harbor, IN in August 1989. All chemical analyses of sediment samples were provided by Battelle Laboratory in Sequim, Washington. The chemical samples were collected by personnel of the Large Lakes Research Station (LLRS) in Grosse Isle, Michigan. For analyses, the samples were divided as follows:

1. 50 grams (g) for metals, percentage solids, and total organic carbon (TOC);
2. 250 g for PAHs;
3. 50 g for tributyltin;
4. 20 g for acid volatile sulfides (AVS) and 20 g for methylmercury; and
5. 100 g for Ames and Mutatox assays.

The percentage solids in each sediment sample was estimated by freeze drying the sample and then comparing wet and dry weights. Freeze drying provided a fine, powdery sample that could be more uniformly homogenized. The TOC in samples was determined with a Leco Model WR-12 carbon determinator. Samples were pre-treated with concentrated hydrochloric acid to remove inorganic carbon. Then the samples were burned at 800 °C in an oxygen atmosphere connected to a boat inlet that transferred the evolved carbon dioxide (CO₂) directly into an organic carbon analyzer. Particle size was determined with a Gilson Model WV-2 wet sieve, using U.S. Standard #18 (1 mm), 60 (250 µm), 230 (63 µm) and 400 (38 µm) sieves. Acid volatile sulfides (AVS) were determined according to the method of Cutter and Oattes (1987).

The sediment samples were analyzed for total metals concentrations using USEPA Method 200.4 (USEPA 1990). These techniques are not intended to measure the biologically significant portion of metals. The samples were completely dissolved by digestion with nitric, perchloric and hydrofluoric acids in Teflon[®] pressure vessels and then analyzed by use of cold vapor atomic absorption, or graphite furnace atomic absorption. For crustal elements that are difficult to dissolve with strong acids, a portion of the freeze-dried samples was ball-milled to about 120 mesh, pelletized, and analyzed with x-ray fluorescence (Nielson and Sanders 1983).

In methylmercury analyses, the homogenized samples were digested in 10 milliliter (mL) of a 25 percent solution of potassium hydroxide in methanol at 60 °C for 2 to 4 hours. Samples were allowed to cool for 24 hours and an additional 10 mL of methanol was added and mixed well by shaking. Before analysis undissolved solids were allowed to completely settle. The samples were analyzed with a cold vapor atomic fluorescence technique (Bloom 1989). The technique is based on the emission of 254 nm radiation by exiting mercury atoms in an inert gas stream. An ethylating agent, sodium tetraethylborate, was added to the sample digestate to form a volatile methylethylmercury derivative. The derivative was then purged onto graphite carbon traps for pre-concentration and removal of interferences. Then the samples were subjected to cryogenic chromatography and pyrolytic degradation to elemental mercury, which was quantified with a cold vapor atomic fluorescence detector.

During analyses for organotins, samples were extracted with 0.2 percent tropolone in methylene chloride, then filtered through glass wool. The filtrates were derivitized with 1 mL hexyl magnesium bromide, a Grignard's reagent, and cleaned-up with a Florisil column. Organotin concentrations were measured with a Hewlett Packard Model 5890 gas chromatograph equipped with a flame photometric detector.

Three groups of organic chemicals were measured for each sediment sample: PAHs, PCBs and chlorinated pesticides, and PCDDs and PCDFs. The analytical procedure for each chemical group included solvent extraction, extract purification with column chromatography, and chemical quantification with capillary column gas chromatography. In the analyses for pesticides and PCBs, aldrin, beta-BHC, gamma-chlordane, 4,4'-DDD, endrin, endrin aldehyde, endrin ketone, heptachlor epoxide, Aroclor 1242 and 1254 were detected in some samples, but either a less than 25 percent difference between the two gas chromatography columns for detected concentrations was observed, or the analyses were conducted at secondary sample dilution factors.

PAHs in sediment samples were extracted according to the USEPA Method 3550 (USEPA 1986). Before extraction, three isotopically labelled surrogate PAH compounds (D10-fluorene, D10-anthracene, D10-pyrene) were added to the samples. Then the samples were extracted with methylene chloride in a Soxhlet extractor. Potential interferences by pigments, lipids and other macromolecules were removed by the use of the USEPA gel permeation chromatography (GPC) Method 3540 (USEPA 1986). Then the extracts were exchanged into hexane and analyzed with the USEPA Gas Chromatography/Mass Spectrometry (GC/MS) Method 8270 (USEPA 1986).

Aroclors quantified were 1016, 1221, 1232, 1242, 1248, 1254 and 1260. Aroclors were extracted from the sediment samples according to the USEPA Method 3550 (USEPA 1986). The GC surrogate compound dibutyl chlorodate (DBC) was added to the samples, and the samples were subsequently extracted with methylene chloride using sonication. Potential interferences by oily-type materials from highly contaminated sediments, lipids, and other macromolecules were eliminated by use of GPC or alumina column chromatography (USEPA 1986, Methods 3540 and 3610). Aroclors were quantified by USEPA Method 8080 (USEPA 1986) using a DB-5 fused silica capillary column (0.25 mm diameter x 30 m) and a Hewlett-Packard 5890 gas chromatography equipped with an electron capture detector (GC/ECD) and a computer for data acquisition. A dual column analysis was always performed simultaneously and the results from both columns were accepted if they showed no more than a 50 percent variation.

The USEPA isotope dilution Method 8290 (USEPA 1986) was used to extract and clean-up the sediment samples for analysis of PCDDs and PCDFs. Isotopically labelled PCDDs and PCDFs were added to the samples before extraction. The samples were extracted with benzene in a Soxhlet extractor for 18 hours. Then a three step column chromatography procedure with acidified silica gel, alumina, and AX-21 activated carbon on silica gel was used to enrich the samples and remove interferences. Isotopically labelled 2,3,7,8-TCDD was added to the samples before the enrichment to determine the efficiency of the method. Two internal standards were added to the samples after sample enrichment to determine percent recoveries. The PCDDs and PCDFs were quantified with capillary columns gas chromatography of groups of ion masses described in the USEPA Method 8290 (USEPA 1986).

Pore water samples were prepared by Battelle's Marine Sciences Laboratory in Sequim, Washington from about 40 L of sediment samples. Aliquots of the 40 L samples were extracted in acid-cleaned 500 mL Teflon jars by centrifugation in a modified clothing extractor at 2,000 RPM for 15 minutes. The pore water was decanted into clean 150 mL glass centrifuge tubes and then centrifuged again at 2000 RPM for one hour. The pore water was then pipetted without filtration into 500 mL acid-cleaned Teflon bottles, acidified to pH 2 with nitric acid (HNO_3), and stored at room temperature for metal analyses.

Immediately after preparation, water quality characteristics of the dilution water and 100 percent elutriate samples were determined (APHA et al., 1975). Dissolved oxygen (mg/L) was measured with a YSI Model 54-A oxygen meter. Conductivity (umhos/cm, corrected to 25 °C) was measured with a YSI Model 33 S-C-T conductivity meter. The pH and alkalinity (mg/L as CaCO_3) was determined by

burette titration. Ammonia (mg/L) was measured with an Orion 940E ionalyzer and a 95-12 ammonia electrode. Turbidity (NTU) was measured with a Cole-Palmer Model 8391-35 turbidity meter. Unionized ammonia was determined by converting the total ammonia measured in the samples to unionized ammonia, and then correcting for pH and temperature (Thurston et al. 1974). After preparation of the dilution water and 100 percent elutriates, samples for chloride (mg/L) were placed in 250 mL I-CHEM bottles, labeled, and stored at $4 \pm 3^{\circ}\text{C}$ until analysis with an Orion 940E ionalyzer and a 94-17B electrode. The pH, dissolved oxygen, and conductivity were measured at the beginning and end of each daphnid test in the 100 and 25 percent treatments, and in the dilution water control. About 500 mL of each 100 percent elutriate sample were placed in Teflon bottles, acidified to pH 2 with redistilled hydrochloric acid, and shipped via overnight courier to Battelle Marine Sciences Laboratory in Sequim, Washington for metals analyses.

Elutriate and pore water samples were analyzed for silver (Ag), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se), and zinc (Zn). With the exception of Hg and Zn in elutriates, all pore water and elutriate samples were analyzed without sample preparation. The Zn in elutriates was quantified by flame atomic absorption. The Hg in elutriates were analyzed for metals by cold vapor atomic fluorescence with sub-nanogram per liter (ng/L) detection limits. Organics prevalent in many of the samples were broken down before Hg analysis by use of a bromine monochloride/UV oxidation procedure (Bloom and Crecelius 1983).

2.4 Quality Control and Quality Assurance

Accuracy and precision of the chemical analyses were determined by analysis of one blank, one matrix spike, one certified reference material, and one sample in duplicate or triplicate for each set of 20 samples. Acceptable recovery values ranged from 85 to 115 percent of the spike concentration for organics and organometals. Analytical values for reference materials were acceptable if they were within 20 percent of the certified ranges. The acceptable coefficient of variation for duplicate or triplicate sample analyses was ≤ 20 percent.

During chemical analyses, three to five standards containing concentrations that bracketed the expected range of concentrations in the samples were used for daily instrument calibrations. In analyses of samples for metals by atomic absorption spectrophotometry, these standards were analyzed as matrix spikes, and the slopes from linear regression analyses were used to estimate sample concentrations. The minimum acceptable r^2 in the regression analyses was 0.97. The standards for each sample set were analyzed at the beginning and end of each analytical run. The analytical results were accepted if the values for standards were within 90 to 110 percent of their certified values. For some samples analyzed by atomic absorption, average response factors, rather than linear regression, were used for instrument calibration. The accuracy of this calibration method was checked by dividing each response factor by the average response value. The calibration values were accepted if they were within 5 percent of the average response value.

During chemical analyses, the method's detection limits (MDL) was estimated according to procedures in the USEPA Federal Register (1984).

Three sample matrices were analyzed; whole sediment (grain size, total and volatile solids, metals, solvent extractable residue, organohalogens, and TOC), sediment elutriates (ammonia and Microtox), and sediment pore water (conductivity). The elutriate creation procedure was originally designed to mimic the rapid desorption of contaminants from sediments resulting from the open-water disposal of dredged materials (Plumb 1981). Elutriates are cheaply and easily prepared, but the mixing of the sediment and water may influence the availability of some contaminants by changing their oxidative states. Pore water sampling better reflects the interstitial concentration of contaminants resulting from the partitioning of chemicals from sediments, and appropriate sampling techniques probably have a lesser

impact on the chemistry of the contaminants than the elutriate procedure. Pore water squeezers and extractors are more expensive than the equipment required for elutriate preparation, however, and require a greater volume of sediment to produce a comparable volume of liquid test media.

Data storage, retrieval and manipulation were performed using Paradox, a PC-based relational database program. To facilitate use of the data, a user "shell" was created using the Paradox Applications Language (PAL). The user shell was designed to allow easy access to the data, calculate RPDs for QC checks, search for missing samples, format data for creation of icons and provide significant figure-formatted output. Analytical data were checked for entry accuracy by the analyst, and the quality of the data was verified by both the analyst and the project QC coordinators by examination of the QC data associated with each assay (blanks, replicate RPDs, reference materials, etc.). Data were not used for statistical calculations (nor released to GLNPO) until all applicable QC criteria were met. Raw data from this study are archived by GLNPO in their Ocean Data Evaluation System (ODES) database.

3. RESULTS

3.1 Introduction

This chapter presents a summary and analysis of the sediment chemical data collected from the Indiana Harbor AOC based on the two major sampling surveys performed by the ARCS Program. The purpose of the analysis is to provide a preliminary examination of the potential for chemical contaminants to cause adverse impacts to aquatic life or uses of the Indiana Harbor system. Since the data presented are chemical only and not biological, the analysis is limited in its ability to predict biological effects.

The data in this chapter are analyzed in two ways:

- On a chemical-by-chemical basis comparing the sediment contaminant concentrations to known guidelines, and
- On a sample-by-sample basis, providing an analysis of which locations contain elevated levels for the greatest number of contaminants.

The first type of analysis aids in the determination of which *chemicals* are of greatest concern. The second analysis assists in determining which *areas* of the AOC suffer the greatest levels of sediment contamination. The analysis relies on the comparison of measured sediment concentrations to chemical-specific guidelines or criteria.

The data presented in this section are based on the results of two primary sampling surveys; Survey 1, performed in August 1989, and Survey 2, performed in November 1990. Survey 1 consisted of grab samples taken at seven Master Stations (IH 03- IH 10) throughout the AOC. Survey 2 consisted of 0-14 foot cores taken at 37 different locations. To simplify the cross references between the maps, graphs and text and to aid in examining upstream or downstream contaminant trends, the stations for Survey 2 were renumbered from downstream to upstream. Table 3.1 presents the original station identification numbers from Survey 2 with its corresponding new station identification. Figure 3.1 shows the sampling stations for both surveys. Methods for sample collection and analysis are more fully described in Chapter 2.

3.2 Availability of Sediment Quality Guidelines

In order to estimate potential effects, benchmark criteria or guidelines were necessary against which the potential for a given concentration of sediment contamination to cause environmental harm could be assessed. USEPA has currently endorsed an equilibrium partitioning (EqP) based approach that utilizes the concentration of organic carbon in sediments along with a measure of the relative tendency of a contaminant to bind with organic carbon (the partitioning coefficient) to predict the interstitial water concentration of the contaminant within a particular sediment (USEPA, 1993b-f). Unfortunately, this method has only been fully developed for a limited number of heavy organic contaminants.

Other efforts have focused on the use of standardized bioassays, comparisons of concentration and effects data (e.g., Apparent Effects Threshold Approach), and leachate and elutriate testing, among others. A complete overview of the available sediment assessment methods can be found in the *Sediment Classification Methods Compendium* (USEPA, 1992). Three sets of guidelines, EPA's EqP-

TABLE 3.1 INDIANA HARBOR SURVEY 2 - CROSS REFERENCE TABLE

CHART ID	SAMPLE ID
1	IH20201
3	IH22701
4	IH20301
5	IH22801
6	IH20403
6D	IH20403D
7	IH20402
9	IH20401
10	IH22001
10D	IH22001D
11	IH22401
12	IH22501
14	IH20501
14D	IH20501D
15	IH22601
16	IH21901
17	IH21902
18	IH20602
20	IH20601
21	IH21801

CHART ID	SAMPLE ID
22	IH21701
23	IH22101
24	IH21601
25	IH22202
26	IH22201
27	IH21502
28	IH21501
29	IH21401
30	IH21402
31	IH20701
33	IH21302
34	IH21301
35	IH20801
36	IH22301
38	IH22302
39	IH21202
40	IH21201
41	IH21001
42	IH21101
42D	IH21101D
43	IH21102

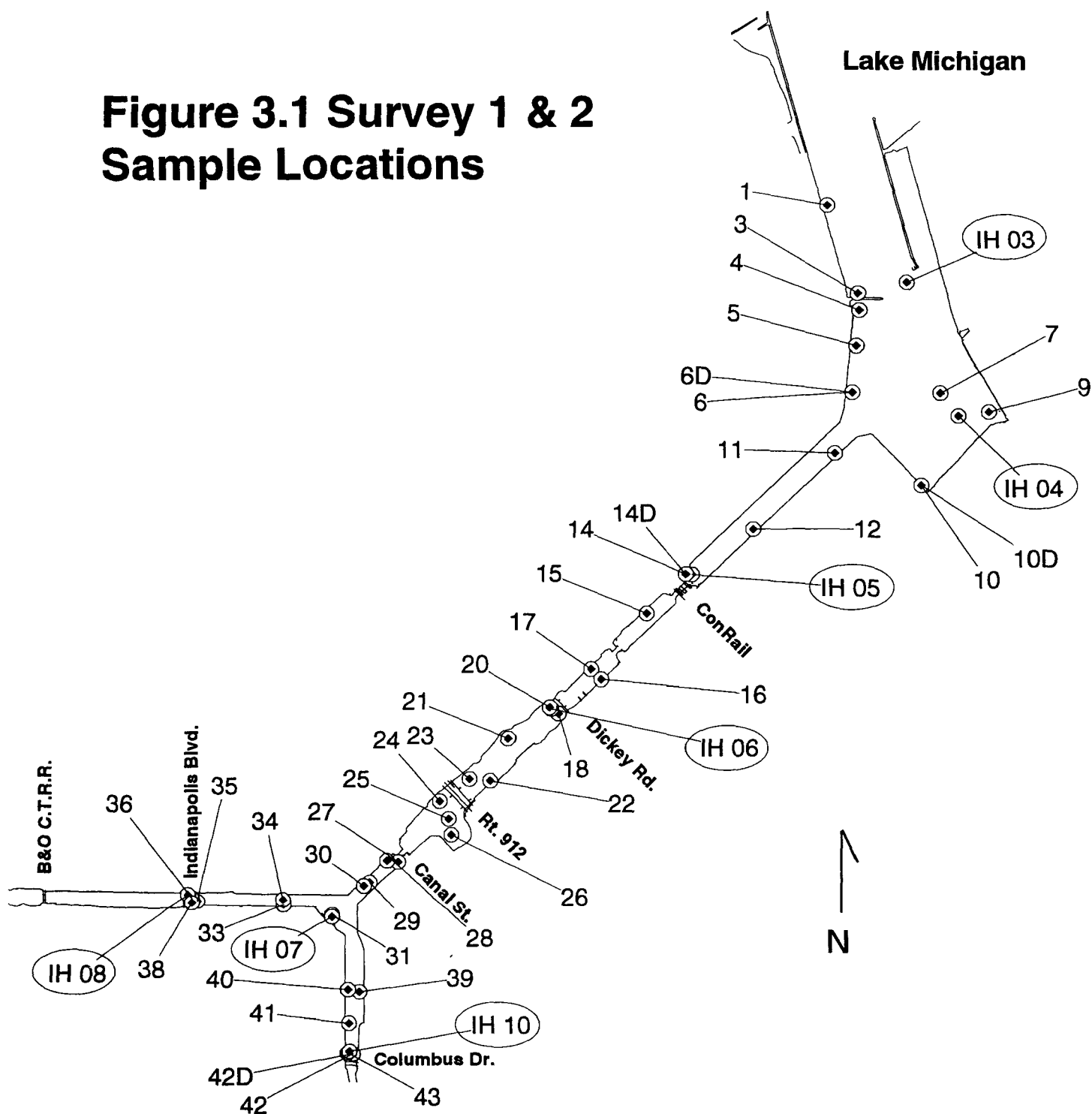
Based Criteria, Long and MacDonald's effects ranges (Long and MacDonald, 1995) and Ontario's Provincial Sediment Quality Guidelines (Persaud, et al, 1993) were utilized for analysis in this report and are briefly discussed in the following sections.

3.2.1 Background on EPA EqP-Based Criteria

EPA has selected the equilibrium partitioning (EqP) method as its primary approach to developing numeric sediment quality criteria for contaminated sediments. The EqP approach is based on three primary observations about the toxicity of organic contaminants in sediment (USEPA, 1993b-f). These are:

- The toxicity of non-ionic organic contaminants in sediments is most closely related to the interstitial water concentrations of the contaminant rather than the bulk sediment concentration of the contaminant;
- Non-ionic organic contaminants bind primarily to the organic carbon within the sediment and partitioning models can relate the relative concentrations of contaminants bound to organic carbon and in pore water; and

**Figure 3.1 Survey 1 & 2
Sample Locations**



- Benthic and water column organisms show similar sensitivities to chemicals so that currently established water quality criteria can be used to determine acceptable pore water chemical concentrations.

The EqP model uses the bulk concentration of contaminant and organic carbon in the sediment and a chemical-specific partitioning coefficient to predict the pore water concentration of the contaminant at equilibrium conditions. The term "equilibrium conditions" indicates that sediment conditions are not in a state of flux and that sufficient time has passed for sediment and pore water concentrations to stabilize. Examples of non-equilibrium conditions include situations where there is significant erosion or deposition of sediments or changes in contaminant concentrations.

There are several limitations to the EqP-based approach. The most obvious is that the method is currently only applicable to non-ionic organic contaminants. This eliminates the approach as a tool for determining the potential toxicity of lighter organic contaminants and toxic metals. Another drawback is that complete criteria are currently developed for only five contaminants. These contaminants are the polynuclear aromatic hydrocarbons (PAHs) phenanthrene (USEPA, 1993f), acenaphthene (USEPA, 1993b), and fluoranthene (USEPA, 1993e), and the pesticides dieldrin (USEPA, 1993c) and endrin (USEPA, 1993d).

For the five EqP-based criteria that are currently available, only phenanthrene and fluoranthene were analyzed for at the Indiana Harbor Master Station locations. A complete list of analytes for the two Indiana Harbor surveys and the applicable sediment quality criteria are presented in Table 3.2.

3.2.2 *Background on the Long and MacDonald (1995) Sediment Quality Guidelines*

Long and MacDonald, updating and utilizing the biological effects database for sediments (BEDS) that was initially developed by Long and Morgan (1990), developed guideline values that were rarely, occasionally or frequently associated with adverse effects. The data from BEDS, which contains sets of sediment contaminant concentrations and associated biological impact data, was arranged in order of concentration and the distributions of effects data were determined using percentiles. Two guideline values were determined;

- the Effects Range-Low (ER-L) which corresponds to the lower 10th percentile of the effects data for each chemical; and
- the Effects Range-Median (ER-M) which corresponds to the median, or 50th percentile of the effects data for each chemical.

Concentrations that fall below the ER-L represent a range intended to estimate conditions in which effects would rarely be observed. Concentrations that are greater than the ER-L, but less than the ER-M, represent a possible-effects range where effects would occasionally occur; concentrations above the ER-M represent a probable-effects range where effects would frequently occur.

The ER-M and ER-L values are not official standards but are intended to be used as guidance in the evaluation of bulk sediment chemistry data. Exceedances of chemical concentrations of ER-L and ER-M levels are not an absolute indicator of effects, but rather define ranges where effects could possibly or probably occur.

A listing of Long and MacDonald's applicable ER-Ls and ER-Ms for the sediments analyzed in the ARCS Indiana Harbor surveys is provided in Table 3.2.

3.2.3 *Province of Ontario Sediment Quality Guidelines*

The Ontario Ministry of the Environment developed three levels of Provincial Sediment Quality Guidelines to provide guidance for making freshwater sediment-related decisions. These guidelines replace the Open Water Disposal Guidelines published by the Ministry in 1976. After reviewing the advantages and limitations of various approaches, the Ministry decided to utilize an equilibrium partitioning approach and the Screening Level Concentration (SLC) approach to derive the following three guidelines:

1. No Effect Level (NEL): Level at which no toxic effects have been observed on aquatic organisms or the level at which no biomagnification through the food chain is expected. Sediment that has a NEL rating is considered clean and may be placed in rivers and lakes provided it does not physically affect the habitat. The NEL is established using a chemical equilibrium partitioning approach and since reliable partition coefficients can only be derived for the nonpolar organics, a NEL cannot be calculated for metals and polar organics.
2. Lowest Effect Level (LEL): Level of sediment contamination that can be tolerated by the majority of benthic organisms. The LEL is based on the 5th percentile of the SLC. Sediments at this level are considered to be clean to marginally polluted and sediments that exceed the LEL may require further testing.
3. Severe Effect Level (SEL): Level at which pronounced disturbance of the sediment-dwelling community can be expected. A compound found at this concentration would be considered to be detrimental to the majority of benthic species. The SEL is based on the 95th percentile of the SLC.

The SLC approach, as developed by Neff et al (1986), is an effects-based approach using field data on the co-occurrence of benthic infaunal species in sediments and different concentrations of contaminants. To calculate a SLC, a species specific SLC is derived by plotting the sediment concentrations at all locations where the species is found. The 90th percentile of this concentration distribution is determined for each species. Then, these 90th percentiles for all of the species present are plotted in order of increasing concentration and from this plot, the 5th and 95th percentiles are calculated.

Concentrations of contaminants within the Indiana Harbor AOC were compared to the SEL only. Table 3.2 provides a complete listing of the Province of Ontario's SELs for freshwater sediments.

TABLE 3.2 ANALYTES AND SEDIMENT QUALITY GUIDELINES

CHEMICAL	Parameters Analyzed		Sediment Quality Guidelines			
	Survey 1	Survey 2	L&M ER-L	L&M ER-M	Ontario SEL	EPA EqP Criteria
PAHS						
Benz(a)anthracene	X		261 ng/g	1,600 ng/g	1,480 ug/g OC	
Benzo(b)fluoranthene	X					
Benzo(a)pyrene	X		430 ng/g	1,600 ng/g	1,440 ug/g OC	
Benzo(k)fluoranthene	X				1,340 ug/g OC	
1,4-Dichlorobenzene	X					
Naphthalene	X		160 ng/g	2,100 ng/g		
2-Methylnaphthalene	X		70 ng/g	670 ng/g		
Dimethyl phthalate	X					
Dibenzofuran	X					
Fluorene	X		19 ng/g	540 ng/g	160 ug/g OC	
Phenanthrene	X		240 ng/g	1,500 ng/g	950 ug/g OC	180 ug/g OC
Anthracene	X		85.3 ng/g	1,100 ng/g	370 ug/g OC	
Fluoranthene	X		600 ng/g	5,100 ng/g	1,020 ug/g OC	620 ug/g OC
Pyrene	X		665 ng/g	2,600 ng/g	850 ug/g OC	
Butyl benzyl phthalate	X					
Bis(2-ethylhexyl) phthalate	X					
Chrysene	X		384 ng/g	2,800 ng/g	460 ug/g OC	
Di-n-octyl phthalate	X					
Indeno(1,2,3)pyrene	X				320 ug/g OC	

TABLE 3.2 ANALYTES AND SEDIMENT QUALITY GUIDELINES

CHEMICAL	Parameters Analyzed		Sediment Quality Guidelines			
	Survey 1	Survey 2	L&M ER-L	L&M ER-M	Ontario SEL	EPA EqP Criteria
Benzo(g,h,i)perylene	X				320 ug/g OC	
Total PAH	X		4,022 ng/g	44,792 ng/g	10,000 ug/g OC	
PESTICIDES/MISCELLANEOUS ORGANICS						
Chlordane, gamma	X					
Chlordane, alpha	X					
4,4 DDD	X				6 ug/g OC	
4,4 DDE	X		2.2 ng/g	27 ng/g	19 ug/g OC	
4,4 DDT	X					
Dieldrin	X				91 ug/g OC	11 ug/g OC
Aldrin	X				8 ug/g OC	
Endrin	X				130 ug/g OC	
Endrin aldehyde	X					
Endosulfan (alpha)	X					
Endosulfan (beta)	X					
Endosulfan sulfate	X					
Toxaphene	X					
Lindane	X					
Methoxychlor	X					
a-BHC	X				10 ug/g OC	
b-BHC	X				21 ug/g OC	
c-BHC	X				1 ug/g OC	

TABLE 3.2 ANALYTES AND SEDIMENT QUALITY GUIDELINES

CHEMICAL	Parameters Analyzed		Sediment Quality Guidelines			
	Survey 1	Survey 2	L&M ER-L	L&M ER-M	Ontario SEL	EPA EqP Criteria
Heptachlor	X					
Heptachlor Epoxide	X				5 ug/g OC	
Dioxins and Furans	X					
PCBS						
Aroclor 1016	X				53 ug/g OC	
Aroclor 1221	X					
Aroclor 1232	X					
Aroclor 1242	X					
Aroclor 1248	X				150 ug/g OC	
Aroclor 1254	X				34 ug/g OC	
Aroclor 1260	X				24 ug/g OC	
Total PCBs	X		22.7 ng/g	180 ng/g	530 ug/g OC	
METALS						
Cadmium	X	X	1.2 ug/g	9.6 ug/g	10 ug/g	
Chromium	X	X	81 ug/g	370 ug/g	110 ug/g	
Copper	X	X	34 ug/g	270 ug/g	110 ug/g	
Iron	X	X			4 %	
Nickel	X	X	20.9 ug/g	51.6 ug/g	75 ug/g	
Lead	X	X	46.7 ug/g	218 ug/g	250 ug/g	
Zinc	X	X	150 ug/g	410 ug/g	820 ug/g	
Selenium	X					
Silver	X		1.0 ug/g	3.7 ug/g		

TABLE 3.2 ANALYTES AND SEDIMENT QUALITY GUIDELINES

CHEMICAL	Parameters Analyzed		Sediment Quality Guidelines			
	Survey 1	Survey 2	L&M ER-L	L&M ER-M	Ontario SEL	EPA EqP Criteria
Arsenic	X		8.2 ug/g	70 ug/g	33 ug/g	
Mercury	X		0.15 ug/g	0.71 ug/g	2 ug/g	
Manganese	X				1,100 ug/g	
Methylmercury	X					
Tributyltin	X					
Monobutyltin	X					
Dibutyltin	X					
NON-METALS						
Total Organic Carbon	X	X			10 %	
Acid Volatile Sulfides	X					
Extractable Residue		X				
pH		X				
Conductivity		X				
Percent Solids	X					
Solids, Total		X				
Volatile Solids		X				
Microtox		X				
Moisture Fraction		X				
Grain Size		X				

3.3 Analysis of Chemical-Specific Data

This section reviews the analytical data on a chemical by chemical basis to aid in determining sampling locations associated with exceedances of criteria or guidelines for a specific contaminant. For the application of EqP-based criteria and the Ontario SELs for PAHs, PCBs, and pesticides, data were normalized using the sediment concentration of organic carbon. The Long and MacDonald

(L&M) effects ranges and the Ontario SELs for metals were applied on a bulk chemistry basis. As stated previously, an exceedance of a guideline is not an absolute indicator of a biological impact, but rather, heightens the possibility of an impact.

3.3.1 *Explanation of Data Presentation*

The data in this section of the report are presented both in narrative and graphical forms. The narrative section provides:

- A table including summary statistics in the form of minimum, maximum, and median concentrations and the applicable sediment quality criteria and/or guidelines; and
- A narrative explanation of the graphs identifying the areal distribution of high concentration data.

The summary statistics are chosen to indicate the range of concentrations present (through the minimum and maximum) and the central concentration (through the median) of a chemical. The use of the median rather than average concentrations eliminates the effect of outliers and the averaging of non-detect data. It should also be noted that the summary statistics presented for Survey 2 are independent of core depth (i.e., the minimum value may be from a 0-2 foot core and the maximum value from a 6-8 foot core depth).

Core depths varied greatly by sample site, and therefore, so did the length of the core segments. For purposes of presentation of the data, reference is made to the first, second, third and fourth core segment. In general, the first core was taken at a depth between 0-2 feet; the second core was a two foot core taken within the 2-7 foot range; the third core was a two foot core taken within the 6-10 foot range; and finally, the two fourth core segments were taken at depths of 13-15 feet and 8.5-10.5 feet. The depth of each maximum core concentration is identified in the text, but for a complete listing of all of the core depths, refer to Appendix A which contains all of the data, including core depth, for both surveys.

The graphical portion of the analysis consists of bar graphs plotting the contaminant concentrations from downstream to upstream and comparing them to sediment quality guidelines. The use of bar graphs was chosen over maps since the number of sampling points and the number of sampling depths in the various surveys make it difficult to present the data on maps in a way in which data from the multiple sampling depths could be directly compared. However, for reference, maps containing the data plotted for all surveys are provided in Appendix B.

The Survey 2 data was plotted with the Survey 1 data. Due to the number of sampling locations and the number of cores, four graphs are used to display the data: two graphs containing the upstream data, one for surface samples and the first core segments and one for the second, third and fourth core segments; and two graphs containing the downstream data organized in the same fashion. As stated previously, the station locations were renumbered so that they are plotted from downstream to upstream.

The following features of the bar graphs should be noted:

- The numbers under each of the graphs correspond to the revised sample numbers for the surveys presented in Figure 3.1.

- The dotted lines through the graphs indicate the level of the applicable criteria or guideline values for the contaminant, either L&M effects ranges, EPA EqP SQC or Ontario's SELs.

3.3.2 Analysis by Chemical Parameter

This section focuses only on the chemicals for which either L&M effects ranges, EPA SQC or Ontario SELs are available. All other data are provided in Appendix A.

Arsenic

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	32	56	93	N/A	8.2	70	33
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g)

As Figure 3.2 shows, all seven surface samples from Survey 1 exceeded the ER-L of 8.2 ug/g with the minimum value of 32 ug/g detected at station IH 04 located downstream in the turning basin. The maximum value of 93 ug/g was found at station IH 07 located at the forks and was the only station that exceeded the ER-M of 70 ug/g. Six of the seven stations exceeded Ontario's SEL of 33 ug/g with the seventh station being just under the SEL at 32 ug/g.

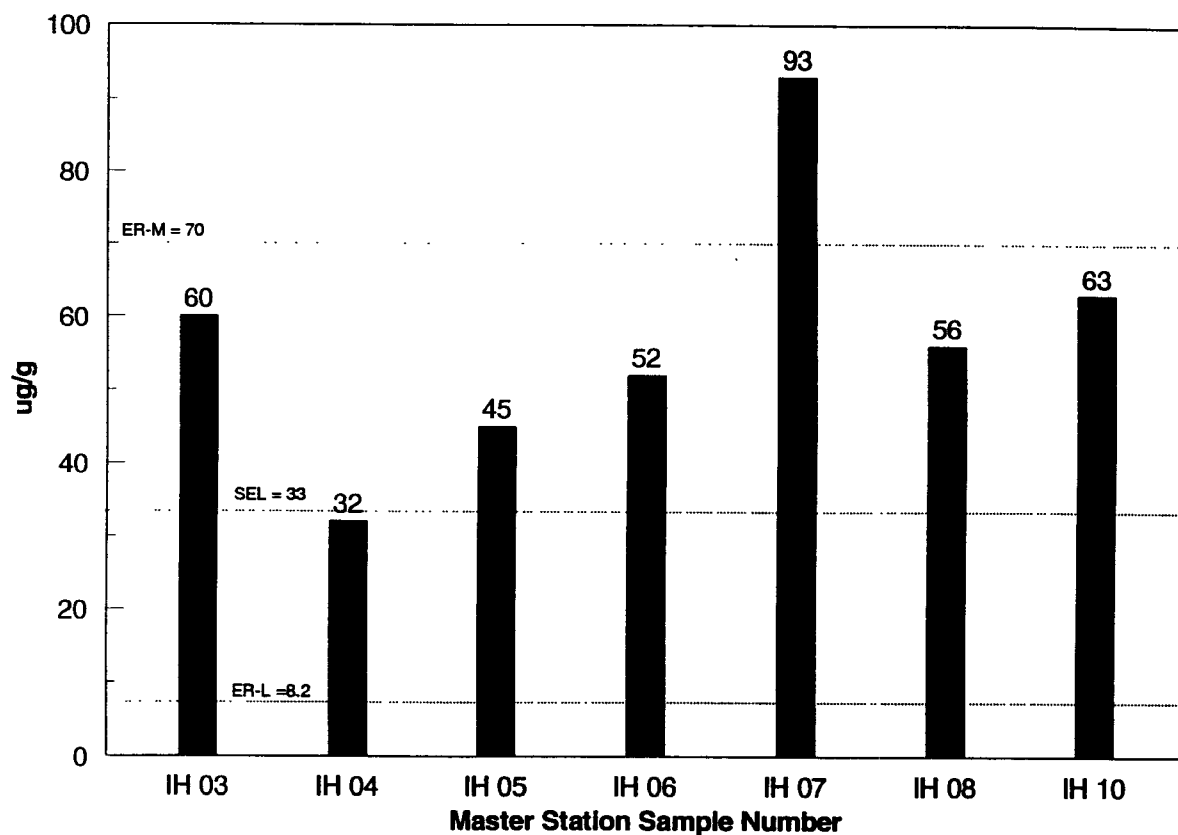
Arsenic was not sampled for in Survey 2.

Cadmium

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	5.2	11.7	24.2	N/A	1.2	9.6	10
2	0.0 PNQ	9.3	45				

N/A - Not Available
PNQ - Present but not quantified
(All units are in ug/g)

Figures 3.3 and 3.4 show the results of the Survey 1 surface samples and the first core segments of Survey 2 for cadmium. All seven surface samples exceeded the ER-L of 1.2 ug/g, with the minimum concentration detected being 5.2 ug/g. Five of the seven Survey 1 samples exceeded both the ER-M of 9.6 ug/g and Ontario's SEL of 10 ug/g. The maximum detected Survey 1 concentration for cadmium, 24.2 ug/g, was found at station IH 07 located at the forks.

Figure 3.2 Arsenic Concentration - Surface Samples

For Survey 2, of the 41 first core segment samples, 37 exceeded the ER-L, 15 exceeded the ER-M, and 15 exceeded the SEL. The maximum concentration detected in the first core samples, 34 ug/g, was found at station 4 (core depth: 0-24 inches) located downstream near Lake Michigan.

Figures 3.5 and 3.6 show the results of the second, third, and fourth core samples for cadmium. Of the 36 second core samples, 29 exceeded the ER-L, 24 exceeded the ER-M, while 22 exceeded the SEL. The maximum concentration for the second core samples, 28 ug/g, was detected at station 6 (core depth: 60-84 inches) situated on the west bank of the turning basin.

The maximum detected cadmium concentration found in Survey 2 (45 ug/g) was detected in a third core segment at station 14 (core depth: 72-96 inches) situated just downstream of the ConRail railroad tracks. Of the 29 third core samples, 21 exceeded the ER-L, 12 exceeded the ER-M, and 12 exceeded the SEL. Finally, of the two fourth core samples taken as duplicates, both exceeded the ER-L and ER-M. The maximum detected concentration of 23 ug/g exceeded the SEL and was found at the same location where the third core maximum was found, station 14 (core depth: 156-179 inches).

Figure 3.3 Cadmium Concentration - Downstream Surface and First Core Samples

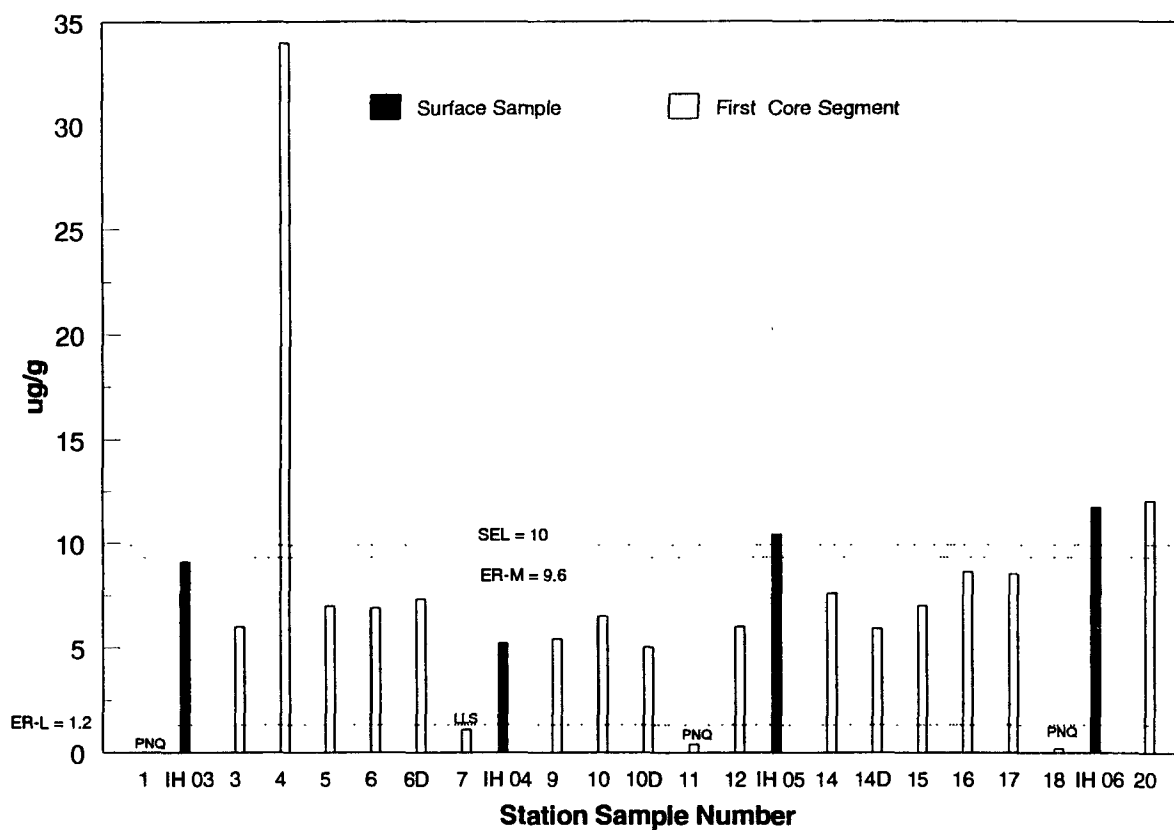


Figure 3.4 Cadmium Concentration - Upstream Surface and First Core Samples

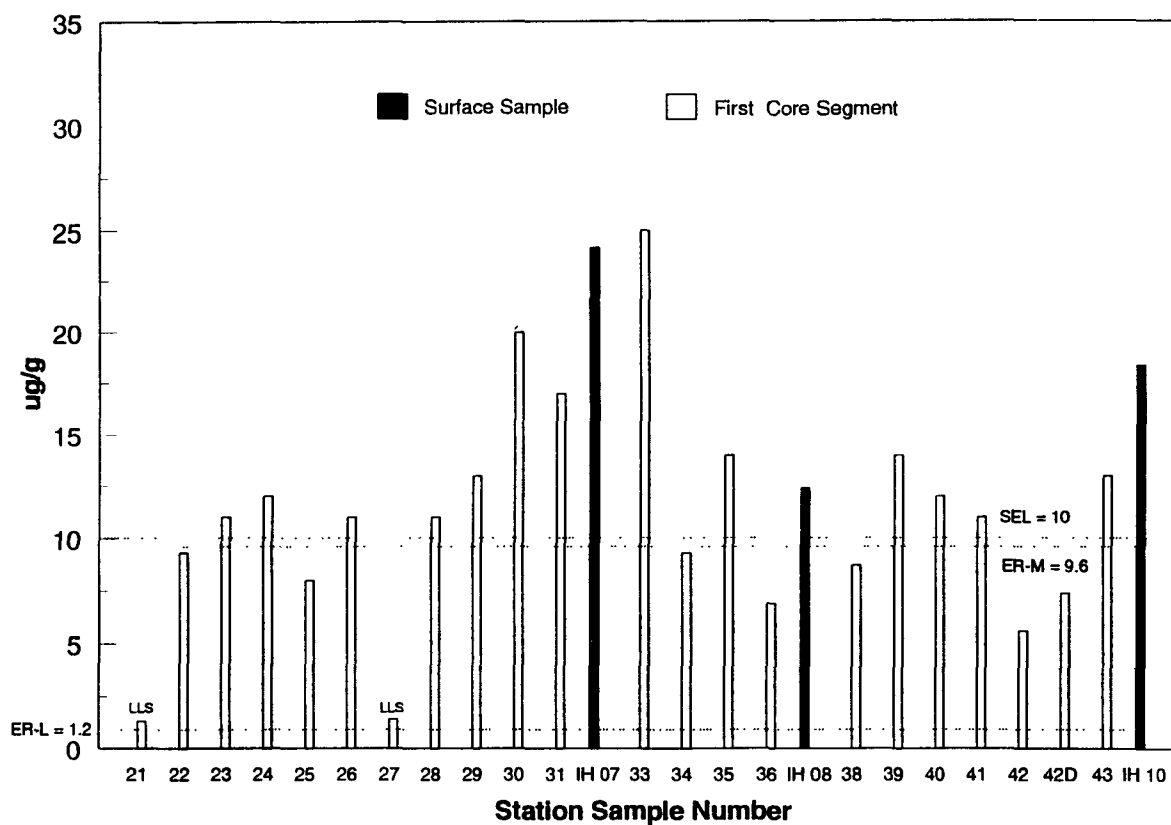


Figure 3.5 Cadmium Concentration - Downstream 2nd, 3rd and 4th Core Samples

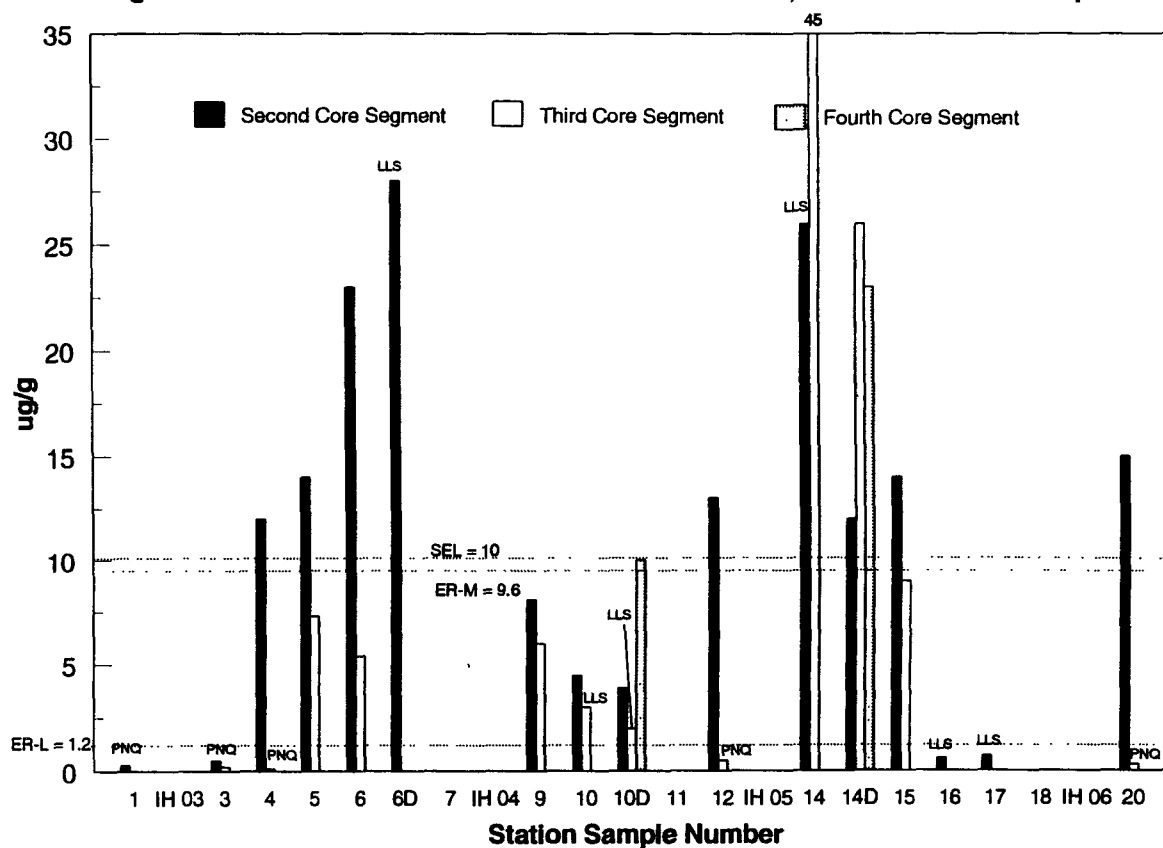
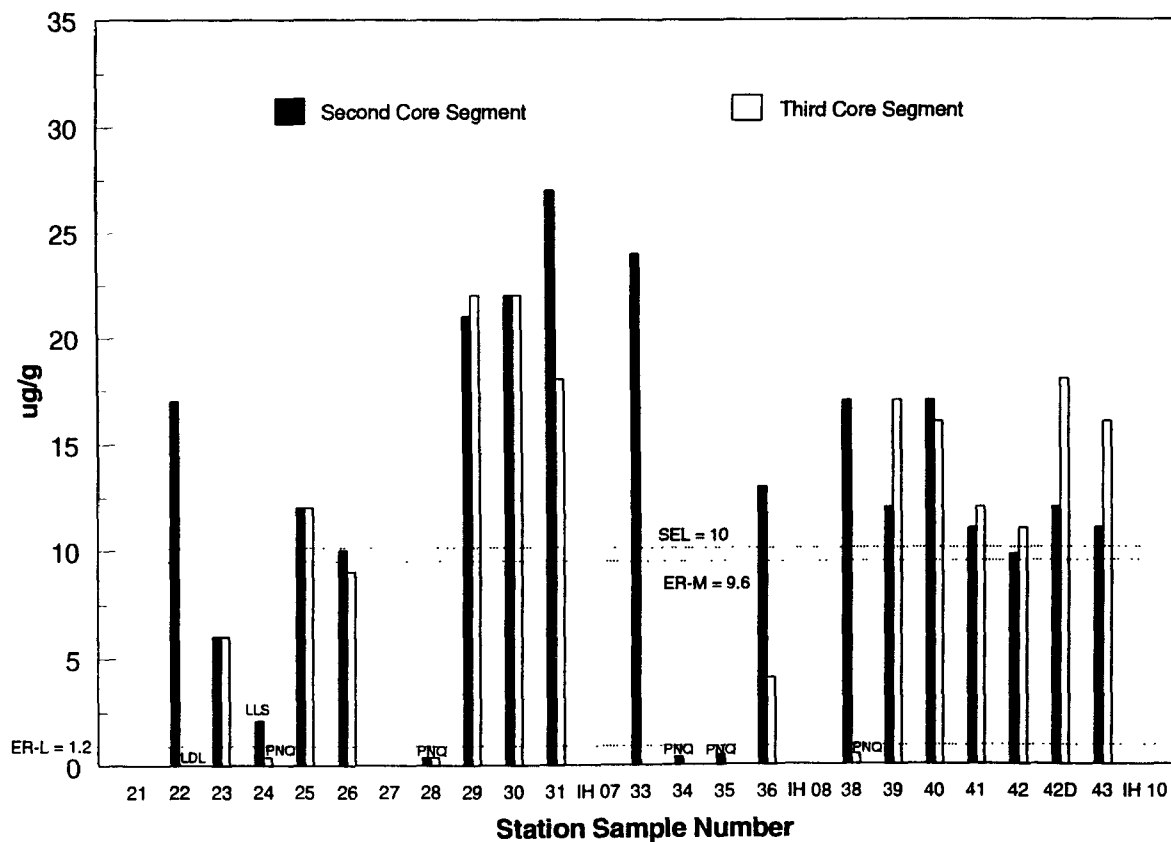


Figure 3.6 Cadmium Concentration - Upstream 2nd and 3rd Core Samples



Chromium

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	407	780	2,610	N/A	81	370	110
2	3.4 LLS	345	1,800				

N/A - Not Available

LLS - Less than the lowest standard. Value reported is measured value.

(All units are in ug/g)

Figures 3.7 and 3.8 show the results of the Survey 1 surface samples and the Survey 2 first core segments for chromium. All seven surface samples exceeded both the ER-L and ER-M as well as Ontario's SEL. The maximum concentration of 2,610 ug/g is more than seven times the ER-M of 370 ug/g and more than 23 times the SEL of 110 ug/g. The maximum concentration was found at station IH 07 located at the forks.

Of the 41 first core segment samples in Survey 2, 35 exceeded the ER-L, 22 exceeded the ER-M, and 34 exceeded the SEL. The maximum concentration of 1,600 ug/g, which is more than four times the ER-L, occurred upstream of Canal Street at station 30 (core depth: 0-24 inches).

Figure 3.7 Chromium Concentration - Downstream Surface and First Core Samples

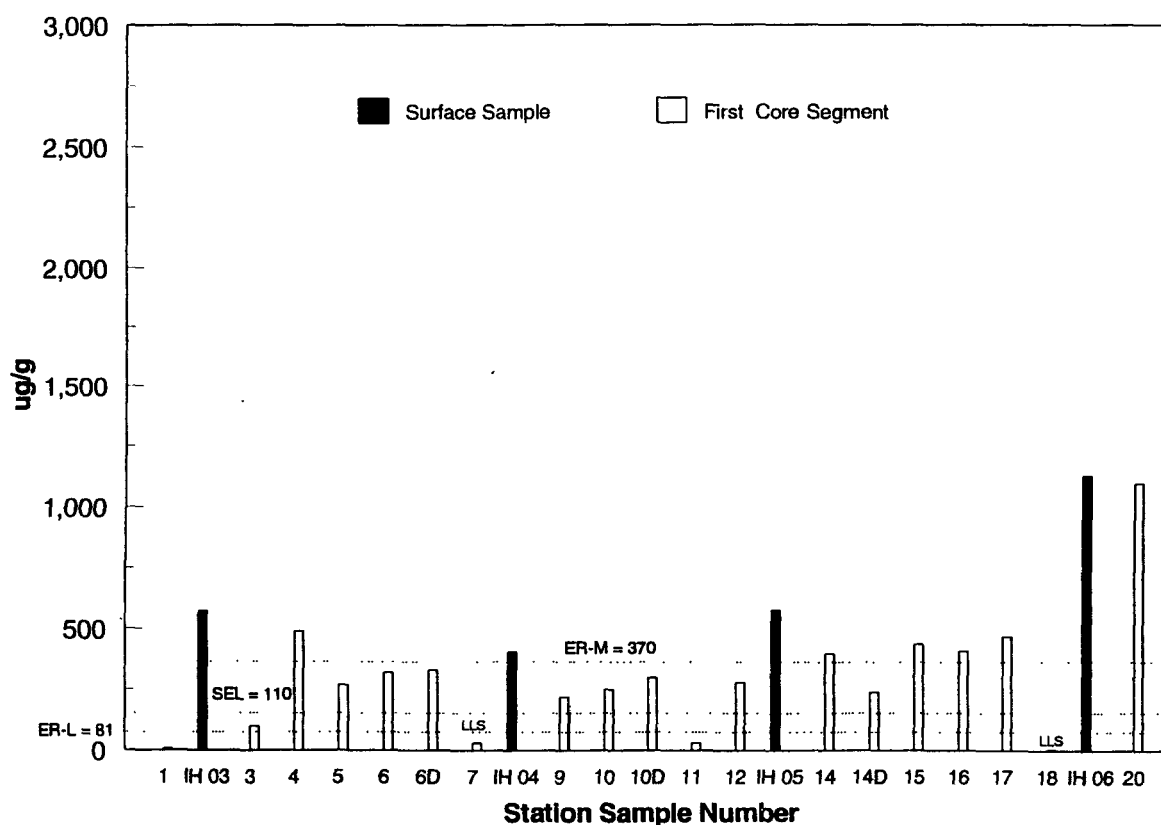
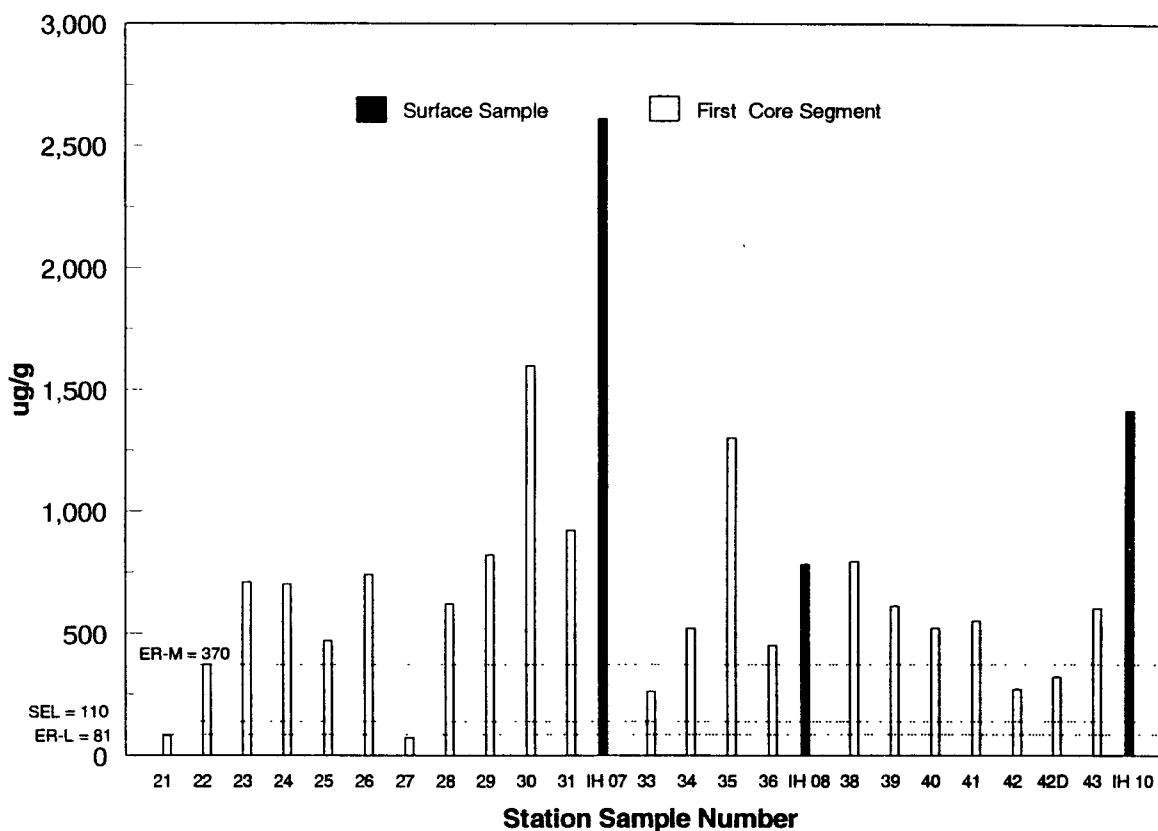


Figure 3.8 Chromium Concentration - Upstream Surface and First Core Samples



Figures 3.9 and 3.10 show the results of the Survey 2 second, third, and fourth core segments for chromium. Of the 36 second core samples, 28 exceeded the ER-L, 19 exceeded the ER-M, while 28 exceeded the SEL. The maximum concentration for the second core samples of 1,800 ug/g occurred at the same location where the maximum was detected in the first core segments, station 30 (core depth 48-72 inches) located upstream of Canal Street, and is also the maximum detected chromium concentration for Survey 2.

Of the 29 third core samples, 18 exceeded the ER-L, 9 exceeded the ER-M, and 17 exceeded the SEL. The maximum concentration for the third core samples, 1,700 ug/g, occurred at station 40 (core depth: 84-109 inches), just downstream of Columbus Drive. Finally, of the two fourth core samples, both exceeded the ER-L, none exceeded the ER-M, and one exceeded the SEL. The maximum value of 370 ug/g for the fourth core segment, which is below the ER-M, occurred in a duplicate sample at station 10 in the southeast corner of the turning basin at a depth of 101-125 inches. In general, for both surveys, the concentration of chromium increased upstream of Canal Street.

Figure 3.9 Chromium Concentration - Downstream 2nd, 3rd and 4th Core Samples

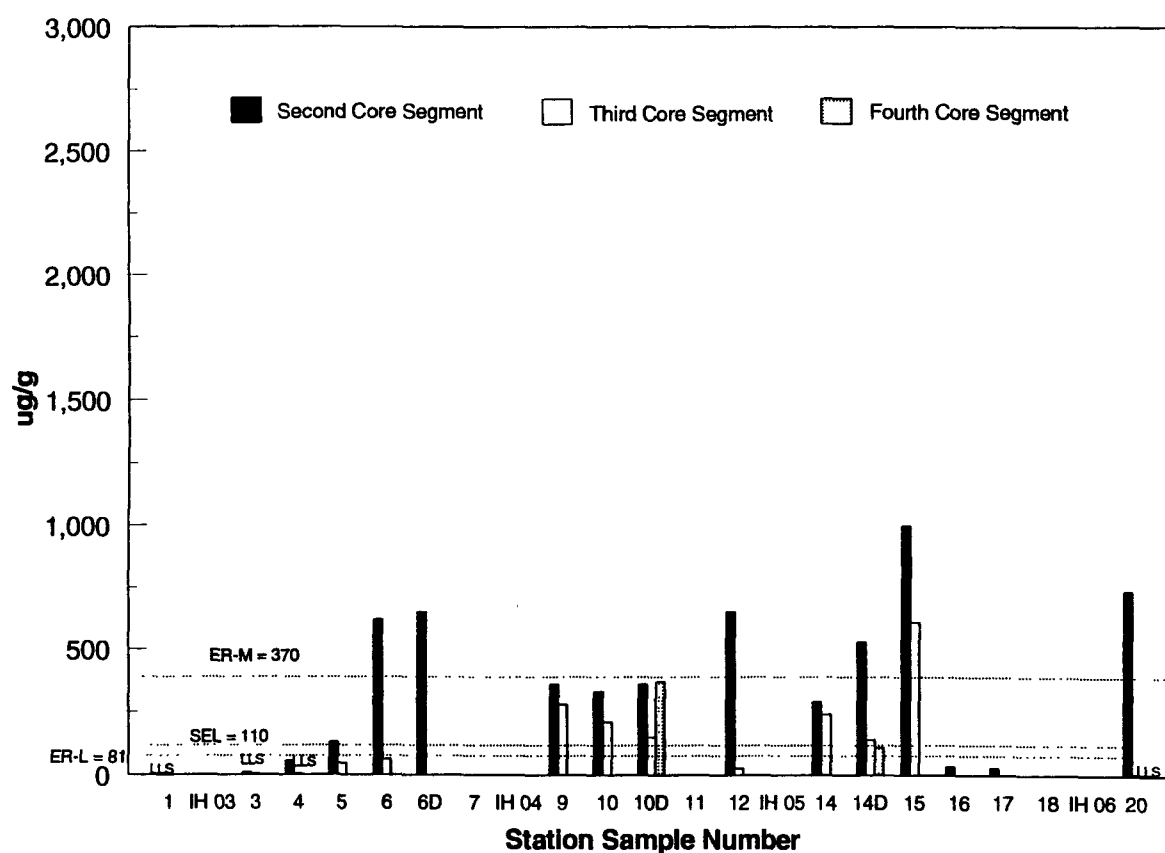
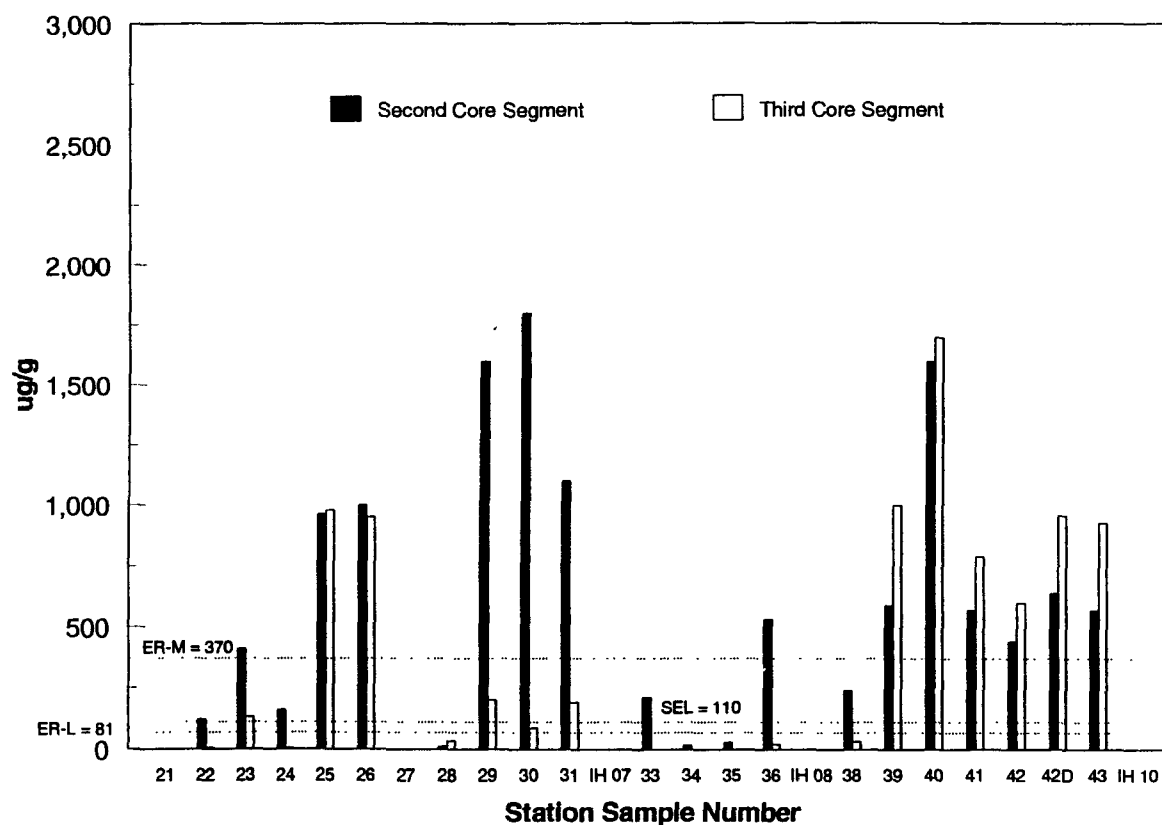


Figure 3.10 Chromium Concentration - Upstream 2nd and 3rd Core Samples



Copper

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	182	284	379	N/A	34	270	110
2	4.5 LLS	275	880				

N/A - Not Available

LLS - Less than the lowest standard. Value reported is measured value.

(All units are in ug/g)

Figures 3.11 and 3.12 show the results of the Survey 1 surface samples and the Survey 2 first core segments for copper. All seven surface samples exceeded both the ER-L of 34 ug/g and the SEL of 100 ug/g with the minimum detected concentration of 182 ug/g found in the turning basin (station IH 04). Three stations exceeded the ER-M of 270 ug/g with the maximum concentration of 379 ug/g occurring at Dicky Road (station IH 06).

For Survey 2, of the 41 first core segment samples, 36 exceeded the ER-L, 21 exceeded the ER-M, and 34 exceeded the SEL. The maximum concentration for these samples, 540 ug/g, which is twice the ER-M of 270 ug/g, was detected near the end of the federal navigation channel at Columbus Drive at station 43 at a depth of 0-24 inches.

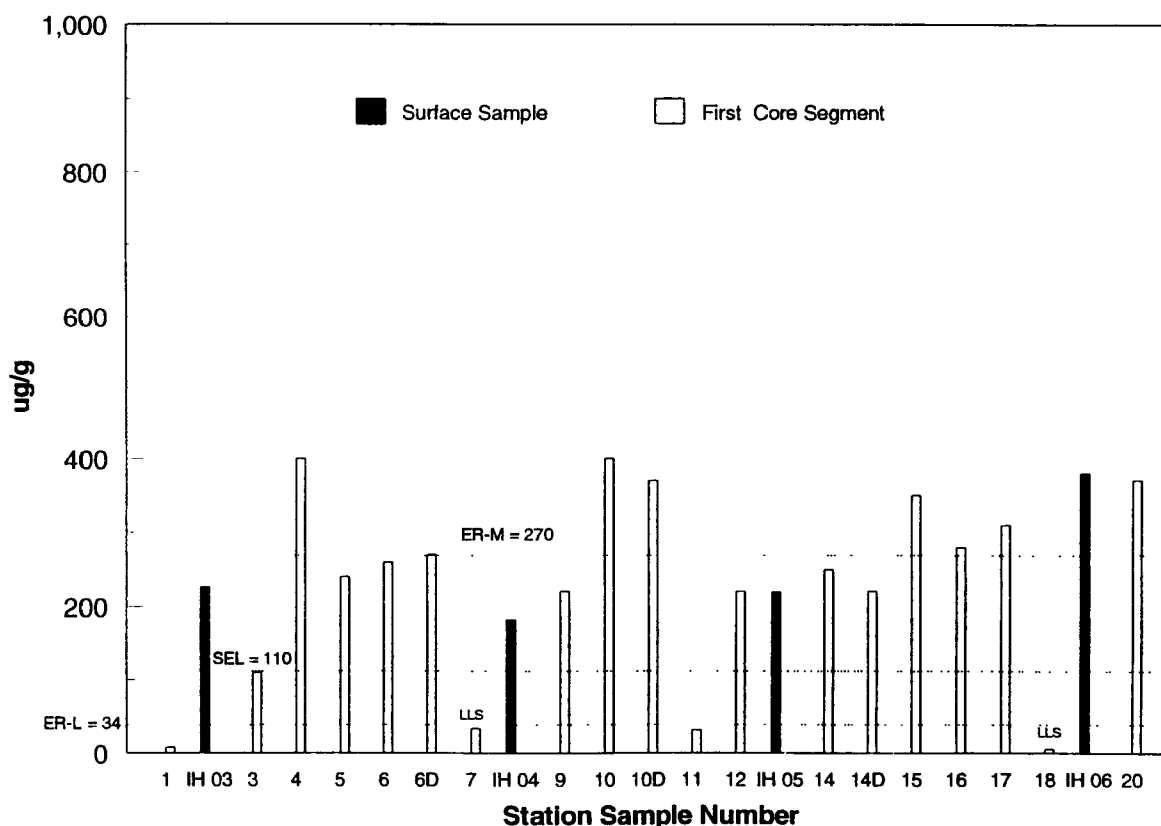
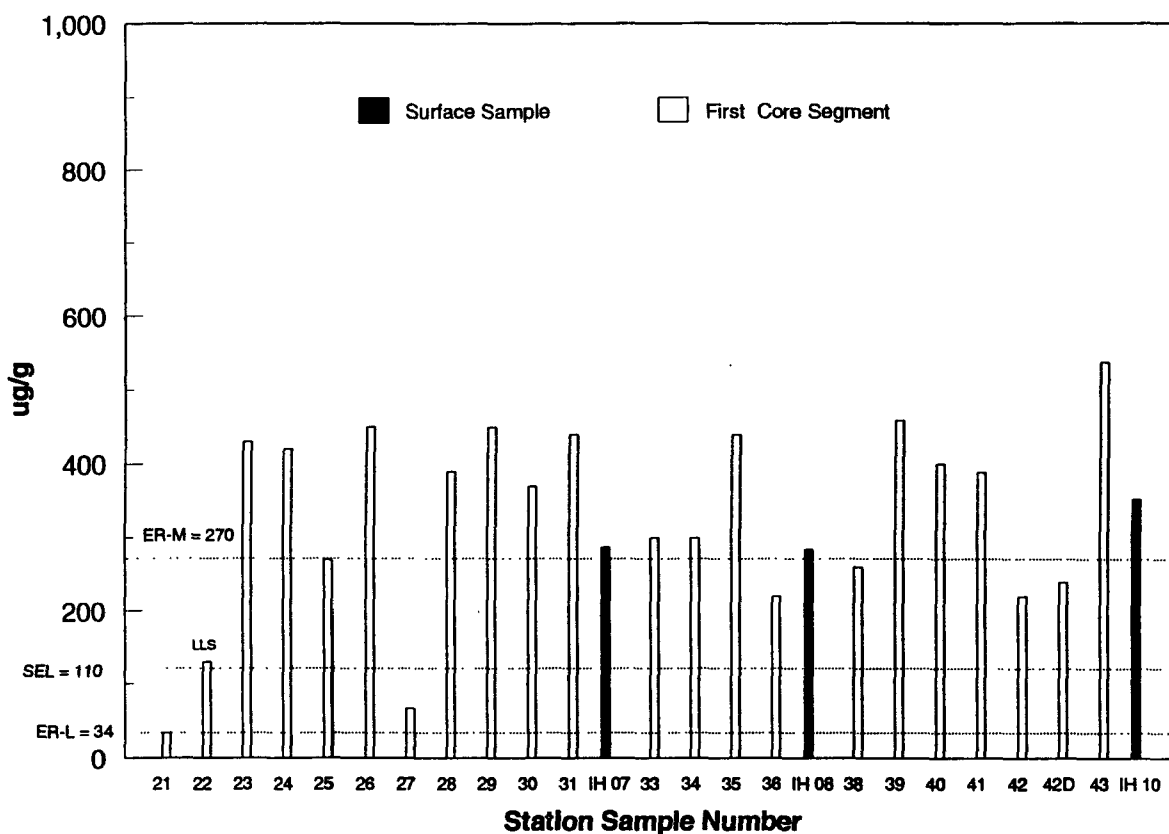
Figure 3.11 Copper Concentration - Downstream Surface and First Core Samples

Figure 3.12 Copper Concentration - Upstream Surface and First Core Samples

The maximum detected concentration of copper for Survey 2 was found in a second core segment, station 26 (core depth: 36-60 inches) located halfway between Canal Street and Rt. 912. This concentration of 880 ug/g is more than three times the ER-M and more than twice the maximum value detected in the surface samples. Figures 3.13 and 3.14 show the results of the Survey 2 second, third, and fourth core samples for copper. Of the 36 second core samples, 29 exceeded the ER-L, 20 exceeded the ER-M, while 28 exceeded the SEL.

Of the 29 third core samples, 21 exceeded the ER-L, 12 exceeded the ER-M, and 17 exceeded the SEL. The maximum concentration for the third core samples, 530 ug/g, occurred at station 39 (core depth 104-128 inches), just downstream of Columbus Drive. Finally, of the two fourth core samples, both stations exceeded the ER-L and Ontario's SEL, and the maximum value of 400 ug/g exceeded the ER-M and was detected in a duplicate sample at station 10 (core depth: 101-125 inches) in the southeast corner of the turning basin.

Iron

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	12.1	19.7	28.8	N/A	N/A	N/A	4
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in %)

Figure 3.13 Copper Concentration - Downstream 2nd, 3rd and 4th Core Samples

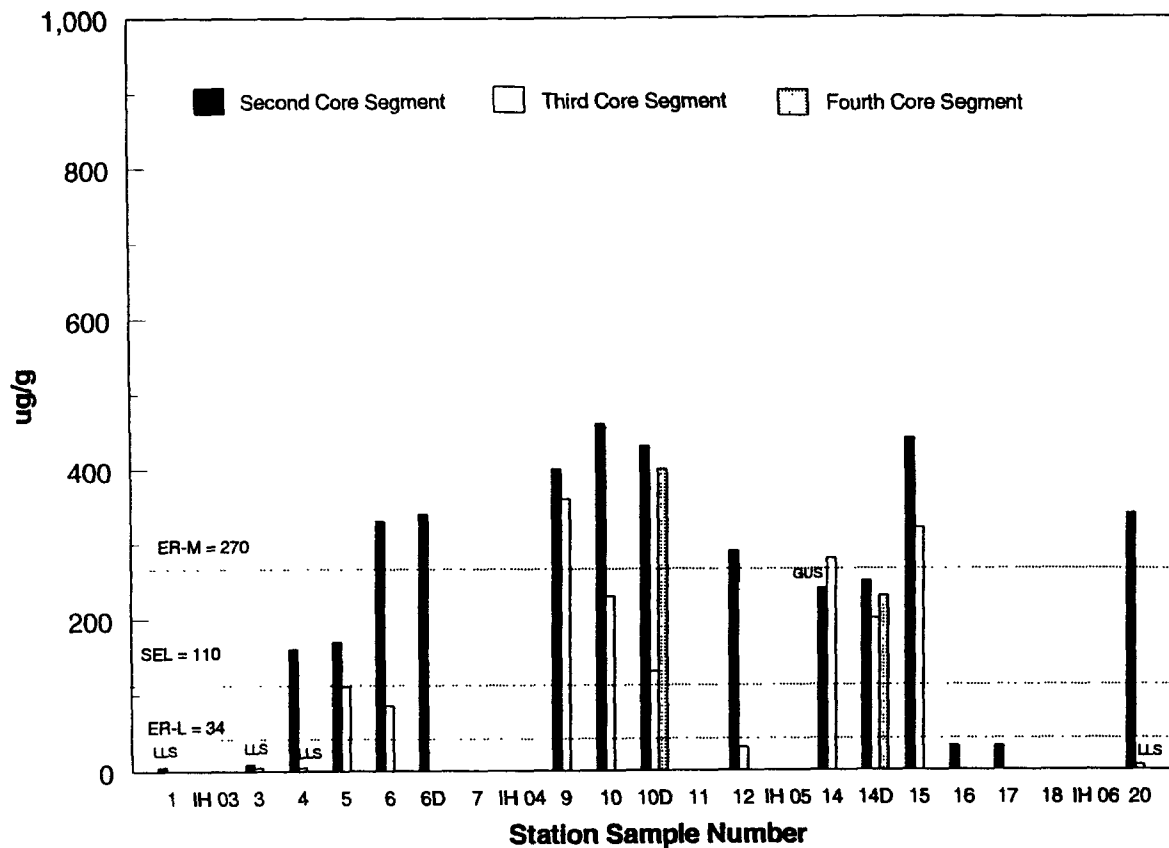
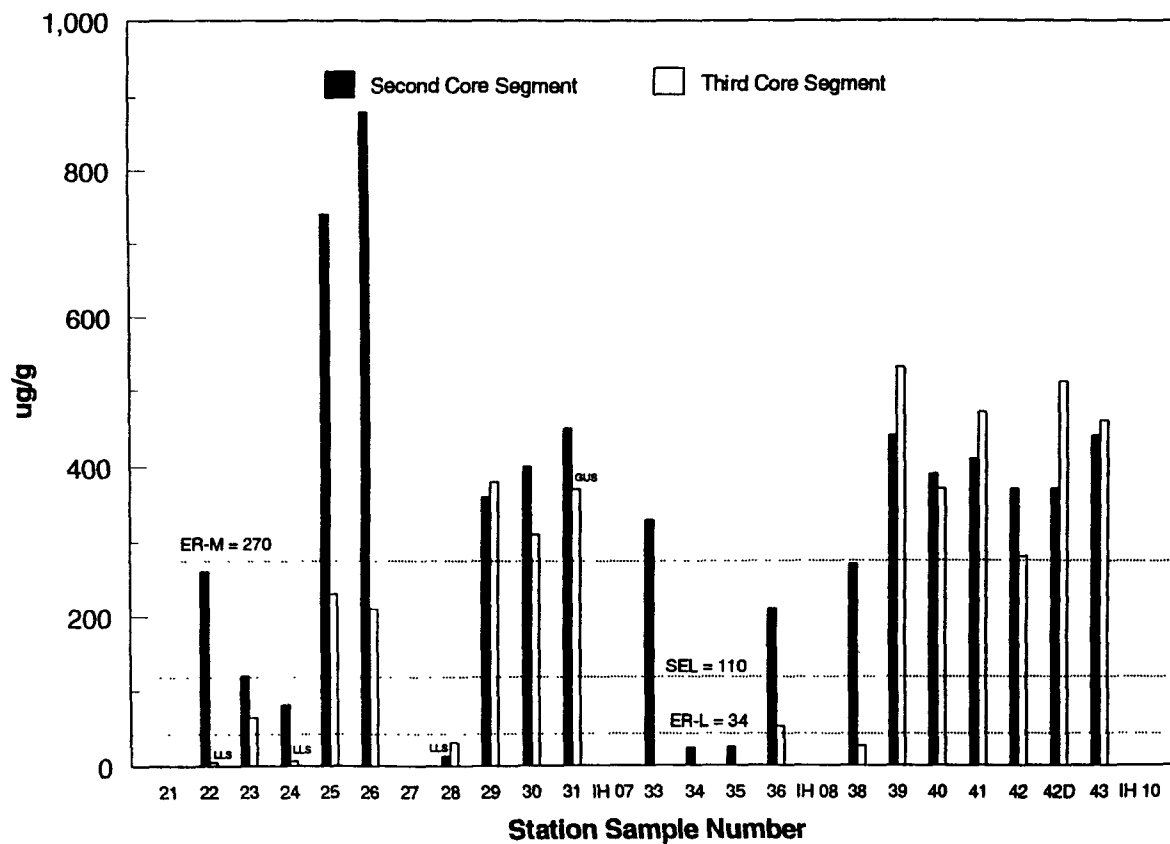


Figure 3.14 Copper Concentration - Upstream 2nd and 3rd Core Samples



Figures 3.15 and 3.16 show the results of the Survey 1 surface samples and the first core segments of Survey 2 for iron. As the figures show, all seven surface samples exceeded the SEL of 4% with the minimum concentration detected being 12.1%, or three times the SEL. The maximum detected concentration of iron, 28.8%, was found at station IH 07 located at the forks.

For Survey 2, of the 41 first core segment samples, 36 exceeded the SEL. The maximum detected concentration of 23% was found at two different locations; station 4, located downstream near Lake Michigan, and station 10, located at the southeast corner of the turning basin. Each of these first core segments represented a depth of 0-24 inches.

Figures 3.17 and 3.18 show the results of the second, third, and fourth core samples for iron. Of the 36 second core samples, 29 exceeded the SEL of 4%. The maximum concentration of 30%, which is more than seven times the SEL, was found at station 40 located upstream of the forks in the Indiana Harbor Canal. Of the 29 third core segments, 19 exceeded the SEL. Station 31, located at the forks with surface station IH 07, had the maximum concentration found in both the third core as well as in Survey 2. This maximum concentration of 31% was found at a depth of 96-113 inches and is higher than the maximum detected concentration in the surface sample found at almost the exact same location. Finally, of the two fourth core samples taken as duplicates, both exceeded the SEL. The maximum detected concentration of 27% (core depth: 101-125 inches) was found in the southeast corner of the turning basin at station 10.

Figure 3.15 Iron Concentration - Downstream Surface and First Core Samples

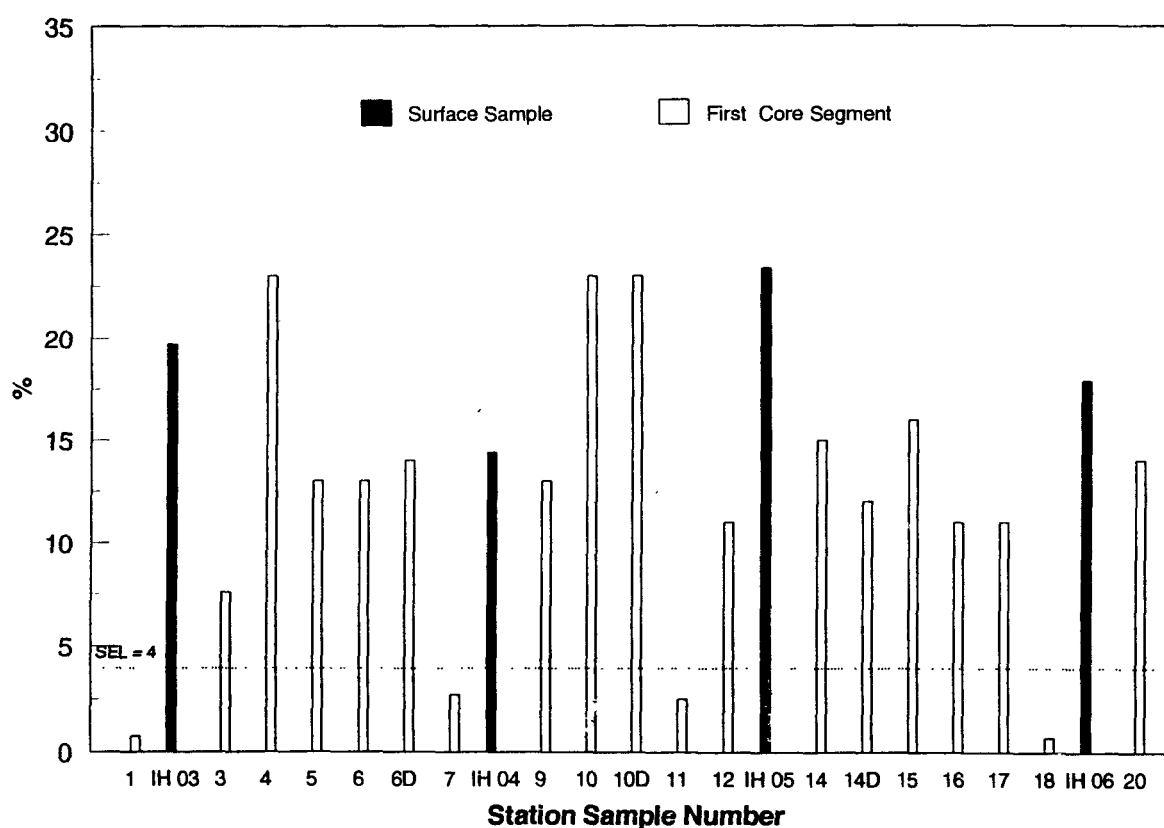


Figure 3.16 Iron Concentration - Upstream Surface and First Core Samples

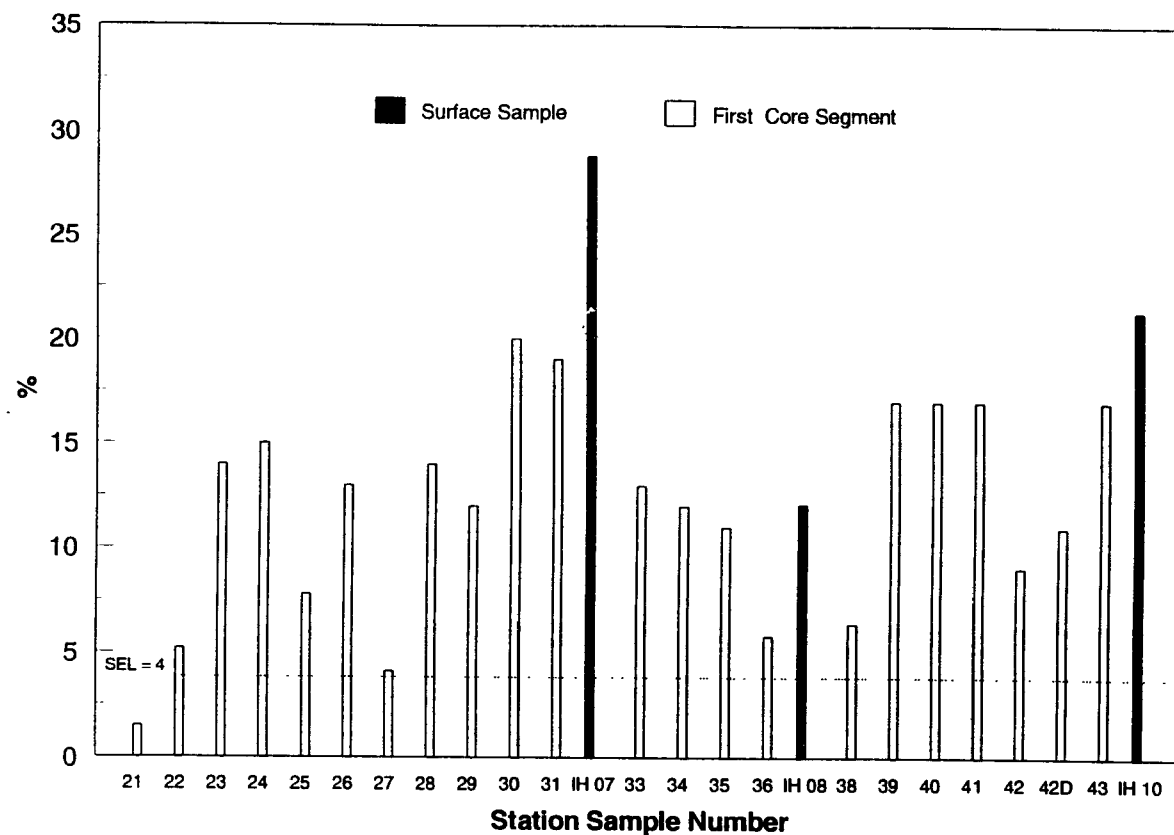


Figure 3.17 Iron Concentration - Downstream 2nd, 3rd and 4th Core Samples

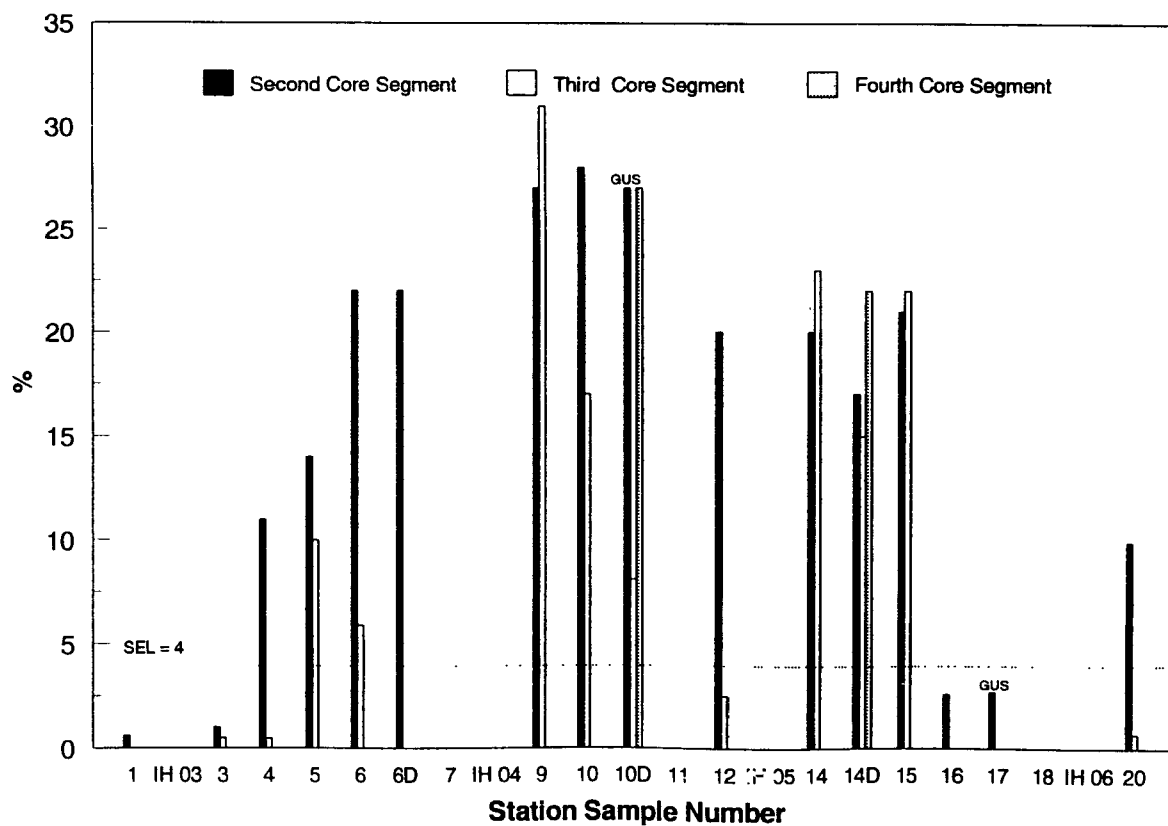
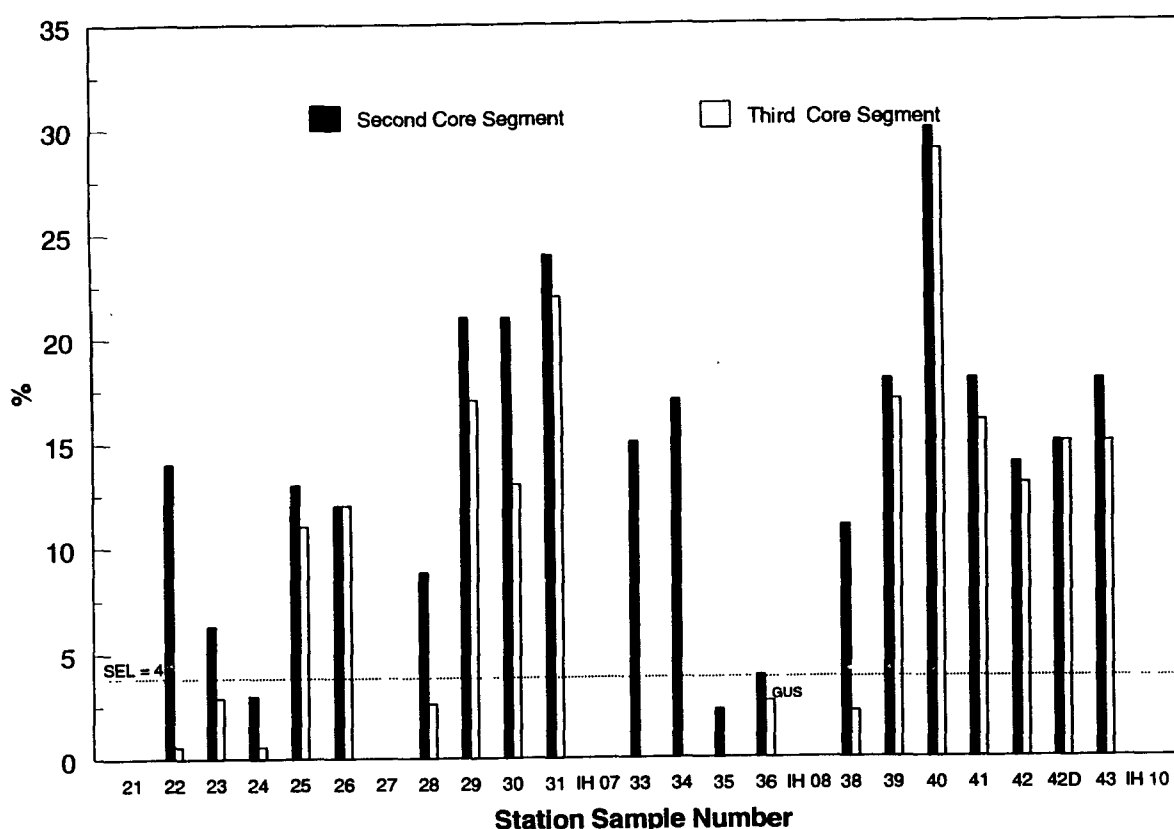


Figure 3.18 Iron Concentration - Upstream 2nd and 3rd Core Samples

**Lead**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	396	791	1,354	N/A	46.7	218	250
2	1.5 LDL	695	3,700				

N/A - Not Available

LDL - Less than detection limit. Value reported is method detection limit.

(All units are in ug/g)

Figures 3.19 and 3.20 show the results of the Survey 1 surface samples and the Survey 2 first core segments for lead. All seven surface samples exceeded both the ER-L and ER-M as well as Ontario's SEL. The minimum detected concentration of 396 ug/g, found at station IH 04 situated in the turning basin, is well above the ER-M of 218 ug/g and the SEL of 250 ug/g. The maximum concentration of 1,354 ug/g, which is more than six times the ER-M and more than five times the SEL, was detected at station IH 07 located at the forks.

For Survey 2, of the 41 first core segment samples, 37 locations exceeded the ER-L and 35 locations exceeded both the ER-M of 218 ug/g and Ontario's SEL of 250 ug/g. The maximum detected concentration of 2,500 ug/g, which is five times the SEL and more than five times the ER-M, was found at station 33, downstream of Indianapolis Boulevard (core depth: 0-24 inches) in the Lake George Branch.

Figure 3.19 Lead Concentration - Downstream Surface and First Core Samples

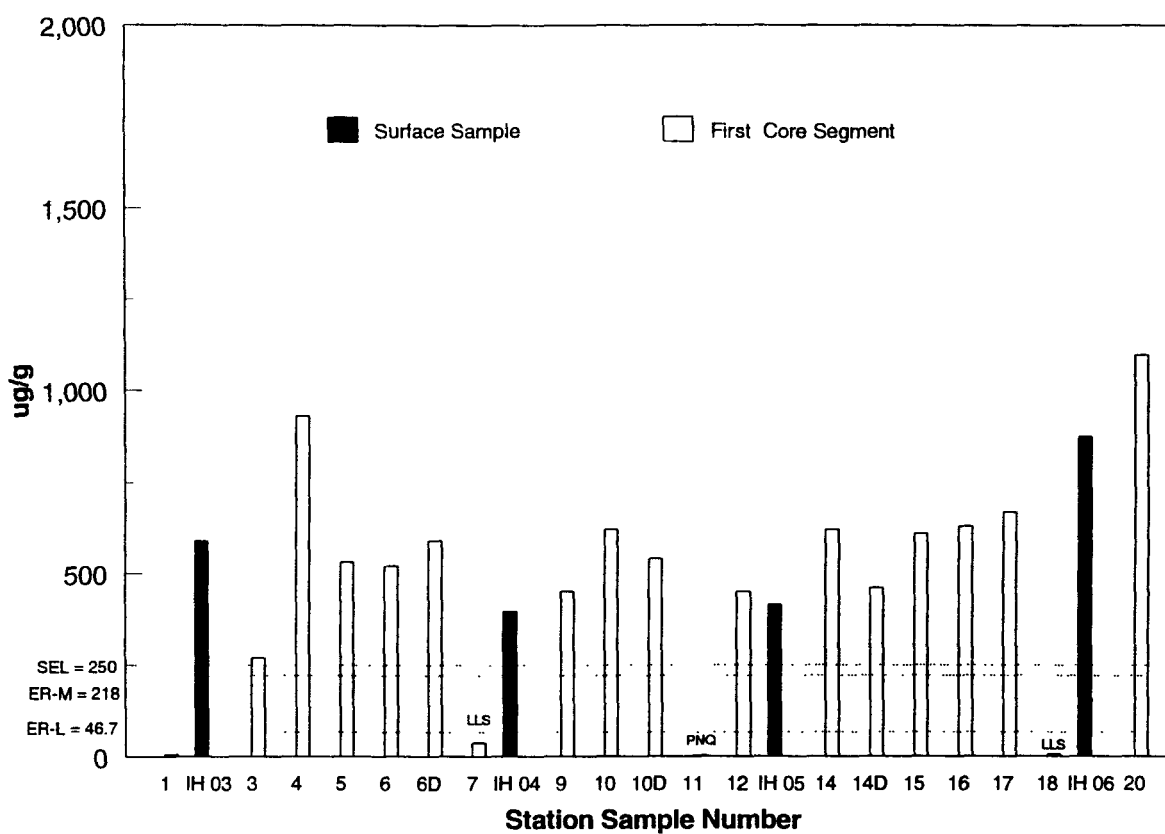
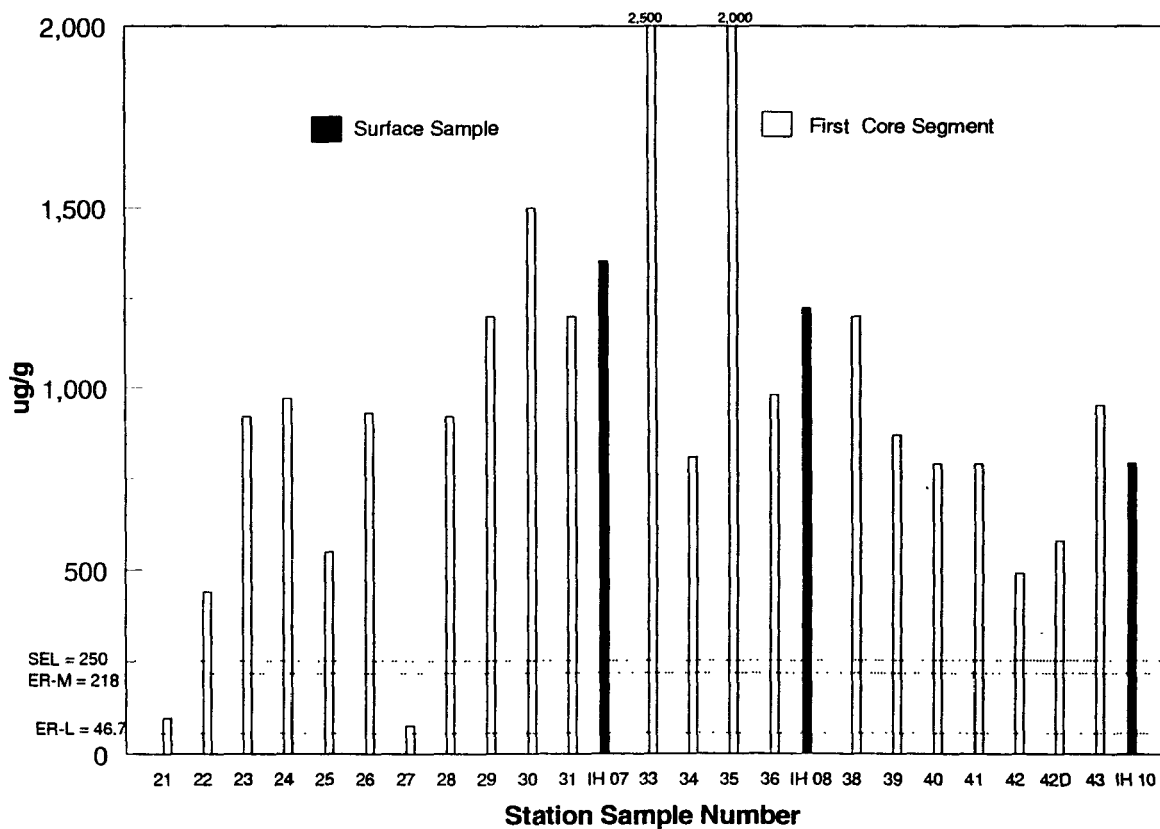


Figure 3.20 Lead Concentration - Upstream Surface and First Core Samples



Figures 3.21 and 3.22 show the results of the Survey 2 second, third, and fourth core samples for lead. Of the 36 second core samples, 29 exceeded the ER-L, and 28 exceeded both the ER-M and Ontario's SEL. The maximum value found in the second core segment of 3,700 ug/g was also the maximum concentration detected in Survey 2. This concentration was found at station 38 (core depth: 40-64 inches), directly off of Indianapolis Boulevard in the Lake George Branch, and is more than 14 times the SEL.

Of the 29 third core samples, 21 exceeded the ER-L of 46.7 ug/g, 20 exceeded the ER-M of 218 ug/g, and 19 exceeded the SEL of 250 ug/g. The maximum concentration of 2,100 ug/g for the third core samples occurred at station 29, just upstream from Canal Street, at a depth of 96-120 inches. Finally, of the two fourth core samples, both exceeded both the ER-L and ER-M as well as Ontario's SEL with a maximum concentration of 740 ug/g occurring in a duplicate sample at a station directly off of the ConRail railroad tracks (station 14D, core depth: 156 -179 inches).

In general, the higher lead concentrations appear upstream of Dickey Road.

Figure 3.21 Lead Concentration - Downstream 2nd, 3rd and 4th Core Samples

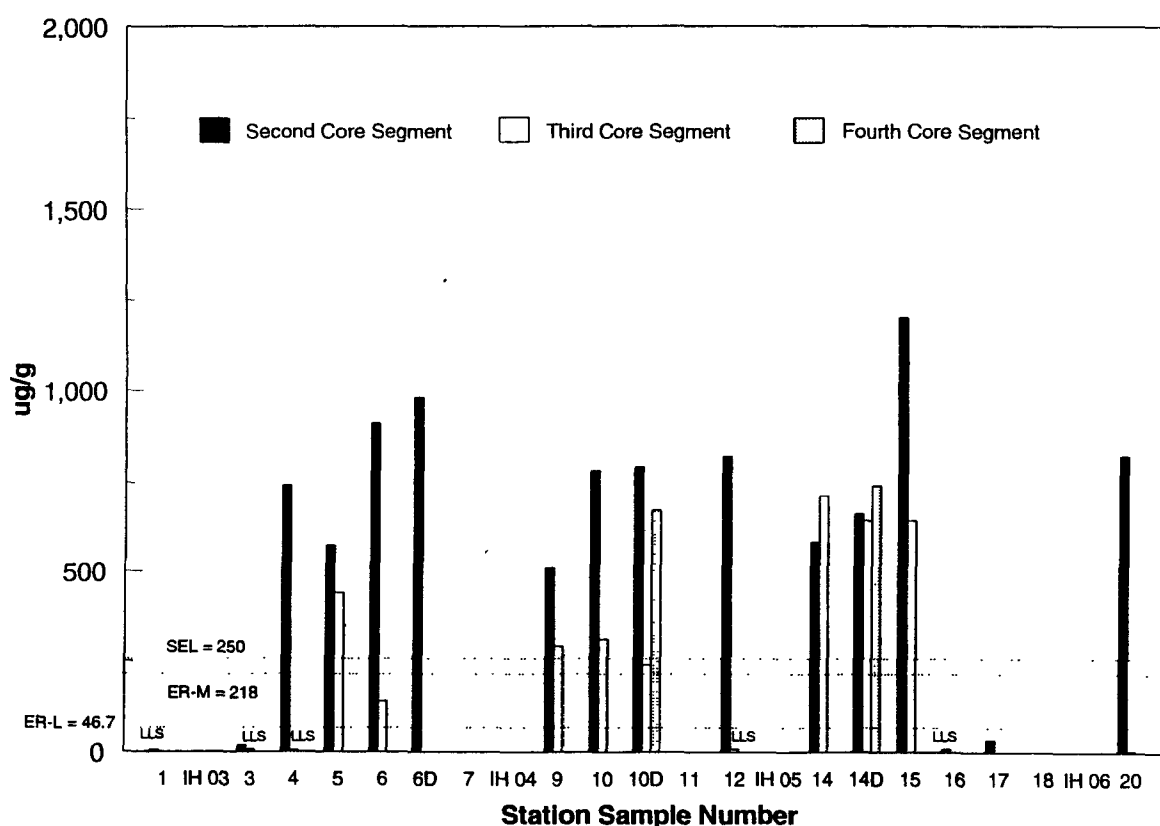
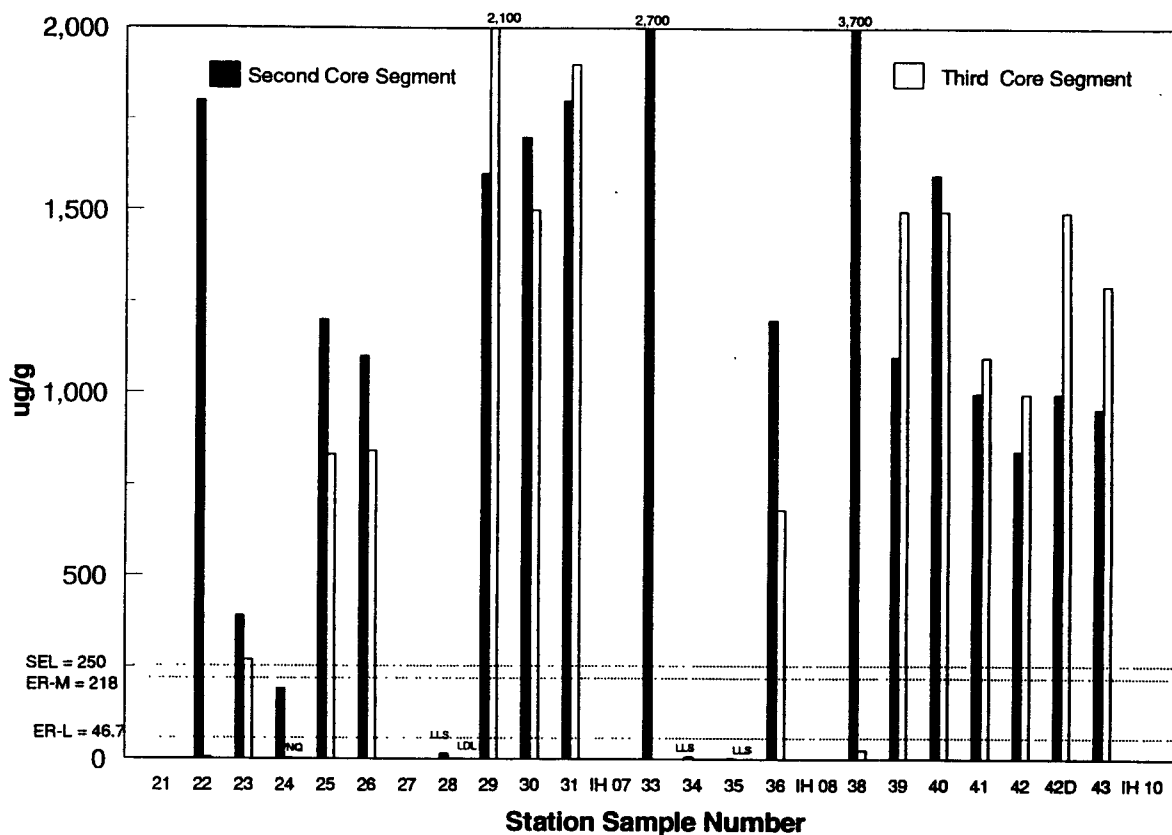


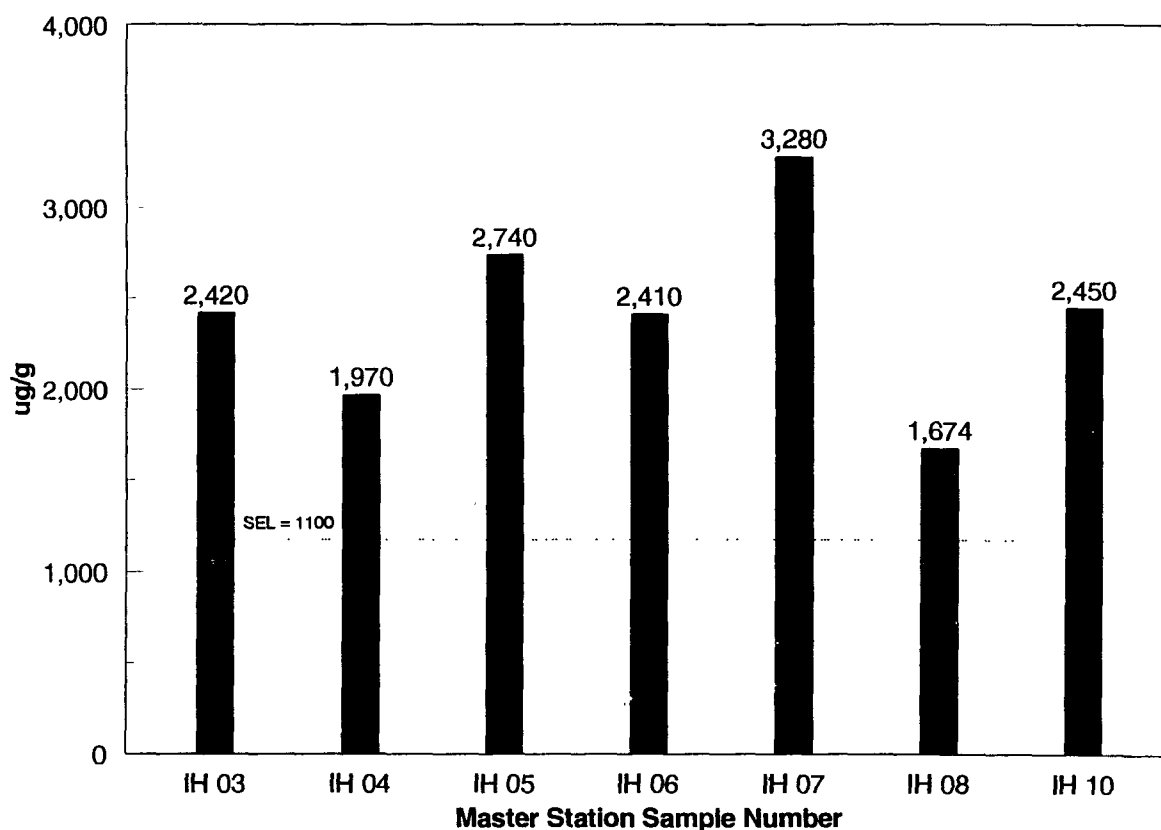
Figure 3.22 Lead Concentration - Upstream 2nd and 3rd Core Samples**Manganese**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	1,674	2,420	3,280	N/A	N/A	N/A	1,100
2	N/A	N/A	N/A				

N/A - Not Available
 (All units are in ug/g)

As Figure 3.23 shows, all seven Survey 1 surface samples exceeded Ontario's SEL of 1,100 ug/g. The maximum concentration, 3,280 ug/g, was detected at station IH 07 which is located at the forks and is almost three times the SEL. Manganese was not sampled for in Survey 2.

Figure 3.23 Manganese Concentration - Surface Samples

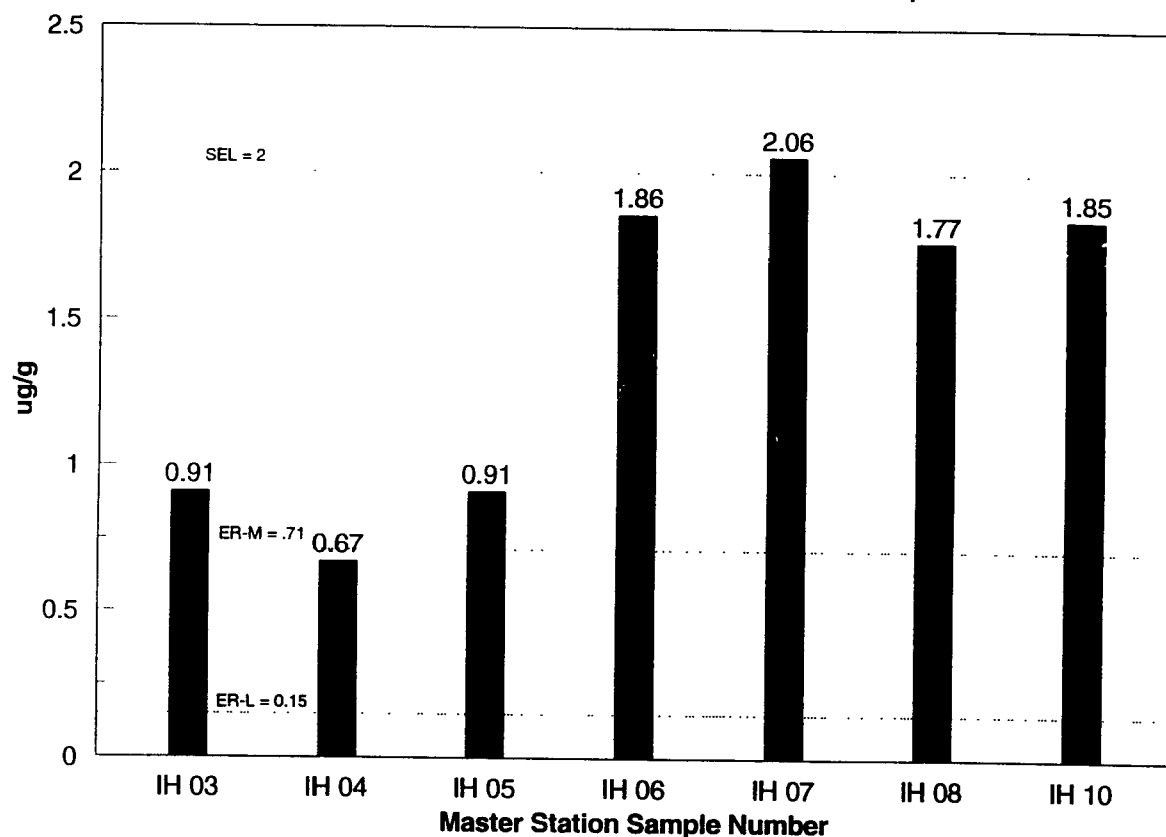
**Mercury**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	0.67	1.77	2.06	N/A	0.15	0.71	2
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g)

The results of the Survey 1 surface samples for mercury are depicted in Figure 3.24. Of the seven samples, all seven exceeded the ER-L of 0.15 ug/g and six of the seven exceeded the ER-M of 0.71 ug/g. The maximum concentration of 2.06 ug/g was found at station IH 07, located at the forks, and was the only location that exceeded Ontario's SEL of 2.0 ug/g.

Figure 3.24 Mercury Concentration - Surface Samples

**Nickel**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	< 50	69	103	N/A	20.9	51.6	75
2	3.0 PNQ	72	560				

N/A - Not Available
(All units are in ug/g)

Figures 3.25 and 3.26 depict the results of the Survey 1 surface samples and the Survey 2 first core segments for nickel. Of the seven samples taken for Survey 1, five exceeded the ER-L, and three exceeded both the ER-M and the SEL. The maximum concentration of 103 ug/g was detected at Dickey Road (station IH 06).

For Survey 2, of the 41 first core segment samples, 38 exceeded the ER-L of 20.9 ug/g, 31 exceeded the ER-M of 51.6 ug/g, and 25 exceeded the SEL of 75 ug/g. The maximum concentration of 170 ug/g for these samples was detected slightly upstream of Canal St. at station 29 (core depth: 0-24 inches).

Figure 3.25 Nickel Concentration - Downstream Surface and First Core Samples

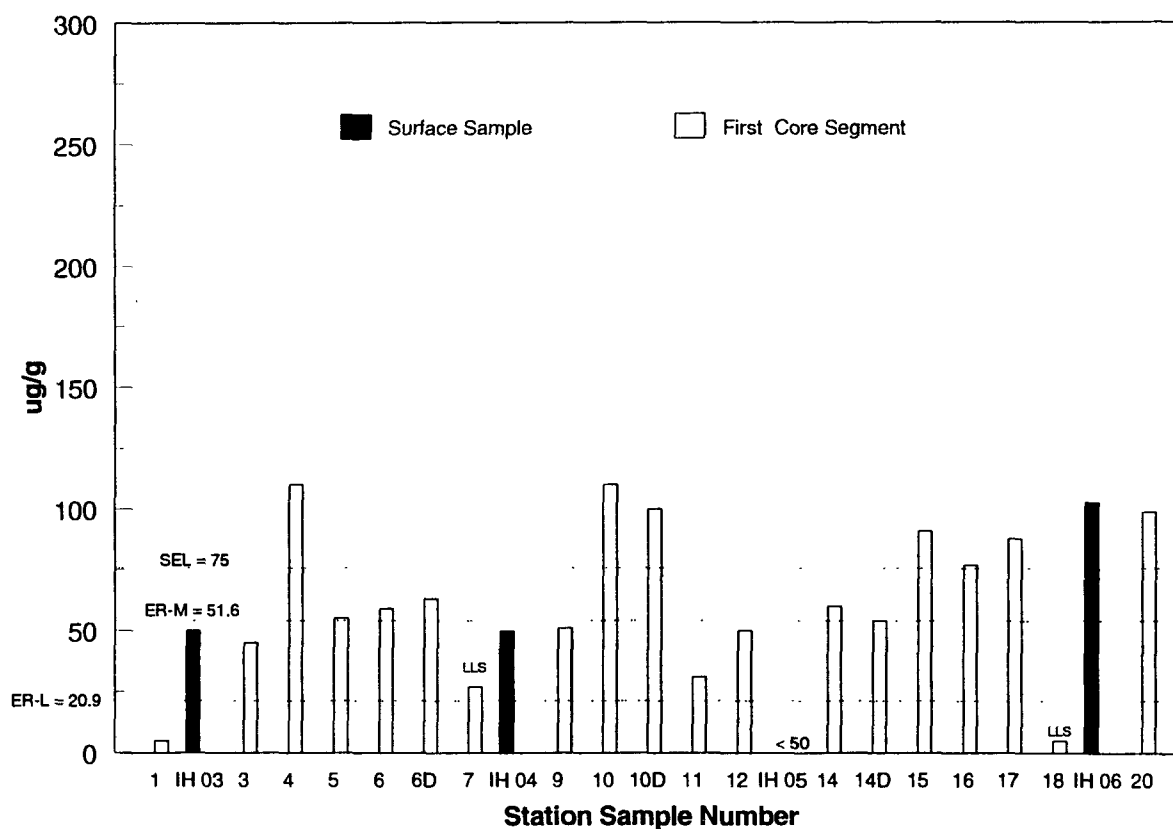
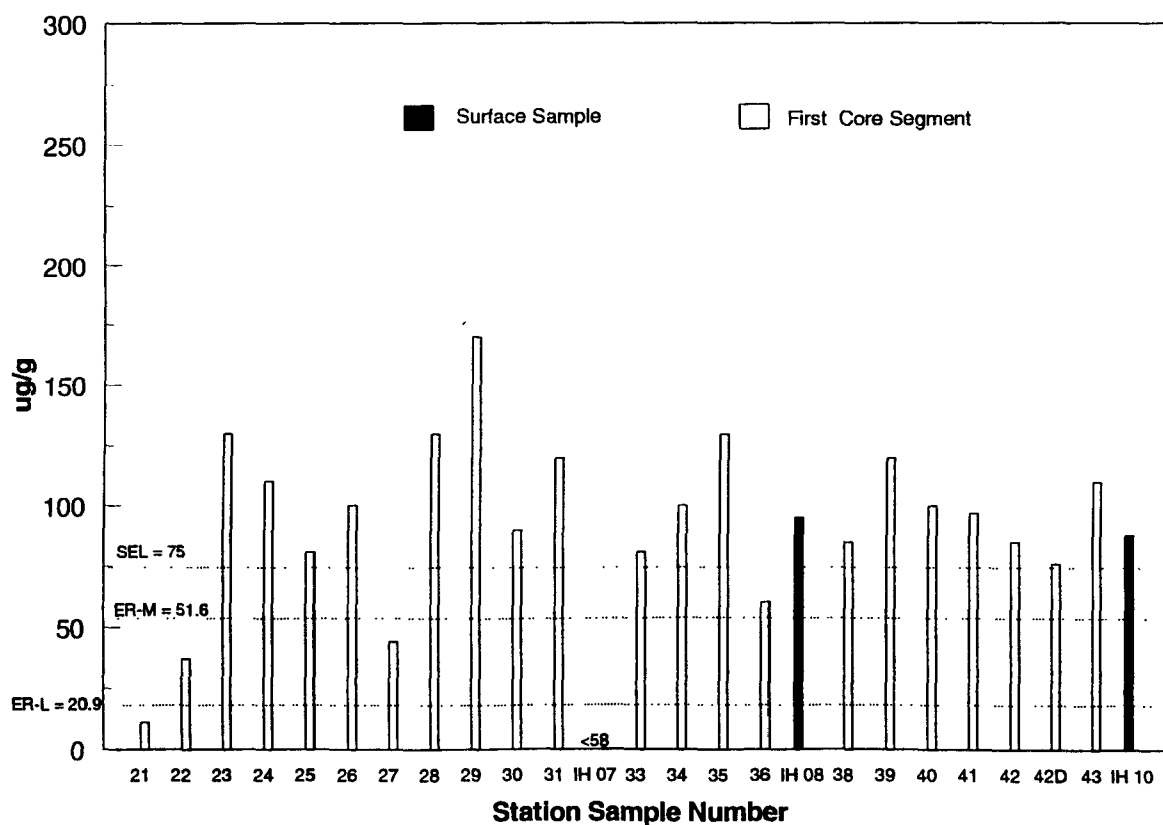


Figure 3.26 Nickel Concentration - Upstream Surface and First Core Samples



Figures 3.27 and 3.28 show the results of the Survey 2 second, third, and fourth core samples for nickel. Of the 36 second core samples, 32 exceeded the ER-L, 25 exceeded the ER-M, while 17 exceeded the SEL. The maximum concentration for the second core samples, 170 ug/g, occurred directly off of Columbus Drive at station 42 (core depth: 24-48 inches) near the end of the federal navigation channel.

Of the 29 third core samples, 23 exceeded the ER-L, 14 exceeded the ER-M, and 9 exceeded the SEL. The maximum concentration detected in the third core segment (560 ug/g) was also the maximum value detected for Survey 2 and was found in a duplicate sample at station 42 (core depth 84-108 inches) directly off of Columbus Drive. The third core segments located north of the forks in the Indiana Harbor Canal had significantly higher concentrations of nickel than any other core or surface locations. Finally, of the two fourth core samples, both exceeded the ER-L and the ER-M. The maximum concentration detected, 94 ug/g, which also exceeded the SEL, occurred at a duplicate sample at the southeast corner of the turning basin (station 10, core depth: 101-125 inches).

Figure 3.27 Nickel Concentration - Downstream 2nd, 3rd and 4th Core Samples

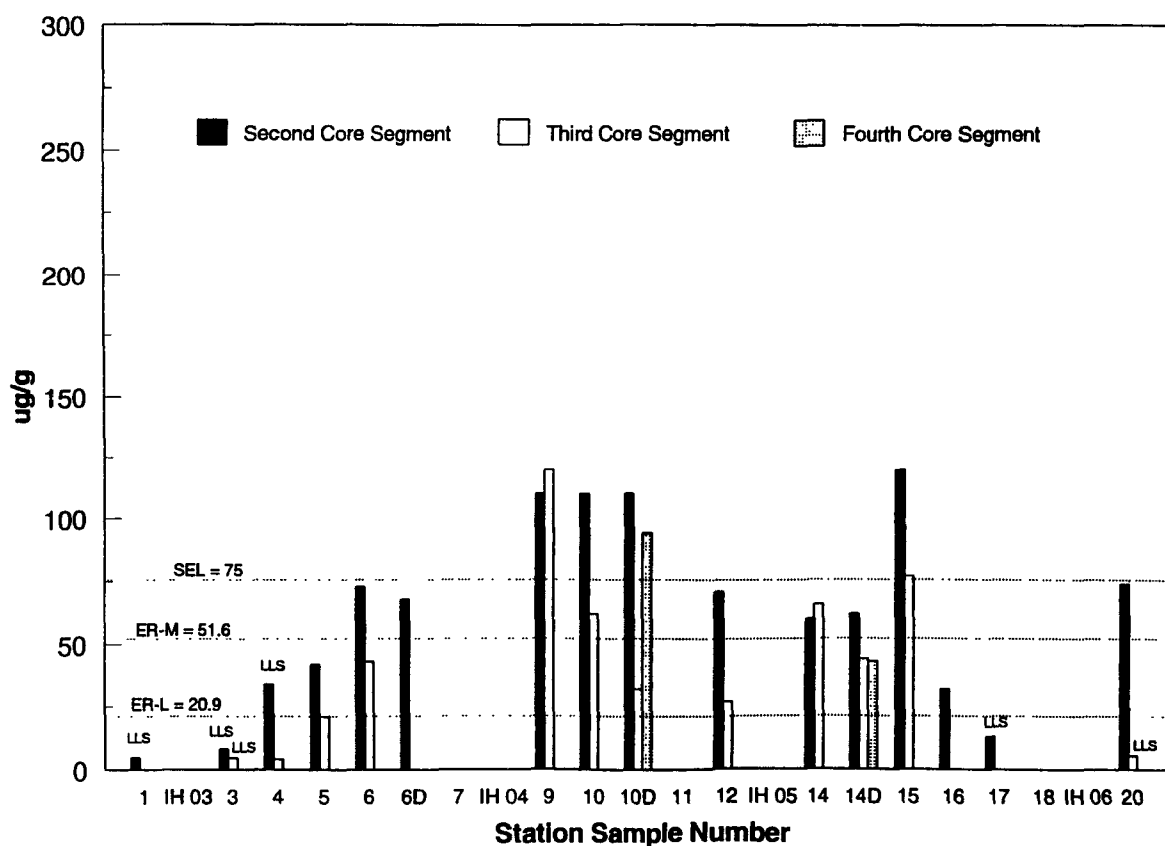
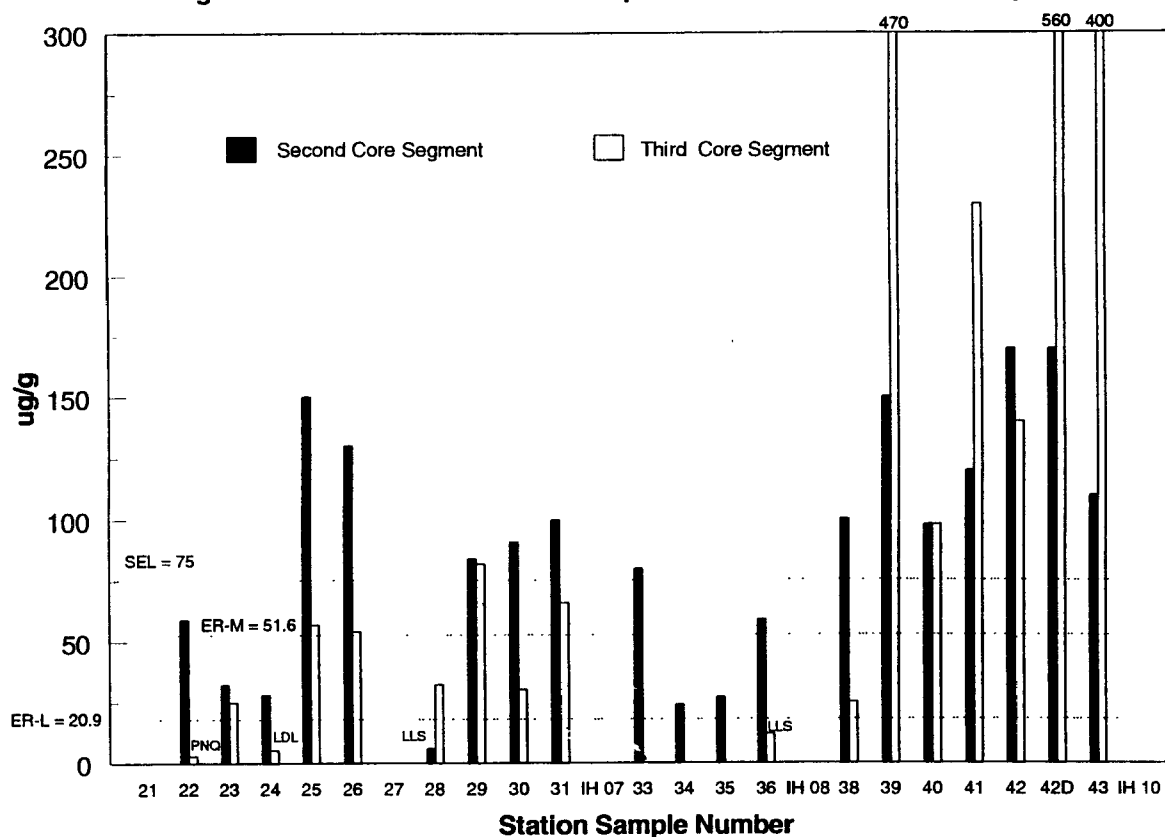


Figure 3.28 Nickel Concentration - Upstream 2nd and 3rd Core Samples



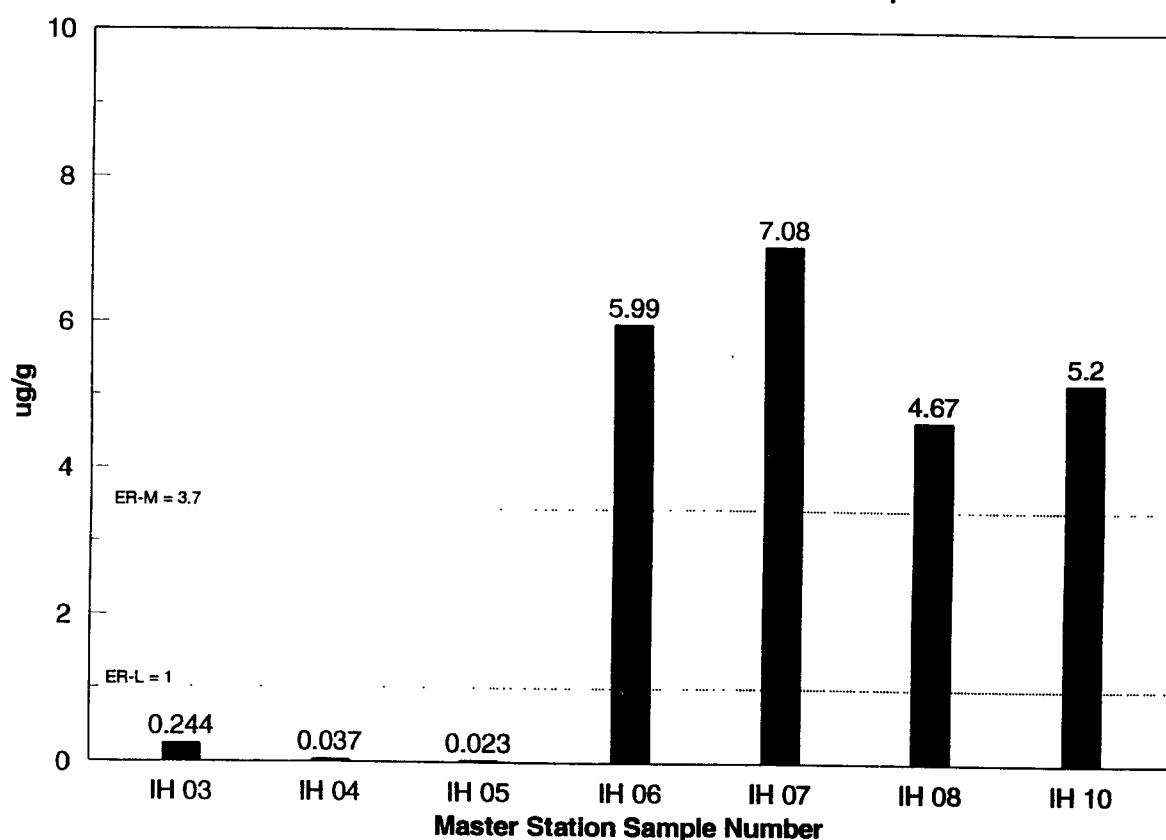
Silver

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	0.023	4.67	7.08	N/A	1	3.7	N/A
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g)

Silver concentrations detected in the Survey 1 grab samples are depicted in Figure 3.29. Of the seven samples, four stations exceeded both the ER-L and the ER-M. The maximum concentration of 7.08 ug/g was detected at location IH 07 at the forks and is more than twice the ER-M of 3.7 ug/g. As shown in Figure 3.29, silver levels increase significantly upstream of Dickey Road.

There are no Ontario guidelines for silver.

Figure 3.29 Silver Concentration - Surface Samples**Zinc**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	2,250	3,540	7,960	N/A	150	410	820
2	20 LLS	3,150	10,000				

N/A - Not Available
(All units are in ug/g)

Figures 3.30 and 3.31 show the results of the Survey 1 surface samples and the Survey 2 first core segments for zinc. All seven samples exceeded both the ER-L and ER-M as well as the SEL. The minimum concentration of 2,250 ug/g, found at station IH 04, is more than five times the ER-M of 410 ug/g. The maximum detected value of 7,960 ug/g was detected at station IH 07 at the forks and is more than 19 times the ER-M of 410 ug/g and more than nine times the SEL of 820 ug/g.

Of the 41 first core segments in Survey 2, 38 exceeded the ER-L, 36 exceeded the ER-M, and 35 exceeded the SEL. The maximum detected concentration of 9,300 ug/g was found upstream of Canal Street at station 30 at a depth of 0-24 inches. This concentration is more than 22 times the ER-M and more than 11 times the SEL.

Figure 3.30 Zinc Concentration - Downstream Surface and First Core Samples

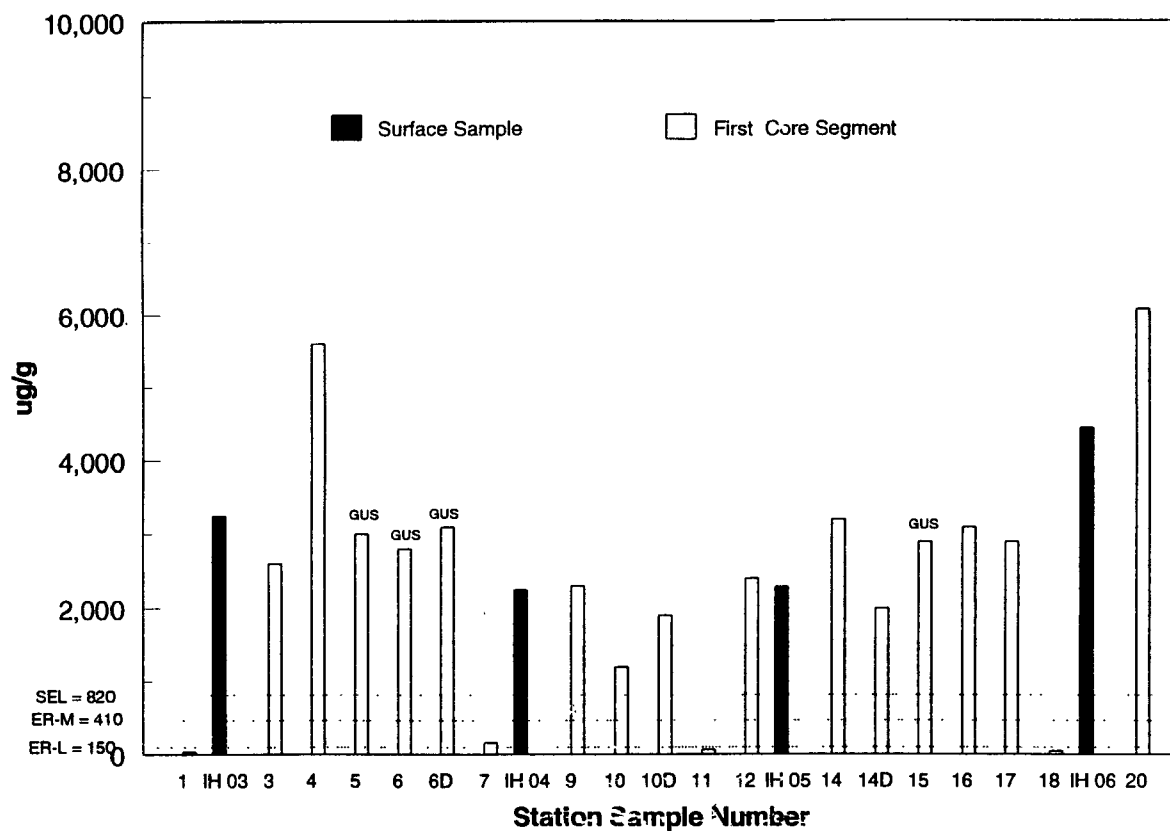
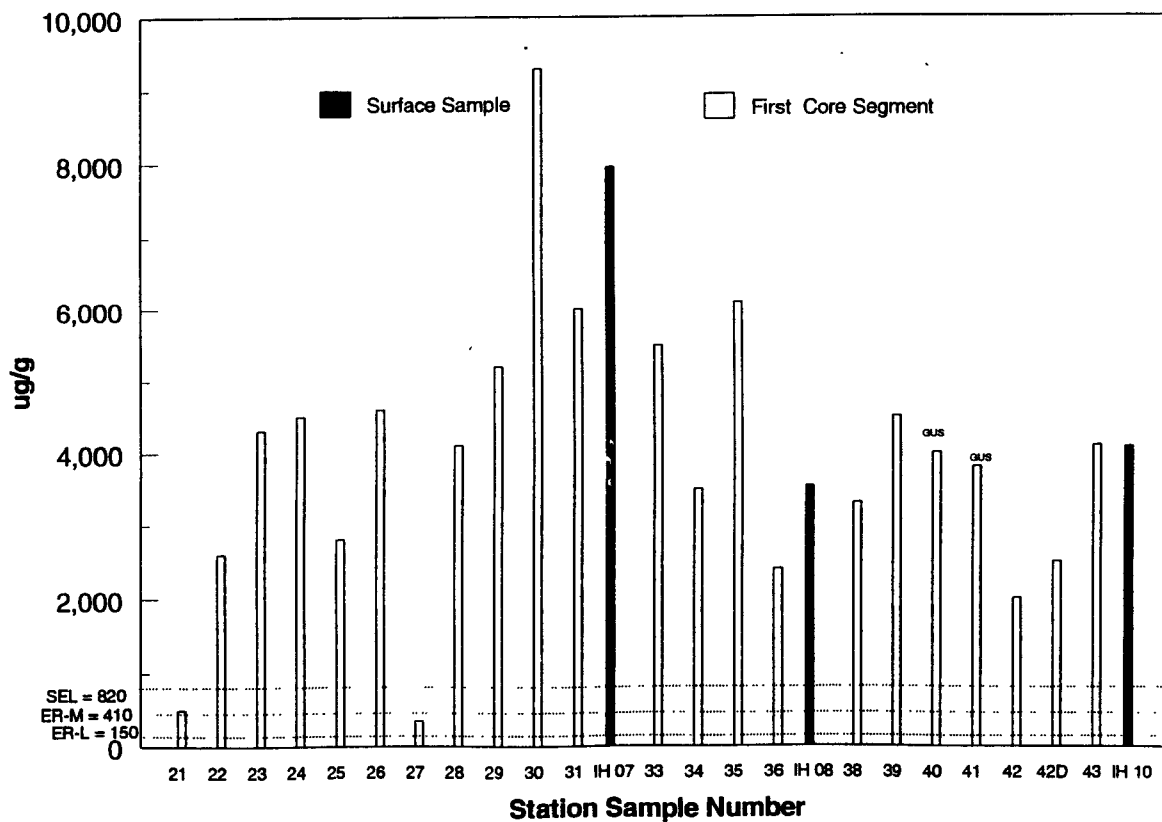


Figure 3.31 Zinc Concentration - Upstream Surface and First Core Samples



Figures 3.32 and 3.33 depict the results of the Survey 2 second, third, and fourth core samples for zinc. Of the 36 second core samples, 31 exceeded the ER-L, 29 exceeded the ER-M, while 29 exceeded the SEL. The maximum detected concentration for the second core samples, as well as the maximum detected zinc concentration for Survey 2, was 10,000 ug/g and was found upstream of Canal Street at station 30 (core depth: 48-72 inches). This location also had the highest zinc concentration for the first core segment.

Of the 29 third core samples, 21 exceeded the ER-L and ER-M, and 19 exceeded the SEL. The maximum concentration for the third core samples, 9,500 ug/g, occurred at station 40 (84-109 inches), just downstream from Columbus Drive. Finally, of the two fourth core samples, both exceeded both the ER-L and ER-M as well as the SEL with a maximum concentration of 3,200 ug/g occurring in a duplicate sample at station 14 (core depth: 156-179 inches) directly off of the ConRail railroad tracks.

Figure 3.32 Zinc Concentration - Downstream 2nd, 3rd and 4th Core Samples

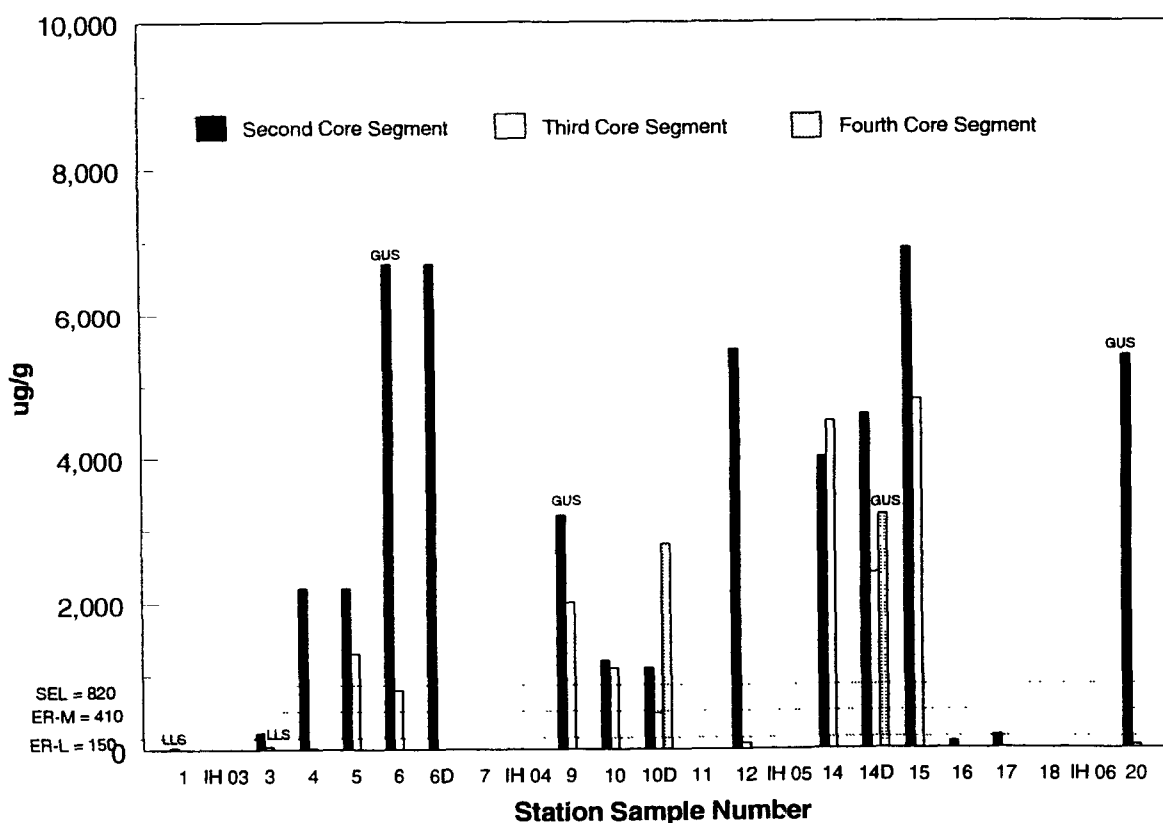
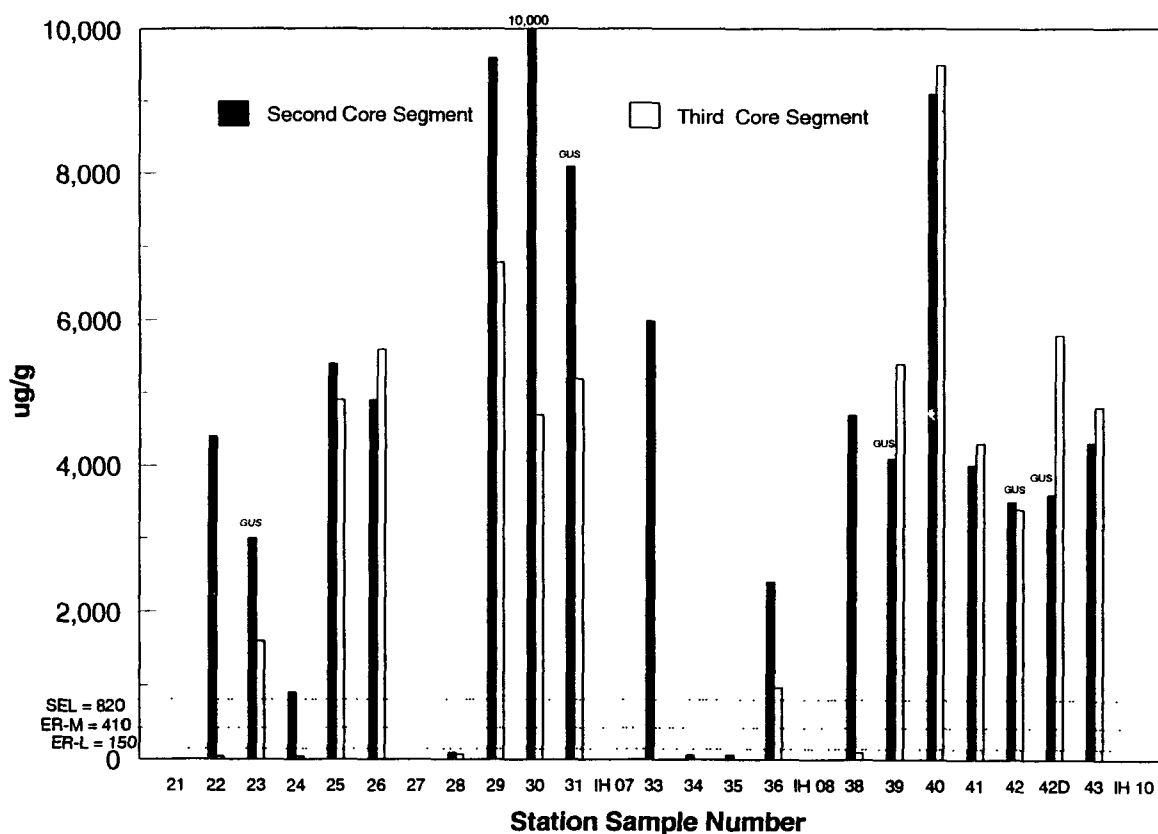


Figure 3.33 Zinc Concentration - Upstream 2nd and 3rd Core Samples

**Anthracene**

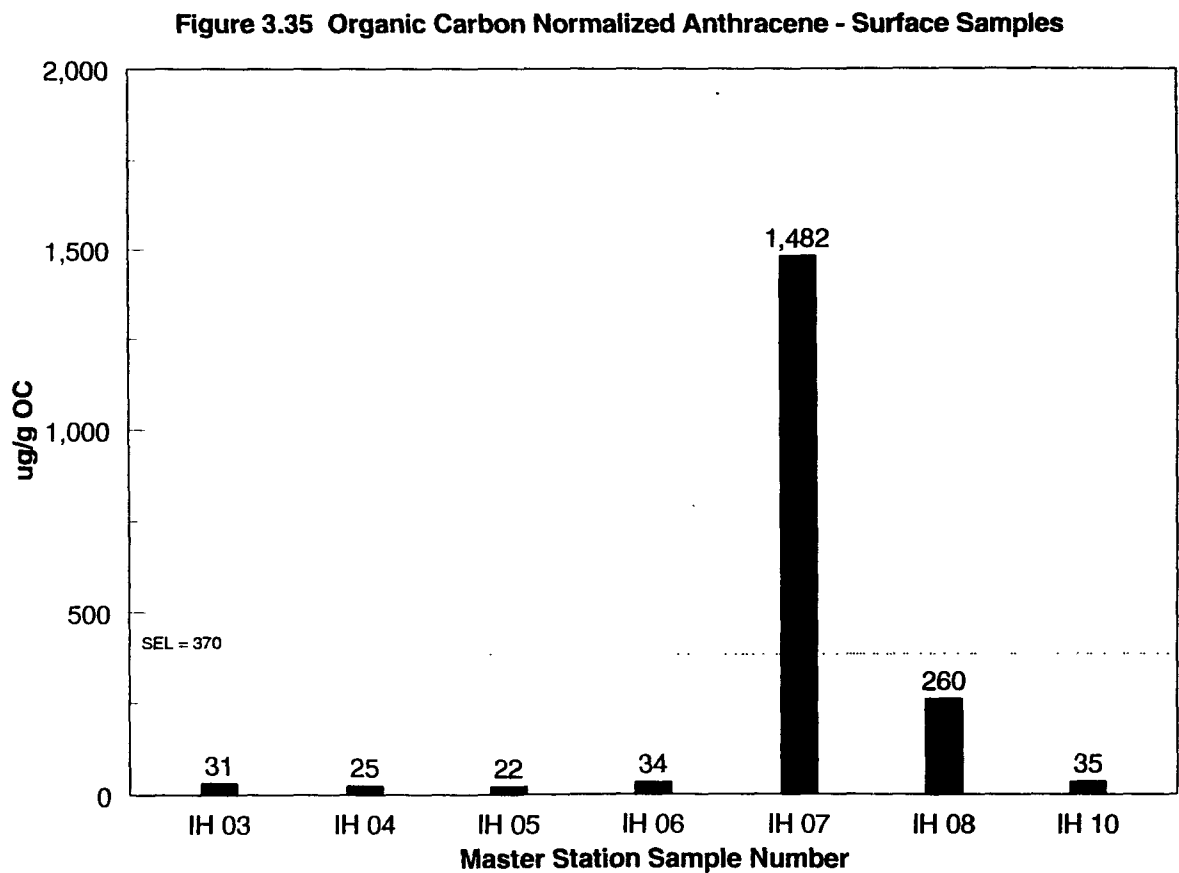
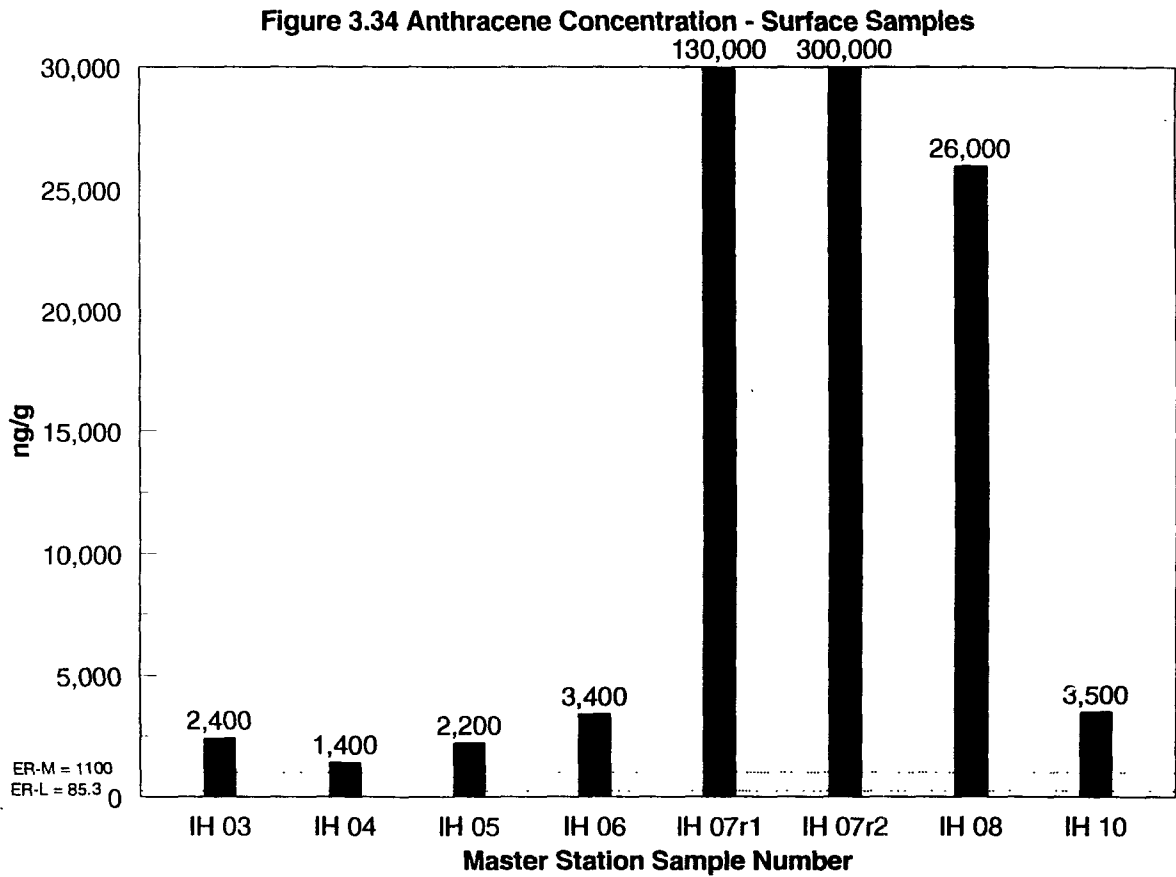
Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	1,400	3,450	300,000	N/A	85.3	1,100	370 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Figure 3.34 shows the results of the Survey 1 surface samples for anthracene. Of the eight samples analyzed (one replicate), all eight exceeded the ER-M of 1,100 ng/g. The maximum concentration of 300,000 ng/g, found at the replicate sample from station IH 07 located at the forks, is more than 270 times the ER-M. Station IH 07, with concentrations of 130,000 ng/g and 300,000 ng/g, is far greater than any other sampling location. Station IH 08, located at Indianapolis Boulevard in the Lake George Branch, had the next highest concentration; 26,000 ng/g. This value far exceeds the next closest concentration found at Columbus Drive at station IH 10 where a concentration of 3,500 ng/g was detected.

Figure 3.35 depicts the anthracene concentrations normalized to total organic carbon (the replicate for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 370 ug/g OC, only one location, station IH 07, exceeds the guideline with an organic carbon normalized concentration of 1,482 ug/g OC. The next highest value is found at station IH 08 with a value of 260 ug/g OC. All other locations are well below the SEL.



Benz(a)anthracene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	4,200	11,650	39,000	N/A	261	1,600	1,480 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Figure 3.36 shows the results of the Survey 1 surface samples for benz(a)anthracene. Of the eight samples analyzed (including one replicate), all eight exceeded the ER-M of 1,600 ng/g. The minimum concentration of 4,200 ng/g, found at station IH 04 located in the turning basin, is three times the ER-M while the maximum concentration of 39,000 ng/g, found at the replicate sample from station IH 07 located at the forks, is more than 24 times the ER-M. Station IH 08, located at Indianapolis Boulevard in the Lake George Branch had the next highest concentration; 30,000 ng/g.

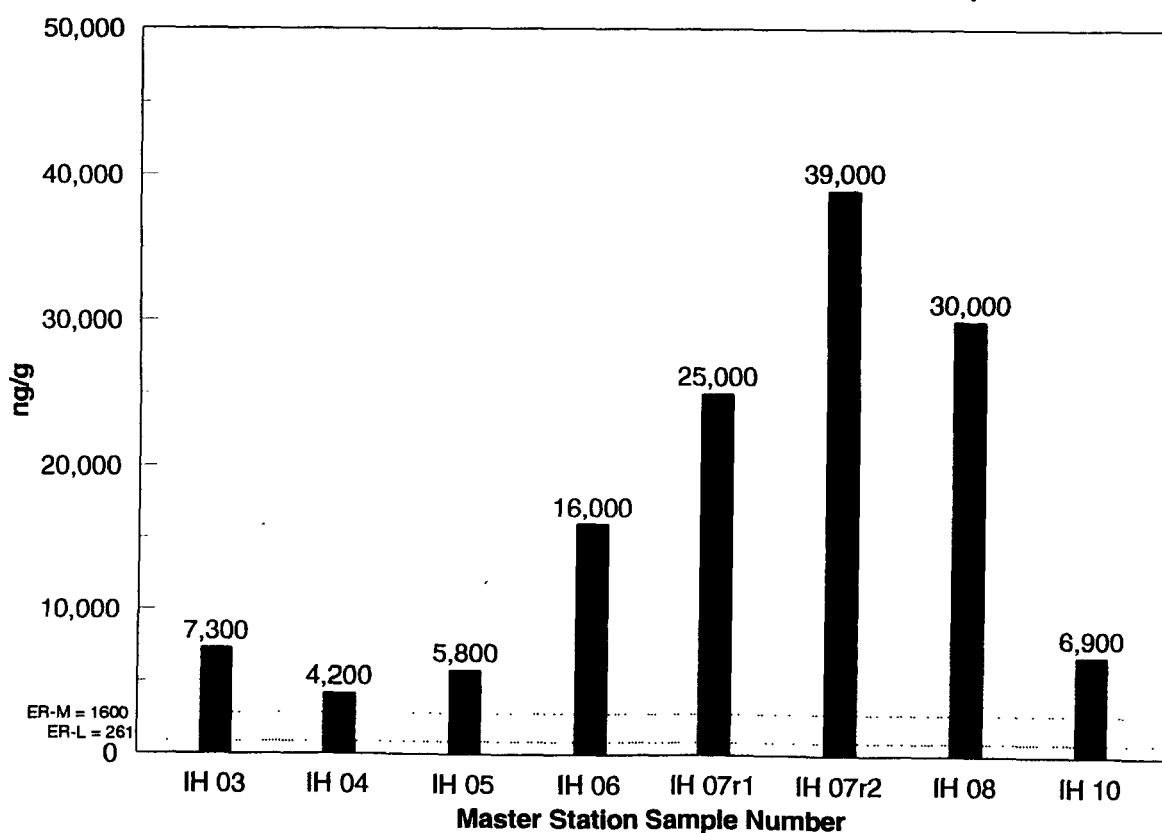
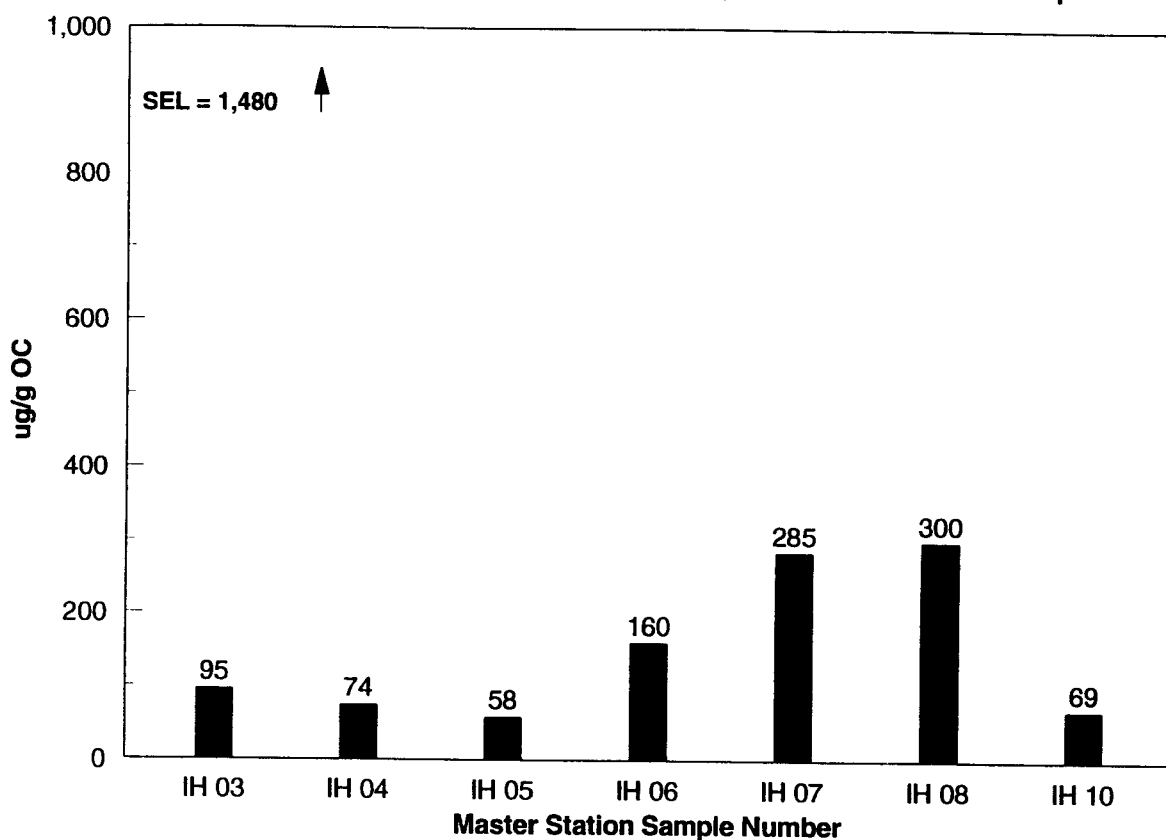
Figure 3.36 Benz(a)anthracene Concentration - Surface Samples

Figure 3.37 depicts the benz(a)anthracene concentrations normalized to total organic carbon (the replicate for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 1,480 ug/g OC, all locations fall well below this guideline with the maximum concentration of 300 ug/g OC found at station IH 08. Station IH 07 fell closely behind station IH 08 with an organic carbon normalized concentration of 285 ug/g OC, even further below the SEL.

Figure 3.37 Organic Carbon Normalized Benz(a)anthracene - Surface Samples***Benzo(a)pyrene***

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	5,700	15,500	41,000	N/A	430	1,600	1,440 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

As shown in Figure 3.38, all eight samples analyzed (including one replicate) for benzo(a)pyrene exceeded the ER-M of 1,600 ng/g. The minimum concentration of 5,700 ng/g, found at station IH 05 located by the ConRail railroad tracks, is more than three times the ER-M while the maximum concentration of 41,000 ng/g, found at the replicate sample from station IH 07 located at the forks, is more than 25 times the ER-M of 1,600 ng/g. Station IH 08, located further upstream in the Lake George Branch had the next highest concentration of 29,000 ng/g, also well above the ER-M.

Figure 3.39 depicts the benzo(a)pyrene concentrations normalized to total organic carbon (the replicate for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 1,440 ug/g OC, all locations fall well below this guideline. The maximum concentration of 290 ug/g OC was found at station IH 08 situated in the Lake George Branch. Station IH 06, located at Dickey Road, falls closely behind station IH 08 with an organic carbon normalized concentration of 250 ug/g OC.

Figure 3.38 Benzo(a)pyrene Concentration - Surface Samples

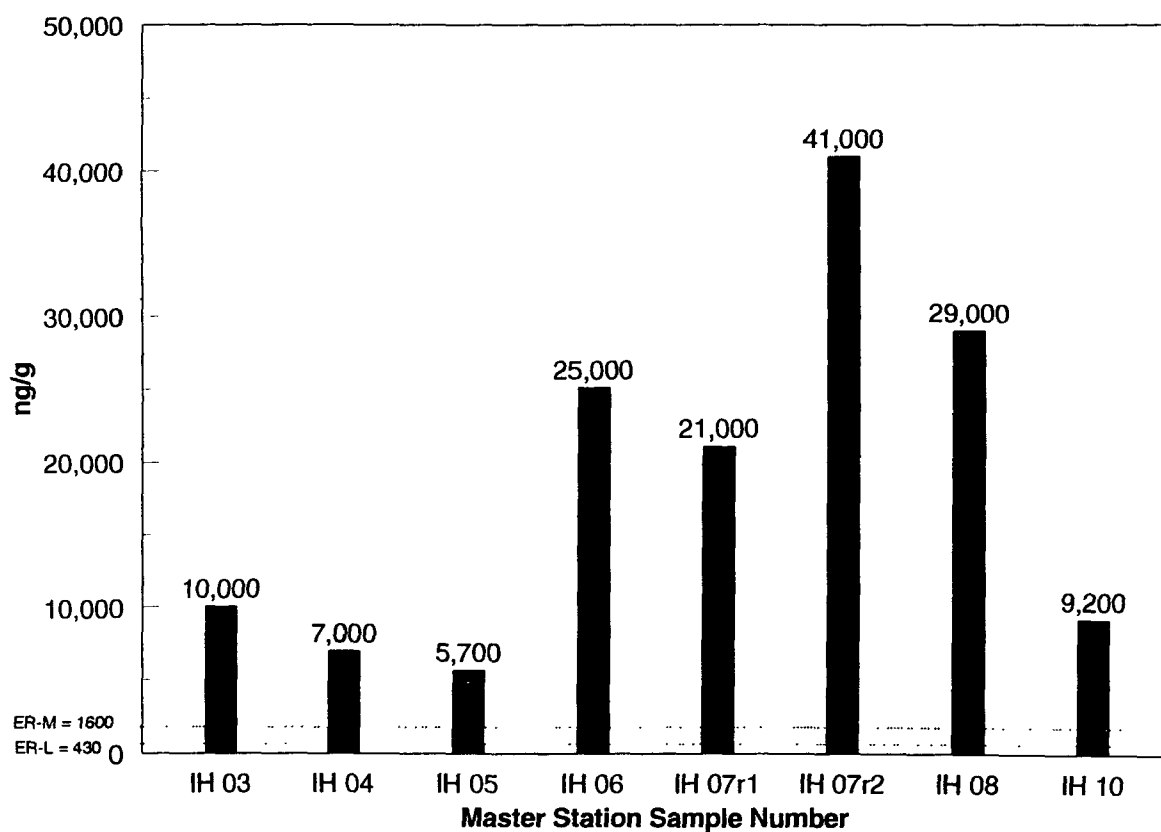
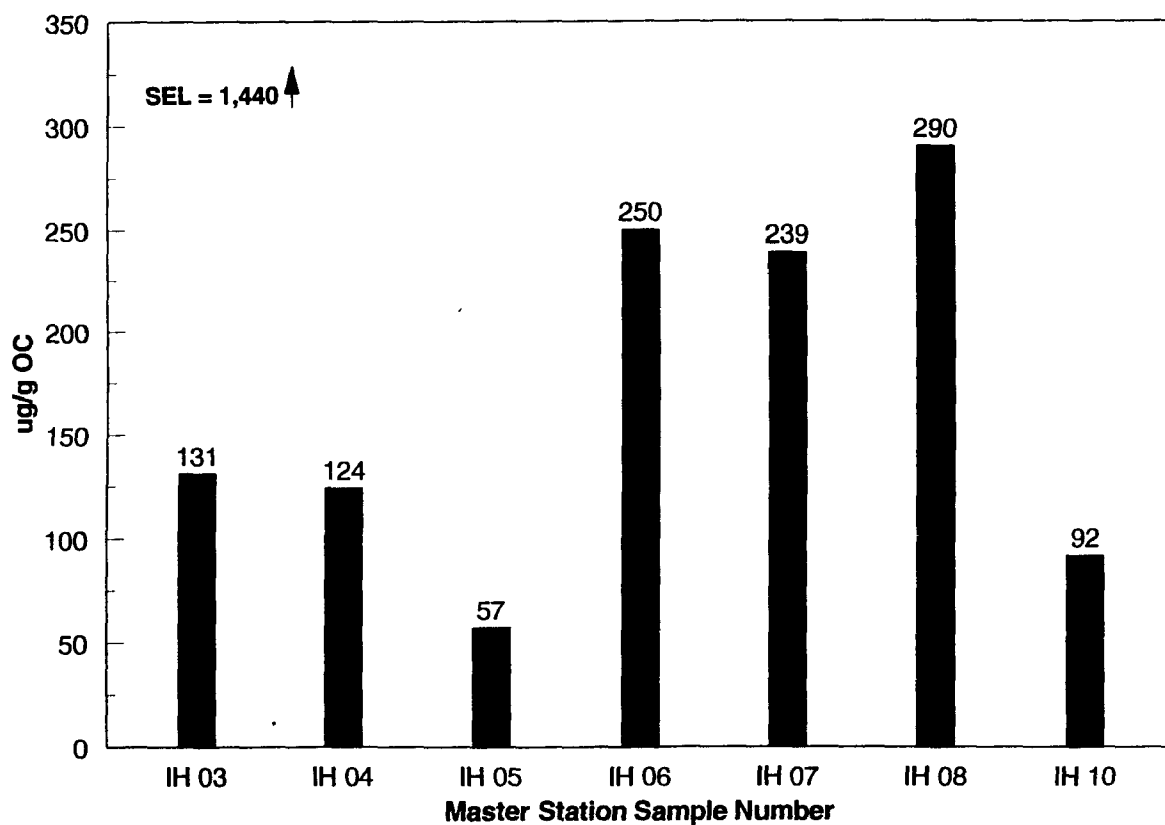


Figure 3.39 Organic Carbon Normalized Benzo(a)pyrene - Surface Samples



Benzo(g,h,i)perylene

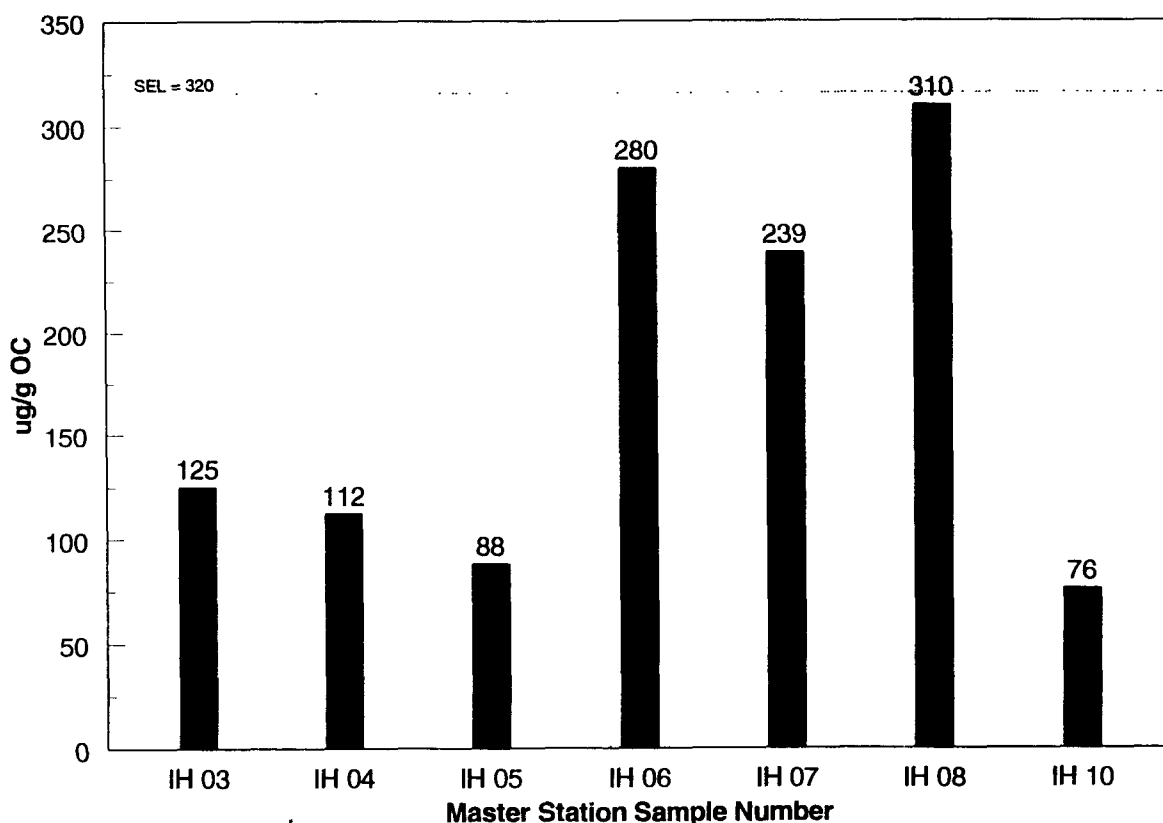
Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	76	125	310	N/A	N/A	N/A	320
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g OC)

Organic carbon-normalized concentrations for benzo(g,h,i)perylene for the seven surface samples from Survey 1 are shown in Figure 3.40. As indicated in the chart, none of the locations exceed the SEL of 320 ug/g OC. The maximum concentration of 310 ug/g OC was found at station IH 08 located at Indianapolis Boulevard in the Lake George Branch. Stations IH 06 and IH 07, located by Dickey Road and at the forks, are where the next highest values of 280 ug/g OC and 239 ug/g OC were found.

There are no L&M effects ranges for benzo(g,h,i)perylene.

Figure 3.40 Organic Carbon Normalized Benzo(g,h,i)perylene - Surface Samples



Benzo(k)fluoranthene

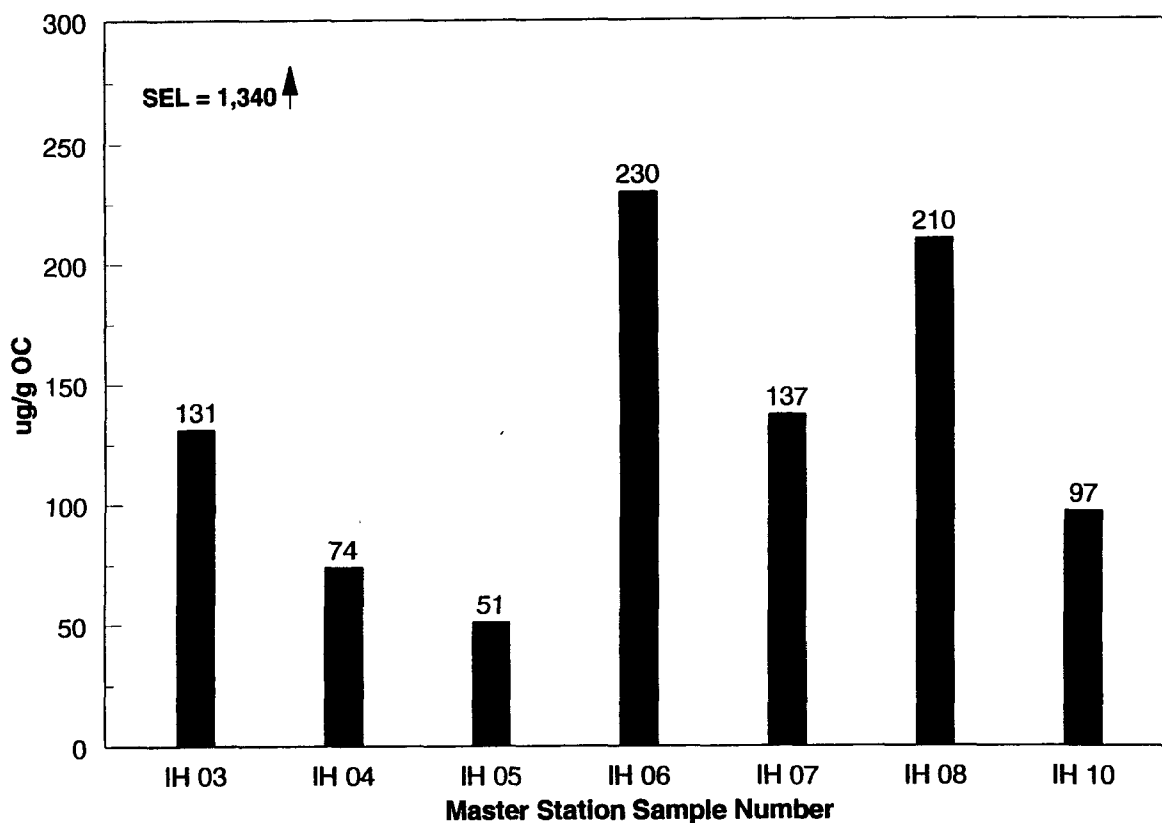
Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	51	131	230	N/A	N/A	N/A	1,340
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g OC)

Figure 3.41 shows the organic carbon-normalized benzo(k)fluoranthene concentrations for the seven surface samples from Survey 1. As indicated in the bar chart, none of the locations exceed the SEL of 1,340 ug/g OC. The maximum concentration of 230 ug/g OC, found at station IH 06 at Dickey Road, is well below the SEL. Station IH 08, located at Indianapolis Boulevard in the Lake George Branch falls closely behind station IH 06 with a concentration of 210 ug/g OC.

There are no L&M effects ranges for benzo(k)fluoranthene.

Figure 3.41 Organic Carbon Normalized Benzo(k)fluoranthene - Surface Samples



Chrysene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	5,200	16,700	39,000	N/A	384	2,800	460 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Figure 3.42 shows the results of the Survey 1 surface samples for chrysene. Of the eight samples analyzed (including one replicate), all eight exceeded the ER-M of 2,800 ng/g. The maximum concentration of 39,000 ng/g, found at the replicate sample from station IH 07 located, at the forks is almost 14 times the ER-M. Station IH 08, located at Indianapolis Boulevard, had the next highest concentration with 33,000 ng/g. The lowest concentration was found at station IH 04 situated in the turning basin with a concentration of 5,200 ng/g, well above the ER-M.

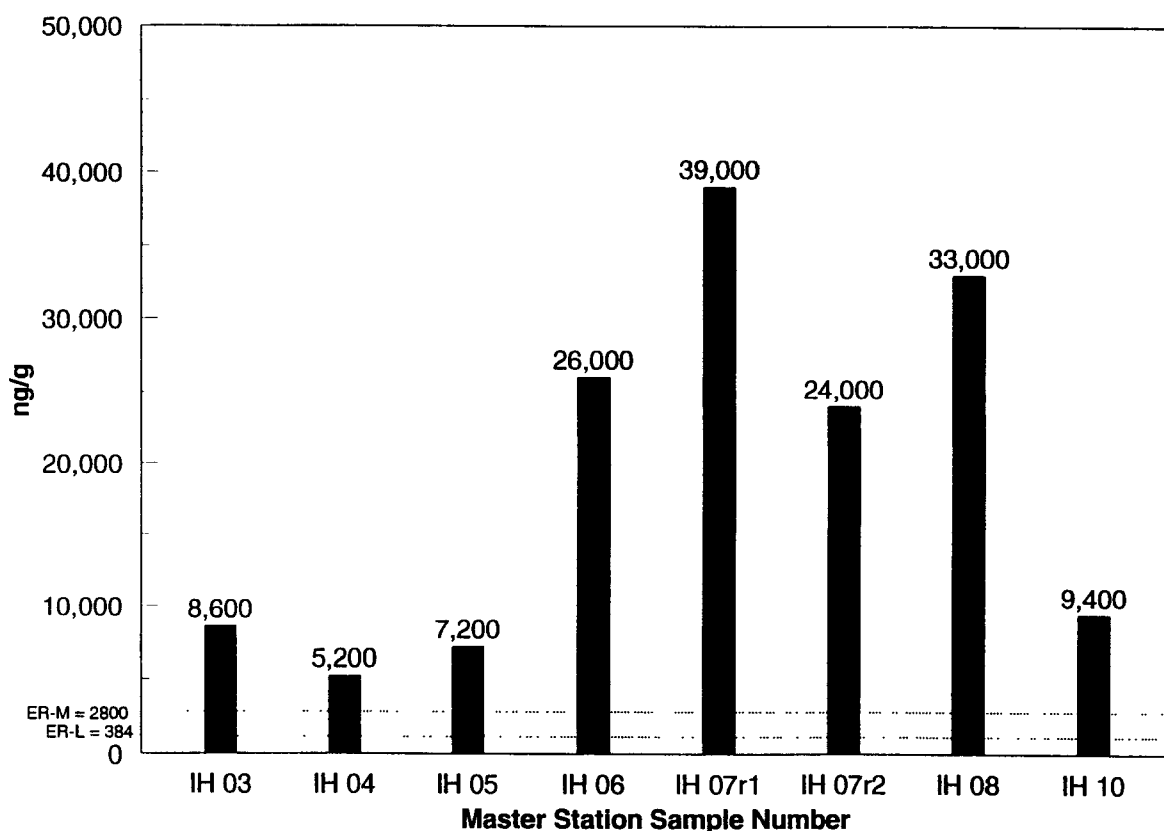
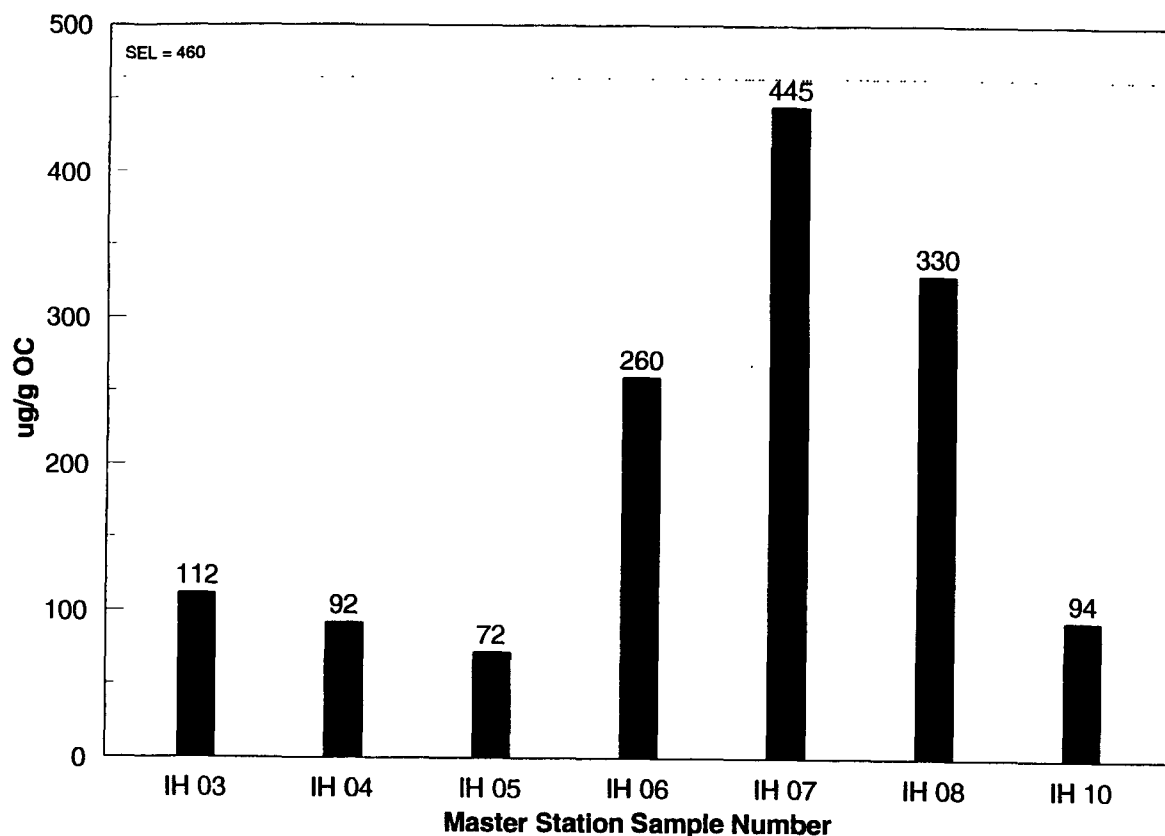
Figure 3.42 Chrysene Concentration - Surface Samples

Figure 3.43 depicts the chrysene concentrations for the Survey 1 surface samples as normalized to total organic carbon (the replicate for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 460 ug/g OC, none of the locations exceed the guideline. Station IH 07 (at the forks) comes closest with a concentration of 445 ug/g OC. Station IH 08 is next with a concentration of 330 ug/g OC.

Figure 3.43 Organic Carbon Normalized Chrysene - Surface Samples***Fluoranthene***

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	4,800	11,800	120,000	620 ug/g OC	600	5,100	1,020 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Fluoranthene concentrations found in Survey 1 are depicted in Figure 3.44. Of the eight samples analyzed (including one replicate), seven exceeded the ER-M of 5,100 ng/g and all eight exceeded the ER-L of 600 ng/g. The maximum concentration of 120,000 ng/g, found at the replicate sample from station IH 07 located at the forks, is more than 20 times the ER-M. Station IH 08 at Indianapolis Boulevard had the next highest concentration; 56,000 ng/g. The lowest concentration was found in the turning basin at station IH 04 with a concentration of 4,800 ng/g, well above the ER-L, but below the ER-M.

Figure 3.45 depicts the fluoranthene concentrations as normalized to total organic carbon (replicate 2 for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 1,020 ug/g OC, all the locations fall well below this guideline with a maximum value of 560 ug/g OC found in the Lake George Branch at station IH 08. Station IH 07 had the second highest concentration with a reported value of 456, even further below the SEL.

Figure 3.44 Fluoranthene Concentration - Surface Samples

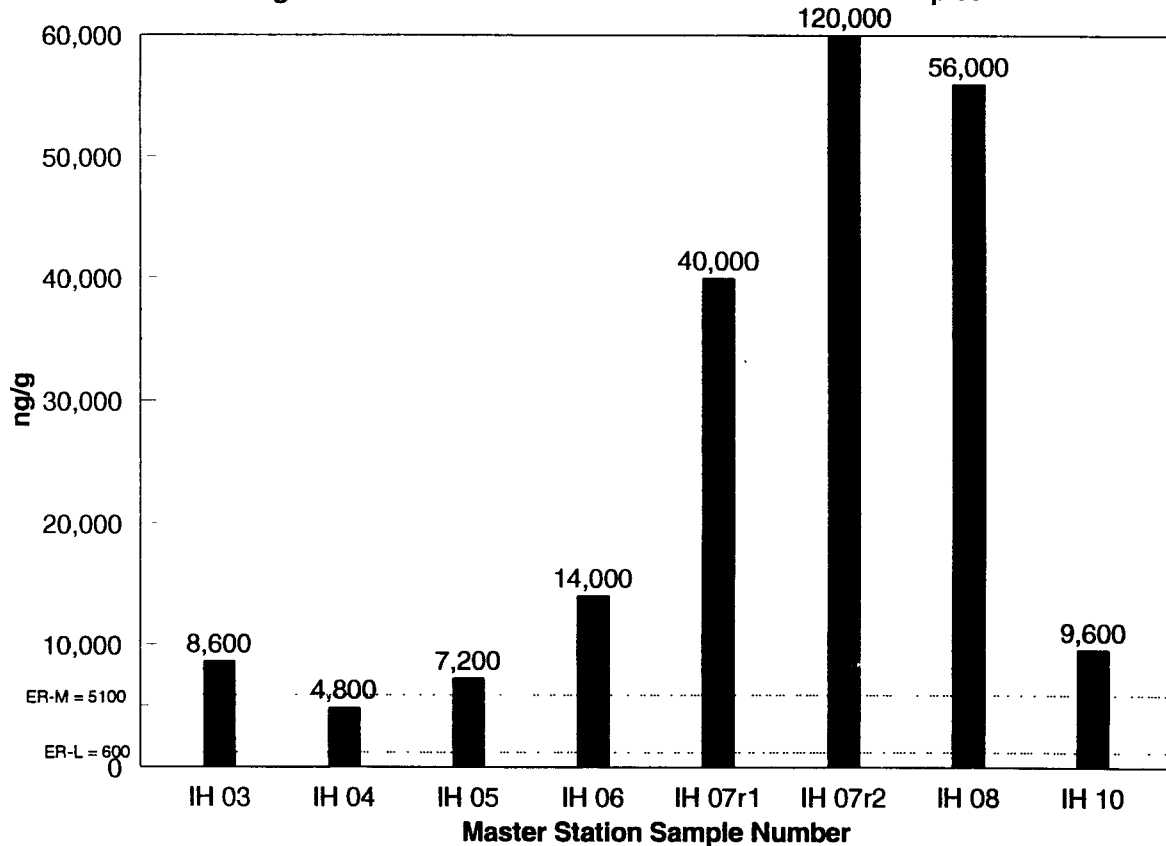
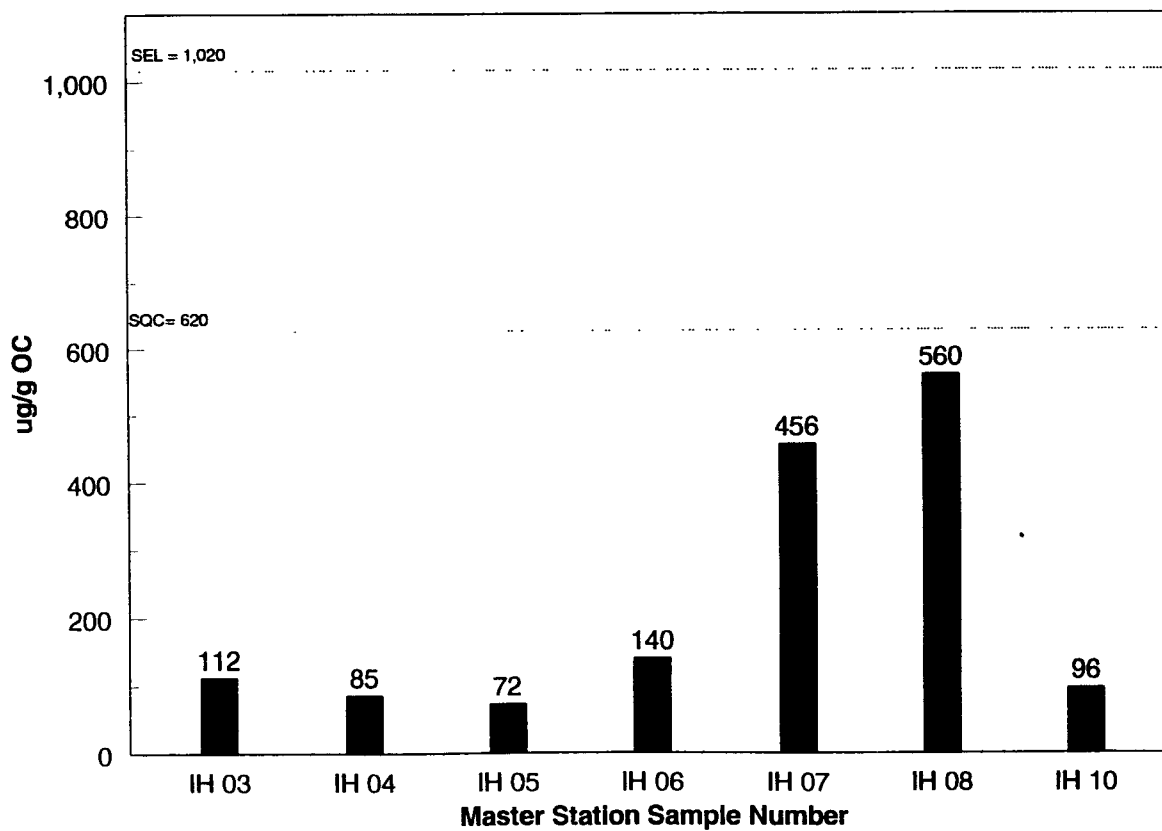


Figure 3.45 Organic Carbon Normalized Fluoranthene - Surface Samples



As indicated in Figure 3.45, when the organic carbon normalized values are compared to EPA's EqP SQC of 620 ug/gOC, all locations fall below this guideline.

Fluorene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	< 61	3,200	61,000	N/A	19	540	160 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Figure 3.46 shows the results of the surface samples from Survey 1 for fluorene. Of the eight samples, seven exceeded both the ER-L and the ER-M. The maximum and minimum concentrations for fluorene were found at the same location, station IH 07. The maximum concentration of 61,000 ng/g is more than 100 times the ER-M and is much higher than the second highest concentration of 12,000 ng/g found at station IH 08 located in the Lake George Branch. The minimum value detected, < 61 ng/g, was found at the replicate for station IH 07 which is located at the forks.

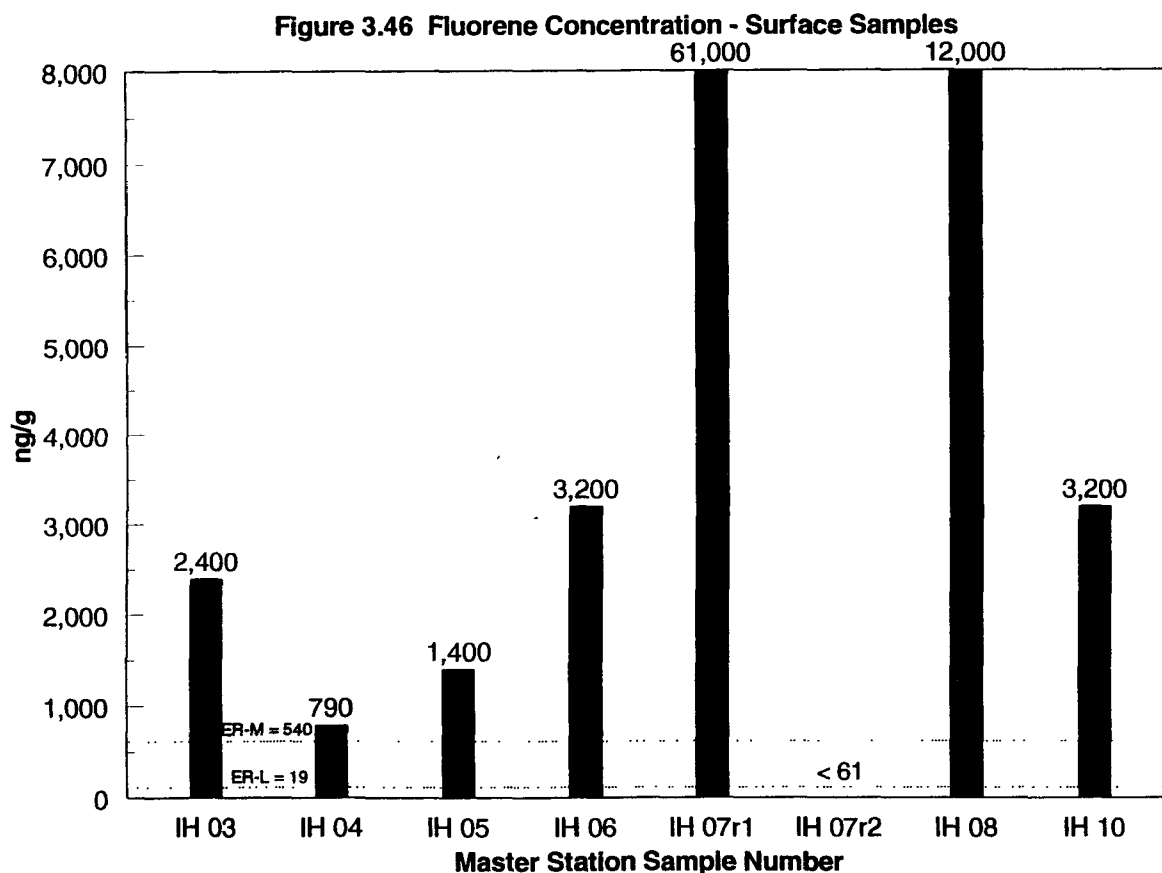
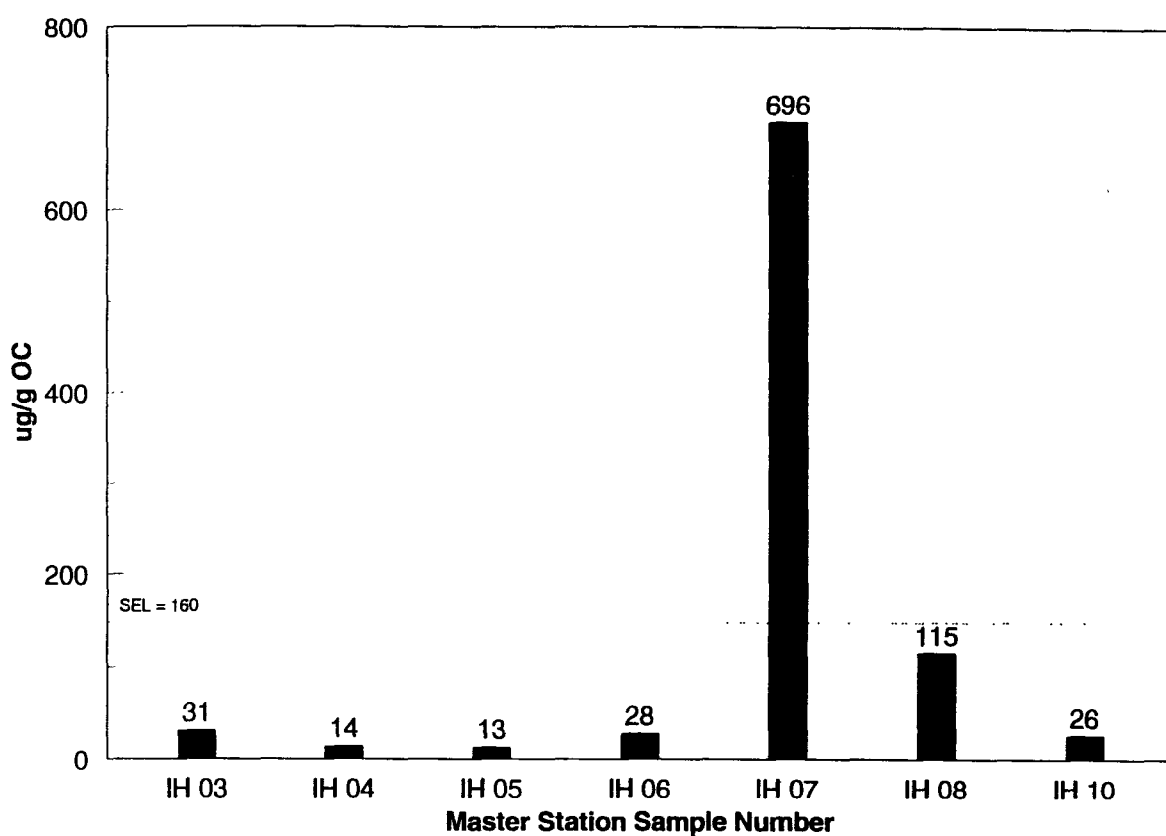


Figure 3.47 depicts the fluorene concentrations as normalized to total organic carbon (replicate 2 for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 160 ug/g OC, only one location, station IH 07 located at the forks with a concentration of 696 ug/g OC, exceeded this guideline. This concentration far exceeded the next highest concentration of 115 ug/g OC found at station IH 08 located in the Lake George Branch. All the other stations fell well below the SEL.

Figure 3.47 Organic Carbon Normalized Fluorene - Surface Samples



Indeno[1,2,3-cd]chrysene

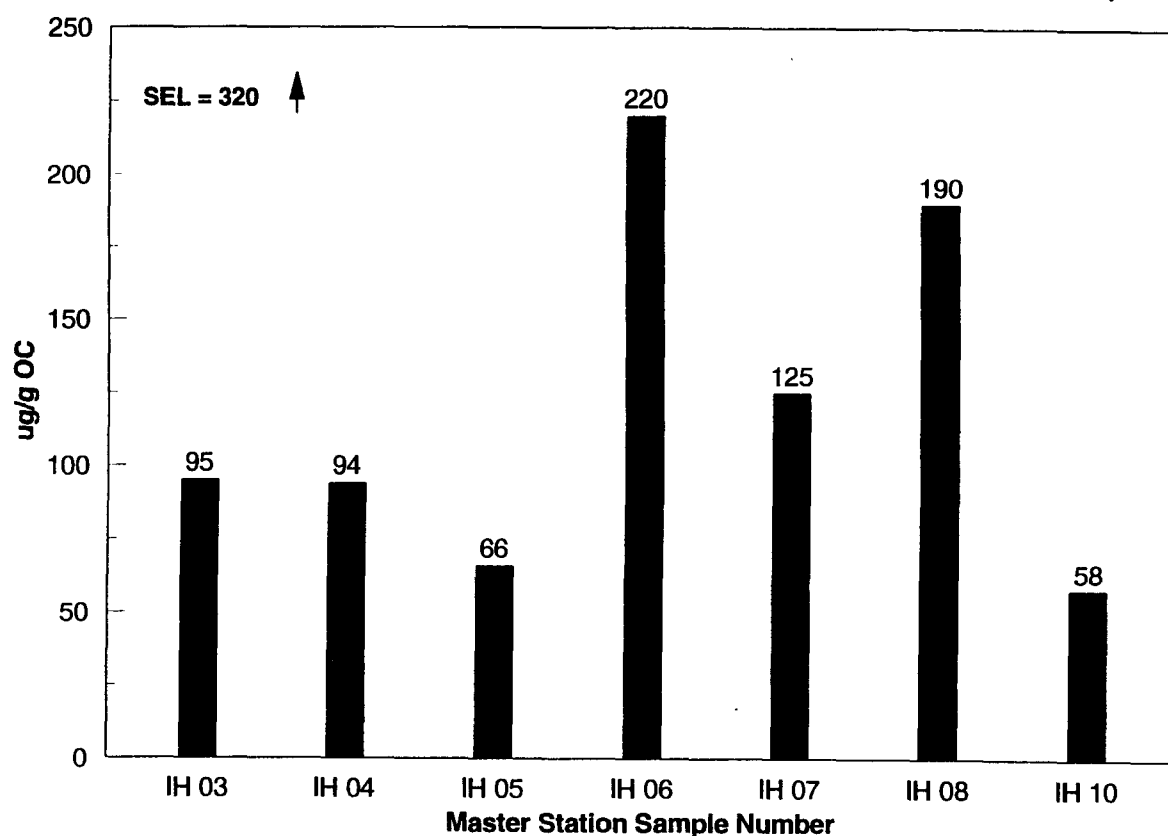
Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	58	95	220	N/A	N/A	N/A	320 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ug/g OC)

The organic carbon-normalized concentrations for indeno[1,2,3]chrysene for the seven surface samples from Survey 1 are depicted in Figure 3.48. As indicated in the bar chart, none of the locations exceed the SEL of 320 ug/g OC. The maximum concentration of 220 ug/g OC was found at station IH 06 located at Dickey Road. The second highest concentration of 190 ug/g OC was found at station IH 08 located in the Lake George Branch.

There are no L&M effects ranges for indeno[1,2,3-cd]chrysene.

Figure 3.48 Organic Carbon Normalized Indeno[1,2,3-cd]chrysene - Surface Sample

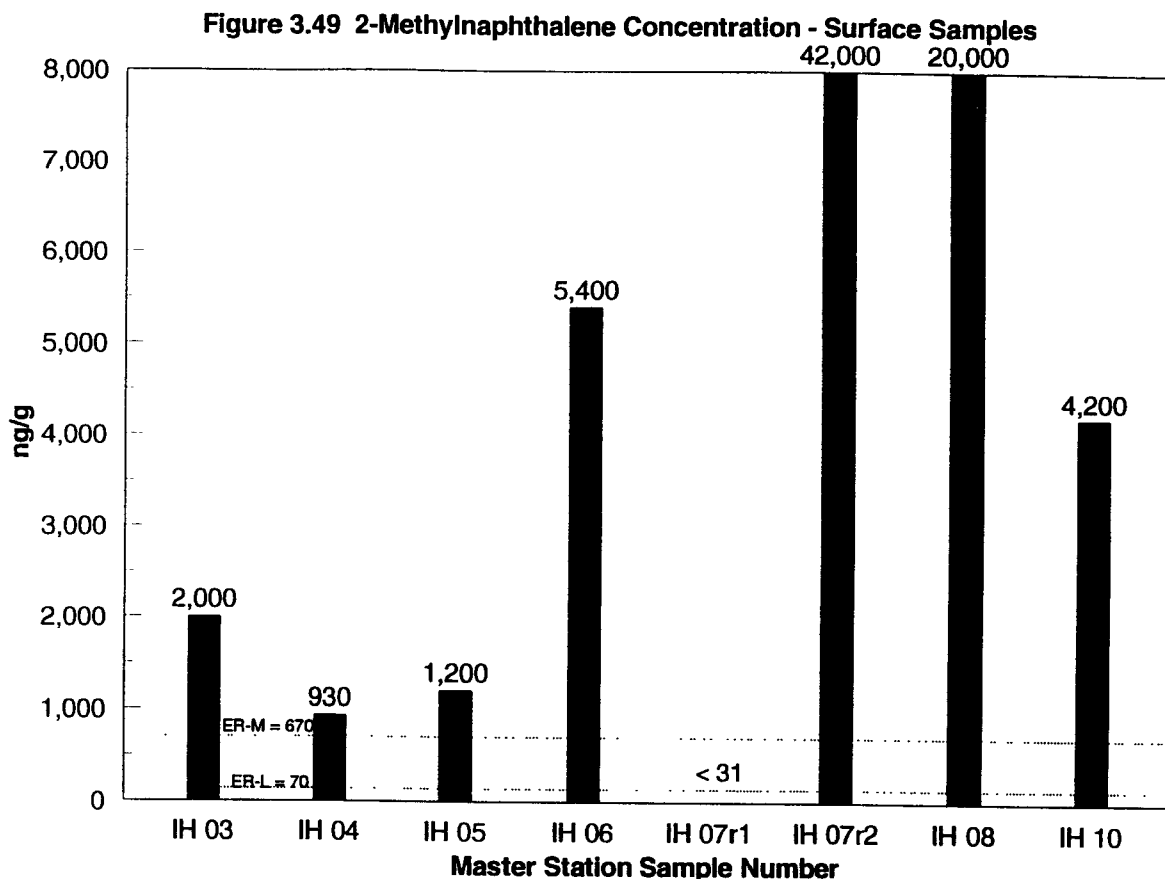


2-Methylnaphthalene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	< 31	2,600	42,000	N/A	70	670	N/A
2	N/A	N/ A	N/A				

N/A - Not Available
(All units are in ng/g)

Figure 3.49 shows the results of the surface samples from Survey 1 for 2-methylnaphthalene. Of the eight samples, seven exceeded both the ER-L and the ER-M. The maximum concentration of 42,000 ng/g was found at station IH 07 at the forks. This concentration exceeds the ER-M of 670 ng/g by more than 60 times. This concentration is twice as high as the second greatest concentration of 20,000 ng/g found at station IH 08 located in the Lake George Branch.



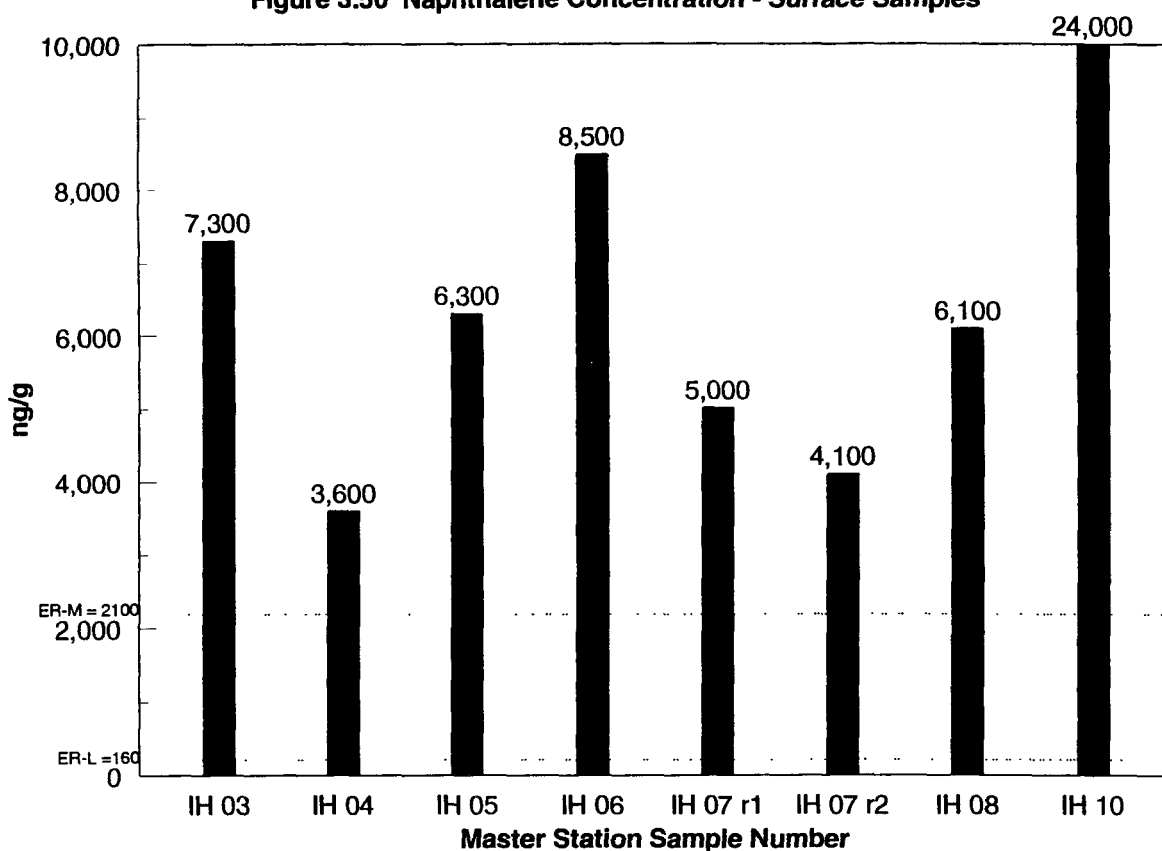
Naphthalene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	3,600	6,200	24,000	N/A	160	2,100	N/A
2	N/A	N/A	N/A				

N/A - Not Available
(All units are in ng/g)

Figure 3.50 shows the results of the surface samples from Survey 1 for naphthalene. All of the eight samples exceeded the ER-M of 2,100 ng/g with the maximum concentration of 24,000 ng/g found upstream of the forks at Columbus Drive (IH 10). This sample is more than 10 times the ER-M and is almost three times more than the next highest concentration of 8,500 ng/g found at station IH 06 located at Dickey Road.

Figure 3.50 Naphthalene Concentration - Surface Samples

**Phenanthrene**

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	3,400	11,450	270,000	180 ug/g OC	240	1,500	950 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless noted otherwise)

Figure 3.51 shows the results of the surface samples from Survey 1 for phenanthrene. All eight samples exceeded the ER-M of 1,500 ng/g with the maximum concentration of 270,000 ng/g located at station IH07 at the forks exceeding the ER-M by 180 times. This concentration is more than three times greater than the second highest concentration of 79,000 ng/g found at station IH 08 located in the Lake George Branch. The minimum value detected, 3,400 ng/g, was found at station IH 04 further downstream in the turning basin and is more than twice the ER-M.

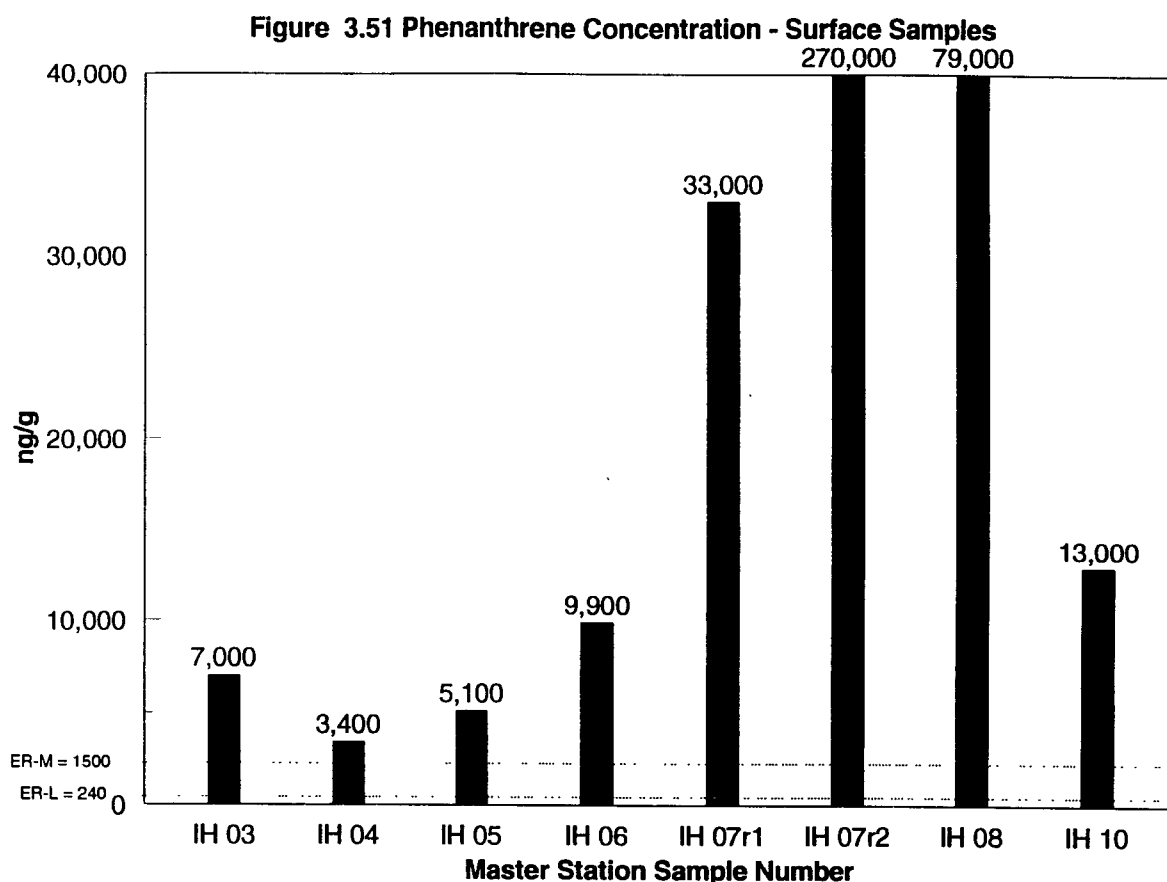


Figure 3.52 depicts the phenanthrene concentrations normalized to total organic carbon (replicate 2 for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 950 ug/g OC, all of the locations fall well below the guideline. The maximum value of 790 ug/g OC was detected at station IH 08 located in the Lake George Branch.

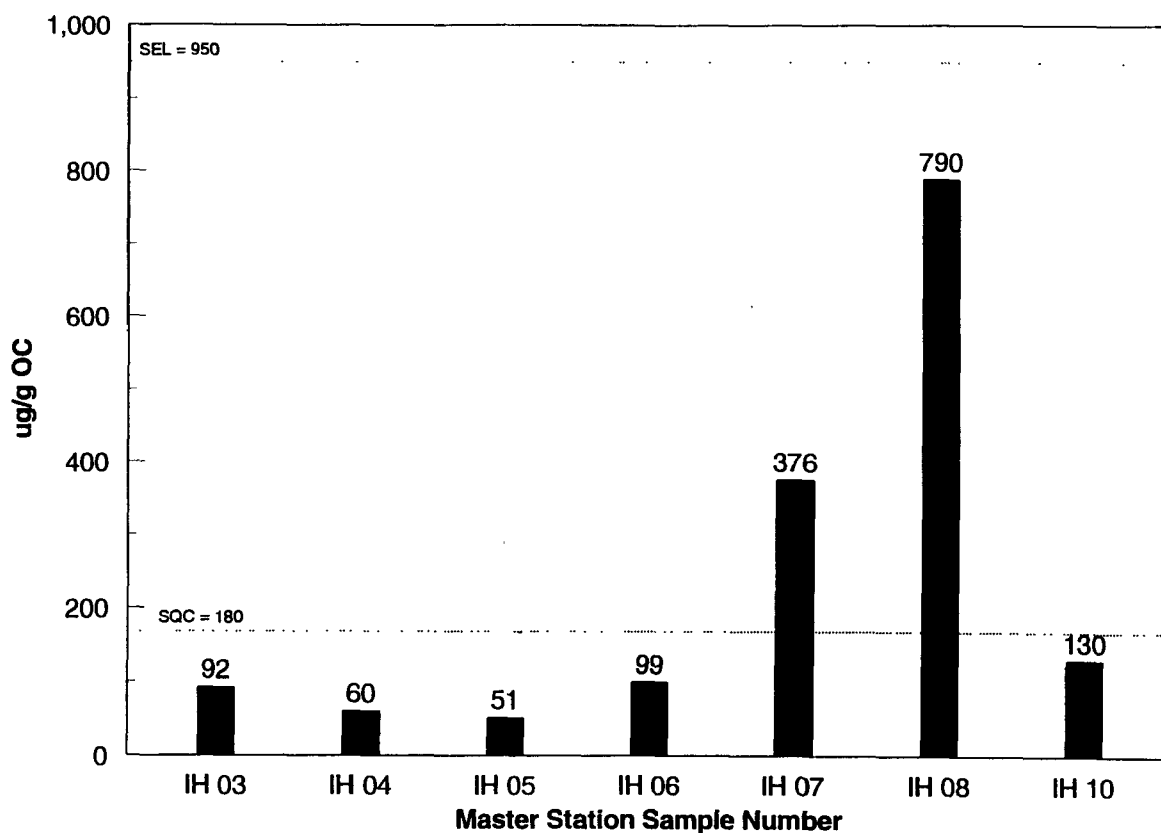
However, when compared to EPA's EqP SQC of 180 ug/g OC, two locations, IH 08 and IH 07 with respective concentrations of 790 ug/g OC and 376 ug/g OC, exceed this criteria. All other sampling locations fall below the SQC.

Pyrene

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	5,500	27,000	55,000	N/A	665	2,600	850 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are in ng/g unless otherwise noted)

Figure 3.52 Organic Carbon Normalized Phenanthrene - Surface Samples

As Figure 3.53 shows, all of the surface samples from Survey 1 for pyrene exceed both the ER-L and the ER-M. The minimum detected value of 5,500 ng/g found at station IH 04 in the turning basin is more than twice the ER-M of 2,600 ng/g. The maximum detected concentration of 55,000 was found at the first replicate sample from station IH 07 (located at the forks).

Figure 3.54 depicts the pyrene concentrations normalized to total organic carbon (replicate 2 for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 850 ug/g OC, all of the locations fall well the guideline. The maximum value of 627 ug/g OC was detected at station IH 07 located at the forks.

Figure 3.53 Pyrene Concentration - Surface Samples

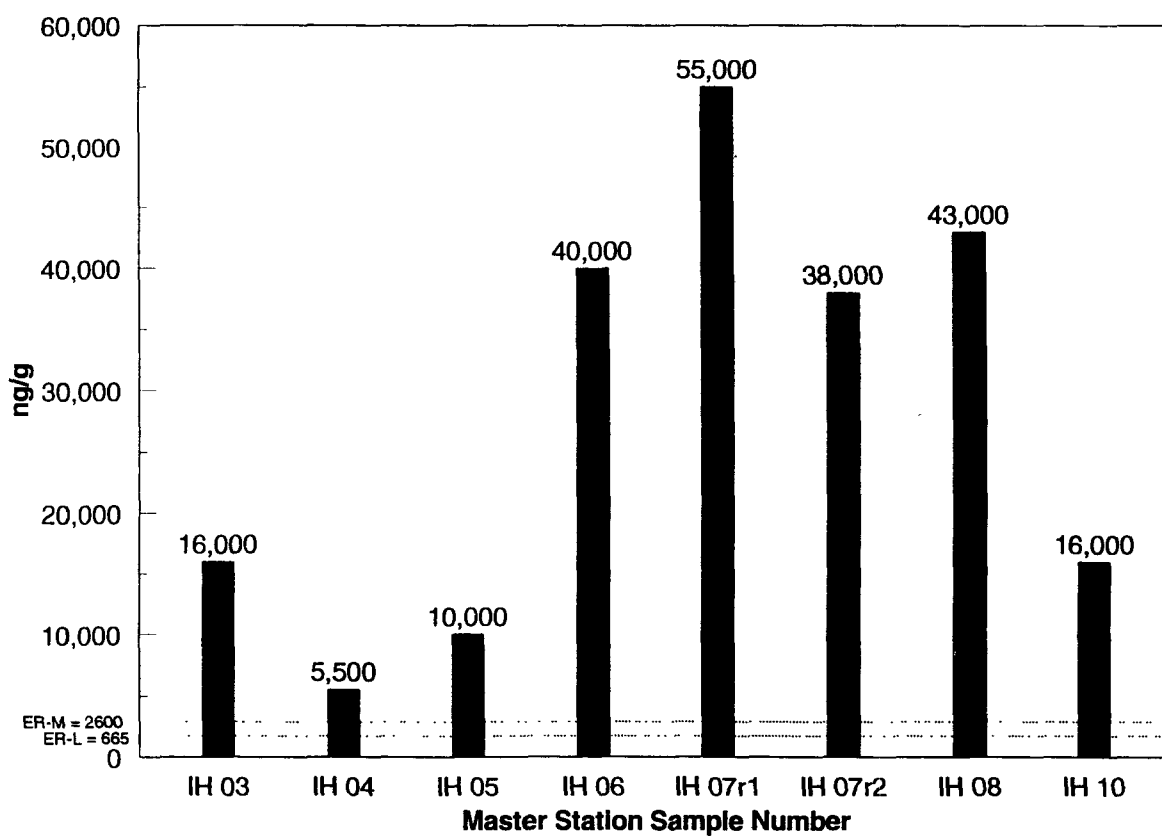
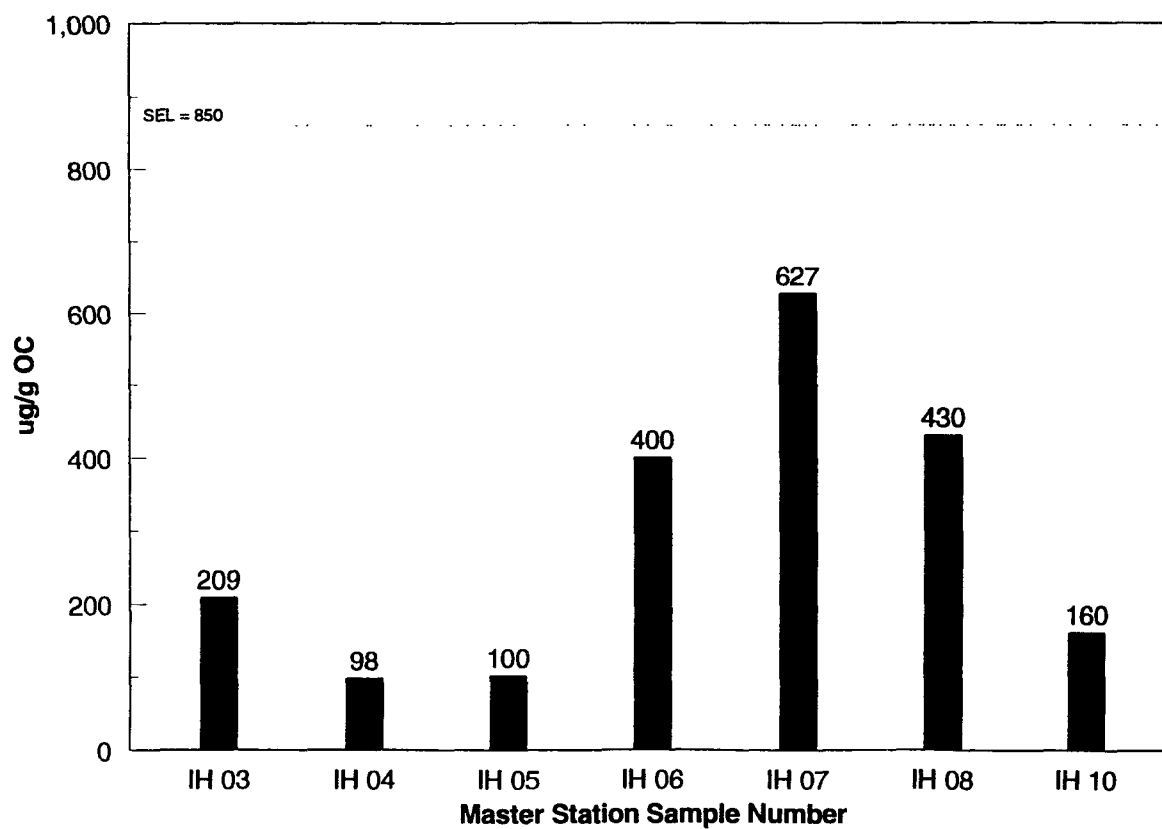


Figure 3.54 Organic Carbon Normalized Pyrene - Surface Samples



Total PAH*

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	67,971	304,045	941,340	N/A	4,022	44,792	10,000 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

(All units are ng/g unless otherwise noted)

* Sum of detected PAHs

Figure 3.55 shows the results of the surface samples from Survey 1 for Total PAHs. All eight samples exceeded the ER-M of 44,792 ng/g with the maximum concentration of 941,340 ng/g located at station IH 07, situated at the forks, exceeding the ER-M by more than 20 times. The second highest concentration of 597,480 ng/g was found at station IH 06 at Dickey Road. The minimum value detected, 67,971 ng/g, was found at station IH 04 further downstream in the turning basin and is well above the ER-M.

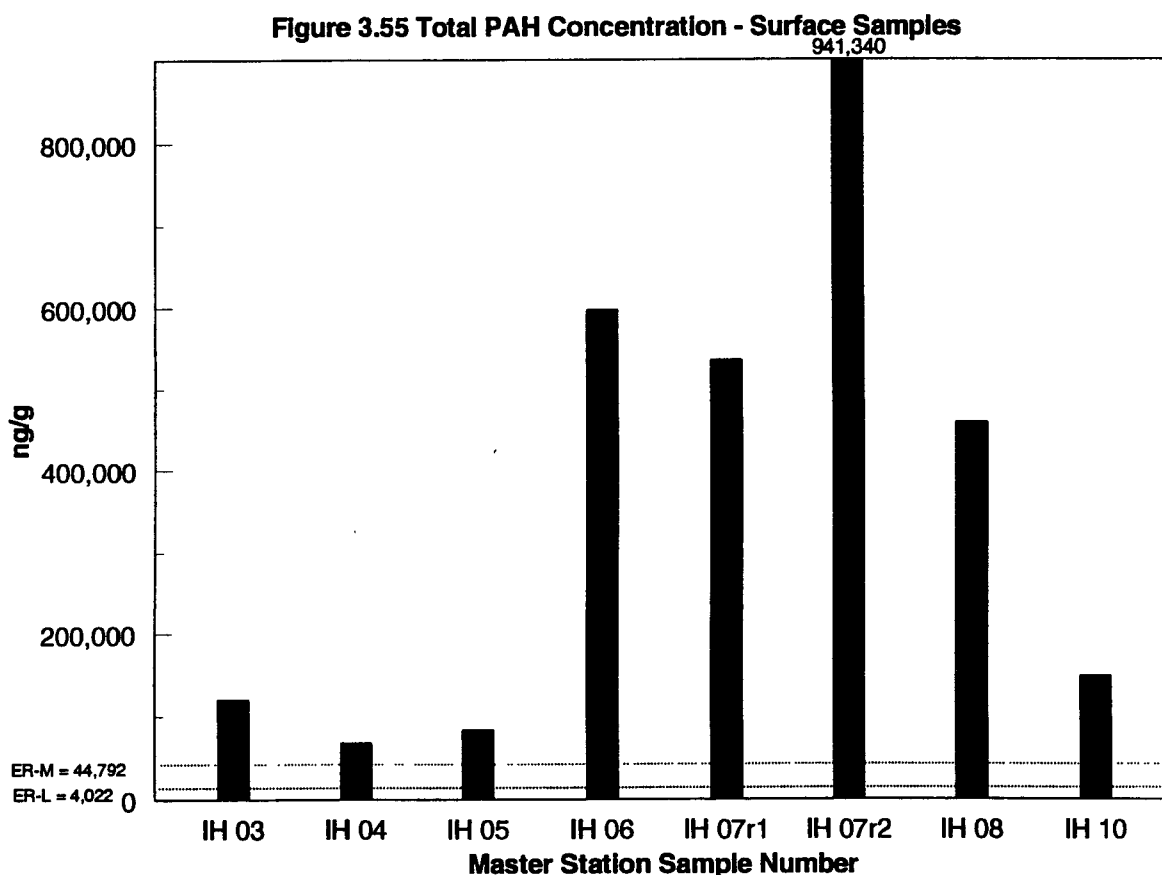
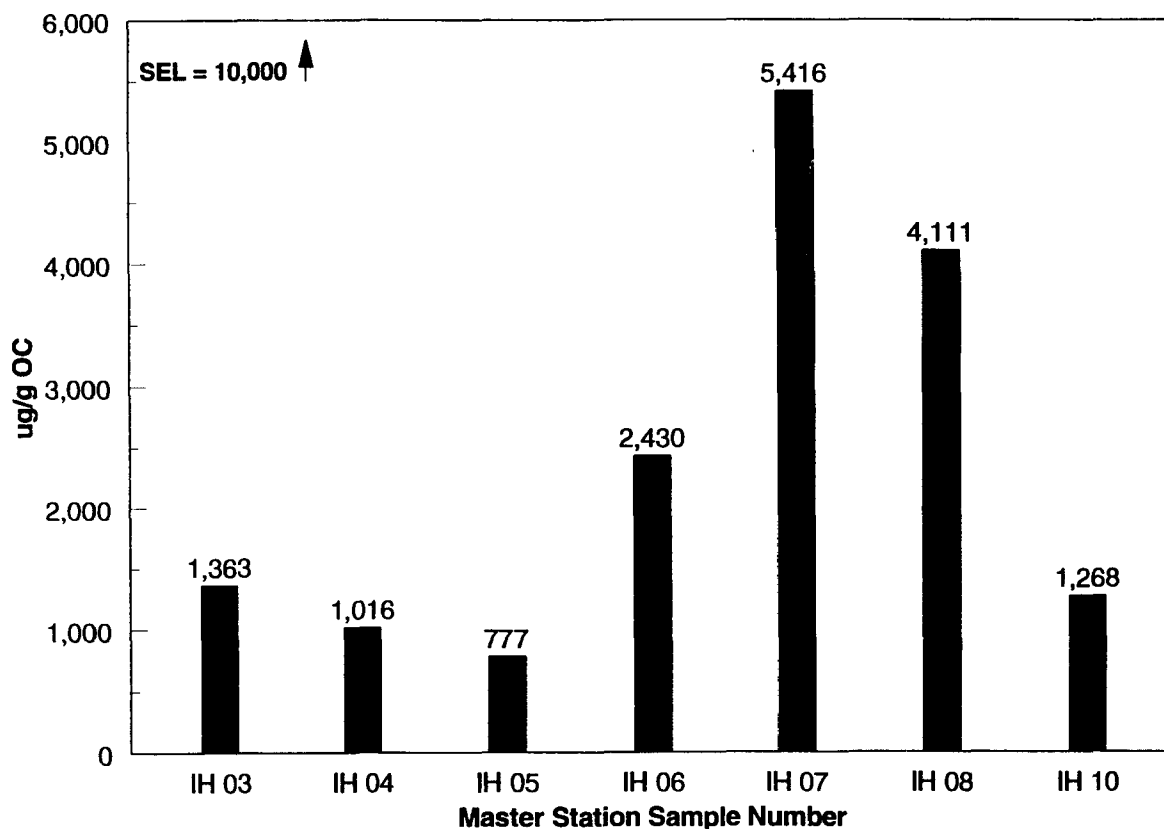


Figure 3.56 depicts the total PAH concentrations normalized to total organic carbon (replicate 2 for station IH 07 did not have a reported value for TOC and therefore is not represented in the bar chart). When normalized to organic carbon and compared to Ontario's SEL of 10,000 ug/g OC, all of the locations fall well below the guideline. The maximum value of 5,416 ug/g OC was detected at station IH 07 which is located at the forks.

Figure 3.56 Organic Carbon Normalized Total PAHs - Surface Samples



Total PCBs*

Survey	Minimum	Median	Maximum	EPA EqP Criteria	L&M ER-L	L&M ER-M	SEL
1	4,000 PD	12,000 D	43,000 PD	N/A	22.7	180	530 ug/g OC
2	N/A	N/A	N/A				

N/A - Not Available

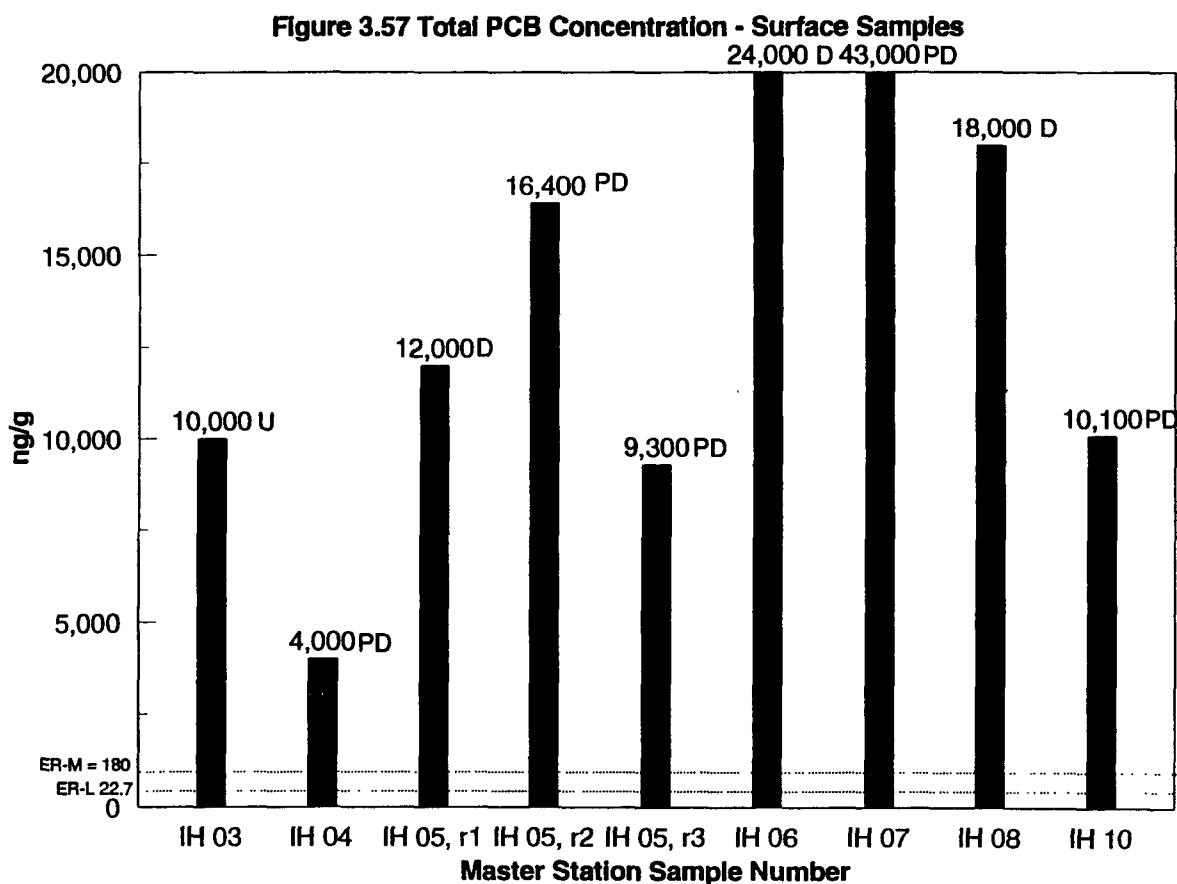
P - Greater than 25% difference between analytical columns. Lower value is reported.

D - Analyzed at secondary dilution factor.

(All units are in ng/g unless otherwise noted)

* Total PCB concentration is the sum of detected aroclors.

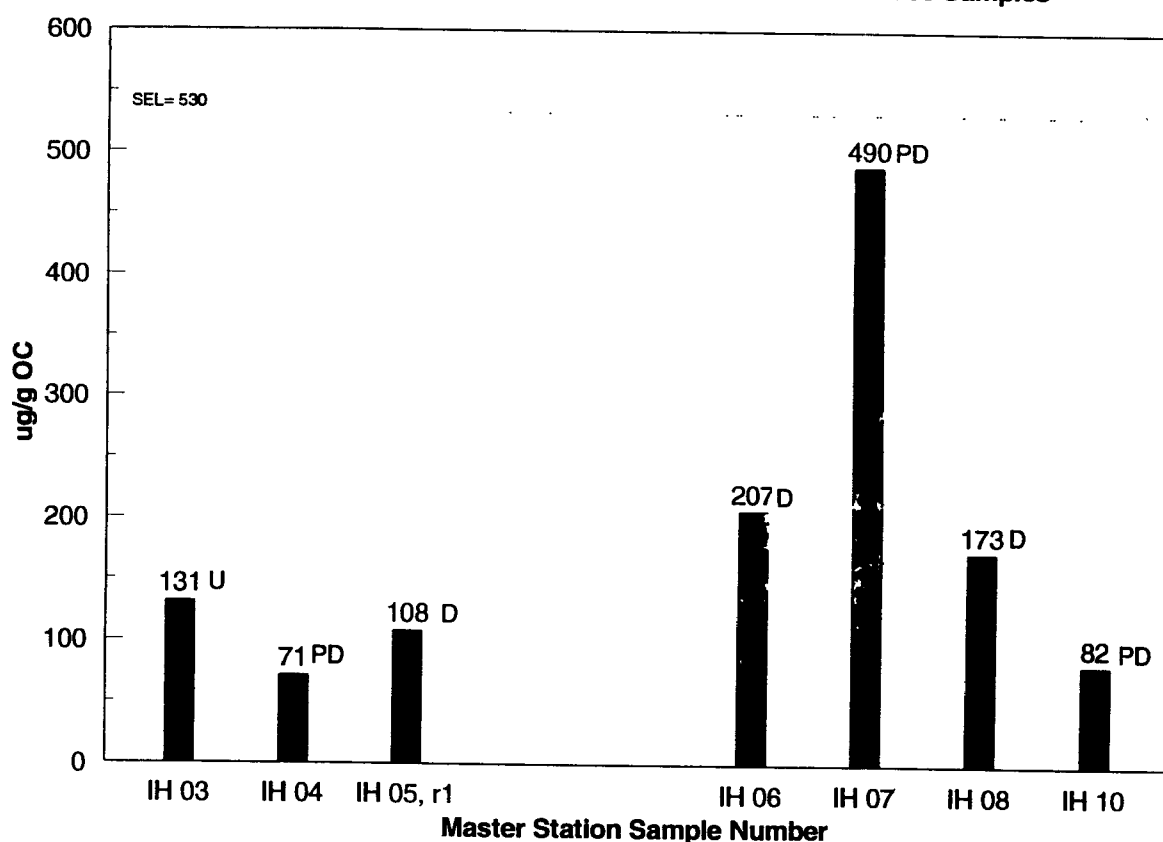
Figure 3.57 shows the total PCBs (sum of detected aroclors) for Survey 1. As the figure indicates, all samples exceed both the ER-L and the ER-M. Station IH 07, situated at the forks, with a concentration of 43,000 ng/g exceeds the ER-M by over 5,000 times.



As shown in Figure 3.58, when normalized to organic carbon, none of the surface samples exceed the SEL of 530 ug/g OC. The maximum concentration, still found at station IH 07 located at the forks, is 490 ug/g OC. The minimum concentration of 71 ug/g OC is well below the SEL and is found at station IH 04 located in the turning basin. For the four aroclors for which there are SELs (aroclors 1016, 1248, 1254 and 1260), only aroclor 1254 was detected at two locations (IH 04 and IH 07) and when these concentrations are normalized to organic carbon, they fall below the SEL guideline of 34 ug/g OC.

Pesticides

No pesticides were analyzed for in Survey 2. However, in Survey 1, pesticides were monitored for, and the majority of sample values were found below detection limits. However, for 4,4 DDE, the one analyte for which an ER-M is available and for which sampling was performed, all stations except for station IH 04 located in the turning basin, exceeded the ER-M. However, when any of the sampled concentrations for which there are SELs (4,4 DDD, 4,4 DDE, dieldrin, aldrin, endrin, a-BHC, b-BHC and c-BHC) or an SQC (dieldrin) are normalized to organic carbon, all locations fall below either guideline.

Figure 3.58 Organic Carbon Normalized Total PCB - Surface Samples

3.3.3 Ranking by Chemical Parameter

To provide a preliminary indication of which chemicals may be of concern in the Indiana Harbor AOC, a simple comparative analysis was performed based on the relative exceedance of the ER-M value. In particular, the mean measured value of each parameter (assuming zero for any nondetect value) was compared to the ER-M value for the parameter. The resulting ratio (herein referred to as the "Mean Exceedance") was calculated for each chemical within each survey. Data between the two surveys are not combined, therefore, if the parameter was analyzed in both surveys, each parameter may have two mean exceedance values. The ER-M was chosen for comparative purposes since one was available for almost all of the chemicals discussed in Section 3.3.2.

Once mean exceedance values were determined, the values were ranked. For the purposes of ranking, metals and organic parameters were ranked separately and separate ranks were determined for each survey. The results of the ranking for Surveys 1 and 2 are presented in Table 3.3.

Of the toxic metals analyzed for in Surveys 1 and 2, zinc and lead rank the highest of the metals in both surveys. The high concentrations for both of these parameters were found upstream of Canal Street, particularly in the Lake George Branch.

TABLE 3.3 MEAN EXCEEDANCE VALUES AND RELATIVE RANKS BY CHEMICAL PARAMETER IN SURVEYS 1 AND 2

Chemical	Survey 1		Survey 2	
	Mean Exceedance	Relative Rank	Mean Exceedance	Relative Rank
Metals				
Arsenic	0.82	9	NA	NA
Cadmium	1.36	5	0.95	6
Chromium	2.89	3	1.25	4
Copper	1.02	7	1.03	5
Lead	3.70	2	3.33	1
Mercury	2.02	4	NA	NA
Nickel	1.07	6	1.51	3
Silver	0.90	8	NA	NA
Zinc	9.70	1	2.97	2
Organics				
Anthracene	32.97	2	NA	NA
Benz(a)anthracene	9.13	8	NA	NA
Benzo(a)pyrene	10.44	6	NA	NA
Chrysene	6.17	10	NA	NA
Fluoranthene	5.05	11	NA	NA
Fluorene	14.15	4	NA	NA
2-Methylnaphthalene	11.67	5	NA	NA
Naphthalene	4.11	12	NA	NA
Phenanthrene	25.61	3	NA	NA
Pyrene	9.73	7	NA	NA
Total PAHs	7.07	9	NA	NA
Total PCBs	88.62	1	NA	NA

NA - Not analyzed.

As for the organic chemicals, the highest mean exceedances in Survey 1 surface samples (organics were not analyzed for in Survey 2) were found for total PCBs and the PAHs anthracene and phenanthrene. Total PCBs had the highest mean exceedance (on average a sample was found at about 89 times the ER-M value). The PAHs anthracene and phenanthrene exceed the ER-M on average by about 33 and 26 times respectively. The highest exceedances for total PCBs, as well as the PAHs anthracene and phenanthrene, were found upstream of Dickey Road, with the maximum concentration found at the forks.

3.3.4 Analysis by Sample Location

The second portion of the analysis of Indiana Harbor sediment samples focuses on which sample locations are of concern. For purposes of this analysis, sample locations are examined in one of two ways; the number of chemicals that exceed the ER-M guidelines at a sample site, and the relative exceedance of the guidelines at the site.

One difficulty in directly comparing sampling locations stems from differences in the number of parameters and number of samples collected from different locations. While most Survey 2 locations were sampled at three sediment core depths, some were sampled at two or only one. Several parameters, including mercury and arsenic, were sampled for only in Survey 1. In light of these differences, an analysis by sample location was still performed to provide a preliminary indication of the areas of concern within the Indiana Harbor AOC.

As shown in Table 3.4, sediment samples taken at the stations upstream of Dickey Road exceeded the ER-M for eight of the nine toxic metals analyzed for in Survey 1. Of the twelve organic parameters analyzed at the seven different stations, samples at five locations (upstream of the turning basin) exceeded the ER-M for all twelve parameters, and samples at the remaining two stations exceeded eleven of the twelve ER-Ms.

TABLE 3.4 TOTAL NUMBER OF L&M ER-M EXCEEDANCES BY SAMPLE LOCATION -- SURVEY 1

Sample Site	Metals	Organics
IH03	4	11
IH04	3	11
IH05	5	12
IH06	8	12
IH07	8	12
IH08	8	12
IH10	8	12

Table 3.5 shows the total number of exceedances by sample location for Survey 2. For the six toxic metals analyzed for in Survey 2, the ER-M was exceeded for all six metals at 18 of the 37

different locations in the first core segment. All but one of these locations are found upstream of the ConRail railroad tracks. In the second core segment, the six ER-Ms were exceeded at 14 of the 32 locations. All but two of these locations are upstream of the ConRail railroad tracks. Finally, in the third core segment, six of the 26 locations exceeded the ER-M for all six metals. Again, all of these stations are upstream of the ConRail railroad tracks.

TABLE 3.5 TOTAL NUMBER OF L&M ER-M EXCEEDANCES BY SAMPLE LOCATION -- SURVEY 2

Sample Site	Metals			
	First Core Segment*	Second Core Segment*	Third Core Segment*	Fourth Core Segment*
1	0	0	--	--
3	2	0	0	--
4	6	2	0	--
5	3	5	2	--
6	3	6	1	--
6D	3	5	--	--
7	0	--	--	--
9	2	4	4	--
10	4	4	3	--
10D	4	4	2	4
11	0	--	--	--
12	2	6	0	--
14	5	2	4	--
14D	3	5	2	2
15	6	6	6	--
16	6	0	--	--
17	6	0	--	--
18	0	--	--	--
20	6	6	0	--
21	1	--	--	--

TABLE 3.5 TOTAL NUMBER OF L&M ER-M EXCEEDANCES BY SAMPLE LOCATION -- SURVEY 2

Sample Site	Metals			
	First Core Segment*	Second Core Segment*	Third Core Segment*	Fourth Core Segment*
22	2	3	0	--
23	6	4	2	--
24	6	1	0	--
25	5	6	5	--
26	6	6	5	--
27	0	--	--	--
28	6	0	0	--
29	6	6	4	--
30	6	6	3	--
31	6	6	4	--
33	4	4	--	--
34	6	0	--	--
35	6	0	--	--
36	5	5	2	--
38	5	3	0	--
39	6	6	6	--
40	6	6	6	--
41	6	6	6	--
42	3	6	6	--
42D	3	6	6	--
43	6	6	6	--

-- No Data

* Core depths vary by segment.

The second analysis performed provides a preliminary indication of which locations may be of concern in the Indiana Harbor AOC, using a simple comparative analysis based on the relative exceedance of the ER-M value. Specifically, the average of the mean exceedances of chemical concentrations (shown previously in Table 3.3) was compared to the ER-M value. For Survey 1, two different mean exceedances were calculated for each sample location; one for all metals and one for all organic chemicals (PAHs and PCBs). For Survey 2, a metals mean exceedance was calculated for each core segment (organics were not analyzed for). The ER-M was chosen for comparative purposes since one was available for most of the chemicals discussed in Section 3.3.2, and was assumed to be a better indicator for concern (as particularly compared to the ER-L).

Table 3.6 presents the mean exceedance values determined for each Survey 1 sample location, and ranks them in relation to all other locations. As the table shows, all locations possess mean exceedances greater than one for both metals and organics. Sample location IH 07, located at the forks, is the highest ranked site for both metals and organics with a mean exceedance for metals of 4.71 and a mean exceedance of 60.5 for organics. Station IH 06, located at Dickey Road, had a metals mean exceedance of 3.06; station IH 10 near the end of the federal navigation channel at Columbus Drive had a mean exceedance of 3.02 for metals. For the organics, the second highest mean exceedance (26.48) was found at station IH 08 located at Indianapolis Boulevard in the Lake George Branch. Station IH 06 located at Dickey also had a high mean exceedance (18.95) for organics.

TABLE 3.6 SURVEY 1 MEAN EXCEEDANCE VALUES AND RANKS FOR METALS AND ORGANICS

Sample Site	Metals		Organics (PAHs and PCBs)	
	Mean Exceedance	Relative Rank	Mean Exceedance	Relative Rank
IH03	1.90	5	3.51	7
IH04	1.33	7	3.65	6
IH05	1.43	6	8.29	5
IH06	3.06	2	18.95	3
IH07	4.71	1	60.5	1
IH08	2.79	4	26.48	2
IH10	3.02	3	9.70	4

As shown in Table 3.7, for the first core segments, station 30, located just downstream of the forks, with a mean exceedance of 7.54, ranked the highest. The top six ranked stations all occur upstream of Dickey Road. Station 35, located in the Lake George Branch was ranked second with a mean exceedance of 6.31. Station 30 also had the highest mean exceedance for the second core segments. Station 29, adjacent to station 30 just upstream of Canal Street, was ranked second with a mean exceedance of 7.78. The top six ranked stations for the second core segment were all found

upstream of Canal Street. For the third core segment, the top ranked seven stations were found upstream of Canal Street. The highest mean exceedance, 7.64 was found at station 40 located upstream of the forks halfway to Columbus Drive. The duplicate sample at station 42 was second with a mean exceedance ranking of 7.27. Finally, both fourth core segments had mean exceedance values greater than one.

TABLE 3.7 SURVEY 2 MEAN SITE EXCEEDANCES AND RANKS FOR METALS

Sample Site	First Core Segment*		Second Core Segment*		Third Core Segment*		Fourth Core Segment*	
	Mean Exceedance	Relative Rank	Mean Exceedance	Relative Rank	Mean Exceedance	Relative Rank	Mean Exceedance	Relative Rank
1	0.05	40	0	36	--	--	--	--
3	1.87	33	0.13	34	0.02	27	--	--
4	4.98	7	2.03	26	0	29	--	--
5	2.45	25	2.12	25	1.30	17	--	--
6	2.39	26	5.20	8	0.83	20	--	--
6D	2.63	23	4.78	10	--	--	--	--
7	0.08	39	--	--	--	--	--	--
9	1.96	32	2.82	23	1.98	15	--	--
10	1.85	35	2.0	27	1.17	19	--	--
10D	2.08	29	1.96	28	0.66	21	2.75	2
11	0.17	38	--	--	--	--	--	--
12	2.05	30	4.33	14	0.16	24	--	--
14	2.74	20	2.87	22	4.17	10	--	--
14D	1.86	34	3.63	19	2.55	14	2.95	1
15	2.71	21	5.76	7	3.74	12	--	--
16	0.79	19	.91	30	--	--	--	--
17	2.80	18	0.13	32	--	--	--	--
18	0.02	41	--	--	--	--	--	--
20	5.21	5	4.39	13	0.02	26	--	--
21	0.38	37	--	--	--	--	--	--
22	2.21	28	4.45	12	0.02	25	--	--
23	4.06	11	2.29	24	1.32	16	--	--
24	4.14	8	0.81	29	0.02	28	--	--
25	2.61	24	5.09	9	4.15	11	--	--
26	4.11	9	4.65	11	4.41	8	--	--

TABLE 3.7 SURVEY 2 MEAN SITE EXCEEDANCES AND RANKS FOR METALS

Sample Site	First Core Segment*		Second Core Segment*		Third Core Segment*		Fourth Core Segment*	
	Mean Exceed- ance	Relative Rank	Mean Exceed- ance	Relative Rank	Mean Exceed- ance	Relative Rank	Mean Exceed- ance	Relative Rank
27	0.45	36	--	--	--	--	--	--
28	3.91	12	0.05	35	0.18	23	--	--
29	5.01	6	7.78	2	6.13	4	--	--
30	7.54	1	8.22	1	4.29	9	--	--
31	5.34	4	7.15	4	5.01	6	--	--
33	5.95	3	6.33	6	--	--	--	--
34	3.31	17	0.13	33	--	--	--	--
35	6.31	2	0.15	31	--	--	--	--
36	2.69	22	3.06	21	1.19	18	--	--
38	3.65	14	6.56	5	0.18	22	--	--
39	4.08	10	4.16	15	6.73	3	--	--
40	3.59	15	7.51	3	7.64	1	--	--
41	3.48	16	3.87	18	4.68	7	--	--
42	2.02	31	3.58	20	3.67	13	--	--
42D	2.37	27	3.93	17	7.27	2	--	--
43	3.89	13	3.94	16	5.92	5	--	--

-- No Data

*Core depths vary by segment.

4. CONCLUSIONS

This report summarizes the results from two sediment sampling surveys performed in the Indiana Harbor AOC. This section presents several preliminary conclusions based on examination of the data resulting from the surveys.

4.1 Metals

Metal concentrations for all ten parameters sampled exceeded either the Long and MacDonald effects ranges or Ontario's SELs and all parameters could be considered to be contaminants of concern in both surficial, as well as deeper sediments. Comparison of bulk sediment concentrations to Long and MacDonald's ER-M indicate that zinc and lead pose the highest potential risk for biota in the Indiana Harbor. Only two parameters, arsenic and silver, had mean exceedances of less than one. Though silver's mean exceedance may not be excessively high, all the stations upstream of Dickey Road exceeded the ER-M and at these locations, silver could be considered to be a contaminant of concern. Arsenic concentrations exceeded the ER-M only at the fork of the Indiana Harbor Canal and the Lake George Branch.

Comparison of bulk sediment concentrations of arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc to Ontario's SELs indicate all parameters would be of concern in some location, if not throughout the AOC. Though metal levels were elevated throughout the Harbor, concentrations were most elevated upstream of Dickey Road, in particular, at the forks of the Lake George Branch and the Indiana Harbor Canal.

4.2 Organic Chemicals

Organic chemicals were not analyzed for in Survey 2; therefore, all conclusions are based on the Survey 1 surface samples results. Based on the Long and MacDonald guideline numbers, total PCBs is the organic pollutant that poses the greatest risk in contaminated sediment in the Indiana Harbor AOC. On average, the total PCB concentration at a site was almost 90 times higher than the ER-M guideline. All the organics had a mean exceedance of the ER-M that was greater than one. The PAHs anthracene and phenanthrene had mean exceedances greater than 25. In general, the highest concentrations of the organics were found at the fork of the Lake George Branch and in the Indiana Harbor Canal.

When normalized to total organic carbon and compared to either the EPA endorsed EqP-based criteria or the Ontario SELs, a different conclusion may be drawn. When compared to Ontario's SELs, only two organics, anthracene and flourene; exceed the Severe Effect Level at only one location - at the fork of the Lake George Branch and the Indiana Harbor Canal. The examination of organic carbon normalized data for flouranthene and phenanthrene (the two PAHs for which EPA-based criteria are available and that were sampled in Survey 1) indicate that only phenanthrene would be of concern. Phenanthrene exceeds the SQC at the forks and in the Lake George Branch; most of the other locations are about half of the SQC. Flouranthene's SQC is not exceeded at any location with the highest concentration of 560 ug/g OC falling 40 ug/g OC below the SQC of 620 ug/g OC. For all of the organics, the highest concentrations are generally found either at the forks, or by Indianapolis Boulevard in the Lake George Branch.

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APPENDIX A

TABLE 1. INDIANA HARBOR SURVEY 1 - INORGANICS (dry wt)

SAMPLE ID	AG (ug/g)	AS (ug/g)	CD (ug/g)	CR (ug/g)	CU (ug/g)	FE (%)	HG (ug/g)	MN (ug/g)	NI (ug/g)	PB (ug/g)	SE (ug/g)	ZN (ug/g)
IH 03	0.244	60	9.1	572	226	19.7	0.91	2420	50	589	2.6	3250
IH 04	0.037	32	5.2	407	182	14.4	0.67	1970	50	396	2.3	2250
IH 05	0.023	45	10.4	580	219	23.4	0.91	2740	<50	415	2.0	2290
IH 06	5.99	52	11.7	1132	379	17.9	1.86	2410	103	878	3.8	4460
IH 07	7.08	93	24.2	2610	287	28.8	2.06	3280	<58	1354	3.1	7960
IH 08	4.67	56	12.4	780	284	12.1	1.77	1674	95	1223	3.9	3540
IH 10	5.2	63	18.4	1412	354	21.4	1.85	2450	88	791	3.3	4080

SAMPLE ID	TOC (wt %)	AVS (uM/g)	SOLIDS (% dry wt)	METHYLM (ng/g)	TBT (ng/g)	DBT (ng/g)	MBT (ng/g)
IH 03	7.65	33.5	40.76	<0.1	240	47	7.4
IH 04	5.64	15.7	44.76	2.0	110	32	7.2
IH 05	11.1	21.8	50.23	<0.1	300	58	17
IH 06	11.58	52.6	29.8	<0.1	1500	370	39
IH 06, REP				<0.1			
IH 07	8.77	71.4	46.67	0.5	<14	<11	12
IH 07, REP		53.9			19	28	<12
IH 08	10.41	54.1	23.02	1.4	370	110	12
IH 10	12.25	31.7	19.58	<0.1	530	160	26

KEY

AG = Silver
AS = Arsenic
CD = Cadmium
CR = Chromium
CU = Copper
FE = Iron

HG = Mercury
MN = Manganese
NI = Nickel
PB = Lead
SE = Selenium
ZN = Zinc

TOC = Total Organic Carbon
AVS = Acid volatile Sulfides
METHYLM = Methylmercury
TBT = Tributyltin
DBT = Dibutyltin
MBT = Monobutyltin

TABLE 2. INDIANA HARBOR SURVEY 1 - PAHS (ng/g dry wt)

SAMPLE ID	1,4 DCB	NAPH	2-MNAPH	DM PH	DBF	FLUORE	PHEN	ANTH	FLUORA	PYRENE	BBPH
IH 03	82	7300	2000	<68	2300	2400	7000	2400	8600	16000	<160
IH 04	31	3600	930	<43	920	790	3400	1400	4800	5500	<100
IH 05	45	6300	1200	<25	1200	1400	5100	2200	7200	10000	<58
IH 06	380	8500	5400	<95	5700	3200	9900	3400	14000	40000	16000
IH 07, REP1	110	5000	<31	<37	53000	61000	33000	130000	40000	55000	<85
IH 07, REP2	140	4100	42000	<68	<61	<61	270000	300000	120000	38000	<160
IH 08	160	6100	20000	<110	6900	12000	79000	26000	56000	43000	<240
IH 10	930	24000	4200	<95	2400	3200	13000	3500	9600	16000	<220

SAMPLE ID	BAANTH	BISPH	CHYRS	DNOPH	BBFLUOR	BKFLUOR	BAPYR	INDPYR	BGHIPER	TOTAL PAH*
IH 03	7300	10000	8600	1900	7800	10000	10000	7300	9600	120582
IH 04	4200	4700	5200	4100	5600	4200	7000	5300	6300	67971
IH 05	5800	3800	7200	430	6300	5100	5700	6600	8800	84375
IH 06	16000	290000	26000	37000	24000	23000	25000	22000	28000	597480
IH 07, REP1	25000	8400	39000	<90	22000	12000	21000	11000	21000	536510
IH 07, REP2	39000	5900	24000	<170	19000	15000	41000	9200	14000	941340
IH 08	30000	18000	33000	2600	26000	21000	29000	19000	31000	458760
IH 10	6900	15000	9400	<240	8900	9700	9200	5800	7600	149330

KEY

1,4 DCB = 1,4-dichlorobenzene
NAPH = Naphthalene
2-MNAPH = 2-Methylnaphtalene
DM PH = Dimethyl phthalate
DBF = Dibenzofuran
FLUORE = Fluorene
PHEN = Phenanthrene
ANTH = Anthracene
FLUORA = Fluoranthene
PYRENE = Pyrene

BBPH = Butyl Benzyl Phthalate
BAANTH = Benz(a)anthracene
BISPH = Bis(2-ethylhexyl) Phthalate
CHYRS = Chrysene
DNOPH = di-n-octylphthalate
BBFLUOR = Benzo(b)Fluoranthene
BKFLUOR = Benzo(k)Fluoranthene
BAPYR = Benzo(a)pyrene
INDPYR = Indeno(1,2,3-cd)pyrene
BGHIPER = Benzo(g,h,i)perylene

* The sum of the detected PAHs.

TABLE 3. INDIANA HARBOR SURVEY 1 - DIOXINS AND FURANS (pg/g dry wt)

SAMPLE ID	2378-TCDF	TOTAL TCDF	2378-TCDD	TOTAL TCDD	12378-PECDF	23478-PECDF	TOTAL PECDF	12378-PECDD	TOTAL PECDD	123478-HXCDF	123678 - HXCDF	123789-HXCDF	234678 - HXCDF
IH 03	290	860	130	190	27	29	340	<52	ND	41	<66	32	<5.6
IH 04	27	400	ND	37	12	21	190	ND	22	16	12	10	ND
IH 05	11	170	ND	32	3.8	7.8	76	ND	35	15	6.8	5.2	ND
IH 06	600	3700	<59	490	56	120	1300	42	510	130	76	55	13
IH 07	480	2400	<37	160	28	82	1300	84	1900	240	86	56	<31
IH 07,REP	740	4500	<110	230	<180	130	1400	<76	ND	210	110	<99	<140
IH 08	320	2200	<39	230	27	89	680	29	140	95	<45	32	<13
IH 10	310	1700	<18	110	30	68	720	20	66	86	43	30	<18

SAMPLE ID	TOTAL HXCDF	123478-HXCDD	123678-HXCDD	123789-HXCDD	TOTAL HXCDD	1234678-HPCDF	1234789-HPCDF	TOTAL HPCDF	1234678-HPCDD	TOTAL HPCDD	OCDF	OCDD
IH 03	700	53	73	97	950	<38	660	660	1400	3300	1600	6700
IH 04	250	13	23	14	350	180	ND	380	410	980	180	2300
IH 05	220	17	31	19	420	220	8.8	510	580	1200	250	2900
IH 06	1900	130	210	380	2500	1600	81	4200	5100	9300	6900	43000
IH 07	3500	560	360	520	9000	3300	120	8800	15000	31000	32000	46000
IH 07, REP	3700	220	480	<800	4600	3000	72	6600	6500	15000	2600	41000
IH 08	2100	<47	230	290	2600	340	700	8200	4700	5300	12000	25000
IH 10	920	32	99	260	1700	810	36	1500	1600	3100	2500	12000

KEY

TCDF = Tetrachlorodibenzofuran
TCDD = Tetrachlorodibenzodioxin
PECDF = Pentachlorodibenzofuran
HXCDF = Hexachlorodibenzofuran
HXCDD = Hexachlorodibenzodioxin

HPCDF = Heptachlorodibenzofuran
HPCDD = Heptachlorodibenzodioxin
OCDF = Octachlorodibenzofuran
OCDD = Octachlorodibenzodioxin
ND = Not detected

TABLE 4. INDIANA HARBOR SURVEY 1 - PESTICIDES (ng/g dry wt)

SAMPLE ID	ALDRIN	A-BHC	B-BHC	C-BHC	CHLORDANE (GAMMA)	CHLORDANE (ALPHA)	4,4 DDD	4,4 DDE	4,4 DDT	DIELDRIN	ENDOSULFAN (ALPHA)
IH 103	84 D	36 U	88 PD	36 U	66 PD	36 U	36 U	49 PD	36 U	280 D	36 U
IH 104	34 D	36 U	47 D	36 U	36 U	36 U	36 U	36 U	36 U	36 U	36 U
IH 105,REP1	98 D	34 U	34 U	34 U	84 PD	34 U	34 U	120 PD	79 PD	343 D	34 U
IH 105,REP2	100 D	36 U	36 U	36 U	86 PD	36 U	36 U	84 PD	36 U	36 U	36 U
IH 105 REP3	63 D	34 U	34 U	34 U	50 PD	34 U	34 U	55 PD	34 U	34 U	34 U
IH 106	190 PD	50 U	50 U	50 U	150 PD	50 U	50 U	100 PD	100 PD	330 PD	50 U
IH 107	330 D	41 U	290 D	41 U	170 PD	41 U	70 PD	210 PD	41 U	48 PD	41 PD
IH 108	160 D	49 U	49 U	49 U	100 PD	49 U	49 U	78 PD	100 PD	280 PD	49 U
IH 110	78 PD	69 U	69 U	69 U	74 D	69 U	69 U	95 D	69 U	69 U	69 U

SAMPLE ID	ENDOSULFAN (BETA)	ENDOSULFAN (SULFATE)	ENDRIN	ENDRIN ALDEHYDE	HEPT- ACHLOR	HEPTACHLOR EPOXIDE	LINDANE (G-BHC)	TOXA- PHENE	METHOXY- CHLOR
IH 103	55 PD	36 U	36 U	36 U	48 PD	36 U	36 U	360 U	180 U
IH 104	36 U	36 U	36 U	36 U	36 U	36 U	36 U	360 U	180 U
IH 105,REP1	160 PD	34 U	34 U	47 PD	70 PD	63 PD	34 U	340 U	170 U
IH 105,REP2	36 U	36 U	36 U	36 U	73 PD	200 PD	36 U	360 U	180 U
IH 105 REP3	34 U	34 U	34 U	34 U	34 U	40 PD	34 U	340 U	170 U
IH 106	50 U	50 U	50 U	65 PD	100 PD	320 PD	50 U	500 U	250 U
IH 107	41 U	41 U	44 D	51 PD	320 PD	270 PD	41 U	410 U	200 U
IH 108	49 U	49 U	49 U	49 U	74 PD	260 PD	49 U	490 U	240 U
IH 110	69 U	69 U	69 U	69 U	69 U	79 PD	69 U	690 U	340 U

KEY

U = Indicates compound was not detected at dection limit shown

P = This flag is used for a pesticide target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported.

D = This flag identifies all compounds identified in an analysis at a secondary dilution factor.

TABLE 5. INDIANA HARBOR SURVEY 1 - PCBS (ug/kg dry wt)

SAMPLE ID	PCB 1016	PCB 1221	PCB 1232	PCB 1242	PCB 1248	PCB 1254	PCB 1260	Total PCB*
IH 103	360 U	360 U	360 U	10000 U	360 U	360 U	360 U	10000 U
IH 104	360 U	360 U	360 U	3000 PD	360 U	1000 PD	360 U	4000 PD
IH 105, REP 1	340 U	340 U	340 U	12000 D	340 U	340 U	340 U	12000 D
IH 105, REP2	360 U	360 U	360 U	13000 D	360 U	**3400 PD	360 U	16,400 PD
IH 105, REP3	340 U	340 U	340 U	7200 D	340 U	**2100 PD	340 U	9,300 PD
IH 106	500 U	500 U	500 U	24000 D	500 U	500 U	500 U	24000 D
IH 107	410 U	410 U	410 U	43000 PD	410 U	410 U	410 U	43000 PD
IH 108	490 U	490 U	490 U	18000 D	490 U	490 U	490 U	18000 D
IH 110	690 U	690 U	690 U	7100 PD	690 U	3000 PD	690 U	10100 PD

KEY

* = The sum of detected aroclors only, or the highest undetected limit if no aroclors were detected.

** = Corrected Values

U = Indicates compound was not detected at detection limit shown

P = This flag is used for an Aroclor target analyte when there is greater than 25 % difference for detected concentrations between the two GC columns. The lower of the two values is reported.

D = This flag identifies all compounds identified in an analysis at a secondary dilution factor.

TABLE 6. INDIANA HARBOR SURVEY 2- INORGANICS

SAMPLE ID	Core Depth	EXT. RES. (ug/g)	pH	TOC (%)	MOISTURE FRACTION	MICROTOX (EC 50)	DRY SOLIDS (fraction)	VOLATILE FRACTION	CONDUCTANCE (uSiemens)
IH20201C101	0-24"	120.00 PNQ	7.93	0.13 LDL	0.20	100.00	0.80	0.160	654
IH20201C102	24-52"	260.00 PNQ	7.92	0.20 LDL	0.15	100.00	0.85	0.009	632
IH20301C101	0-24"	42000.00	7.81	9.42	0.64	67.00	0.36	0.180	1800
IH20301C102	48-72"	14000.00	7.87	6.74	0.55	67.00	0.45	0.099	1500
IH20301C103	97-116"	250.00 PNQ	8.19	0.15 LDL	0.16	100.00	0.84	0.094	0 NSQ
IH20401C101	0-24"	31000.00	7.27	7.74	0.50	8.60	0.50	0.110	1060
IH20401C102	48-72"	42000.00	7.92	8.30	0.47	21.00	0.53	0.130	1450
IH20401C103	84-106"	13000.00	8.29	5.04	0.36	75.00	0.64	0.088	1270
IH20402C101	0-24"	410.00	7.27	0.99	0.24	100.00	0.76	0.031	0 NSQ
IH20403C101	0-24"	22000.00	7.30	8.62	0.50	8.70	0.50	0.120	1690
IH20403C102	60-84"	13000.00	8.14	10.63	0.57	77.00	0.43	0.170	1690
IH20403C103	101-116"	2100.00	7.77	2.16	0.32	93.00	0.68	0.060	0 NSQ
IH20403C201 D	0-24"	4600.00	7.51	8.79	0.52	11.00	0.48	0.130	1390
IH20403C202 D	60-84"	21000.00	8.57	8.87	0.52	16.00	0.48	0.160	1580
IH20501C101	0-24"	19000.00	8.02	17.73	0.46	7.00	0.54	0.180	2400
IH20501C102	48-72"	15000.00	8.81	12.19	0.38	24.00	0.62	0.110	2360
IH20501C103	72-96"	28000.00	9.31	8.00	0.42	15.00	0.58	0.130	1660
IH20501C201 D	0-24"	17000.00	7.91	13.26	0.43	4.00	0.57	0.170	2000
IH20501C202 D	72-96"	30000.00	8.40	19.57	0.40	16.00	0.60	0.073	3340
IH20501C203 D	132-156"	11000.00	7.02	4.10	0.31	100.00	0.69	0.100	0 NSQ
IH20501C204 D	156-179"	19000.00	7.31	6.25	0.33	100.00	0.67	0.110	0 NSQ
IH20601C101	0-24"	59000.00	7.23	9.65	0.58	22.00	0.42	0.200	1850
IH20601C102	36-60"	36000.00	7.18	7.71	0.34	100.00	0.66	0.079	2710
IH20601C103	79-103"	190.00 PNQ	7.37	1.77	0.17	100.00	0.83	0.011	0 NSQ
IH20602C101	0-24"	150.00 PNQ	7.64	2.35	0.18	100.00	0.82	0.035	0 NSQ
IH20701C101	0-24"	22000.00	7.20	11.17	0.69	8.50	0.31	0.220	2210
IH20701C102	48-72"	45000.00	7.38	9.50	0.38	1.30	0.62	0.170	0 NSQ
IH20701C103	96-113"	38000.00	7.66	8.92	0.38	0.86	0.62	0.150	0 NSQ
IH20801C101	0-14"	40000.00	6.93	14.83	0.44	13.00	0.56	0.170	1940
IH20801C102	48-66"	55.00	7.33	0.93	0.18	100.00	0.82	0.030	0 NSQ
IH21001C101	0-24"	7900.00	7.04	12.54	0.68	5.80	0.32	0.220	2910
IH21001C102	36-60"	11000.00	7.15	12.41	0.54	2.10	0.46	0.220	4660
IH21001C103	72-100"	5700.00	7.00	12.71	0.55	1.60	0.45	0.190	0 NSQ
IH21101C101	0-24"	12000.00	7.21	23.74	0.59	1.80	0.41	0.120	4170
IH21101C102	24-48"	12000.00	7.18	34.88	0.56	0.90	0.44	0.170	7890
IH21101C103	84-108"	10000.00	6.87	14.48	0.55	1.70	0.45	0.180	0 NSQ
IH21101C201 D	0-24"	14000.00	7.17	14.53	0.59	2.60	0.41	0.130	4260
IH21101C202 D	48-72"	9900.00	7.18	13.79	0.55	3.10	0.45	0.230	0 NSQ
IH21101C203 D	96-121"	2900.00	7.88	14.14	0.58	2.20	0.42	0.260	0 NSQ

TABLE 6. INDIANA HARBOR SURVEY 2- INORGANICS

SAMPLE ID	Core Depth	EXT. RES. (ug/g)	pH	TOC (%)	MOISTURE FRACTION	MICROTOX (EC 50)	DRY SOLIDS (fraction)	VOLATILE FRACTION	CONDUCTANCE (uSiemens)
IH21102C101	0-24"	12000.00	7.48	12.71	0.65	2.40	0.35	0.190	5750
IH21102C102	48-72"	2600.00	7.32	13.14	0.58	0.81	0.42	0.210	6580 GUS
IH21102C103	84-114"	3600.00	7.75	13.39	0.58	1.80	0.42	0.420	7660 GUS
IH21201C101	0-24"	5600.00	7.06 EAC	14.46	0.77	12.00	0.23	0.190	3250
IH21201C102	48-72"	17000.00	6.78	9.76	0.47	34.00	0.53	0.160	0 NSQ
IH21201C103	84-109"	17000.00	6.27	9.63	0.44	100.00	0.56	0.160	0 NSQ
IH21202C101	0-24"	5600.00	7.37	13.95	0.70	5.00	0.30	0.220	4780
IH21202C102	60-84"	12000.00	7.44 EAC	12.96	0.58	1.20	0.42	0.190	5560
IH21202C103	104-128"	6300.00	7.76 EAC	13.72	0.64	1.70	0.36	0.230	0 NSQ
IH21301C101	0-12"	8000.00	6.95 EAC	11.64	0.53	1.60	0.47	0.140	2400
IH21301C102	36-61"	260.00	7.30 EAC	0.50 PNQ	0.20	12.00	0.80	0.019	0 NSQ
IH21302C101	0-24"	49000.00	7.54 EAC	9.71	0.37	7.00	0.63	0.150	0 NSQ
IH21302C102	24-41"	62000.00	7.11 EAC	11.13	0.40	12.00	0.60	0.170	0 NSQ
IH21401C101	0-24"	23000.00	7.57	13.59	0.63	0.83	0.37	0.200	5190
IH21401C102	48-72"	41000.00	7.14	10.78	0.47	4.00	0.53	0.150	0 NSQ
IH21401C103	96-120"	57000.00	6.98	11.31	0.38	26.00	0.62	0.160	0 NSQ
IH21402C101	0-24"	40000.00	7.17	11.37	0.60	18.00	0.40	0.160	2640
IH21402C102	48-72"	27000.00	7.24	11.09	0.48	2.90	0.52	0.150	0 NSQ
IH21402C103	96-122"	32000.00	7.00	9.53	0.31	9.50	0.69	0.170	0 NSQ
IH21501C101	0-24"	16000.00	6.98	13.77	0.66	1.30	0.34	0.110	2600
IH21501C102	42-59"	610.00	7.24	3.12	0.24	100.00	0.76	0.007	1220
IH21501C103	84-108"	0.00 LDL	7.09	1.42	0.22	100.00	0.78	0.015	0 NSQ
IH21502C101	0-12"	2800.00	7.06	2.28	0.25	73.00	0.75	0.037	1340
IH21601C101	0-24"	28000.00	7.01	11.73	0.68	3.40	0.32	0.180	2050
IH21601C102	29-50"	7000.00	7.07	1.76	0.28	9.50	0.72	0.045	2920
IH21601C103	69-93"	450.00 PNQ	7.12	1.15	0.20	100.00	0.80	0.006	0 NSQ
IH21701C101	0-24"	22000.00	6.72	5.91	0.28	18.00	0.72	0.052	2820
IH21701C102	48-72"	68000.00	7.04	10.76	0.41	27.00	0.59	0.200	2430
IH21701C103	96-120"	740.00	7.30	1.32	0.22	100.00	0.78	0.004	0 NSQ
IH21801C101	0-24"	20000.00	7.13	8.53	0.18	100.00	0.82	0.050	0 NSQ
IH21901C101	0-24"	16000.00	7.20	4.59	0.44	9.90	0.56	0.080	1430
IH21901C102	24-48'	430.00	7.33	1.87	0.20	100.00	0.80	0.026	0 NSQ
IH21902C101	0-24"	11000.00	6.87	10.16	0.60	2.40	0.40	0.083	1390
IH21902C102	24-48'	3900.00	7.12	1.07	0.18	100.00	0.82	0.009	0 NSQ
IH22001C101	0-24"	43000.00	7.43	9.77	0.57	29.00	0.43	0.130	1340
IH22001C102	36-60"	68000.00	7.70	28.89	0.60	3.20	0.40	0.130	1280
IH22001C103	108-132"	120000.00	7.16	46.44	0.45	2.50	0.55	0.200	0 NSQ
IH22001C201 D	0-24'	43000.00	7.76	23.54	0.53	5.80	0.47	0.077	1290
IH22001C202 D	24-48'	78000.00	7.87	23.71	0.51	2.10	0.49	0.110	1460

TABLE 6. INDIANA HARBOR SURVEY 2- INORGANICS

SAMPLE ID	Core Depth	EXT. RES. (ug/g)	pH	TOC (%)	MOISTURE FRACTION	MICROTOX (EC 50)	DRY SOLIDS (fraction)	VOLATILE FRACTION	CONDUCTANCE (uSiemens)
IH22001C203 D	72-96"	140000.00	8.23	60.21	0.46	1.60	0.54	0.180	0 NSQ
IH22001C204 D	101-125"	62000.00	8.44	17.80	0.60	3.30	0.40	0.150	0 NSQ
IH22101C101	0-24"	25000.00	6.88	11.76	0.64	1.90	0.36	0.150	1020
IH22101C102	36-60"	20000.00	6.91	2.89	0.29	21.00	0.71	0.051	1860
IH22101C103	72-96"	7100.00	6.71	1.56	0.23	27.00	0.77	0.037	1200
IH22201C101	0-24"	14000.00	7.00	9.69	0.62	2.70	0.38	0.180	1770
IH22201C102	36-60"	16000.00	7.61	10.43	0.56	4.30	0.44	0.190	3840
IH22201C103	84-108"	32000.00	6.76	7.72	0.32	40.00	0.68	0.130	4220
IH22202C101	0-24"	16000.00	6.94	11.67	0.62	2.20	0.38	0.180	1510
IH22202C102	48-72'	17000.00	6.97	10.70	0.52	31.00	0.48	0.180	2930
IH22202C103	84-106'	26000.00	6.94	9.00	0.39	100.00	0.61	0.130	3310
IH22301C101	0-24"	22000.00	7.03	5.61	0.48	5.00	0.52	0.140	1880
IH22301C102	24-48'	45000.00	7.04	5.56	0.36	18.00	0.64	0.130	2950
IH22301C103	62-86'	22000.00	7.02	4.69	0.28	48.00	0.72	0.079	3620
IH22302C101	0-24"	42000.00	6.40	10.94	0.47	21.00	0.53	0.150	2080
IH22302C102	40-64"	51000.00	7.22	10.85	0.40	13.00	0.60	0.200	2760
IH22302C103	82-100"	770.00	7.26	2.93	0.18	100.00	0.82	0.017	0 NSQ
IH22401C101	0-24"	1400.00	7.19	0.76 PNQ	0.22	100.00	0.78	0.028	0 NSQ
IH22501C101	0-24"	19000.00	6.83	9.31	0.48	4.40	0.52	0.074	1050
IH22501C102	36-59.5"	44000.00	6.73	12.43	0.37	65.00	0.63	0.060	2070
IH22501C103	90-115"	1900.00	6.91	1.41	0.32	100.00	0.68	0.035	0 NSQ
IH22601C101	0-24"	20000.00	6.58	13.70	0.49	8.70	0.51	0.095	2070
IH22601C102	48-72"	20000.00	6.99	15.60	0.48	31.00	0.52	0.130	2280
IH22601C103	96-118"	28000.00	7.15	20.96	0.34	6.10	0.66	0.082	1790
IH22701C101	0-24"	25000.00	7.24	3.88	0.20	83.00	0.80	0.032	991
IH22701C102	24-48"	380.00 PNQ	7.25	0.08 LDL	0.17	100.00	0.83	0.005	0 NSQ
IH22701C103	48-72"	490.00 PNQ	7.54	0.17 LDL	0.14	100.00	0.86	0.008	0 NSQ
IH22801C101	0-24"	16000.00	6.85	7.85	0.55	21.00	0.45	0.120	1170
IH22801C102	66-90"	9000.00	7.14	4.93	0.50	43.00	0.50	0.050	1080
IH22801C103	90-114"	4800.00	7.19	3.99	0.43	64.00 RP	0.57	0.044	1370

D - Duplicate sample

LDL - Less than detection limit. Value reported is method limit of detection.

PNQ - Present but not quantified. Value reported is measured value.

EAC - Exceeds accuracy criteria. pH analysis only. QC standard exceeded accuracy criteria by 0.01 pH units.

RPD - Relative percent difference. RPD of normal sample and replicate sample greater than 20%.

NSQ - Not Sufficient Quantity. Conductivity only; insufficient pore water for conductivity analysis. No value reported.

TABLE 7. INDIANA HARBOR SURVEY 2 - METALS (dry wt)

SAMPLE ID	CADMIUM (ug/g)	CHROMIUM (ug/g)	COPPER (ug/g)	IRON (%)	NICKEL (ug/g)	LEAD (ug/g)	ZINC (ug/g)
IH20201C101	0.00 PNQ	7.00	8.00	0.75	5.00	6.00	38.00
IH20201C102	0.30 PNQ	5.30 LLS	5.60 LLS	0.60	4.90 LLS	5.60 LLS	34.00 LLS
IH20301C101	34.00	490.00	400.00	23.00	110.00	930.00	5600.00
IH20301C102	12.00	56.00	160.00	11.00	34.00 LLS	740.00	2200.00
IH20301C103	0.10 PNQ	3.40 LLS	4.50 LLS	0.49	4.10 LLS	4.90 LLS	20.00 LLS
IH20401C101	5.40	220.00	220.00	13.00	51.00	450.00	2300.00
IH20401C102	8.10	360.00	400.00	27.00	110.00	510.00	3200.00 GUS
IH20401C103	6.00	280.00	360.00	31.00	120.00	290.00	2000.00
IH20402C101	1.10 LLS	32.00 LLS	34.00 LLS	2.70	27.00 LLS	38.00 LLS	160.00
IH20403C101	6.90	320.00	260.00	13.00	59.00	520.00	2800.00 GUS
IH20403C102	23.00	620.00	330.00	22.00	73.00	910.00	6700.00
IH20403C103	5.40	63.00	86.00	5.90	43.00	140.00	800.00
IH20403C201 D	7.30	330.00	270.00	14.00	63.00	590.00	3100.00 GUS
IH20403C202 D	28.00 LLS	650.00	340.00	22.00	68.00	980.00	6700.00
IH20501C101	7.60	400.00	250.00	15.00	60.00	620.00	3200.00
IH20501C102	26.00 LLS	290.00	240.00 GUS	20.00	60.00	580.00	4000.00
IH20501C103	45.00	240.00	280.00	23.00	66.00	710.00	4500.00
IH20501C201 D	5.90	240.00	220.00	12.00	54.00	460.00	2000.00
IH20501C202 D	12.00	530.00	250.00	17.00	62.00	660.00	4600.00
IH20501C203 D	26.00	140.00	200.00	15.00	44.00	640.00	2400.00
IH20501C204 D	23.00	110.00	230.00	22.00	43.00	740.00	3200.00 GUS
IH20601C101	12.00	1100.00	370.00	14.00	99.00	1100.00	6100.00
IH20601C102	15.00	740.00	340.00	9.90	74.00	820.00	5400.00 GUS
IH20601C103	0.30 PNQ	5.80 LLS	6.20 LLS	0.70	5.50 LLS	4.40 PNQ	39.00
IH20602C101	0.20 PNQ	5.30 LLS	6.10 LLS	0.70	5.10 LLS	6.20 LLS	50.00
IH20701C101	17.00	920.00	440.00	19.00	120.00	1200.00	6000.00
IH20701C102	27.00	1100.00	450.00 GUS	24.00	100.00	1800.00	8100.00 GUS
IH20701C103	18.00	190.00	370.00	22.00	66.00	1900.00	5200.00
IH20801C101	14.00	1300.00	440.00	11.00	130.00	2000.00	6100.00
IH20801C102	0.50 PNQ	29.00	24.00	2.30	27.00	1.90 LDL	71.00
IH21001C101	11.00	550.00	390.00	17.00	97.00	790.00	3800.00 GUS
IH21001C102	11.00	570.00	410.00	18.00	120.00	1000.00	4000.00
IH21001C103	12.00	790.00	470.00	16.00	230.00	1100.00	4300.00
IH21101C101	5.60	270.00	220.00	9.10	85.00	490.00	2000.00
IH21101C102	9.80	440.00	370.00	14.00	170.00	840.00	3500.00 GUS
IH21101C103	11.00	600.00	280.00	13.00	140.00	1000.00	3400.00
IH21101C201 D	7.40	320.00	240.00	11.00	76.00	580.00	2500.00
IH21101C202 D	12.00	640.00	370.00	15.00	170.00	1000.00	3600.00 GUS
IH21101C203 D	18.00	960.00	510.00	15.00	560.00	1500.00	5800.00
IH21102C101	13.00	600.00	540.00	17.00	110.00	950.00	4100.00

TABLE 7. INDIANA HARBOR SURVEY 2 - METALS (dry wt)

SAMPLE ID	CADMIUM (ug/g)	CHROMIUM (ug/g)	COPPER (ug/g)	IRON (%)	NICKEL (ug/g)	LEAD (ug/g)	ZINC (ug/g)
IH21102C102	11.00	570.00	440.00	18.00	110.00	960.00	4300.00
IH21102C103	16.00	930.00	460.00	15.00	400.00	1300.00	4800.00
IH21201C101	12.00	520.00	400.00	17.00	100.00	790.00	4000.00 GUS
IH21201C102	17.00	1600.00	390.00	30.00 GUS	98.00	1600.00	9100.00
IH21201C103	16.00	1700.00	370.00	29.00	98.00	1500.00	9500.00
IH21202C101	14.00	610.00	460.00	17.00	120.00	870.00	4500.00
IH21202C102	12.00	590.00	440.00	18.00	150.00	1100.00	4100.00 GUS
IH21202C103	17.00	1000.00	530.00	17.00	470.00	1500.00	5400.00
IH21301C101	9.30	520.00	300.00	12.00	100.00	810.00	3500.00
IH21301C102	0.40 PNQ	17.00	23.00	17.00	24.00	6.70 LLS	61.00
IH21302C101	25.00	260.00	300.00	13.00	81.00	2500.00	5500.00
IH21302C102	24.00	210.00	330.00	15.00	80.00	2700.00	6000.00
IH21401C101	13.00	820.00	450.00	12.00	170.00	1200.00	5200.00
IH21401C102	21.00	1600.00	360.00	21.00	84.00	1600.00	9600.00
IH21401C103	22.00	200.00	380.00	17.00	82.00	2100.00	6800.00
IH21402C101	20.00	1600.00	370.00	20.00	90.00	1500.00	9300.00
IH21402C102	22.00	1800.00	400.00	21.00	91.00	1700.00	10000.00
IH21402C103	22.00	88.00	310.00	13.00	30.00	1500.00	4700.00
IH21501C101	11.00	620.00	390.00	14.00	130.00	920.00	4100.00
IH21501C102	0.40 PNQ	11.00 LLS	13.00 LLS	8.80	6.00 LLS	15.00 LLS	94.00
IH21501C103	0.40 PNQ	34.00	31.00	2.60	32.00	1.50 LDL	71.00
IH21502C101	1.40 LLS	73.00	67.00	4.10	44.00	77.00	350.00
IH21601C101	12.00	700.00	420.00	15.00	110.00	970.00	4500.00
IH21601C102	2.10 LLS	160.00	81.00	3.00	28.00	190.00	900.00
IH21601C103	0.40 PNQ	5.80 LLS	6.10 LLS	0.60	5.40 LDL	2.30 PNQ	40.00
IH21701C101	9.30	370.00	130.00 LLS	5.20	37.00	440.00	2600.00
IH21701C102	17.00	120.00	260.00	14.00	59.00	1800.00	4400.00
IH21701C103	0.00 LDL	5.00 LLS	5.00 LLS	0.60	3.00 PNQ	4.00 PNQ	41.00
IH21801C101	1.30 LLS	81.00	34.00	1.50	11.00 LLS	98.00	500.00
IH21901C101	8.60	410.00	280.00	11.00	77.00	630.00	3100.00
IH21901C102	0.60 LLS	35.00	32.00	2.60	32.00	9.40 LLS	93.00
IH21902C101	8.50	470.00	310.00	11.00	88.00	670.00	2900.00
IH21902C102	0.70 LLS	29.00	32.00	2.70 GUS	13.00 LLS	33.00	180.00
IH22001C101	6.50	250.00	400.00	23.00	110.00	620.00	1200.00
IH22001C102	4.50	330.00	460.00	28.00	110.00	780.00	1200.00
IH22001C103	3.00 LLS	210.00	230.00	17.00	62.00	310.00	1100.00
IH22001C201 D	5.00	300.00	370.00	23.00	100.00	540.00	1900.00
IH22001C202 D	3.90	360.00	430.00	27.00 GUS	110.00	790.00	1100.00
IH22001C203 D	2.00 LLS	150.00	130.00	8.10	32.00	240.00	490.00
IH22001C204 D	10.00	370.00	400.00	27.00	94.00	670.00	2800.00

TABLE 7. INDIANA HARBOR SURVEY 2 - METALS (dry wt)

SAMPLE ID	CADMIUM (ug/g)	CHROMIUM (ug/g)	COPPER (ug/g)	IRON (%)	NICKEL (ug/g)	LEAD (ug/g)	ZINC (ug/g)
IH22101C101	11.00	710.00	430.00	14.00	130.00	920.00	4300.00
IH22101C102	6.00	410.00	120.00	6.30	32.00	390.00	3000.00 GUS
IH22101C103	6.00	130.00	64.00	2.90	25.00	270.00	1600.00
IH22201C101	11.00	740.00	450.00	13.00	100.00	930.00	4600.00
IH22201C102	10.00	1000.00	880.00	12.00	130.00	1100.00	4900.00
IH22201C103	9.00	950.00	210.00	12.00	54.00	840.00	5600.00
IH22202C101	8.00	470.00	270.00	7.80	81.00	550.00	2800.00
IH22202C102	12.00	960.00	740.00	13.00	150.00	1200.00	5400.00
IH22202C103	12.00	980.00	230.00	11.00	57.00	830.00	4900.00
IH22301C101	6.90	450.00	220.00	5.80	60.00	980.00	2400.00
IH22301C102	13.00	530.00	210.00	3.90	59.00	1200.00	2400.00
IH22301C103	4.10	20.00	52.00	2.70 GUS	12.00 LLS	680.00	970.00
IH22302C101	8.70	790.00	260.00	6.40	85.00	1200.00	3300.00
IH22302C102	17.00	240.00	270.00	11.00	100.00	3700.00	4700.00
IH22302C103	0.50 PNQ	32.00	26.00	2.20	25.00	24.00	95.00
IH22401C101	0.40 PNQ	32.00	32.00	2.50	31.00	4.00 PNQ	68.00
IH22501C101	6.00	280.00	220.00	11.00	50.00	450.00	2400.00
IH22501C102	13.00	650.00	290.00	20.00	71.00	820.00	5500.00
IH22501C103	0.50 PNQ	27.00	31.00	2.50	27.00	8.20 LLS	82.00
IH22601C101	7.00	440.00	350.00	16.00	91.00	610.00	2900.00 GUS
IH22601C102	14.00	1000.00	440.00	21.00	120.00	1200.00	6900.00
IH22601C103	9.00	610.00	320.00	22.00	77.00	640.00	4800.00
IH22701C101	6.00	99.00	110.00	7.60	45.00	270.00	2600.00
IH22701C102	0.50 PNQ	9.80 LLS	10.00 LLS	1.00	8.20 LLS	19.00	230.00
IH22701C103	0.20 PNQ	4.10 LLS	4.50 LLS	0.50	4.70 LLS	7.10 LLS	45.00
IH22801C101	7.00	270.00	240.00	13.00	55.00	530.00	3000.00 GUS
IH22801C102	14.00	130.00	170.00	14.00	42.00	570.00	2200.00
IH22801C103	7.30	46.00	110.00	10.00	21.00	440.00	1300.00

D - Duplicate sample

LDL - Less than detection limit. Value reported is method limit of detection.

PNQ - Present but not quantified. Value reported is measured value.

LLS - Lower than lowest standard. Value reported is measured value.

GUS - Greater than upper standard. Value reported is measured value.

TABLE 8. INDIANA HARBOR SURVEY 2 - GRAIN SIZE

SAMPLE ID	GT38	GT63	GT250	GT1000	LT38
IH20201C101	1.00	57.00	31.00	9.70	1.50
IH20201C102	2.30	80.00	10.00	2.70	2.10
IH20301C101	4.70	12.00	1.50	0.37	80.00
IH20301C102	5.70	20.00	2.50	3.60	66.00
IH20301C103	0.71	54.00	32.00	10.00	1.40
IH20401C101	6.40	25.00	2.40	0.14	64.00
IH20401C102	9.60	17.00	1.80	0.54	67.00
IH20401C103	12.00	58.00	6.30	0.58	23.00
IH20402C101	2.10	7.70	2.00	1.30	87.00
IH20403C101	8.70	22.00	2.00	0.07	64.00
IH20403C102	5.70	13.00	1.70	0.24	77.00
IH20403C103	3.90	13.00	7.20	2.80	84.00
IH20403C201 D	8.20	18.00	1.10	0.82	42.00
IH20403C202 D	5.90	10.00	1.20	0.19	80.00
IH20501C101	7.30	52.00	11.00	1.10	35.00
IH20501C102	9.30	26.00	4.80	4.30	48.00
IH20501C103	10.00	19.00	2.40	3.20	66.00
IH20501C201 D	6.90	51.00	9.90	2.50	29.00
IH20501C202 D	9.50	37.00	8.70	3.30	42.00
IH20501C203 D	4.60	37.00	14.00	2.30	42.00
IH20501C204 D	7.40	32.00	7.40	0.77	53.00
IH20601C101	2.60	34.00	6.20	1.70	52.00
IH20601C102	3.40	43.00	11.00	4.10	32.00
IH20601C103	7.20	84.00	3.50	0.48	5.20
IH20602C101	3.80	86.00	2.50	2.80	2.70
IH20701C101	8.90	12.00	1.10	0.16	75.00
IH20701C102	5.70	14.00	2.10	1.40	73.00
IH20701C103	5.10	20.00	2.00	0.10	69.00
IH20801C101	4.80	29.00	3.30	1.60	43.00
IH20801C102	0.94	1.20	1.20	1.30	87.00
IH21001C101	11.00	14.00	1.90	1.20	67.00
IH21001C102	7.80	14.00	2.40	0.84	72.00
IH21001C103	5.70	8.60	2.00	0.70	76.00
IH21101C101	5.00	5.90	30.00	39.00	33.00
IH21101C102	7.10	16.00	7.90	9.60	55.00
IH21101C103	6.50	11.00	3.60	2.40	69.00
IH21101C201 D	7.60	22.00	7.70	15.00	48.00
IH21101C202 D	5.80	13.00	3.80	4.00	73.00
IH21101C203 D	6.00	5.70	1.30	0.94	81.00
IH21102C101	10.00	15.00	1.60	0.52	61.00
IH21102C102	10.00	9.50	1.10	0.29	79.00
IH21102C103	6.70	5.70	0.91	1.10	73.00
IH21201C101	16.00	16.00	1.90	0.63	80.00
IH21201C102	6.00	8.50	1.30	0.74	82.00
IH21201C103	5.80	11.00	3.50	1.50	78.00
IH21202C101	16.00	22.00	1.00	0.25	56.00
IH21202C102	9.50	11.00	0.34	0.33	77.00
IH21202C103	11.00	5.50	0.43	0.15	83.00
IH21301C101	8.80	32.00	5.10	0.92	47.00
IH21301C102	0.93	1.10	0.78	0.55	95.00
IH21302C101	6.90	27.00	2.70	0.84	55.00
IH21302C102	5.50	27.00	3.40	0.59	63.00
IH21401C101	11.00	16.00	1.60	1.90	67.00
IH21401C102	6.80	14.00	2.50	1.10	69.00
IH21401C103	5.70	15.00	1.40	2.30	72.00
IH21402C101	15.00	13.00	1.90	8.30	75.00

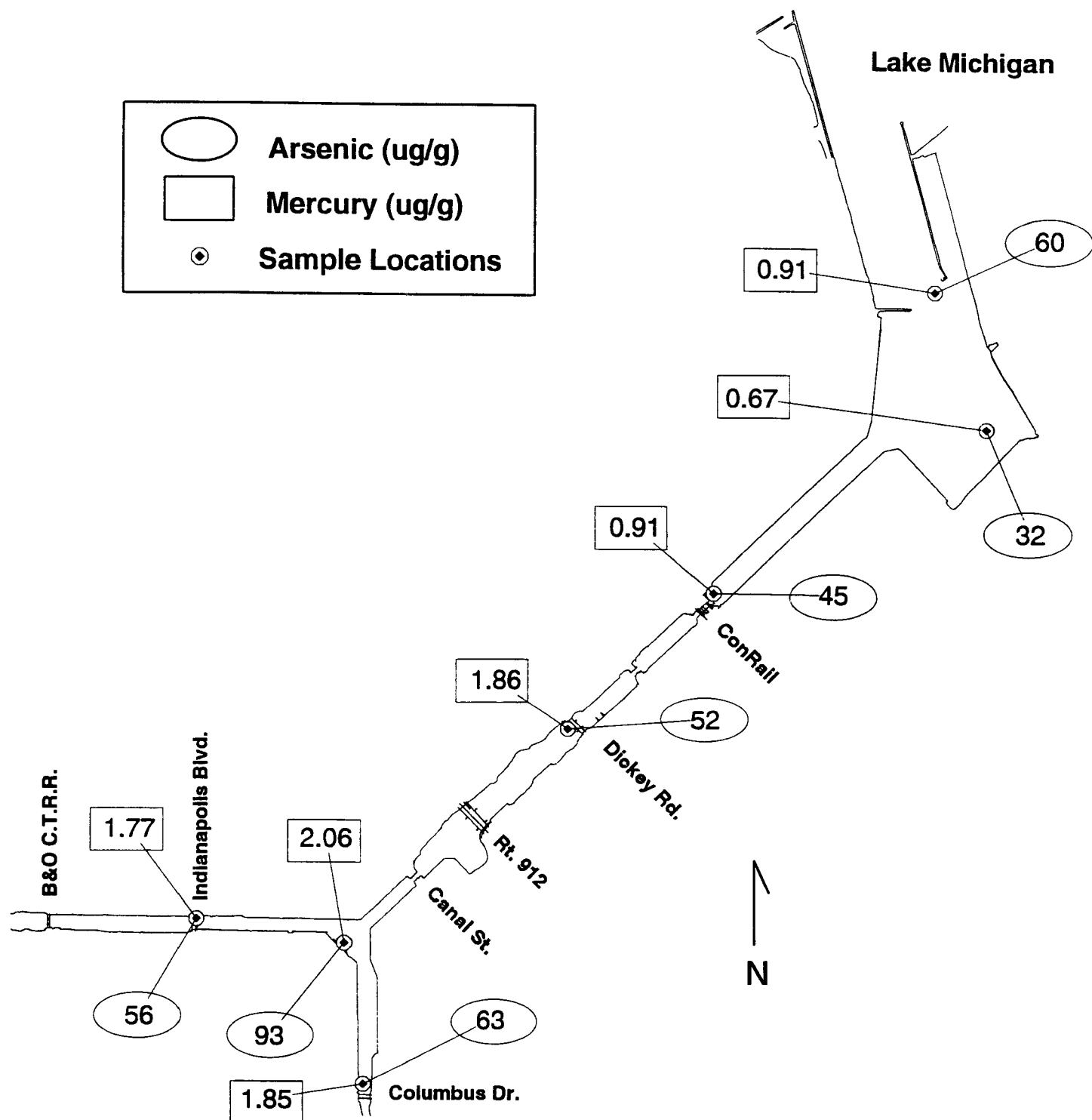
TABLE 8. INDIANA HARBOR SURVEY 2 - GRAIN SIZE

SAMPLE ID	GT38	GT63	GT250	GT1000	LT38
IH21402C102	5.30	14.00	1.80	0.95	74.00
IH21402C103	4.80	25.00	2.40	1.40	61.00
IH21501C101	15.00	22.00	3.20	0.18	73.00
IH21501C102	26.00	58.00	0.34	0.11	12.00
IH21501C103	1.90	3.30	2.20	1.70	91.00
IH21502C101	3.70	14.00	8.50	5.60	62.00
IH21601C101	11.00	14.00	1.60	0.73	66.00
IH21601C102	1.60	44.00	34.00	8.00	4.80
IH21601C103	2.40	93.00	0.56	1.00	2.80
IH21701C101	2.50	12.00	61.00	2.10	16.00
IH21701C102	3.90	56.00	12.00	0.68	37.00
IH21701C103	0.96	86.00	3.60	0.03	2.00
IH21801C101	1.40	45.00	9.50	2.40	24.00
IH21901C101	1.90	5.40	2.60	2.30	80.00
IH21901C102	1.30	2.20	1.50	0.61	91.00
IH21902C101	4.80	61.00	14.00	3.60	48.00
IH21902C102	2.60	88.00	4.90	2.40	1.40
IH22001C101	7.30	9.70	1.50	0.41	80.00
IH22001C102	12.00	19.00	7.10	3.00	79.00
IH22001C103	3.50	8.00	23.00	18.00	22.00
IH22001C201 D	11.00	18.00	8.60	4.40	53.00
IH22001C202 D	8.60	12.00	5.90	4.10	50.00
IH22001C203 D	-9.00	-9.00	-9.00	-9.00	-9.00
IH22001C204 D	6.10	12.00	6.60	6.60	72.00
IH22101C101	7.70	19.00	1.20	0.32	67.00
IH22101C102	2.40	53.00	11.00	2.30	25.00
IH22101C103	3.00	57.00	18.00	5.80	13.00
IH22201C101	5.60	22.00	2.20	0.20	65.00
IH22201C102	3.10	22.00	2.90	0.53	69.00
IH22201C103	3.00	45.00	6.20	0.54	37.00
IH22202C101	3.80	17.00	2.90	28.00	59.00
IH22202C102	5.80	27.00	4.10	0.63	59.00
IH22202C103	5.10	38.00	5.50	0.96	54.00
IH22301C101	3.90	36.00	15.00	6.40	36.00
IH22301C102	1.70	40.00	15.00	9.10	30.00
IH22301C103	3.10	66.00	5.10	0.61	24.00
IH22302C101	3.20	45.00	11.00	2.40	30.00
IH22302C102	4.30	26.00	1.90	0.19	55.00
IH22302C103	1.10	1.20	0.18	0.75	96.00
IH22401C101	1.40	2.40	1.70	1.40	95.00
IH22501C101	8.90	35.00	4.50	1.30	51.00
IH22501C102	9.50	15.00	3.40	0.85	69.00
IH22501C103	0.27	2.50	0.78	1.30	97.00
IH22601C101	5.70	43.00	9.50	1.20	24.00
IH22601C102	6.50	30.00	5.20	2.40	64.00
IH22601C103	7.70	8.80	43.00	1.70	35.00
IH22701C101	4.50	42.00	17.00	1.40	18.00
IH22701C102	0.51	52.00	44.00	2.40	1.00
IH22701C103	0.10	14.00	47.00	39.00	0.50
IH22801C101	7.40	17.00	1.80	0.25	68.00
IH22801C102	7.90	14.00	0.80	0.11	69.00
IH22801C103	6.50	33.00	2.70	10.00	50.00

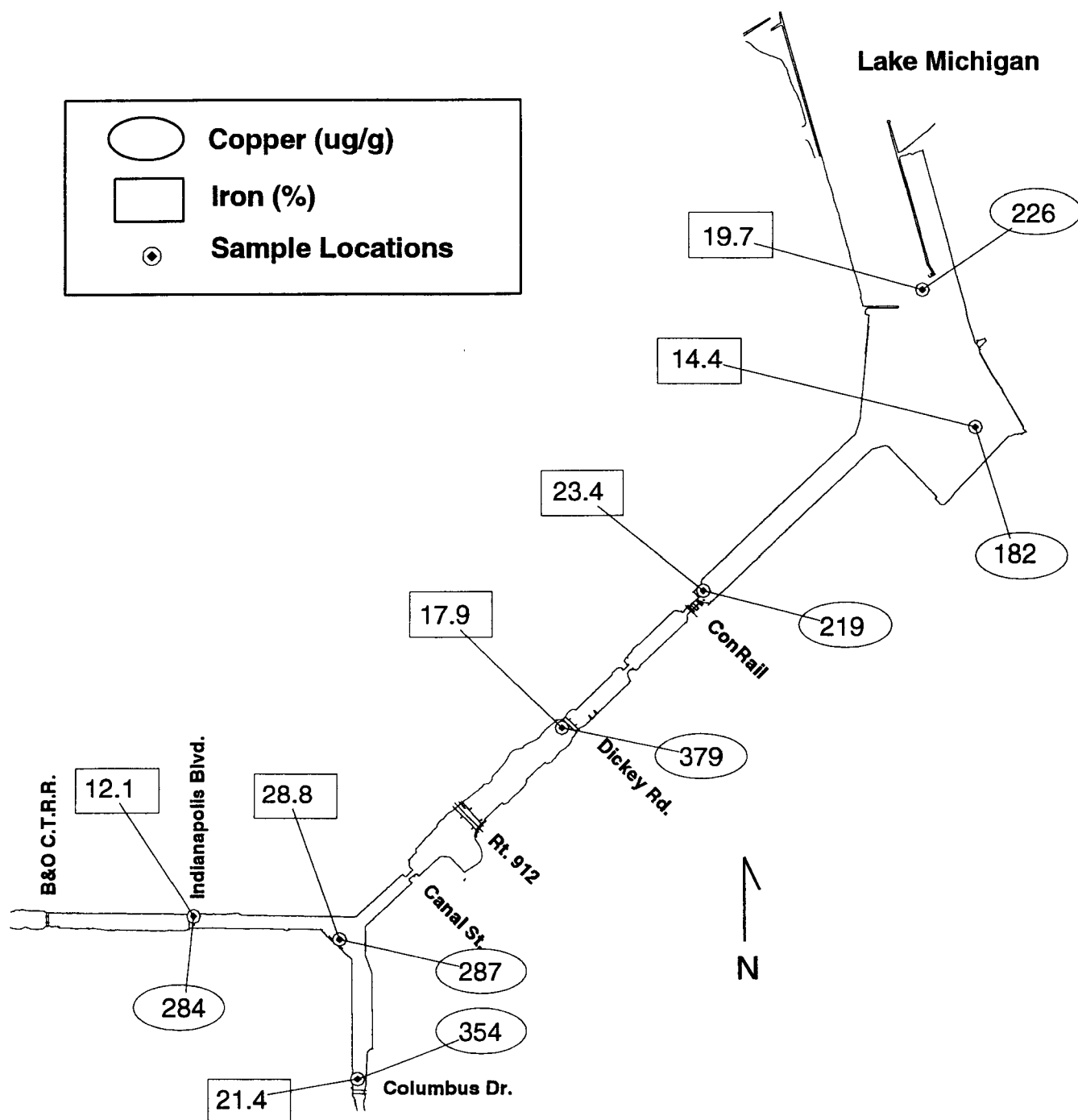
D - Duplicate sample

APPENDIX B

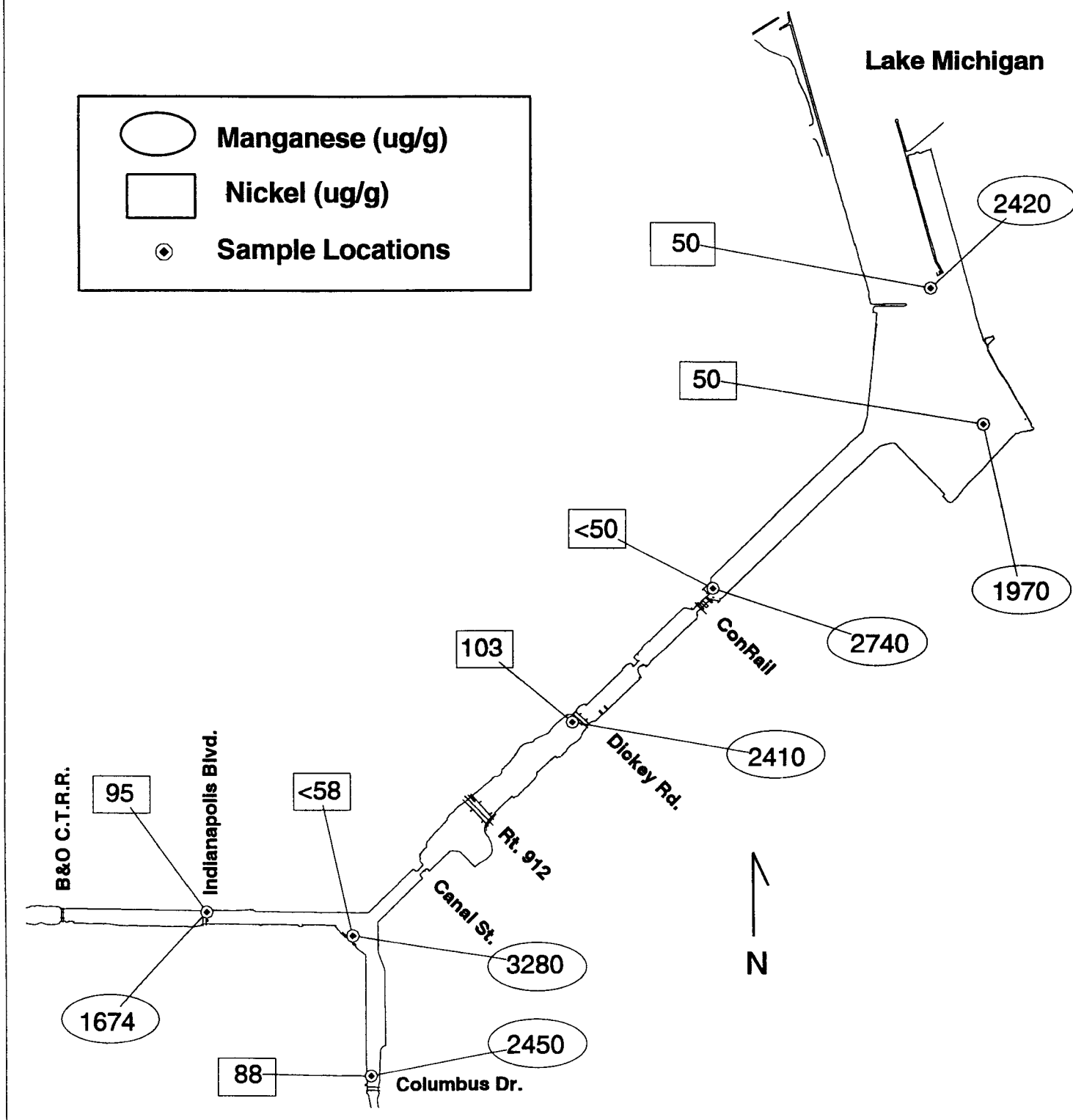
Indiana Harbor Survey 1 Surface Samples Arsenic and Mercury Concentrations



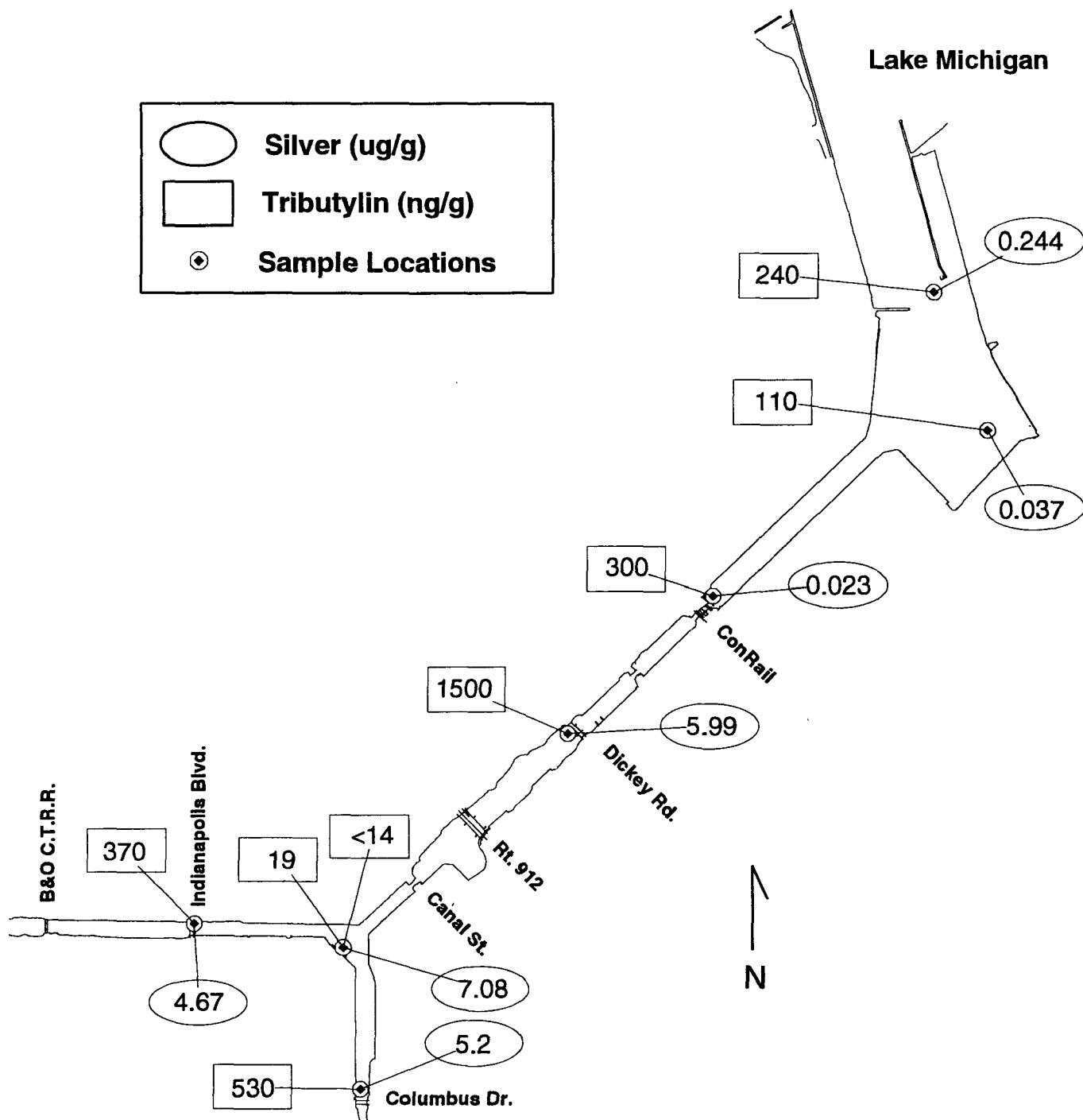
Indiana Harbor Survey 1 Surface Samples Copper and Iron Concentrations



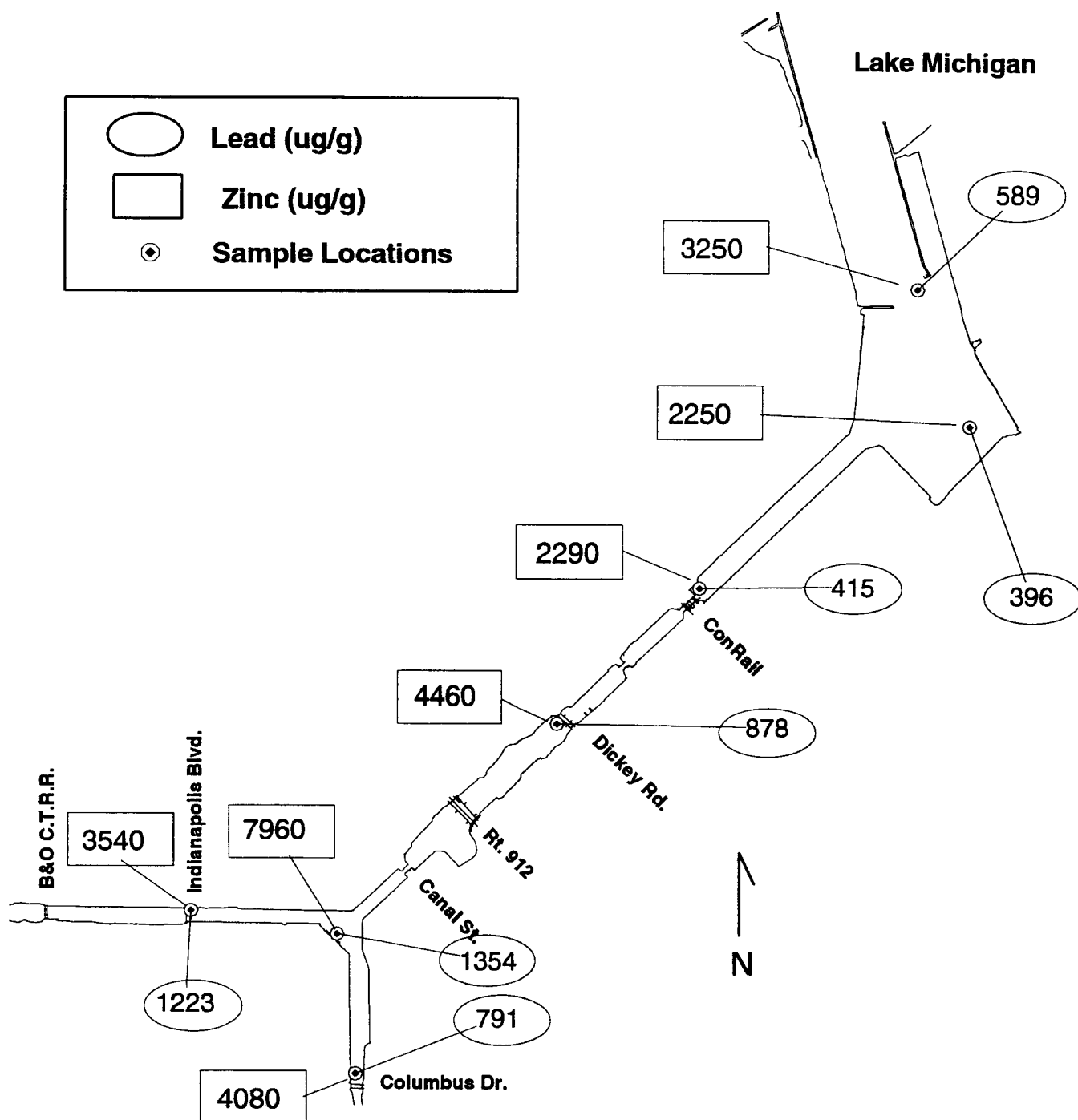
Indiana Harbor Survey 1 Surface Samples Manganese and Nickel Concentrations



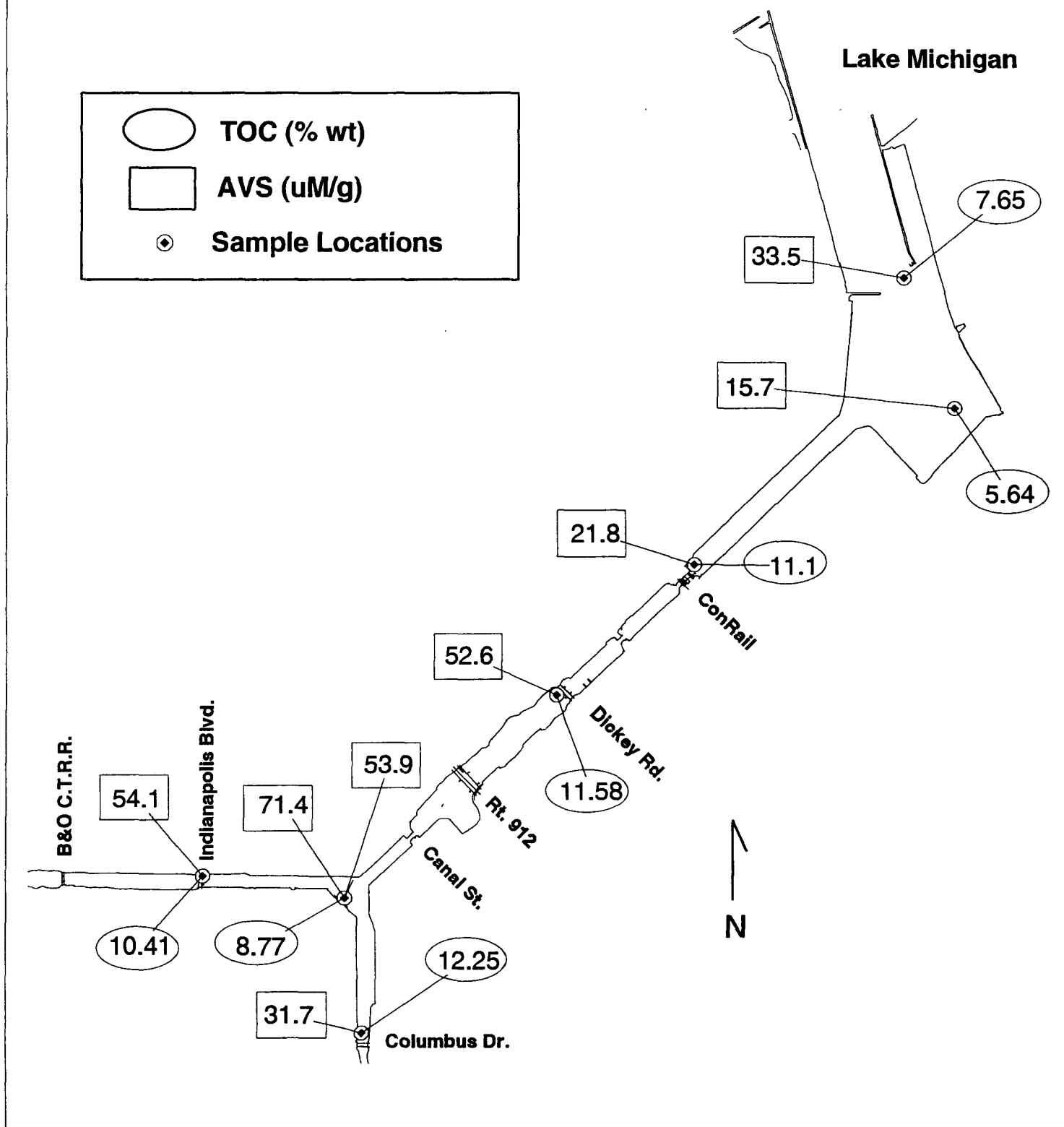
Indiana Harbor Survey 1 Surface Samples Silver and Tributyltin Concentrations



Indiana Harbor Survey 1 Surface Samples Lead and Zinc Concentrations

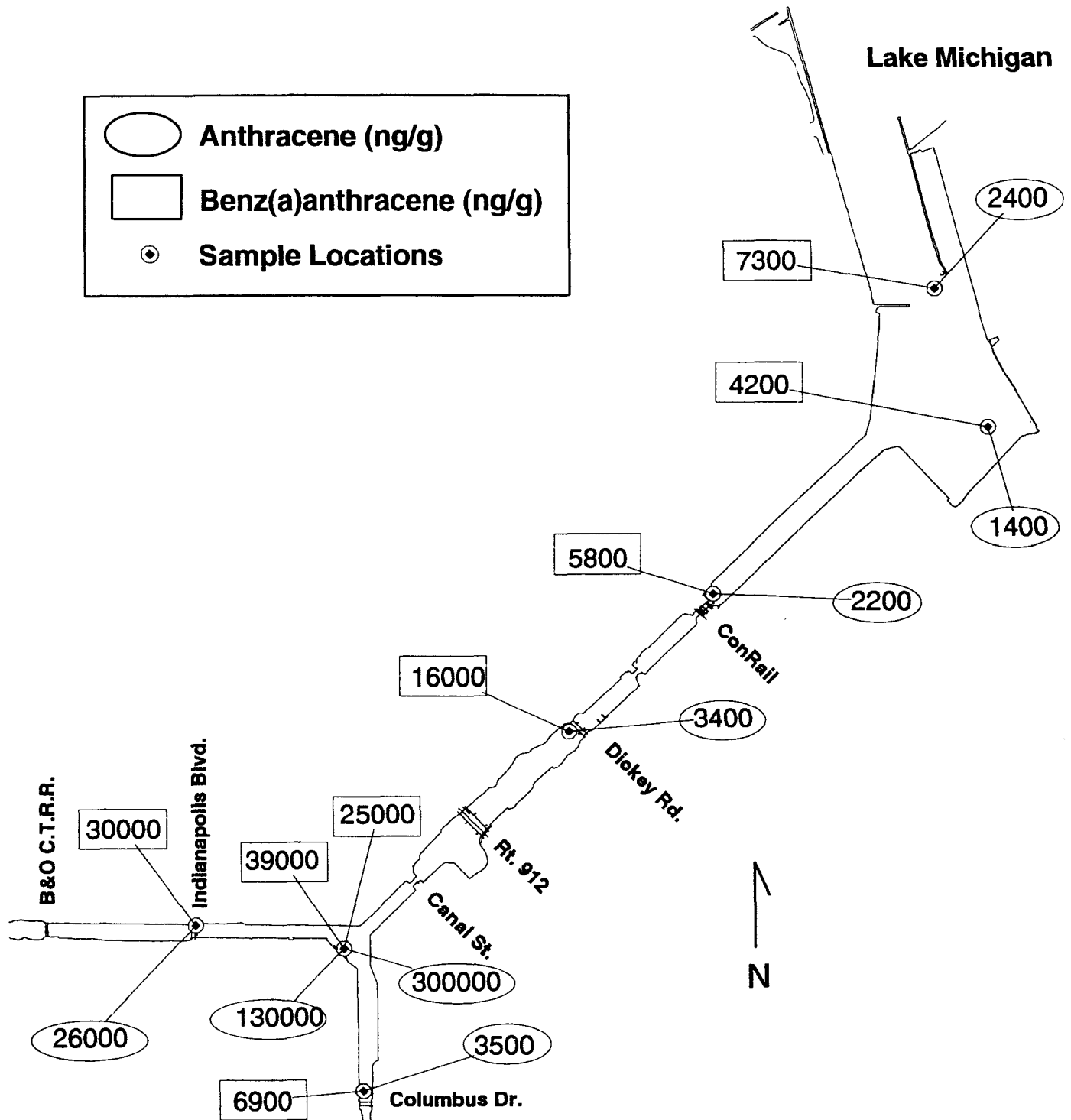


Indiana Harbor Survey 1 Surface Samples TOC and AVS Concentrations



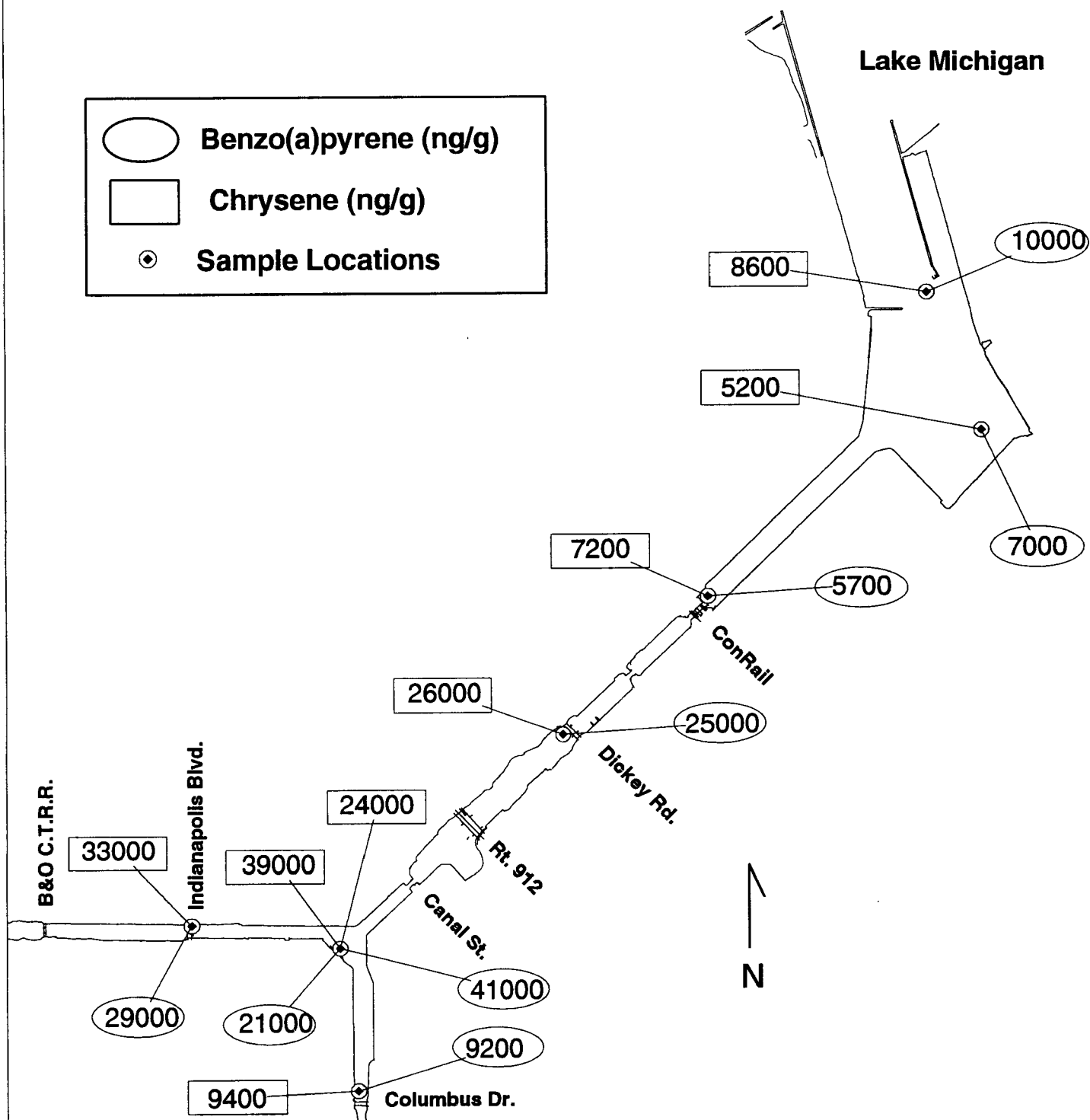
Indiana Harbor Survey 1 Surface Samples

Anthracene and Benz(a)anthracene

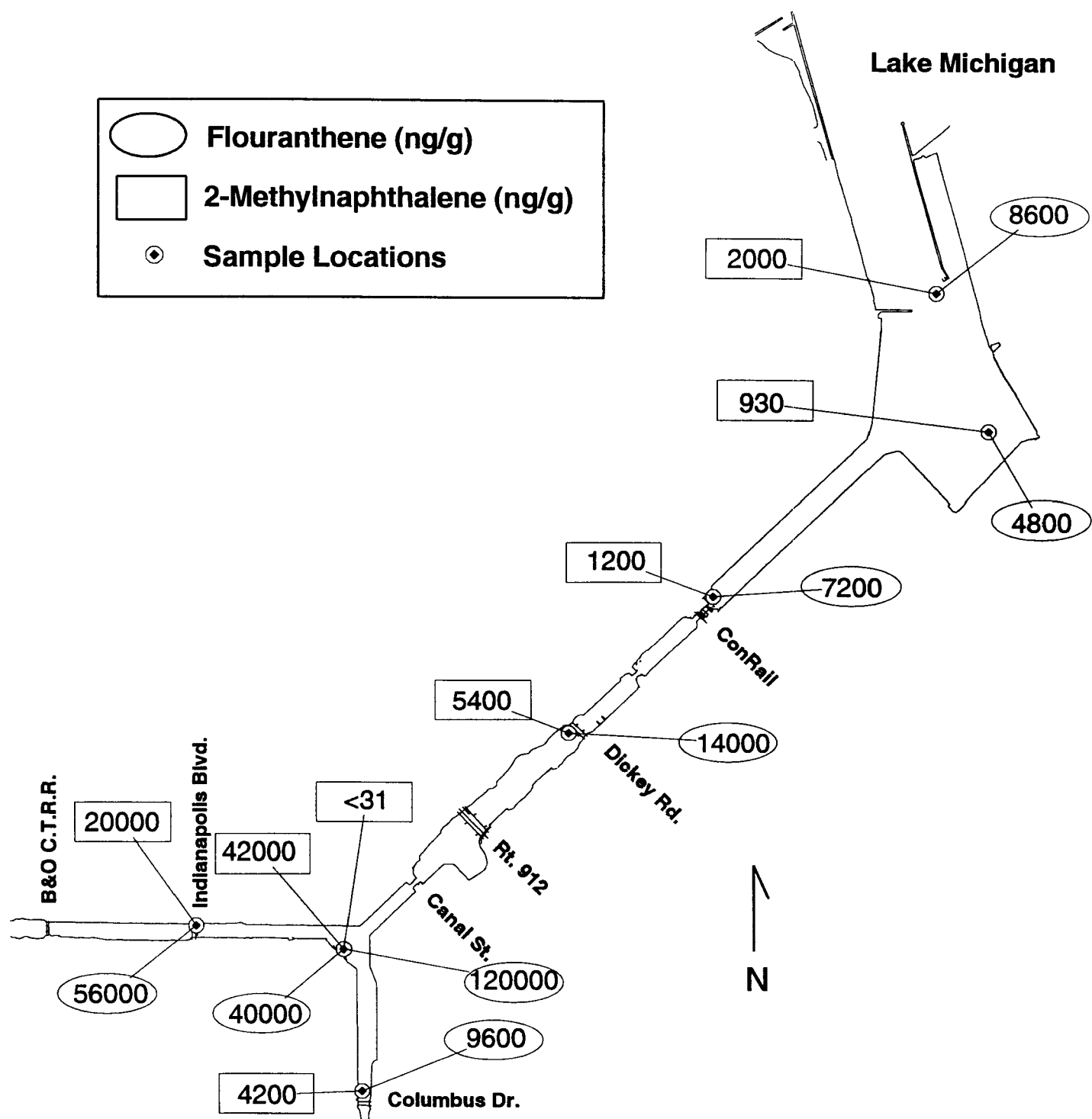


Indiana Harbor Survey 1 Surface Samples

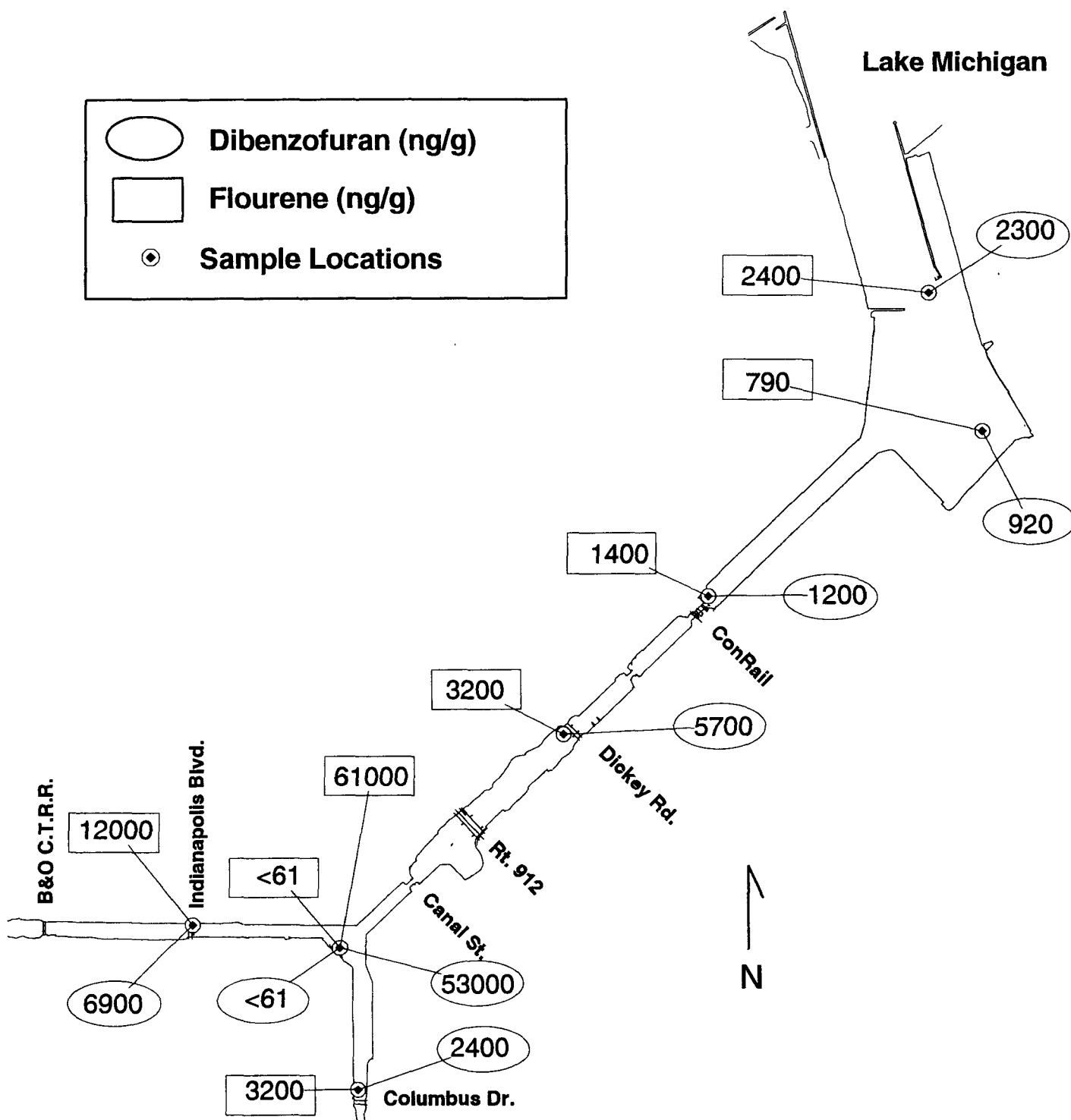
Benzo(a)pyrene and Chrysene



Indiana Harbor Survey 1 Surface Samples Flouranthene and 2-Methylnaphthalene

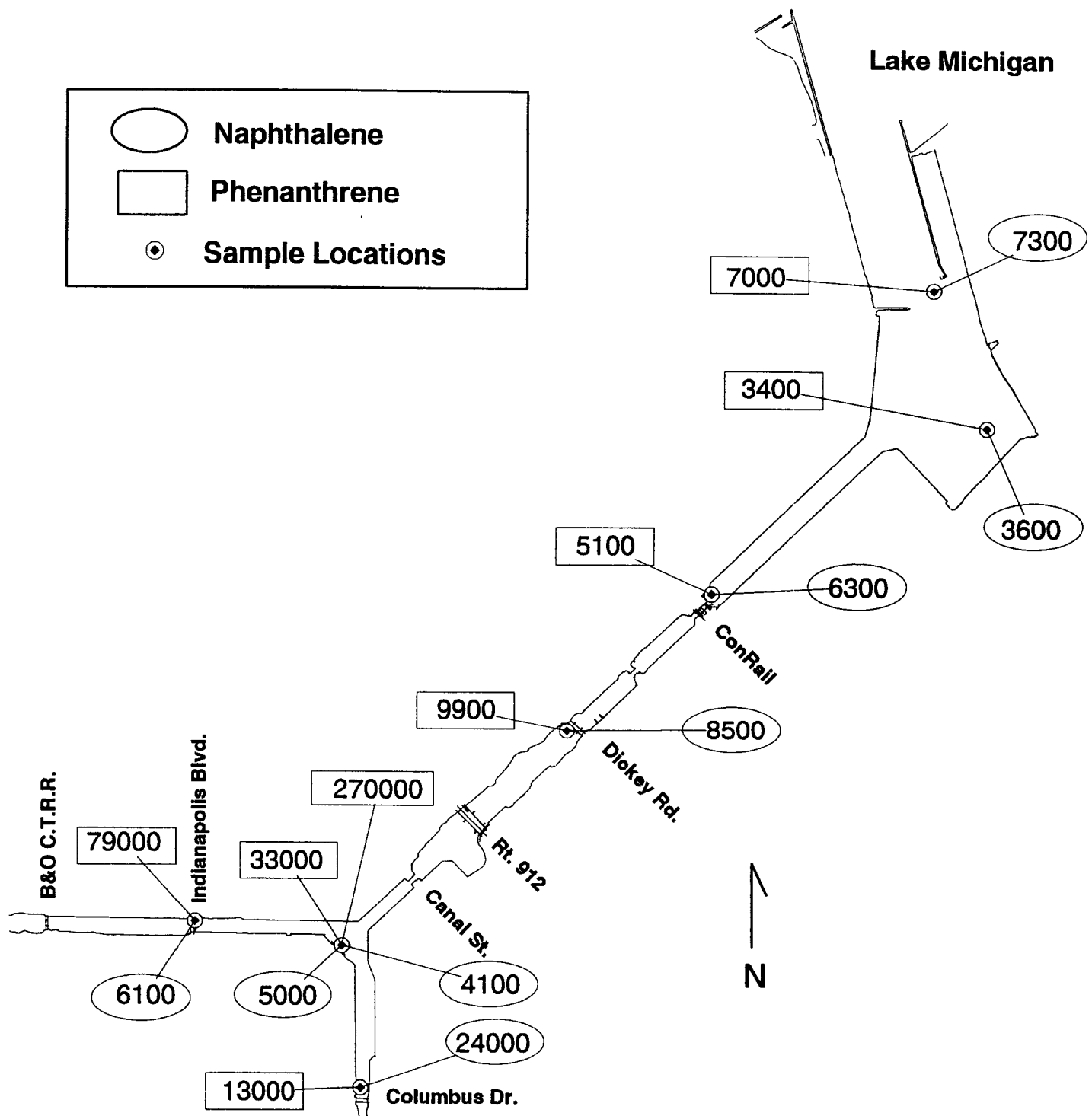
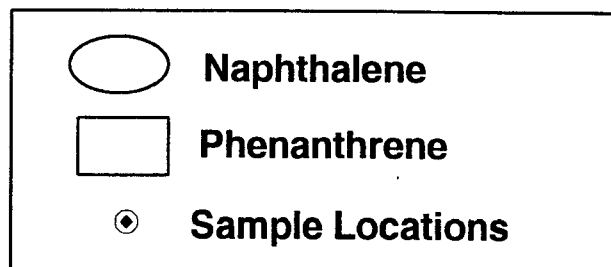


Indiana Harbor Survey 1 Surface Samples Dibenzofuran and Flourene

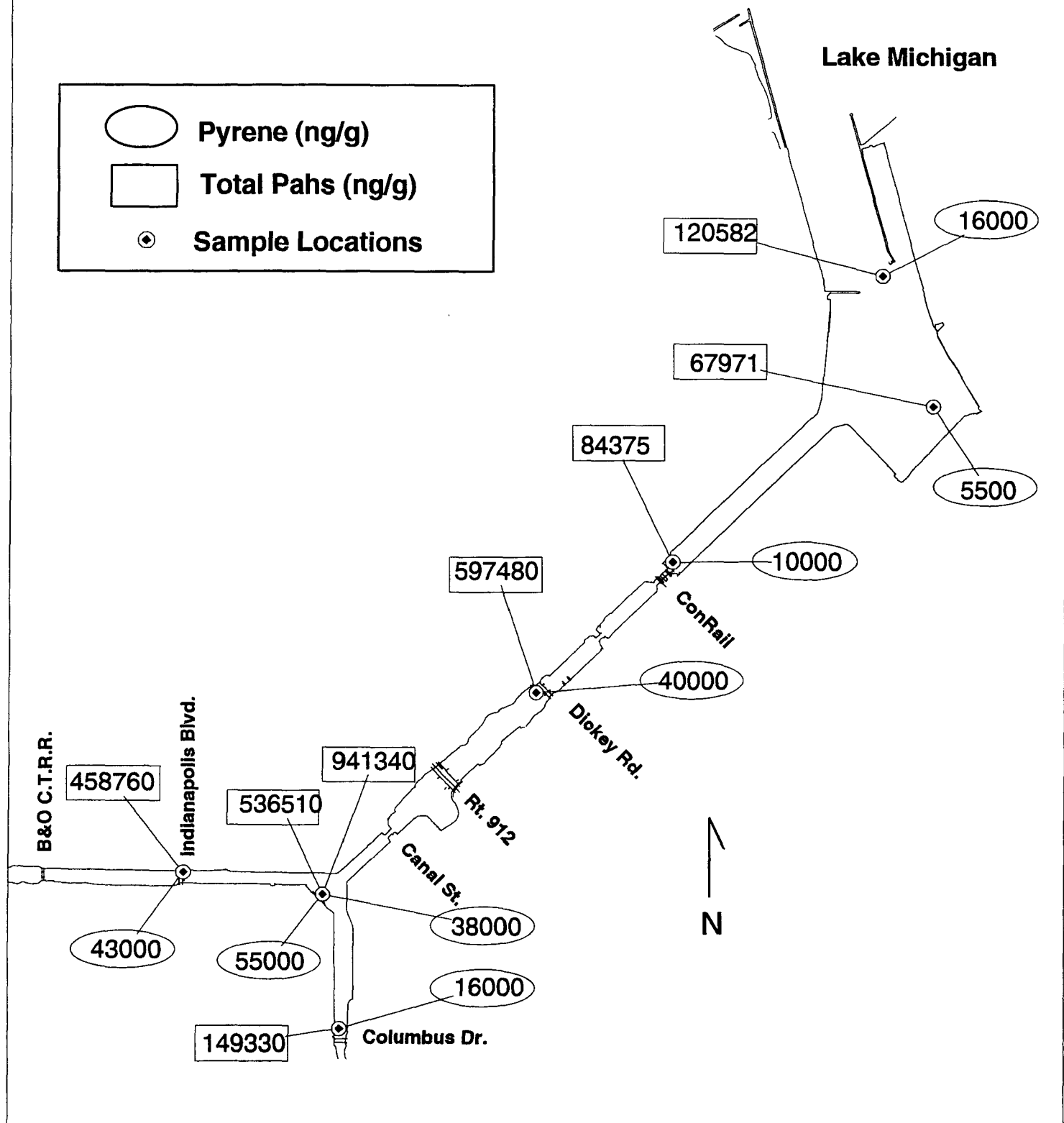


Indiana Harbor Survey 1 Surface Samples

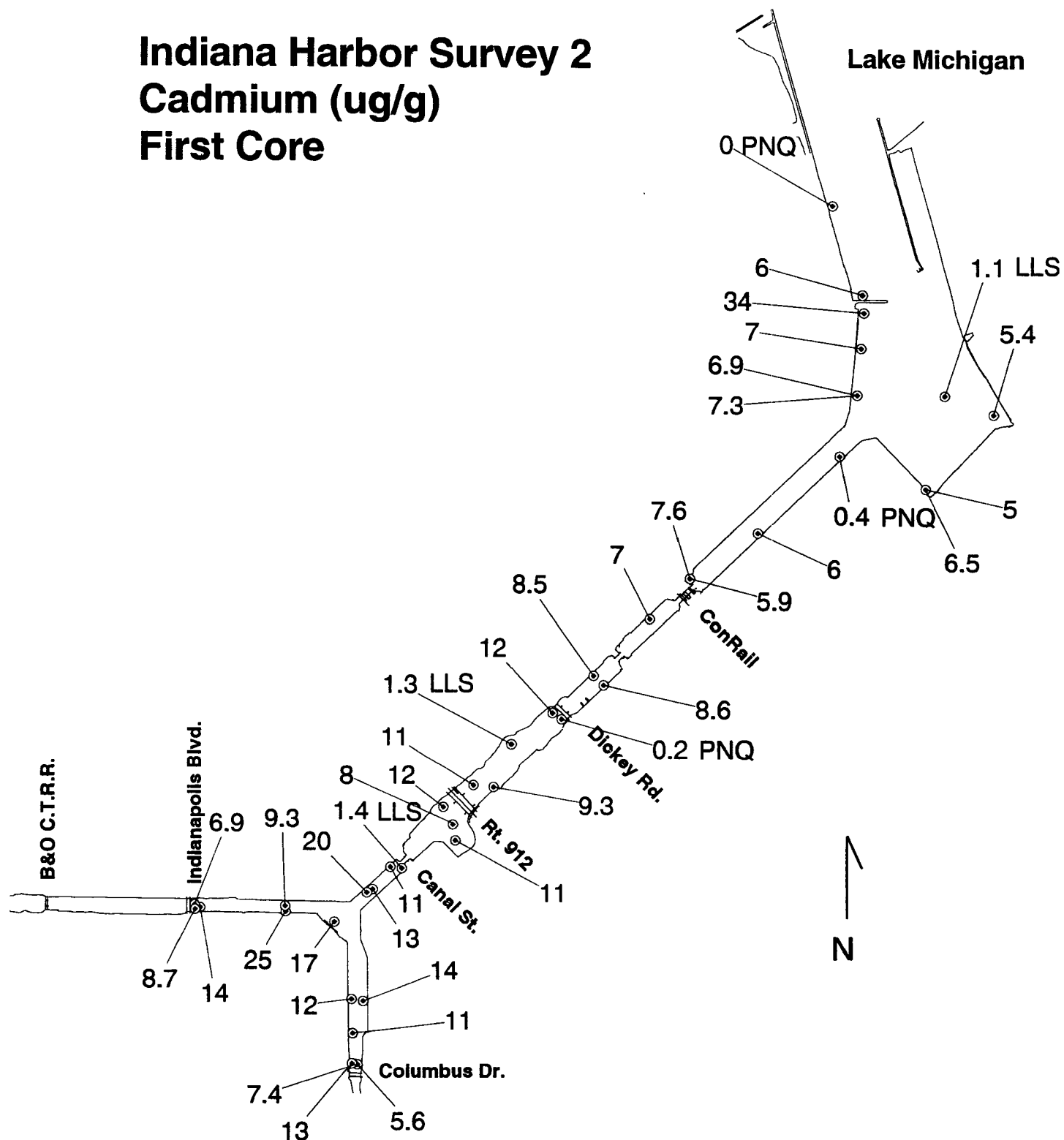
Naphthalene and Phenanthrene



Indiana Harbor Survey 1 Surface Samples Pyrene and Total PAHs



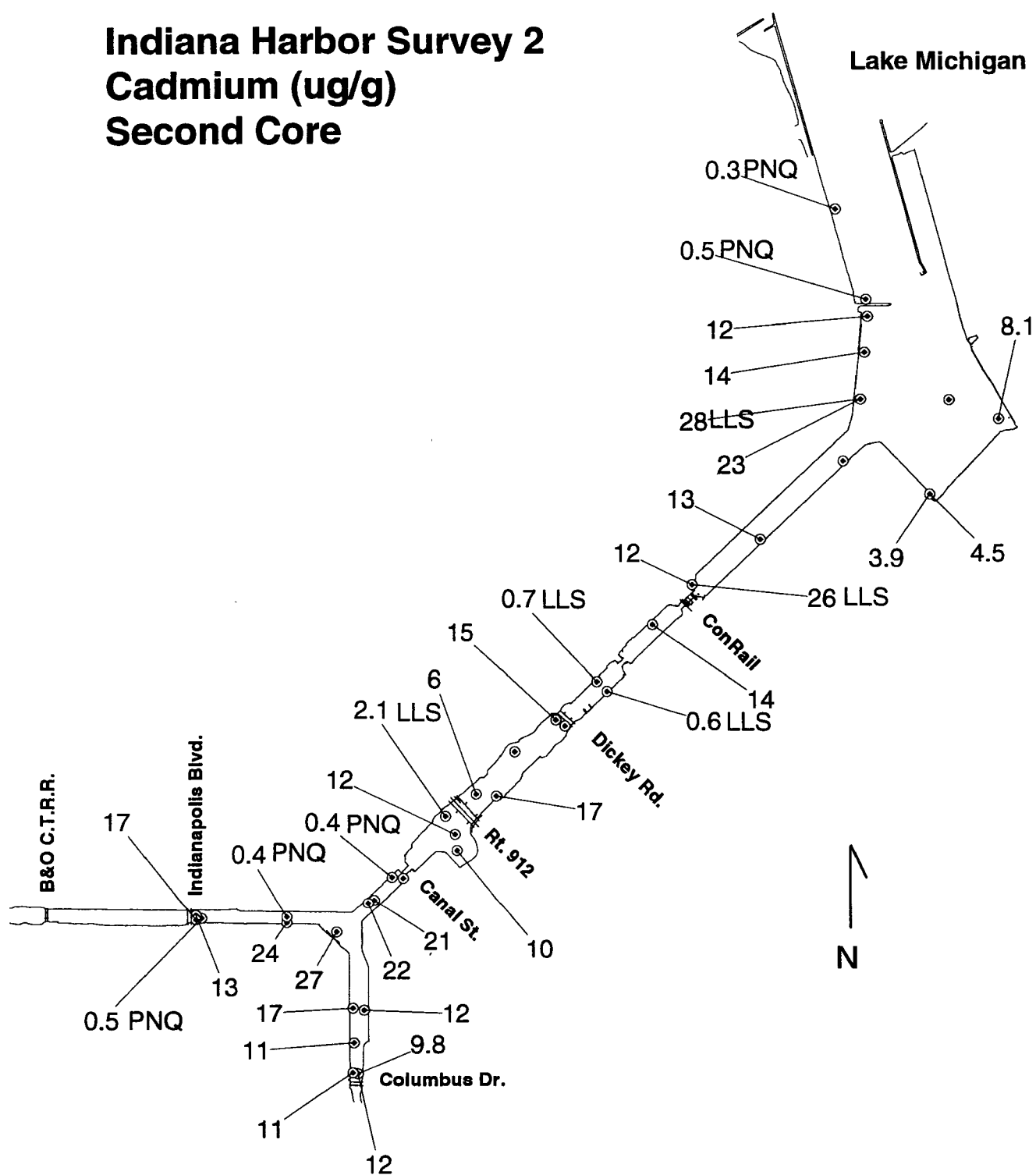
Indiana Harbor Survey 2 **Cadmium (ug/g)** **First Core**



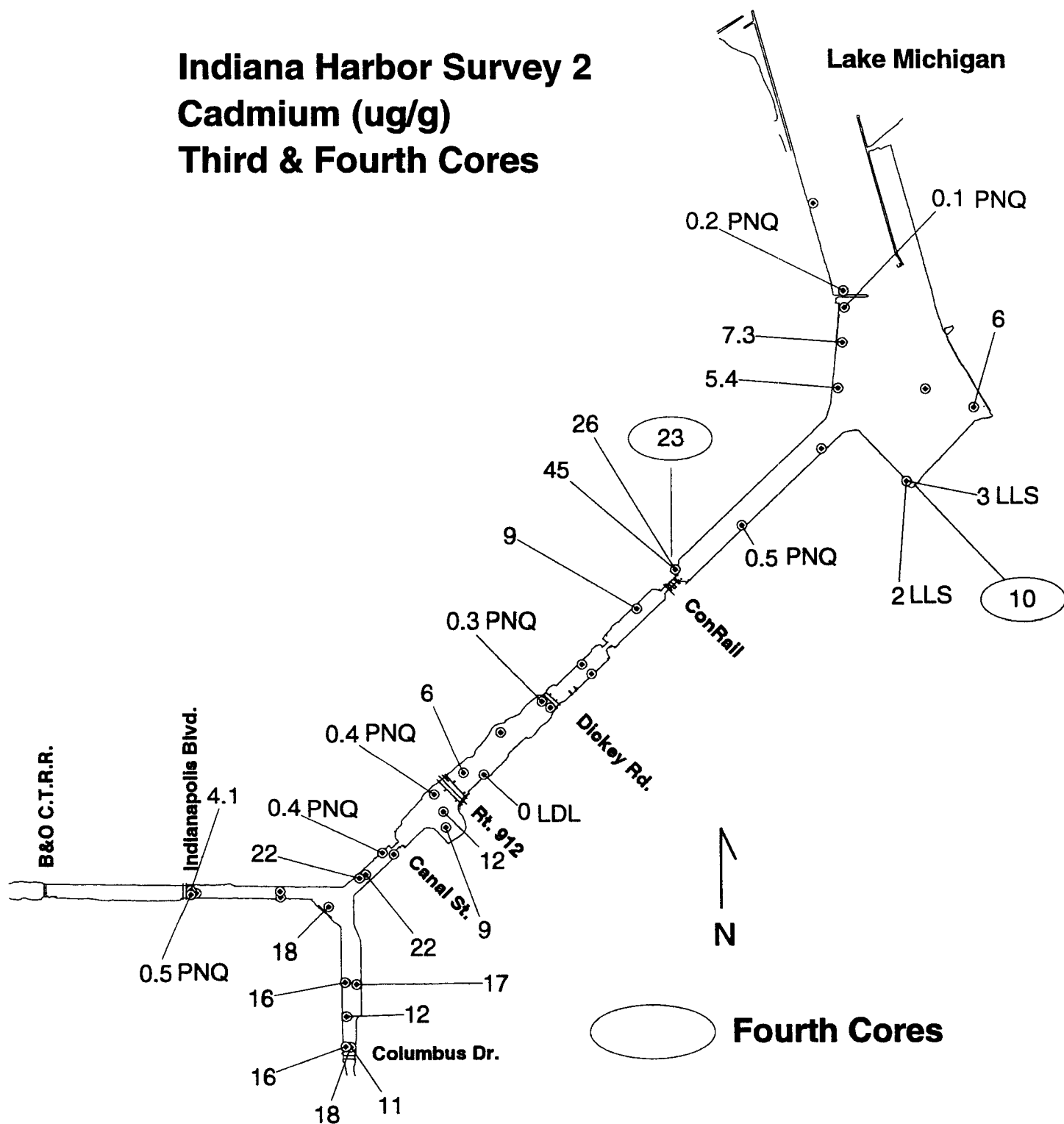
Indiana Harbor Survey 2

Cadmium (ug/g)

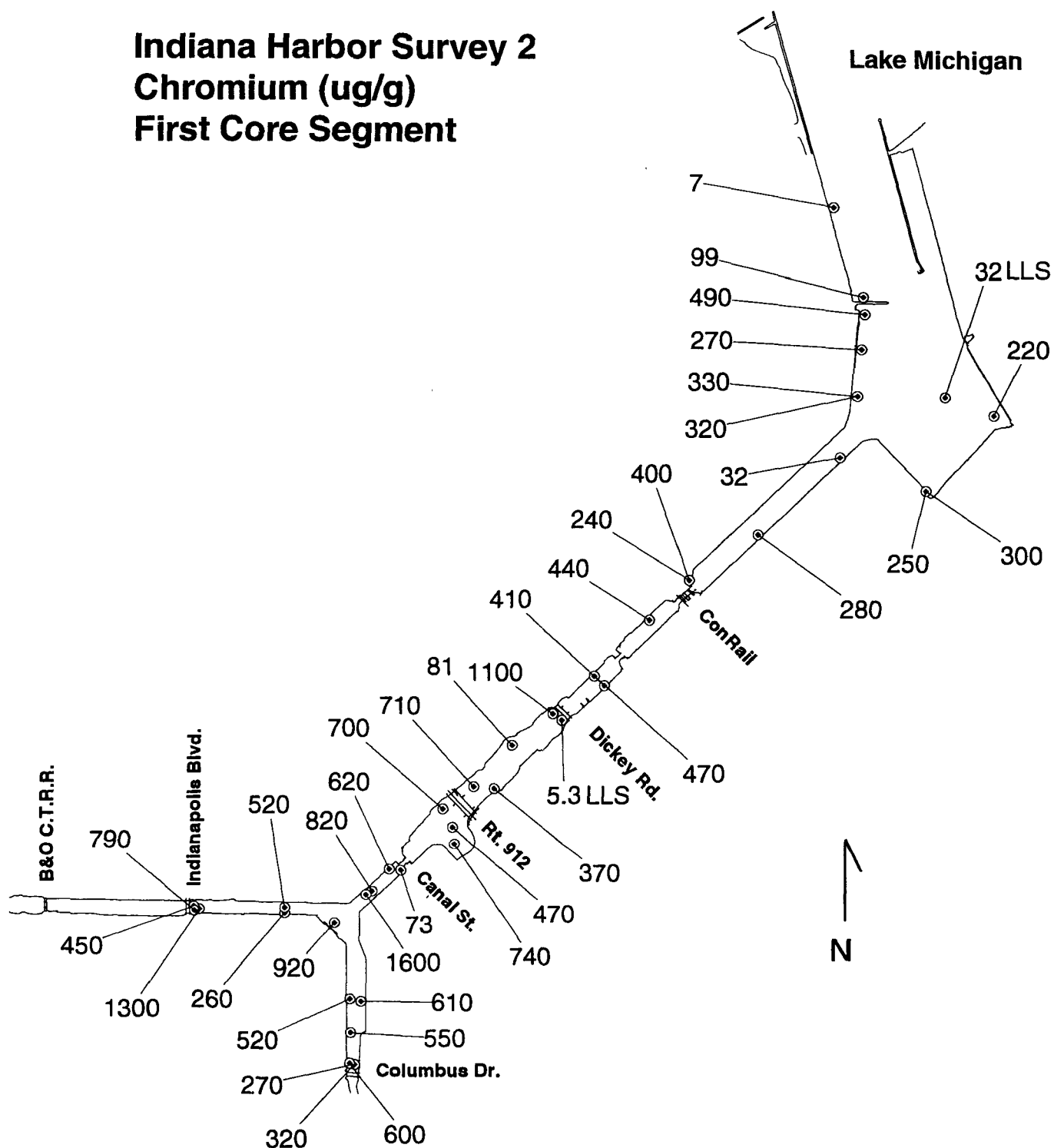
Second Core



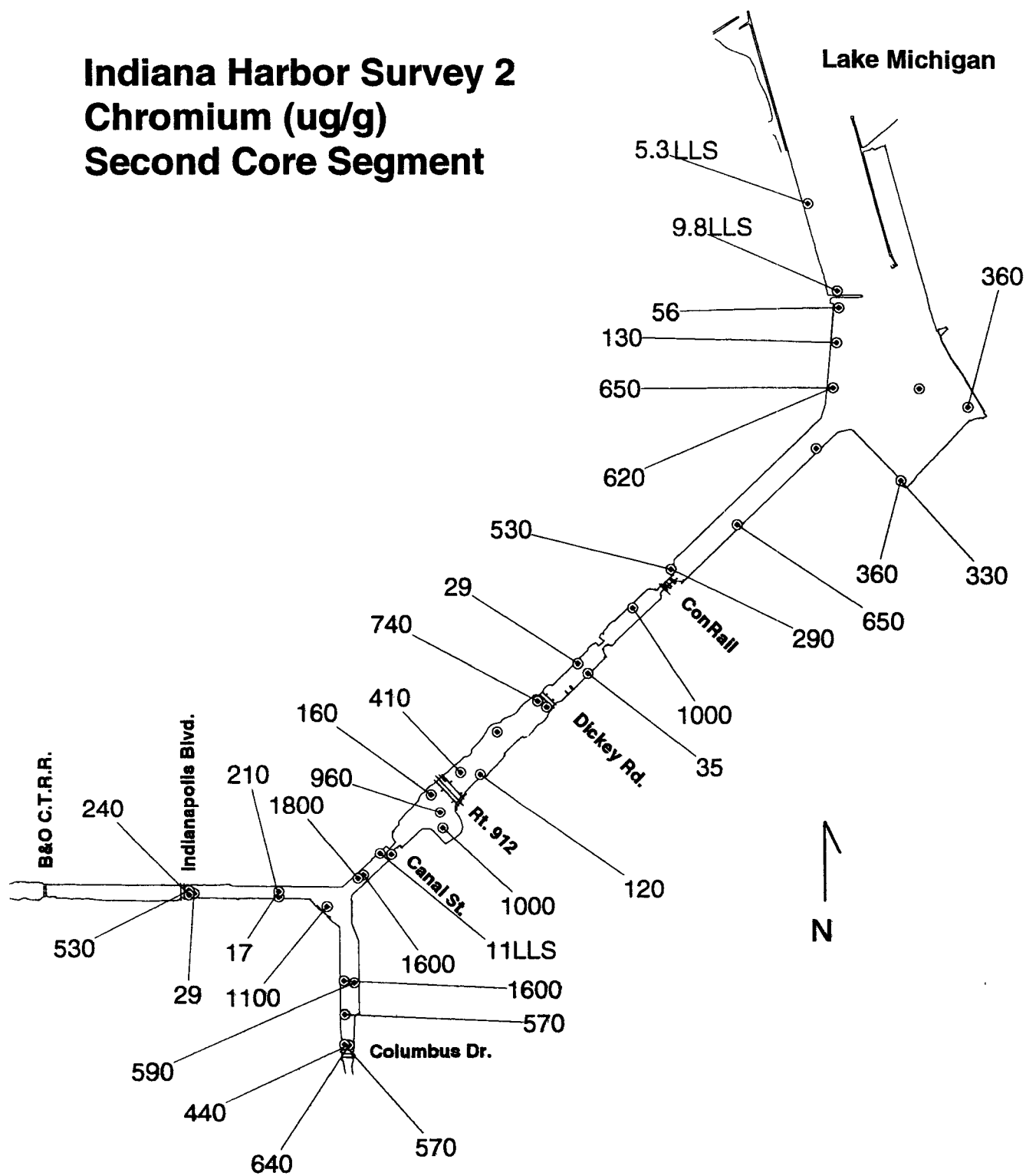
Indiana Harbor Survey 2 **Cadmium (ug/g)** **Third & Fourth Cores**



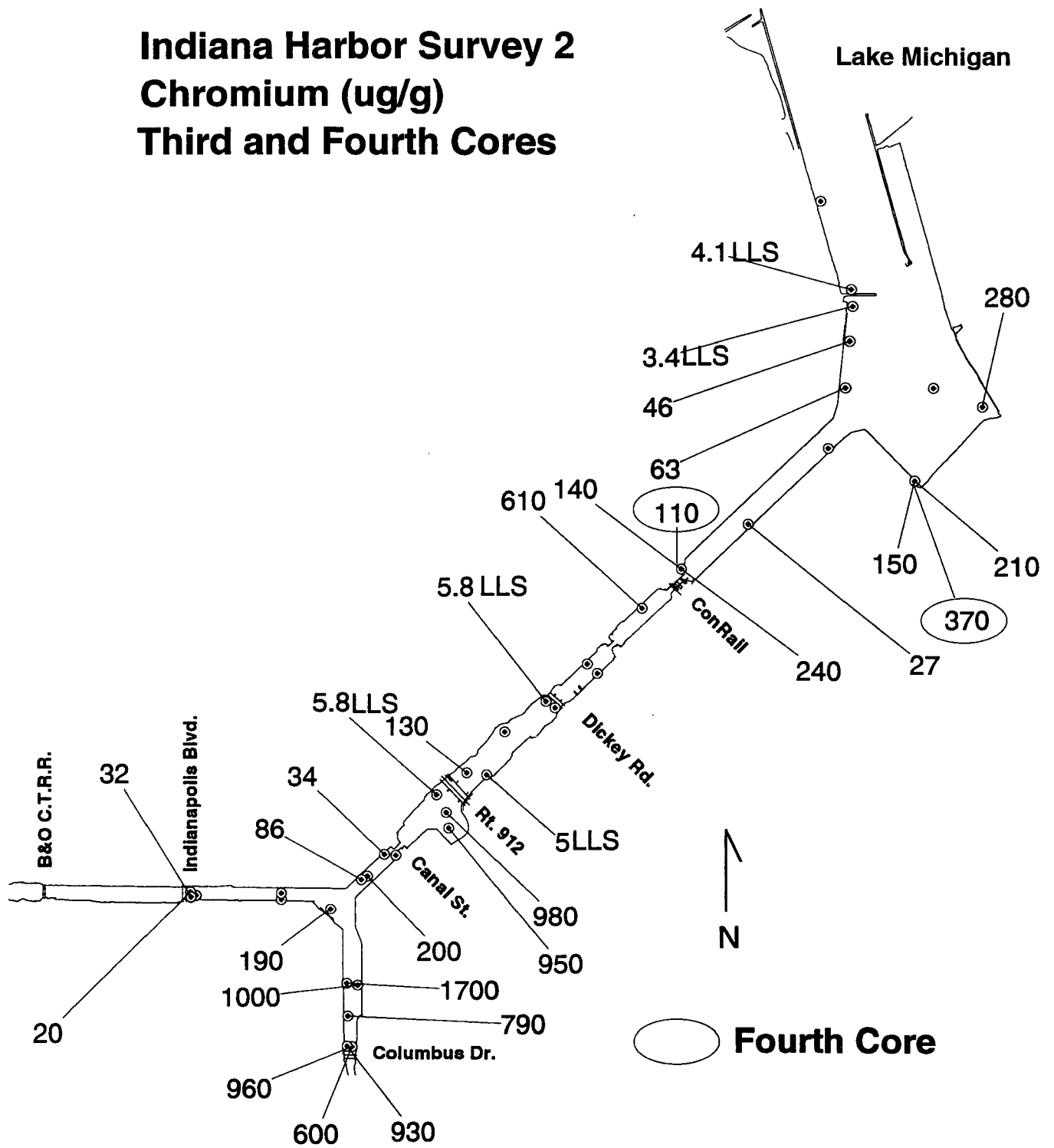
Indiana Harbor Survey 2 **Chromium (ug/g)** **First Core Segment**



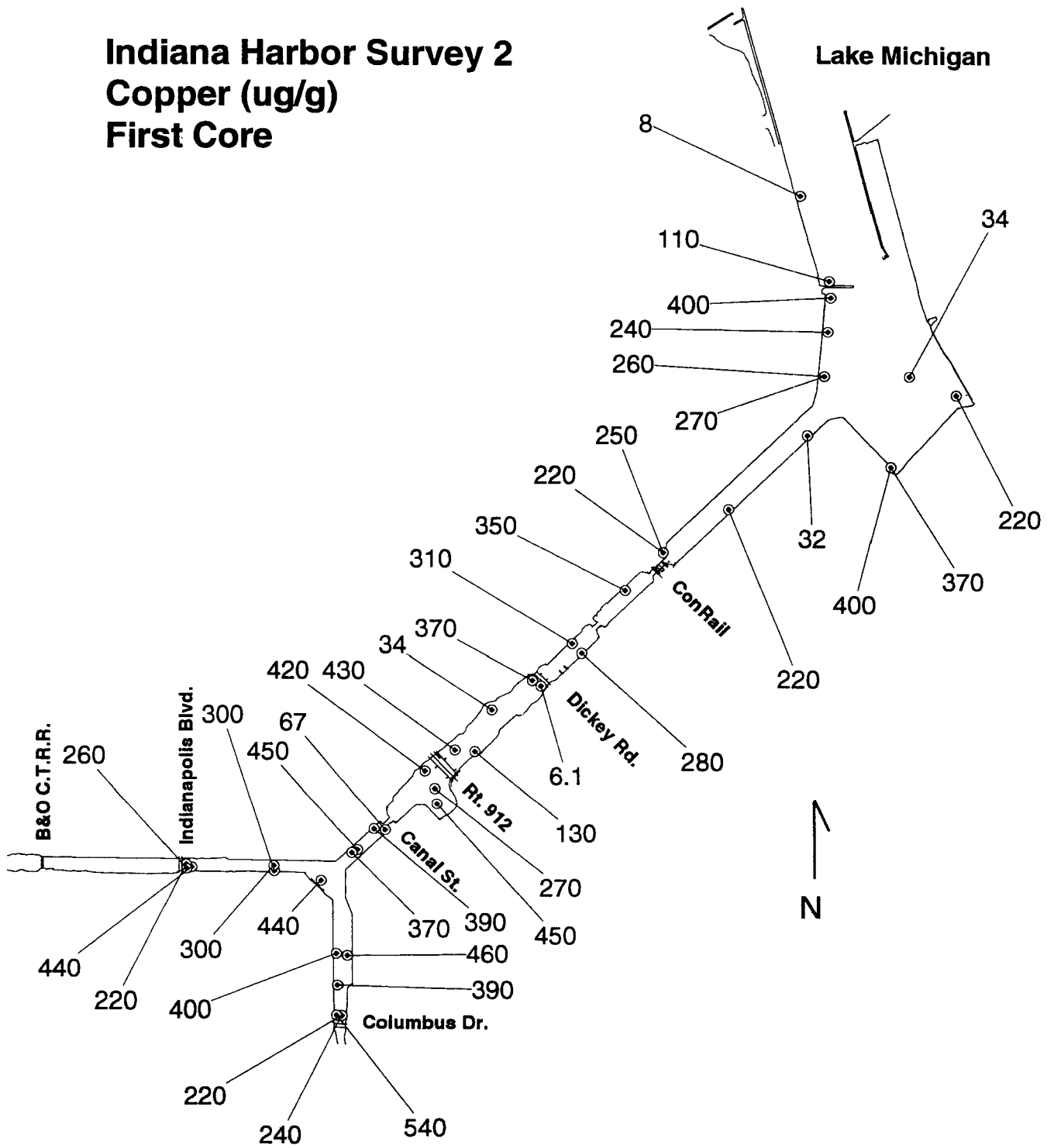
Indiana Harbor Survey 2 **Chromium (ug/g)** **Second Core Segment**



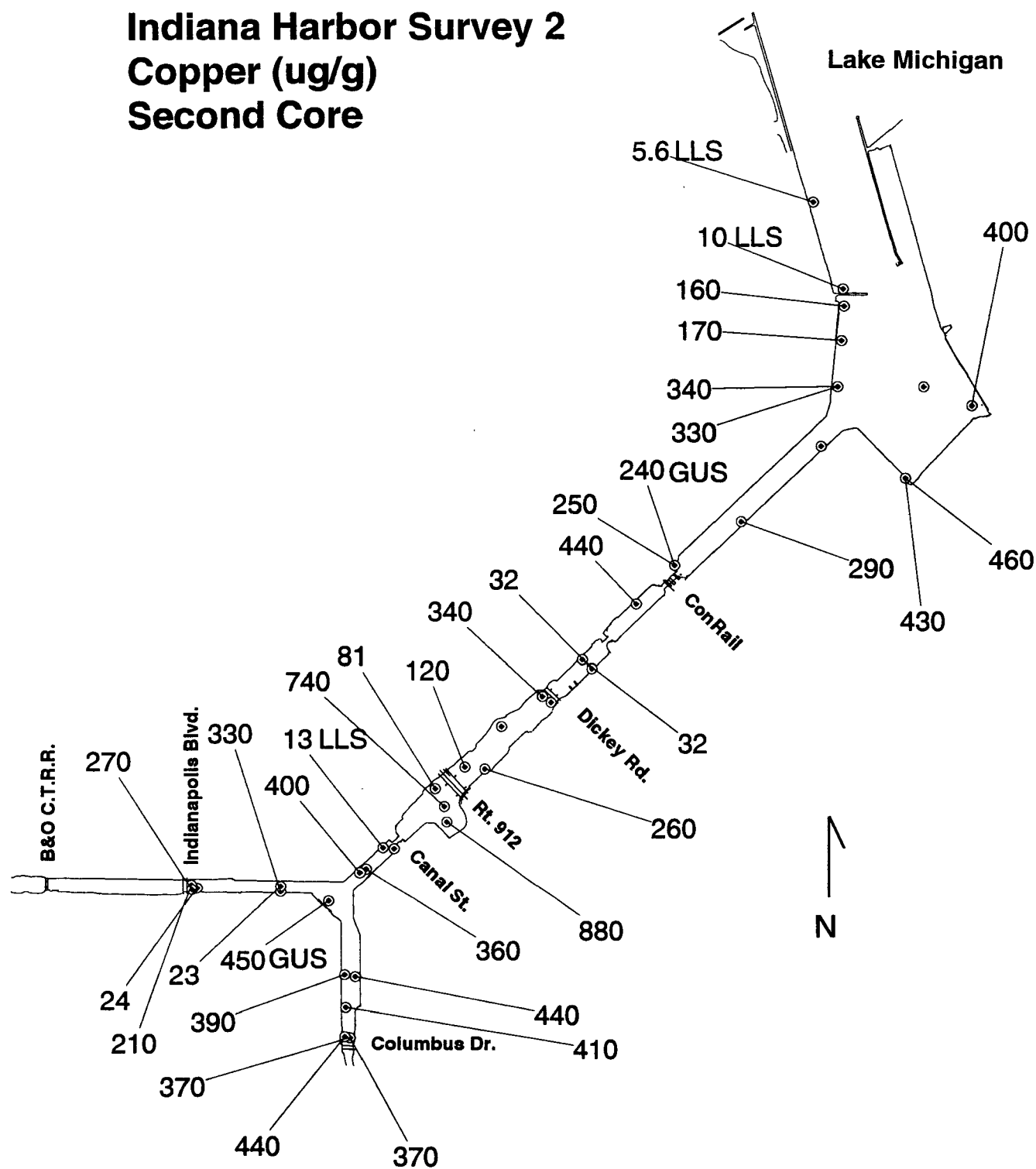
Indiana Harbor Survey 2 **Chromium (ug/g)** **Third and Fourth Cores**



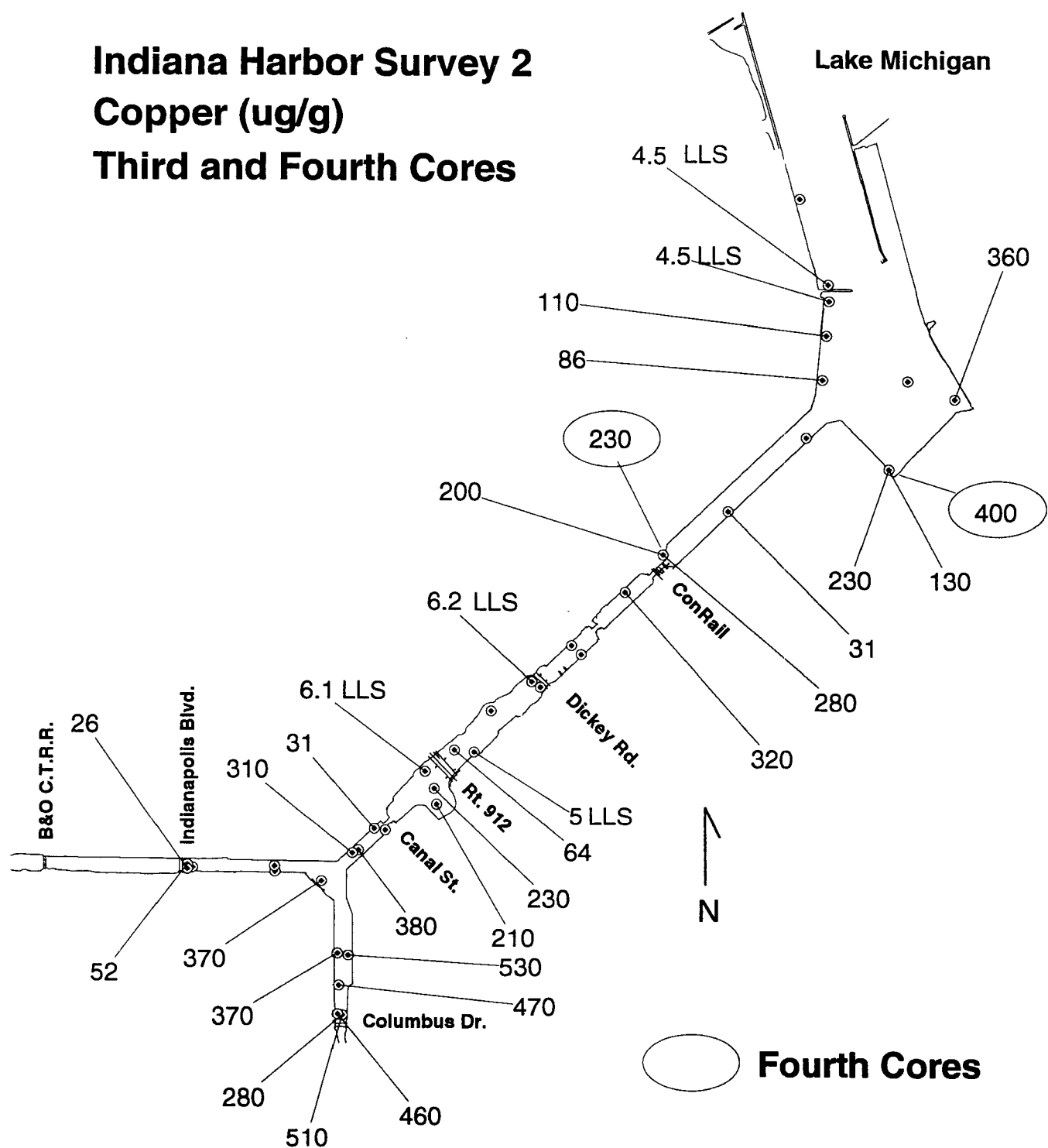
Indiana Harbor Survey 2 **Copper (ug/g)** **First Core**



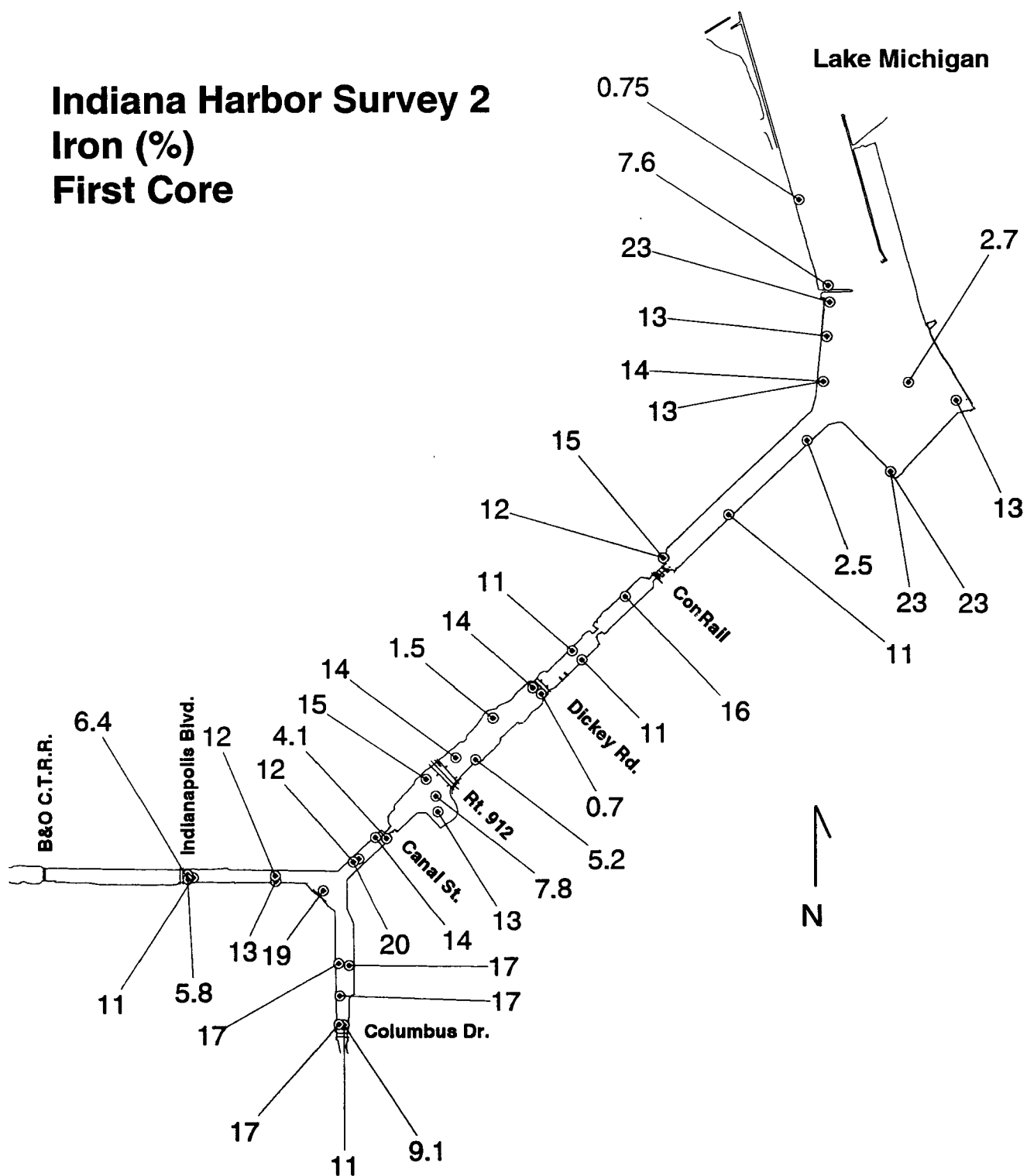
Indiana Harbor Survey 2 **Copper (ug/g)** **Second Core**



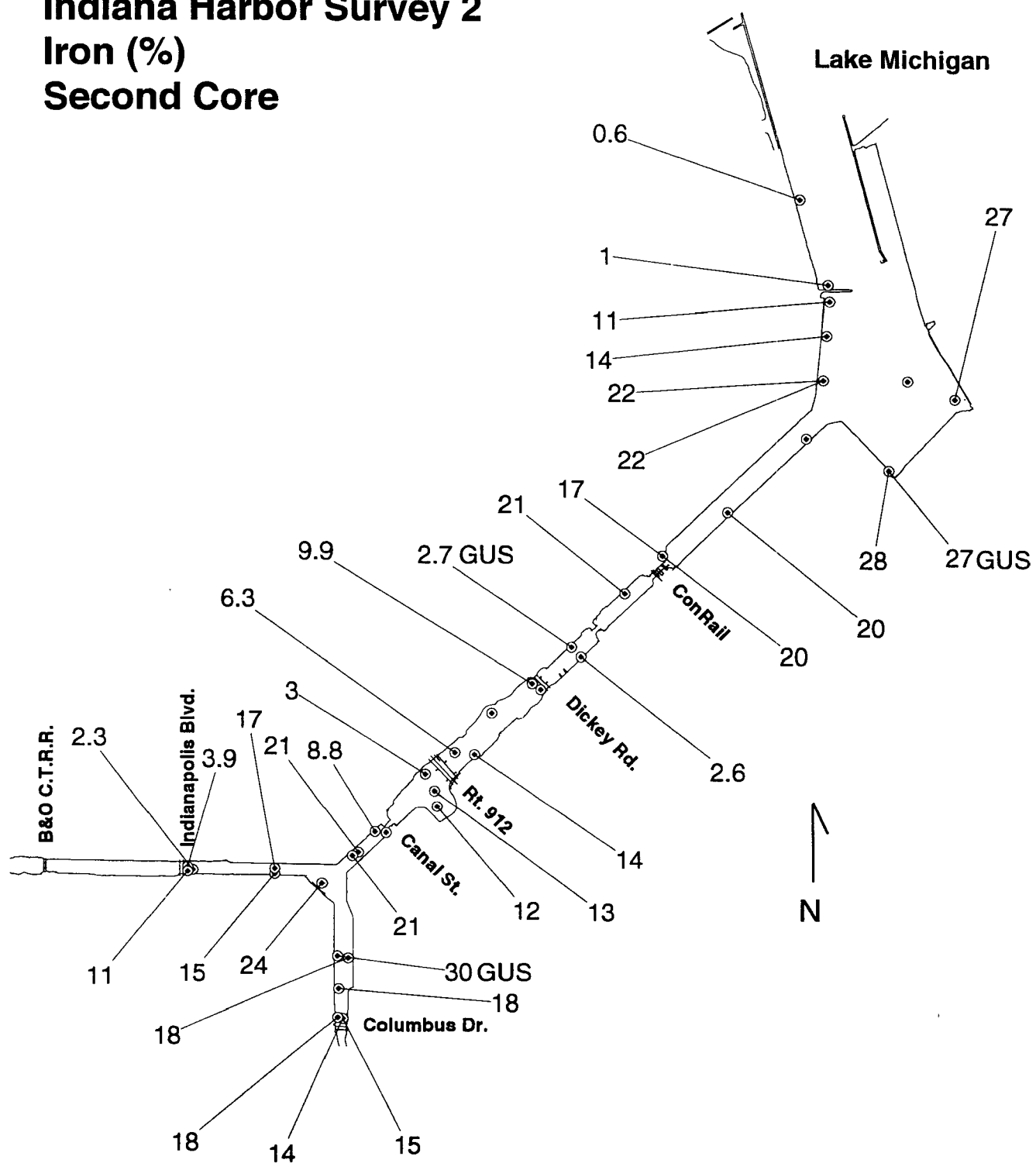
Indiana Harbor Survey 2 **Copper (ug/g)** **Third and Fourth Cores**



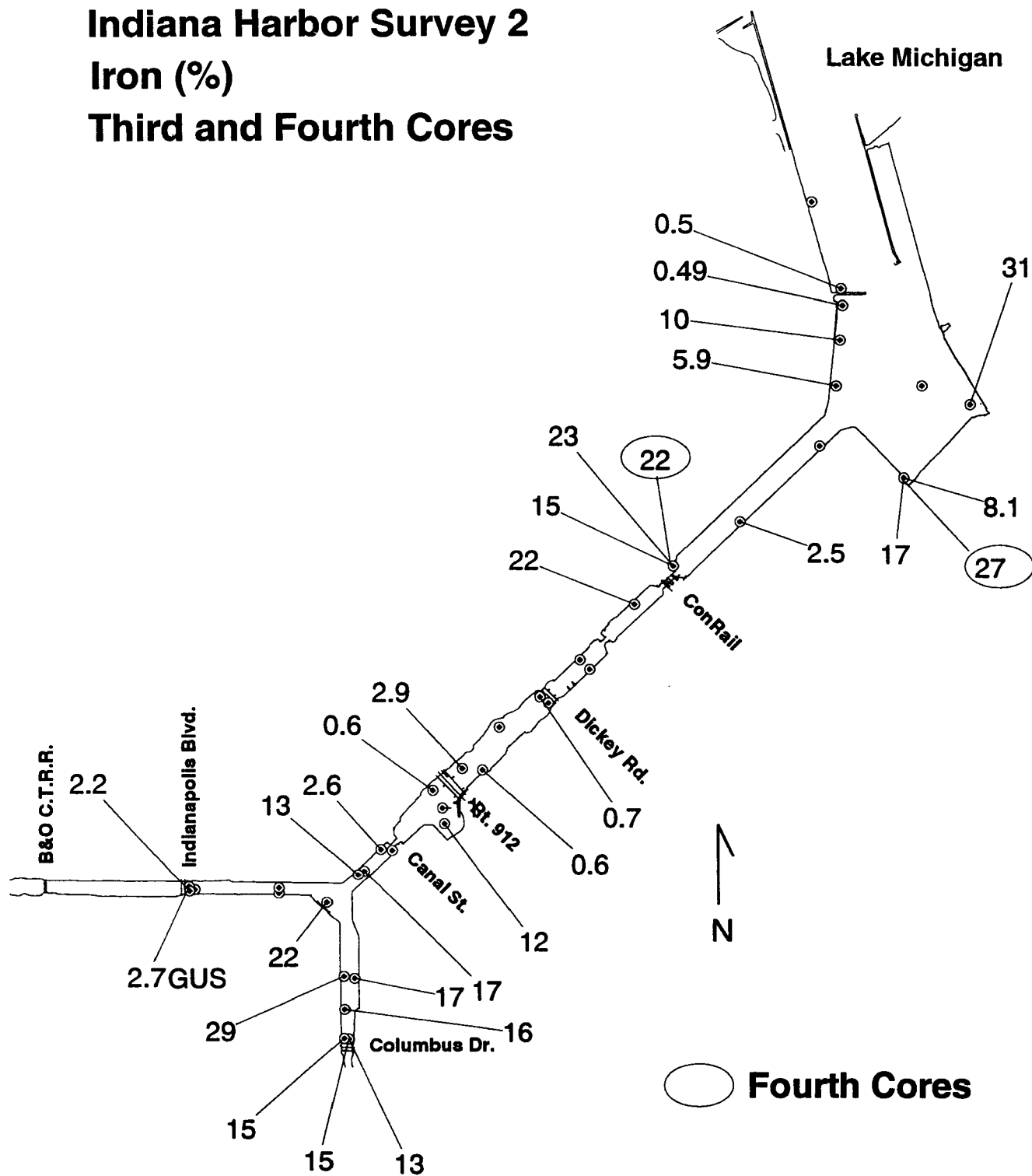
Indiana Harbor Survey 2 **Iron (%)** **First Core**



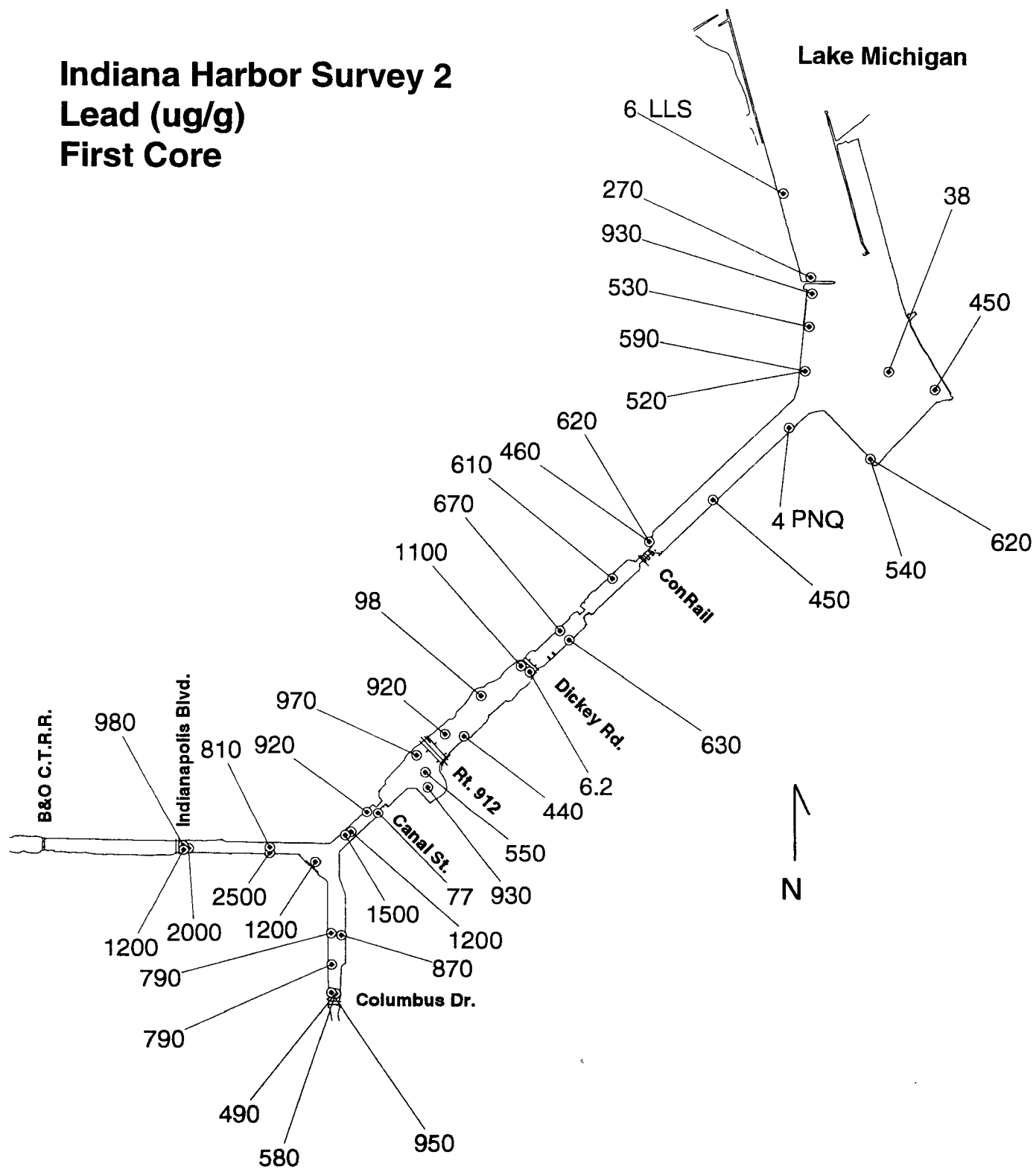
Indiana Harbor Survey 2 **Iron (%)** **Second Core**



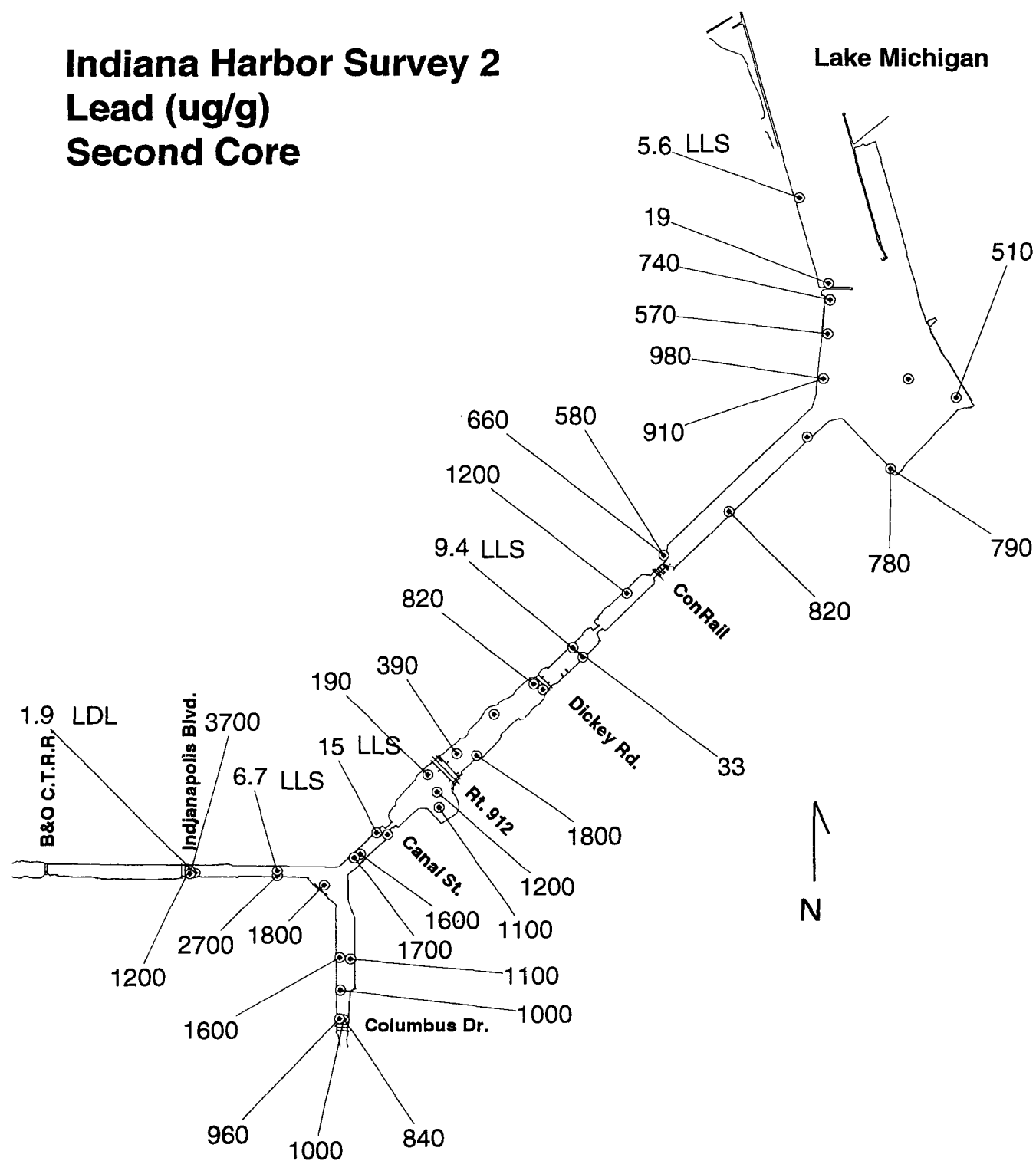
Indiana Harbor Survey 2 **Iron (%)** **Third and Fourth Cores**



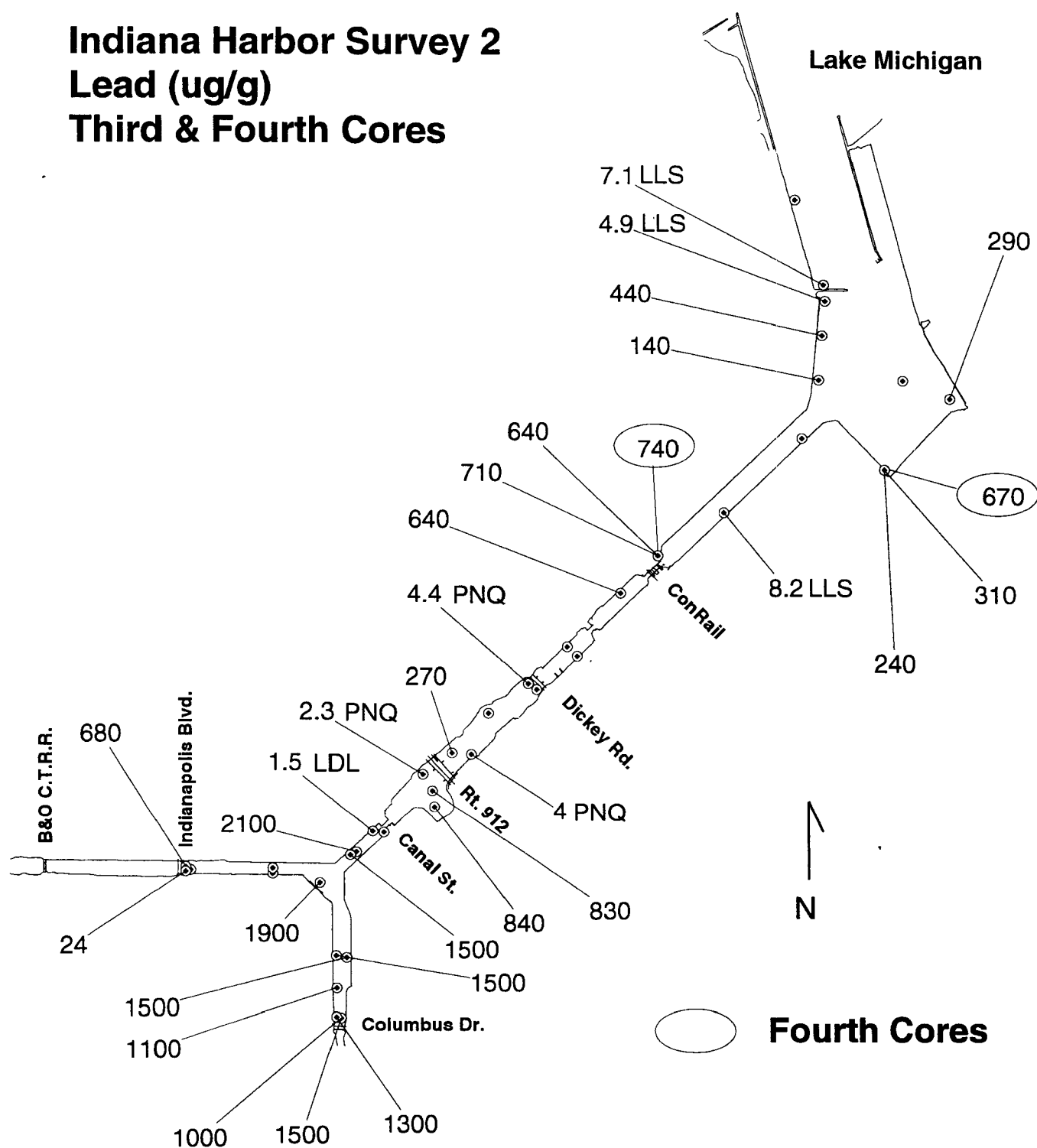
Indiana Harbor Survey 2 **Lead (ug/g)** **First Core**



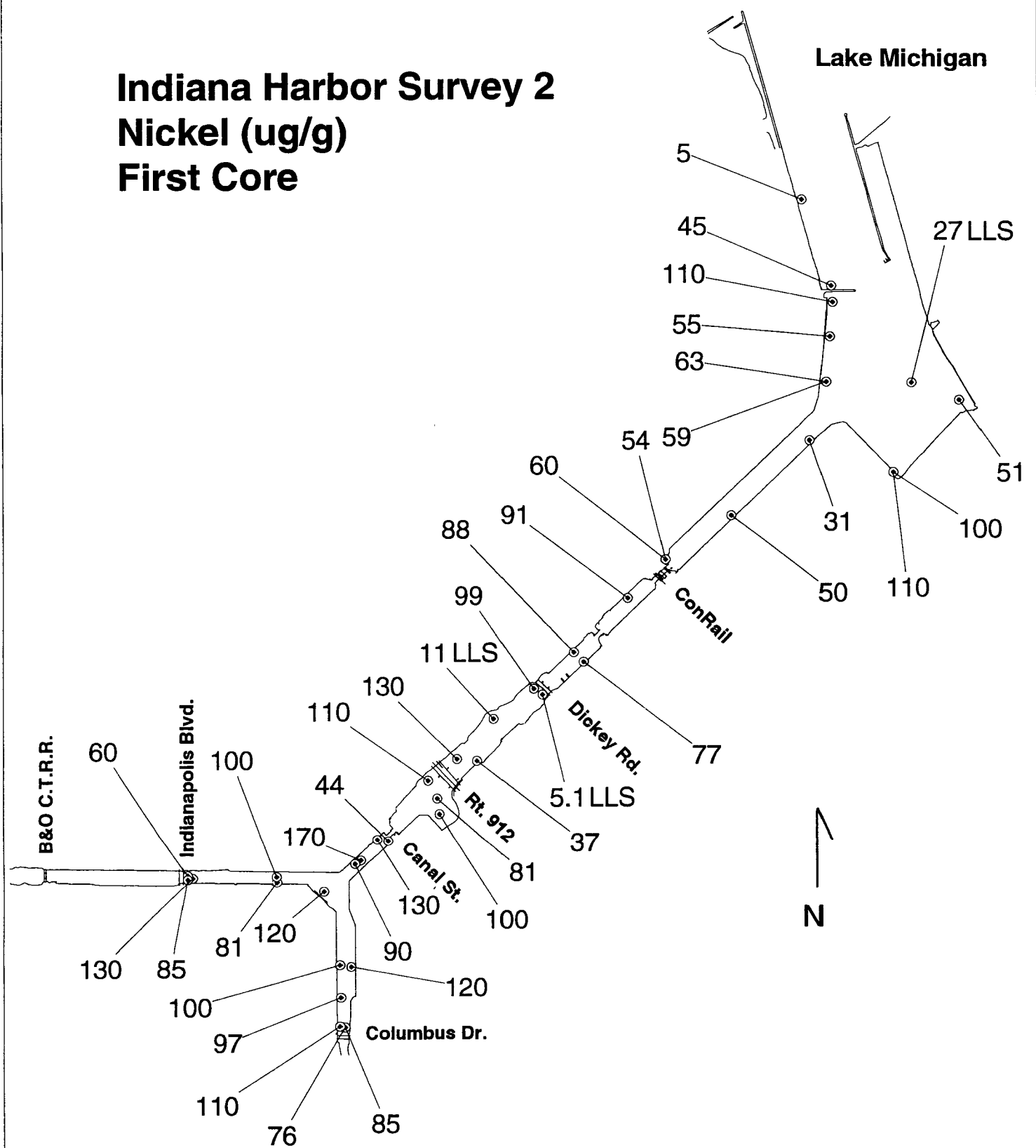
Indiana Harbor Survey 2 **Lead (ug/g)** **Second Core**



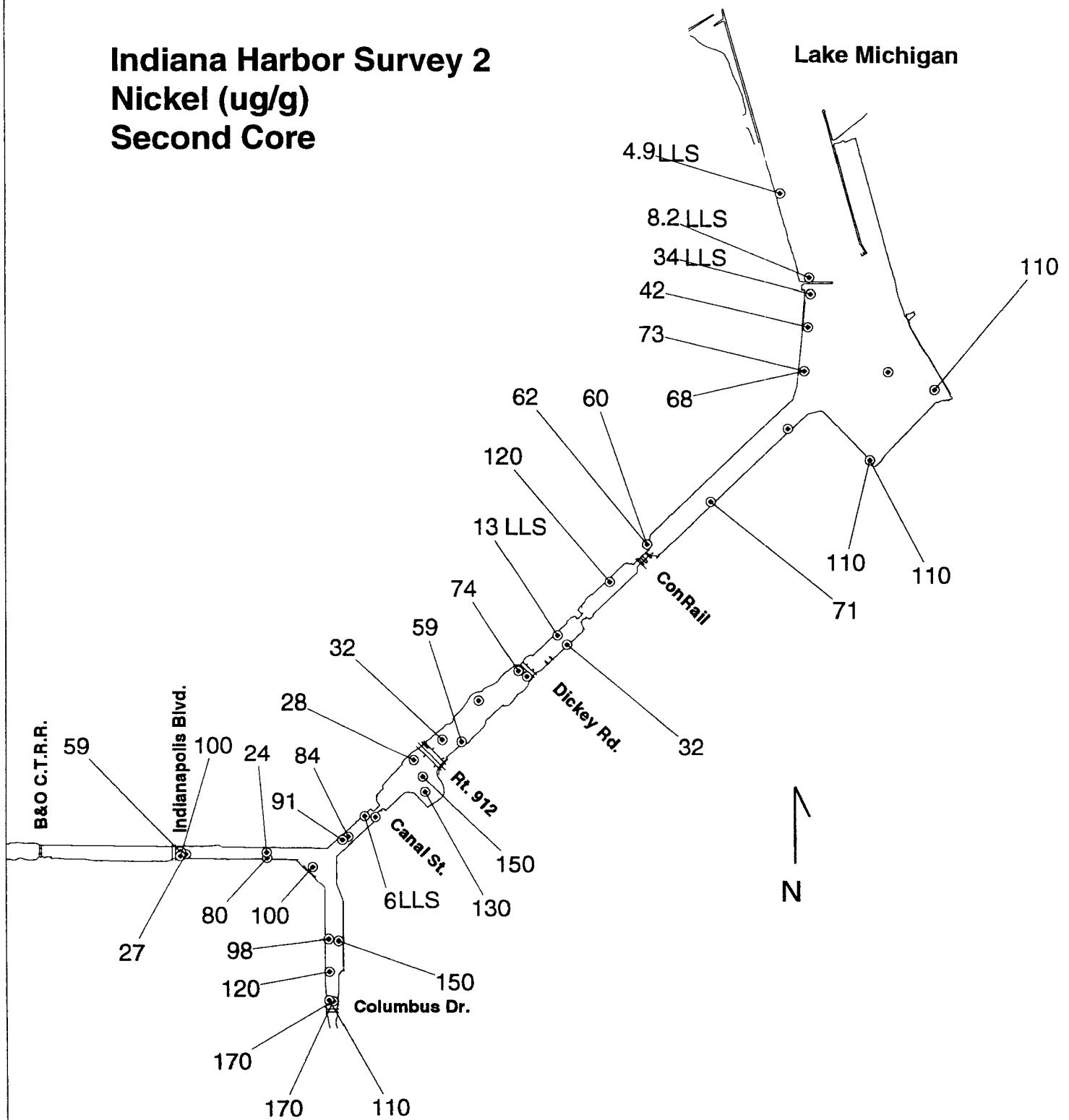
Indiana Harbor Survey 2 **Lead (ug/g)** **Third & Fourth Cores**



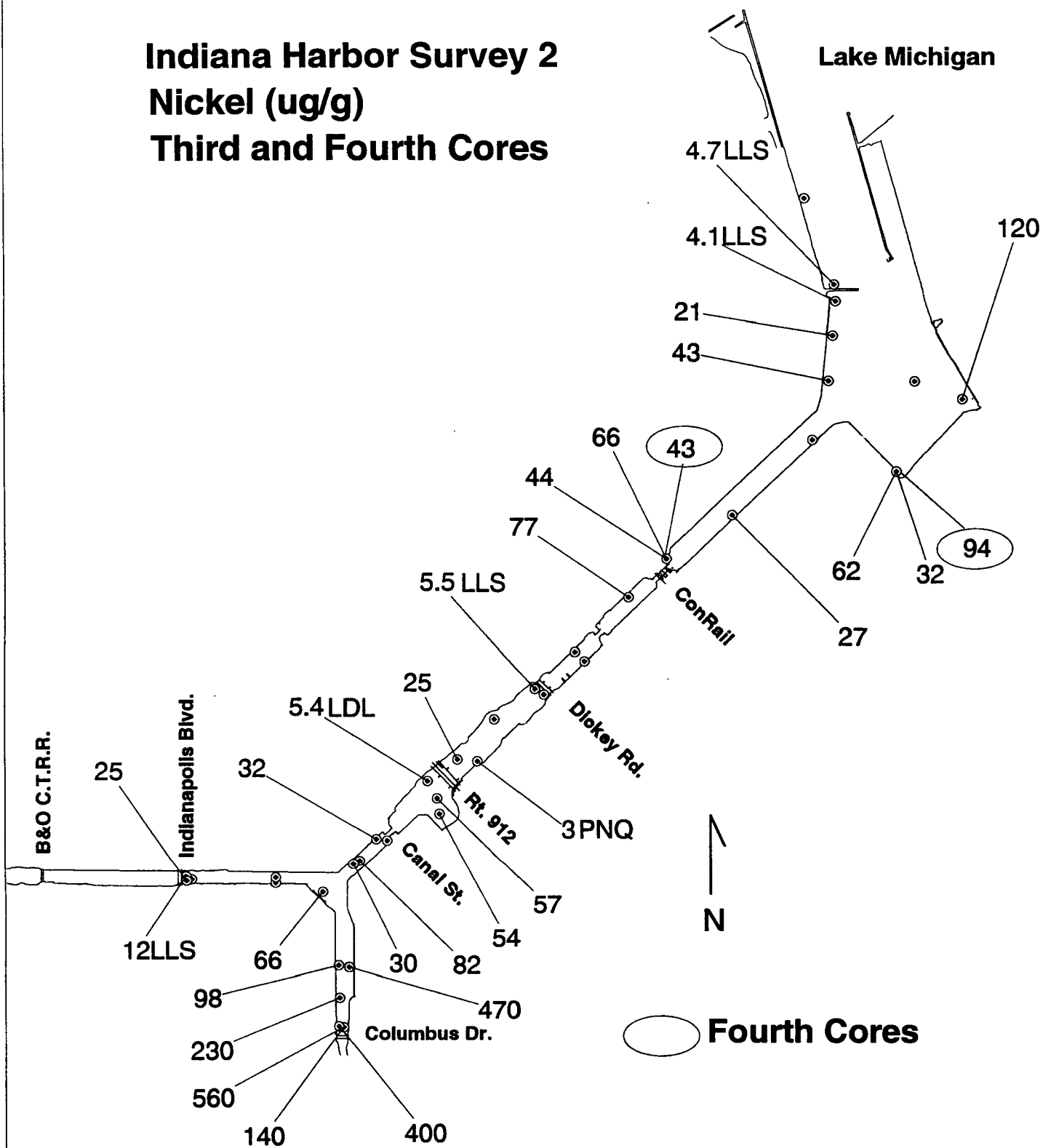
Indiana Harbor Survey 2 **Nickel (ug/g)** **First Core**



Indiana Harbor Survey 2 **Nickel (ug/g)** **Second Core**



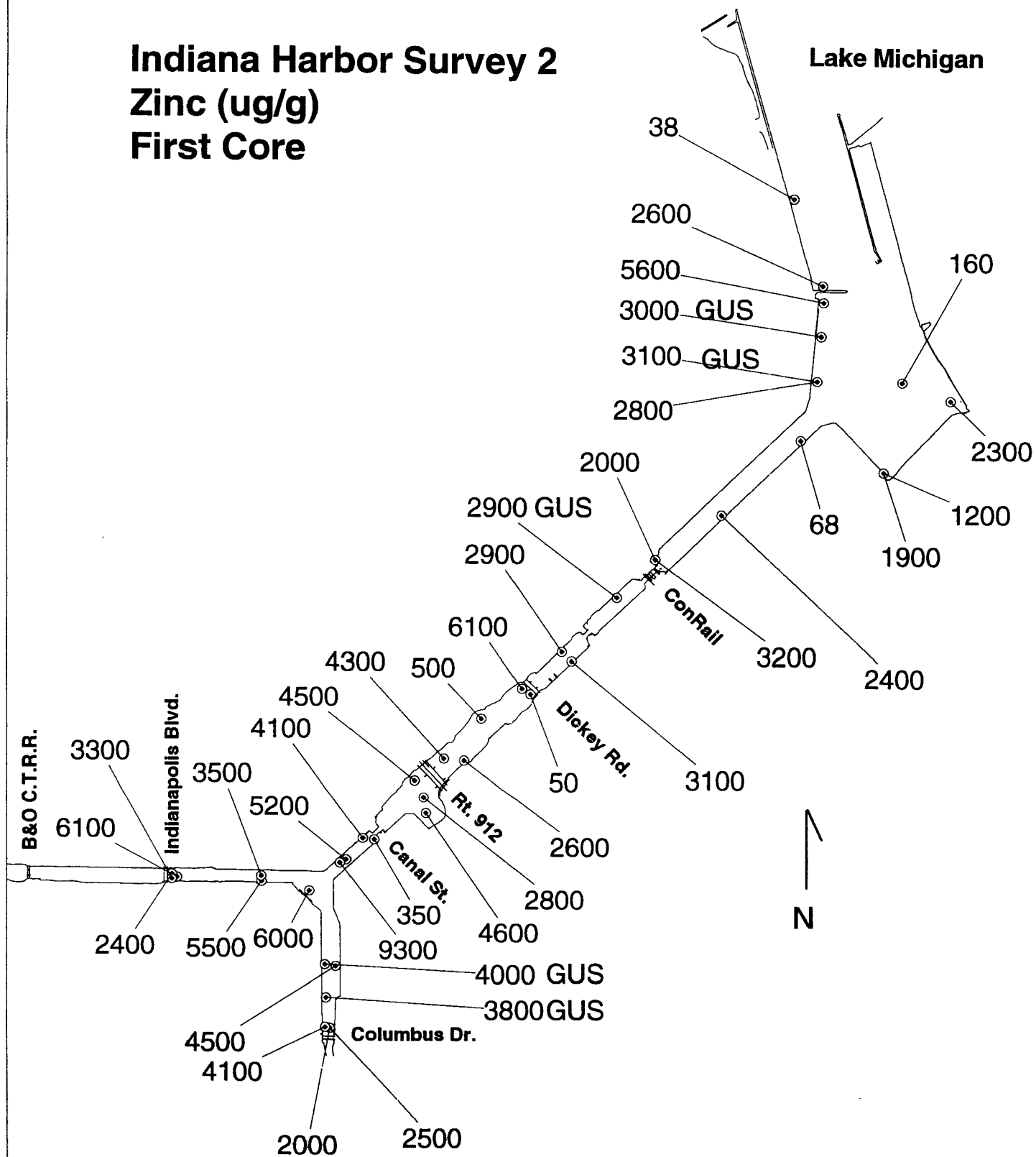
Indiana Harbor Survey 2 **Nickel (ug/g)** **Third and Fourth Cores**



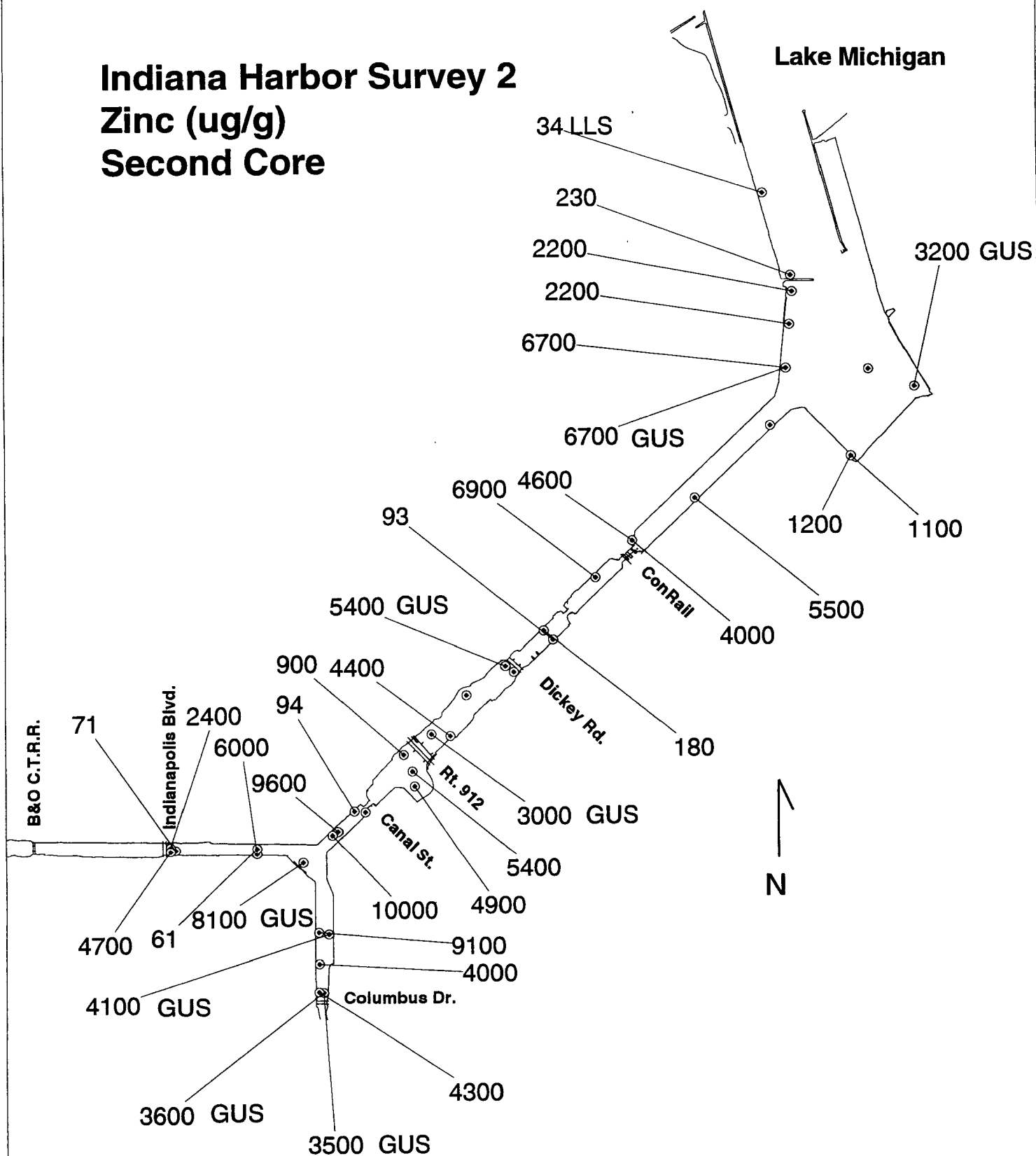
Indiana Harbor Survey 2

Zinc (ug/g)

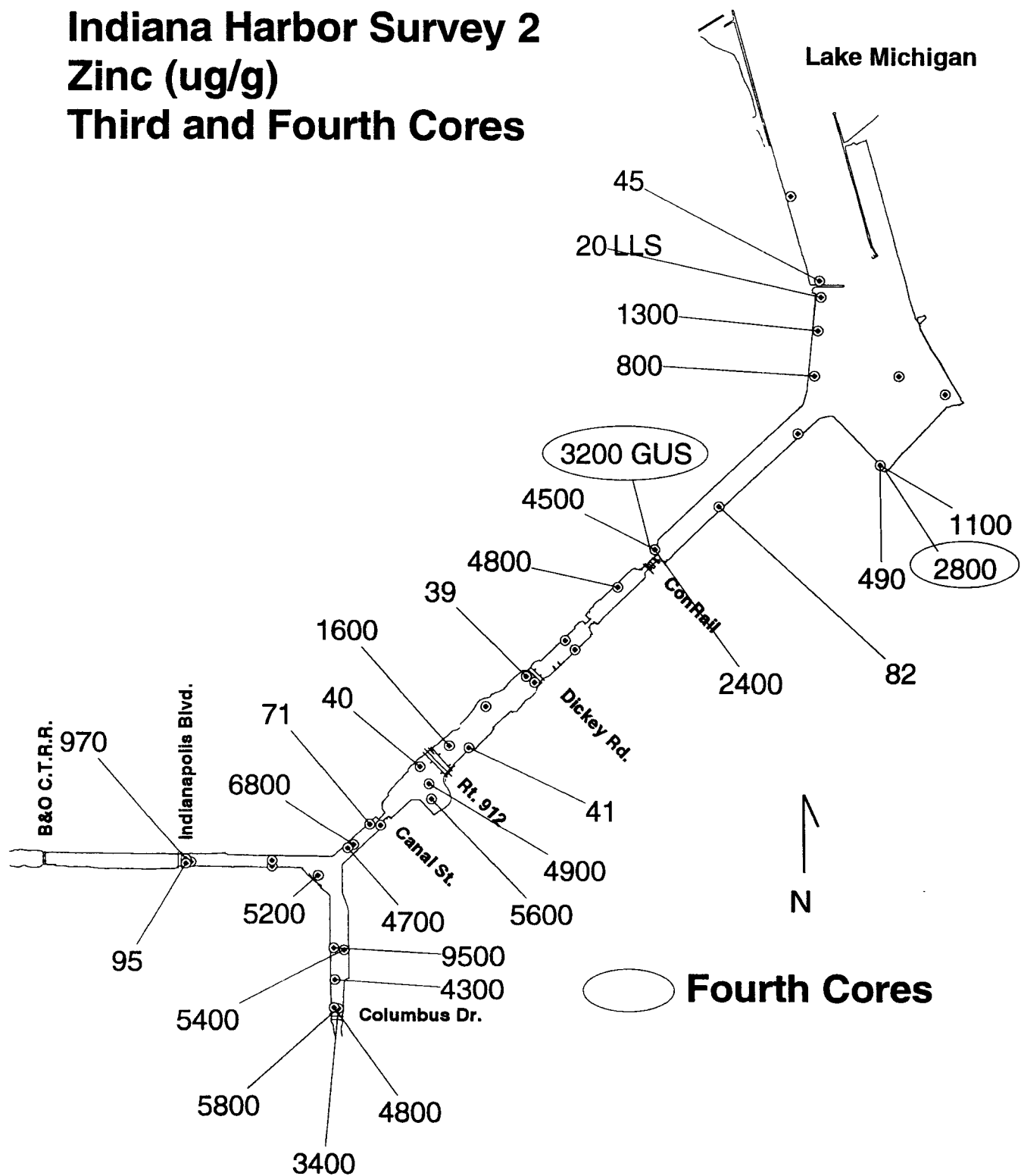
First Core



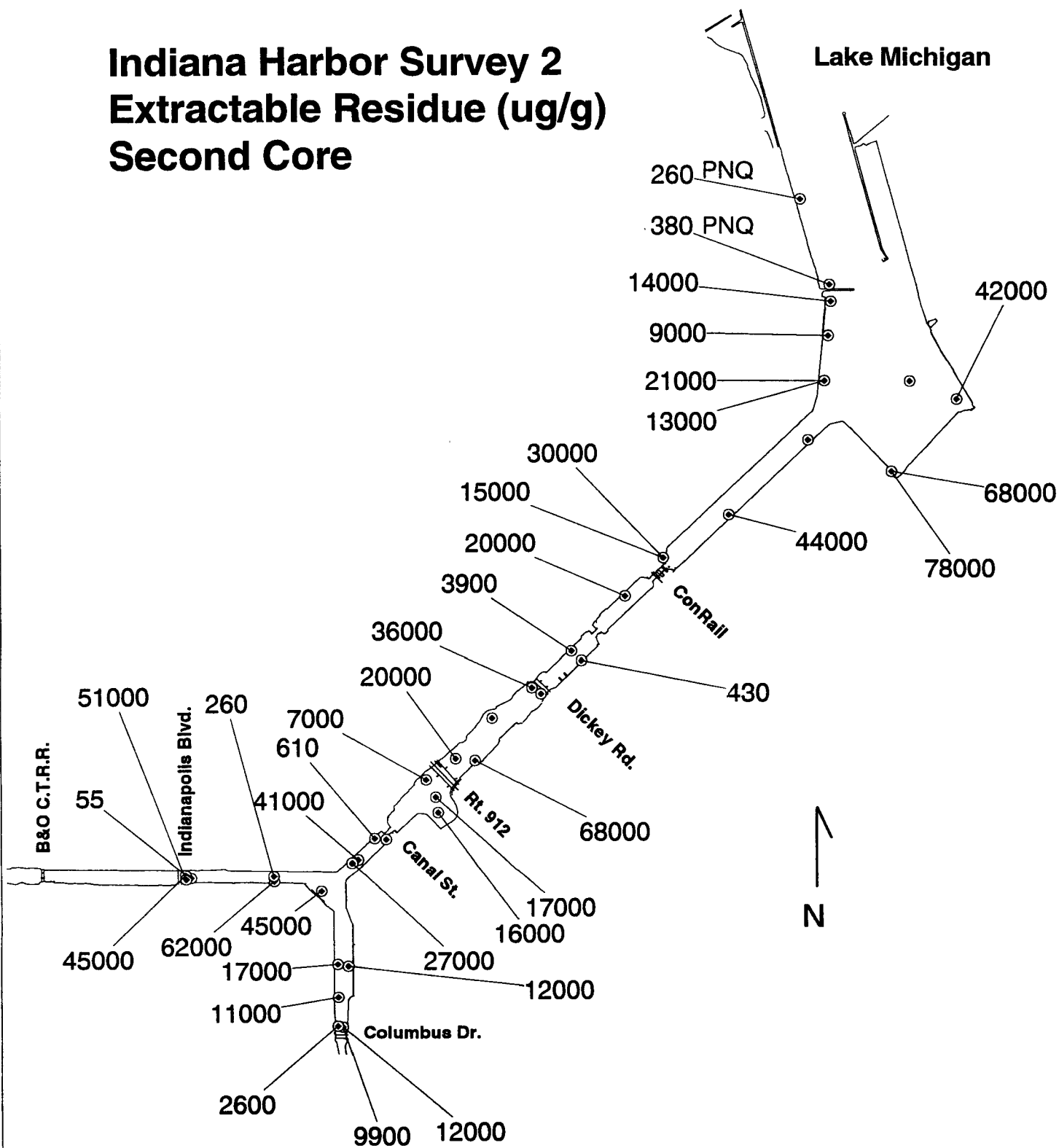
Indiana Harbor Survey 2 **Zinc (ug/g)** **Second Core**



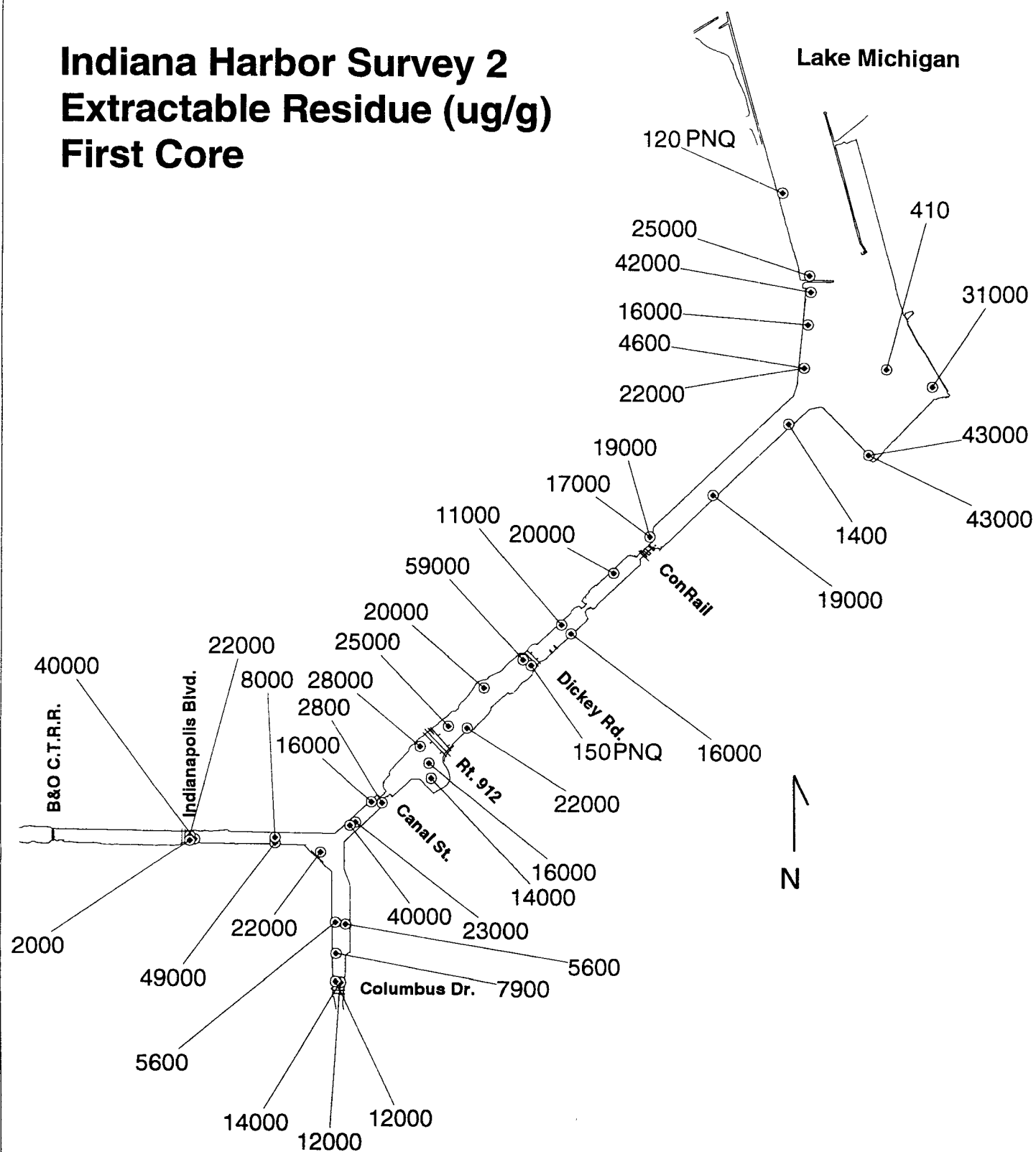
Indiana Harbor Survey 2 Zinc (ug/g) Third and Fourth Cores



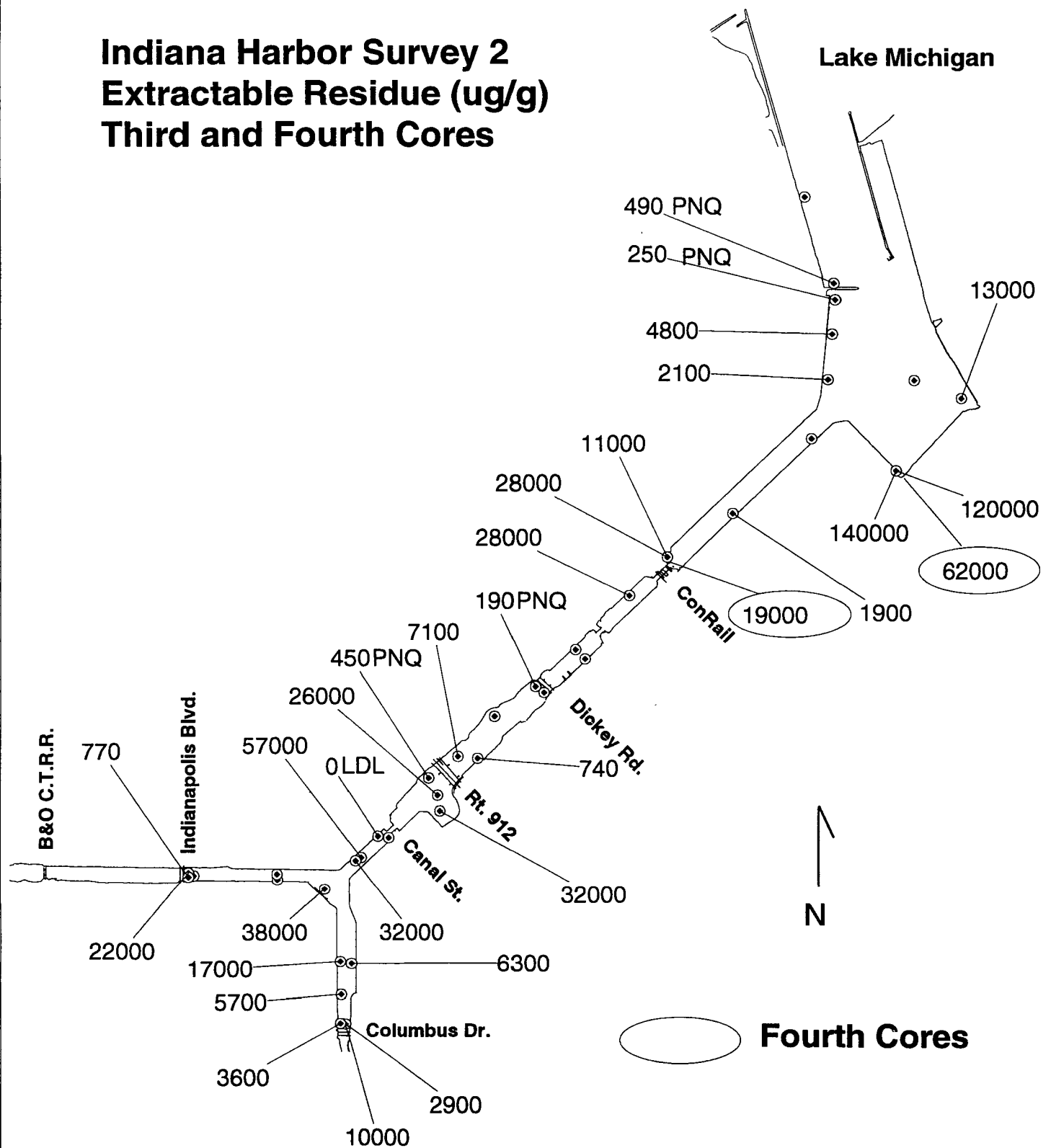
Indiana Harbor Survey 2 **Extractable Residue (ug/g)** **Second Core**



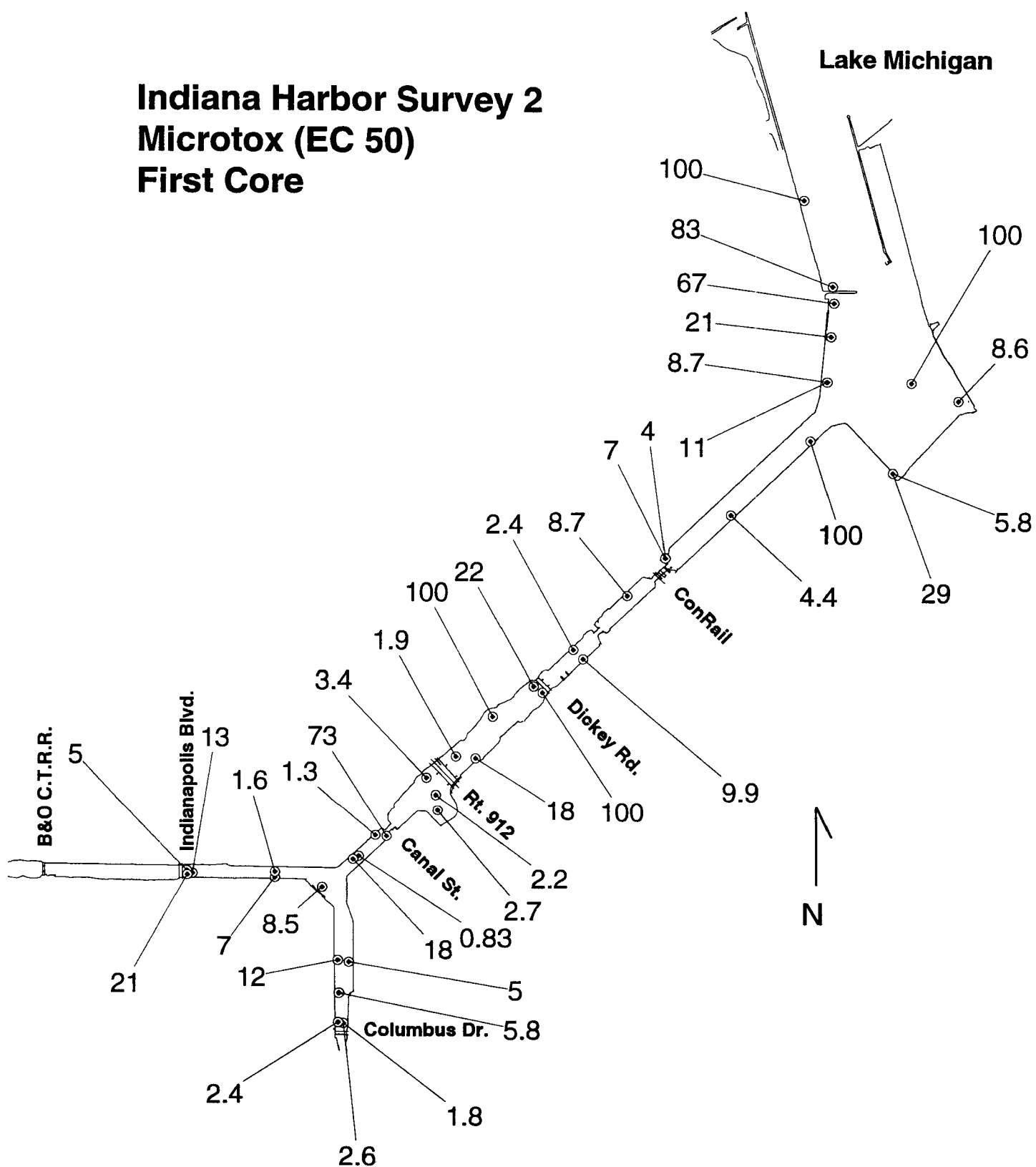
Indiana Harbor Survey 2 Extractable Residue (ug/g) First Core



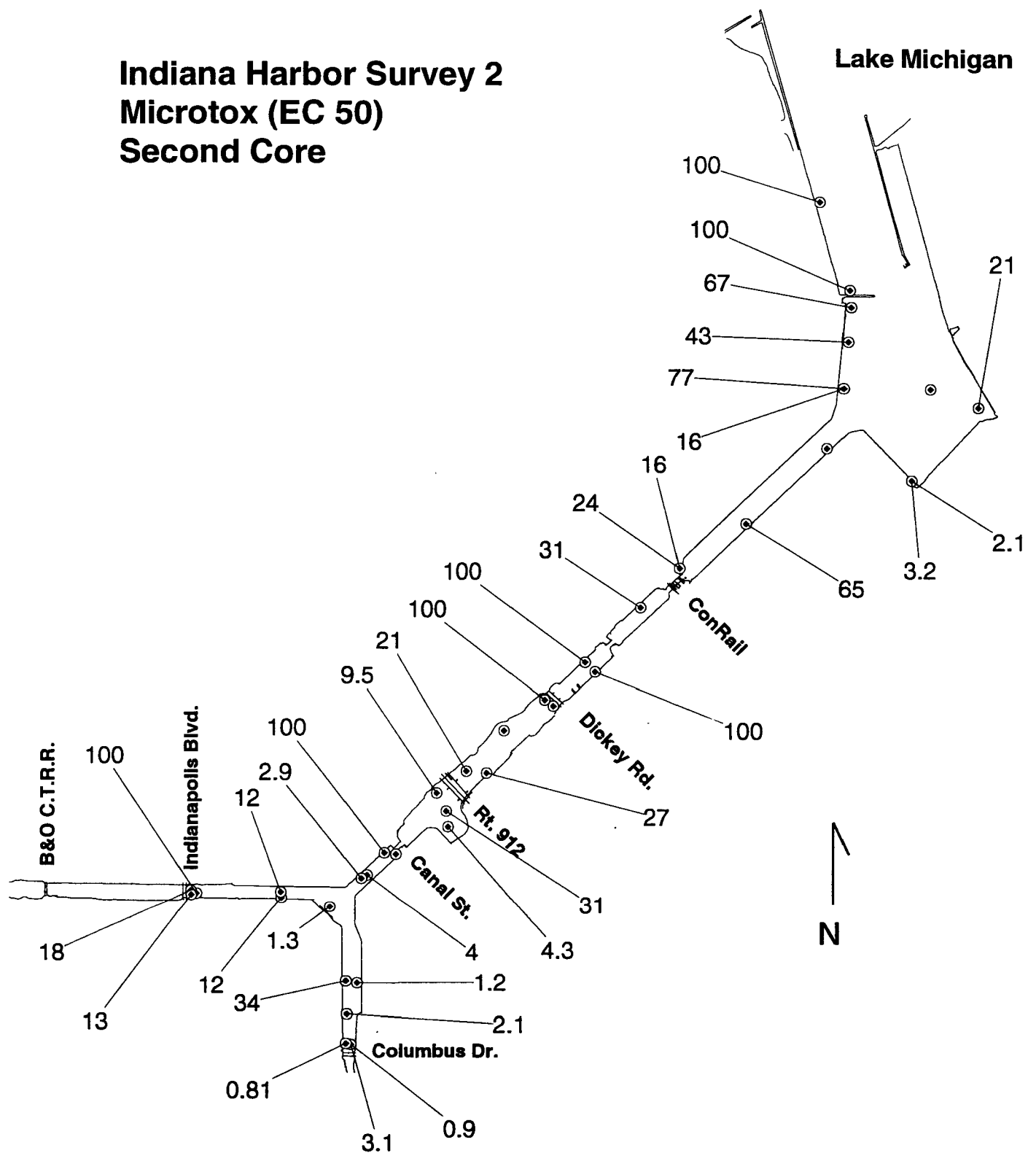
Indiana Harbor Survey 2 **Extractable Residue (ug/g)** **Third and Fourth Cores**



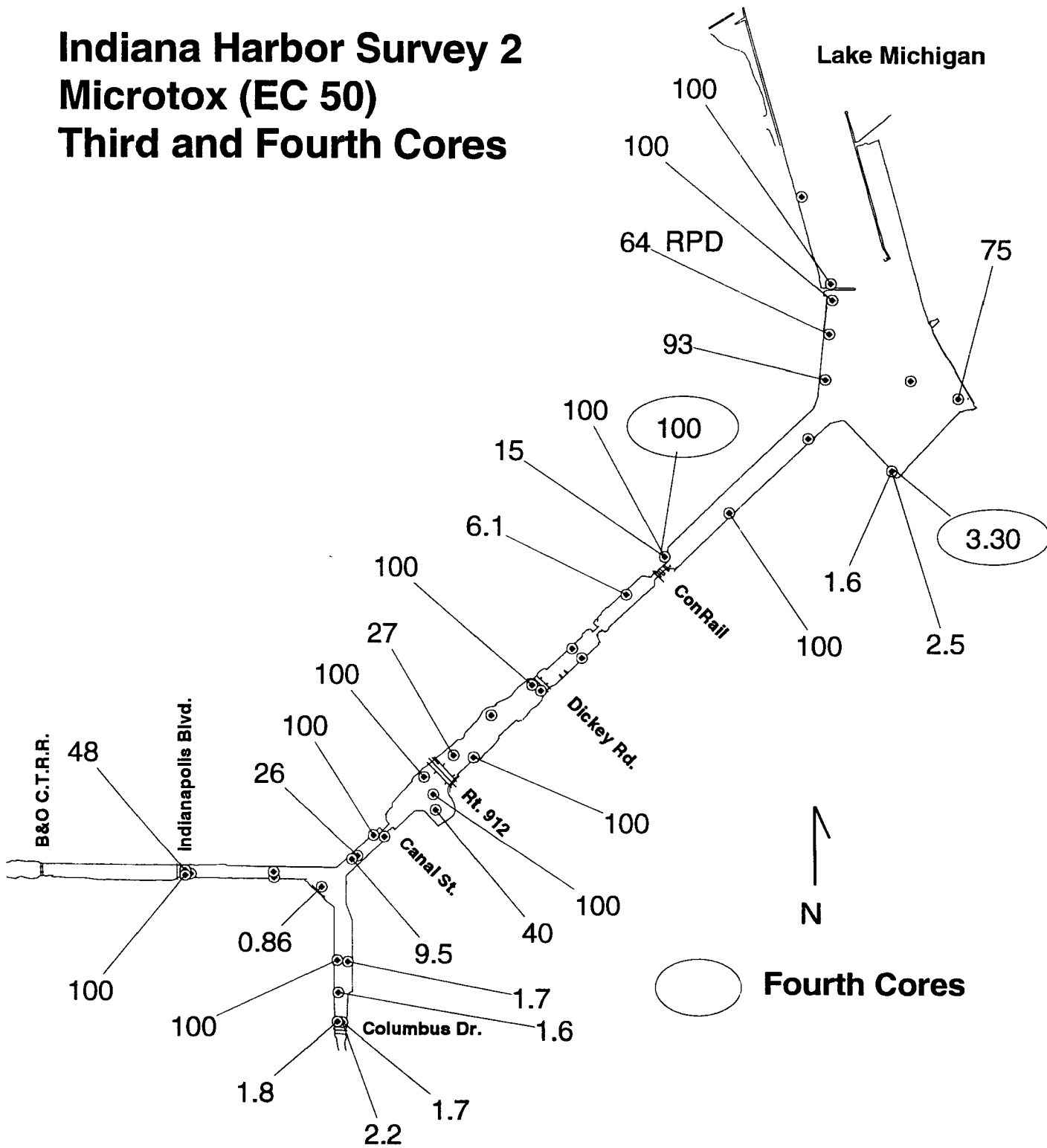
Indiana Harbor Survey 2 Microtox (EC 50) First Core



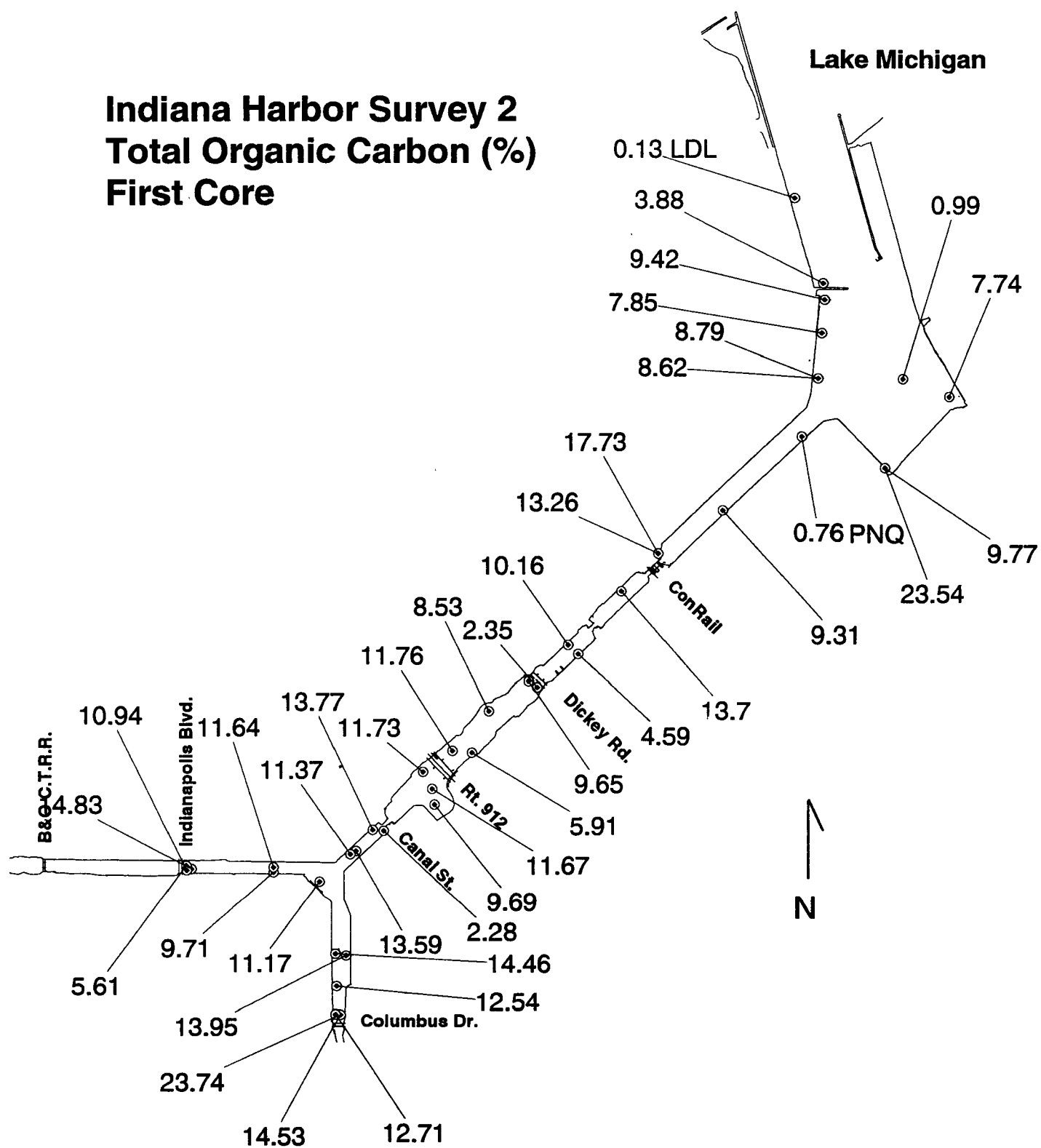
Indiana Harbor Survey 2 Microtox (EC 50) Second Core



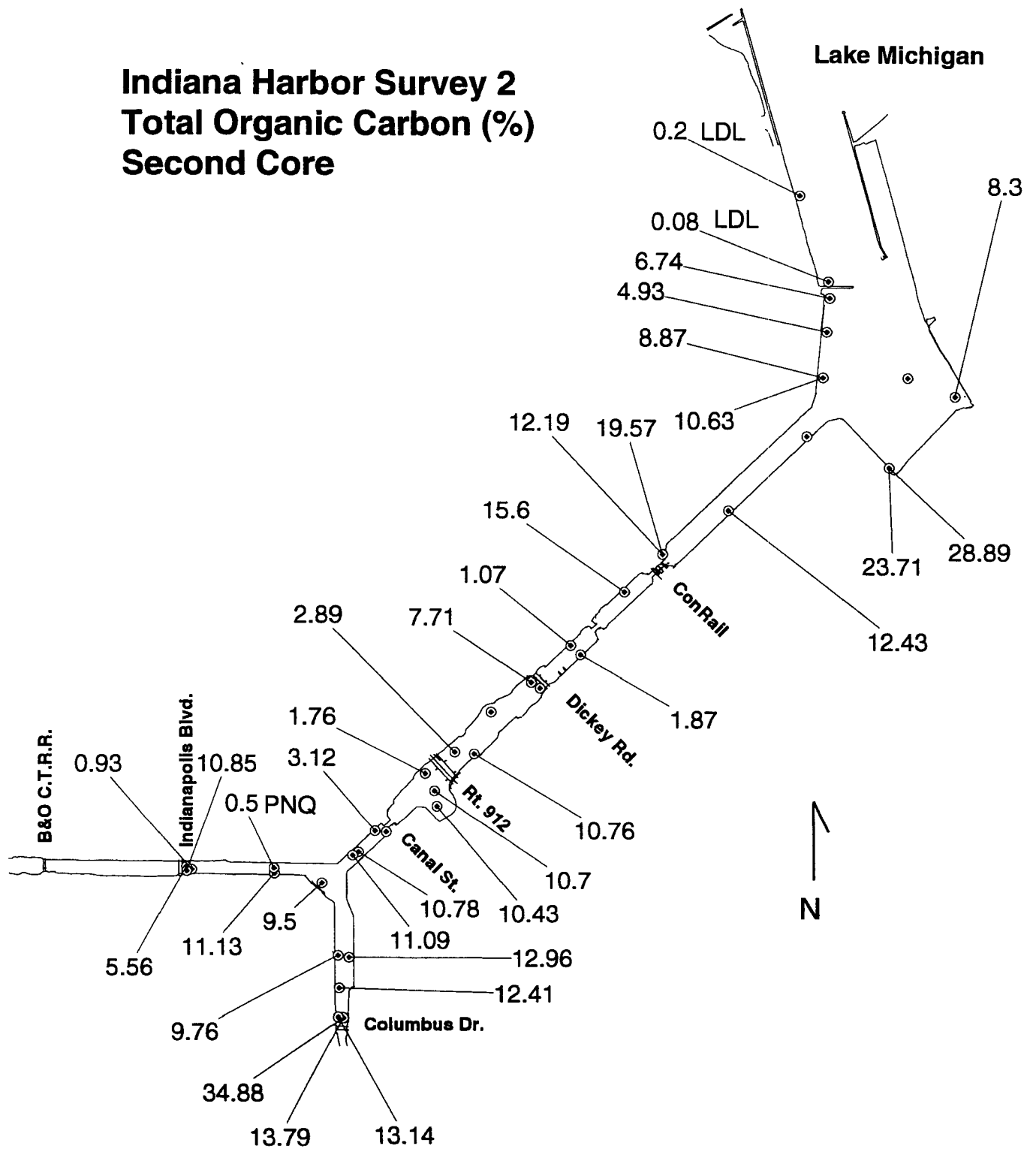
Indiana Harbor Survey 2 Microtox (EC 50) Third and Fourth Cores



Indiana Harbor Survey 2 Total Organic Carbon (%) First Core



Indiana Harbor Survey 2 Total Organic Carbon (%) Second Core



Indiana Harbor Survey 2 Total Organic Carbon Third and Fourth Cores

