ADDENDUM # 1
to the
ASSESSMENT PLAN
for the
NATURAL RESOURCE DAMAGE ASSESSMENT
of the
GRAND CALUMET RIVER, INDIANA HARBOR SHIP CANAL, INDIANA HARBOR, AND WATERS OF NEARSHORE LAKE MICHIGAN

SEPTEMBER 1998

SAMPLING PLAN

1.0 INTRODUCTION

The Grand Calumet River comprises two east-west oriented branches that meet at the southern end of the Indiana Harbor Ship Canal (Figure 1). The east branch of the Grand Calumet River (EBGCR) originates at the Grand Calumet Lagoons, just east of the United States Steel Gary Works facility. The EBGCR flows west from this point for approximately 10 miles to its confluence with the Canal. The west branch of the Grand Calumet River (WBGCR) usually flows both east and west, with a hydraulic divide typically present in the vicinity of Indianapolis Boulevard. The assessment area includes the Grand Calumet lagoons, the EBGCR, and the reach of the WBGCR between the hydraulic divide and the canal, along with the riparian, wetland and upland habitats closely associated with these stretches of the river.

The Indiana Harbor Ship Canal flows north for approximately three miles from its confluence with the east and west branches of the Grand Calumet River before turning to the northeast and flowing for an additional two miles through Indiana Harbor and into Lake Michigan. The Lake George Branch of the Canal extends to the west from the point where the main canal turns to the northeast. The assessment area includes the entire length of the canal and harbor, including the Lake George Branch.

The purposes of this study are to: a) fill in data gaps as determined by historical data review; b) compare surficial grab samples to core samples; and c) analyze the influence of compositing across the river for spatial variability.

This document pertains to tasks 3 & 4 of the "Assessment Plan for the Natural Resource Damage Assessment of the Grand Calumet River, Indiana Harbor Ship Canal, Indiana Harbor, and Waters of Nearshore Lake Michigan" submitted in October of 1997.

2.0 Project Description

This project is designed to characterize the surficial (biologically active layer) and deeper historical sediments in the Grand Calumet River/Indiana Harbor Ship Canal. In addition to the sediment characterization, toxicity testing will be conducted with the amphipod *Hyallela azteca* and sediment bioaccumulation studies will be conducted with the oligochaete *Lumbriculus variegatus*.

2.1 Study Area

The natural watershed of the Grand Calumet River lies within the Calumet lacustrine plain, or lake plain, which extends from the modern Lake Michigan shore of the Valparaiso terminal moraine. The Lake Michigan lobe of the Laurentian ice sheet began to retreat, after the Wisconsin glaciation, and the

Valparaiso terminal moraine marks its furthest southern advance before receding.

Prior to about 1850, the Grand Calumet River flowed east from a point near the Calumet River to the area now encompassed by Marquette Park in Miller, Indiana where the river emptied into Lake Michigan. As the western end of the river was developed for navigation at the confluence with the Little Calumet River, the mouth of the Grand Calumet River at Marquette Park became permanently closed by sand dunes. Construction of the Indiana Harbor Canal began in 1903. Between 1953 and 1959, two reaches of the river between Clark and Grant Streets in Gary were relocated for construction of the I-90 toll road (USACE, 1997).

2.2 Historical Data

Previous sediment characterization studies have detected a wide array of chemical compounds that include: conventional pollutants, metals, and organic chemicals such as PCBs. Characterization of Grand Calumet River and Indiana Harbor Ship Canal sediments, conducted by Hoke *et al*. (1993), analyzed for one hundred and four organic chemicals and detected sixty-three compounds. Concentrations of the various compounds present in the sediments varied greatly. Compounds exhibiting the greatest sediment concentrations were the various polycyclic aromatic hydrocarbons (PAHs), total polychlorinated biphenyls (PCBs, such as Aroclor 1248), *p,p'*-DDE, toxaphene, *p*-chlorotoluene, ethylbenzene, and *p*-dichlorobenzene. These compounds were generally present in the 2 - 20 mg/kg (ppm) range although several of the PAHs were present at concentrations as great as 100 mg/kg. Detectable concentrations of most metals analyzed were present in all study sites' sediments. Iron, magnesium, and manganese were generally present in high mg/kg to low gm/kg (ppt - parts per thousand) concentrations in solid phase sediments. Of the metals of toxicological concern in aquatic systems, zinc, lead, and chromium were present at concentrations as great as 5.23, 3.94, and 1.22 gm/kg, respectively. Copper, nickel, cadmium concentrations were generally below 500 mg/kg. Compounds detected at these concentrations have the potential of causing adverse ecological effects (Hoke *et al*, 1993).

Sediment toxicity has been analyzed from various locations throughout the Grand Calumet River/Indiana Harbor Ship Canal. One such study revealed that statistically significant *Hyalella azteca* mortality occurred in all East Branch sediments (Sobiech *et al*, 1994). Sediment toxicity was also observed with *Chironomus tentans* (Hoke *et al*, 1993), which analyzed sediment collected from 10 locations along the Grand Calumet River (spanning the East Branch to the Indiana/Illinois border) and three locations in the Indiana Harbor Ship Canal. In this study, toxicity is demonstrated by an inhibition in weight gain of the test species (*C. tentans*) exposed to the sediment. The results of this study demonstrated an average inhibition in growth of 91.9 percent. Compared to a control, this indicates a significant increase in toxicity.

2.3 Sampling Procedures

Two types of samples will be collected during this study: a) surficial grabs; and b) transect cores. Sediment grab samples will be collected by petite Ponar grabs (approximately 0 - 10 cm depth) to sample the surficial, biologically active sediments. Multiple grabs will be collected within a ten (10) foot radius of the center of each site. A minimum of five (5) grabs will be combined into a composite sediment sample, to provide sufficient volume for performing bioassays (toxicity or bioaccumulation analyses) and

chemical analyses.

Transect cores will be collected by the use of a vibracore and will be segregated into distinct five (5) foot depths within each core. Each individual five (5) foot core segment will be composited for chemical analyses. Two grab samples will also be collected in conjunction with the core samples. These grab samples will be collected by petite ponar grabs (0 - 10 cm depth) to sample the surficial, biologically active sediments. One grab will be collected from an area within five (5) feet of a core near the bank and consist of multiple grabs [a minimum of five (5) grabs] within in a ten (10) foot radius of the center of this site and combined into a composite sediment sample, to provide sufficient volume for performing bioassays (toxicity analyses) and chemical analyses. The other grab sample will be collected in the vicinity of one of the other two core locations. This grab will also consist of multiple grabs [a minimum of five (5) grabs] within in a ten (10) foot radius of the center of this site and combined into a composite sediment sample. This sample will only be used for selective chemical analyses.

Sediment grab samples for toxicity and chemical analyses will be collected from Twenty-eight (28) sites in the study area (Figure 2 - 4). Sediment grab samples will be collected at all locations signified by a blue dot (5 additional grab samples will be collected in the Grand Calumet Lagoons which is not indicated on the map). Analysis will be performed as indicated above (chemical and toxicity analyses). Pore water analyses will be conducted at locations where toxicity analyses is conducted.

Sites on Figure 2, represented by the red crosses, indicate where transect cores for chemical will be collected. At these sites, three (3) cores will be taken at equal distances across the stream (both banks and the middle of the river) down to native material.

Sediment grab samples for bioaccumulation and chemical analyses will be collected at all sites signified by a green triangle (Figure 4 - these locations are roughly the same areas as corresponding red crosses for transect cores). Bioaccumulation analyses will be conducted on a total of five (5) locations. Multiple grabs will be collected within a ten (10) foot radius of the center of each site. A minimum of five (5) grabs will be combined into a composite sediment sample, to provide sufficient volume for performing bioaccumulation analyses and chemical analyses.

2.4 Laboratory Analysis

Laboratory analyses of the sediment samples will consist of bioassays (toxicity or bioaccumulation) with whole sediment, and chemical analyses of sediment and porewater.

Bioassays. Bioassays will be conducted with whole sediment grab samples collected as stated above. Test conditions are outlined in Table 1. Test acceptability is summarized on Table 2. Whole sediment bioassays will be conducted with the amphipod *Hyalella azteca* (10-day survival and growth).

Bioaccumulation analyses will be conducted with the oligochaete *Lumbriculus variegatus* (28-day bioaccumulation). Bioassays will be conducted at the Environmental and Contaminants Research Center, USGS, Columbia Missouri.

Analytical Chemistry. Analyses for organic and chemical contaminants will be conducted on samples of whole sediments and pore water from all locations. Organic analyses will identify and quantitate organochlorine compounds (PCBs/Aroclors and pesticides) by gas chromatography-mass spectroscopy, and polycyclic aromatic hydrocarbons by high-performance liquid chromatography. Metals in sediments and pore waters will be analyzed by inductively-coupled plasma emission spectroscopy. Whole sediments will be characterized for oil and grease, total organic carbon, total metals, acid volatile sulfides-simultaneously extracted metals (AVS-SEM), and grain size. Pore waters will be analyzed for metals, ammonia, pH, alkalinity, hardness, and conductivity. Bioaccumulation analyses will focus on the organic constituents (i.e., PAHs, PCBs, pesticides).

Table 1. Conditions for conducting sediment tests with *Hyalella azteca* (HA) and *Lumbriculus variegatus* (LV) as described in EPA (1994) and ASTM (1997).

Parameter	Conditions
1. Test Type:	Whole-sediment with renewal of overlying water
2. Temperature:	23°C

3.	Light quality:	Wide-spectrum fluorescent lights
4.	Illuminance:	about 500 to 1000 lux
5.	Photoperiod:	16L:8D
6.	Test chamber:	HA: 300-ml high-form lipless beaker LV: 4- to 6-L chamber
7.	Sediment volume:	HA: 100 ml LV: 1 L or more depending on sediment organic carbon
8.	Overlying water:	HA: 175 ml LV: 1 L or more depending on sediment organic carbon
9.	Renewal water:	2 volume additions/d
10.	Age of organisms:	HA: 7- to 14-d old LV: adults
11.	Organisms/chamber:	HA: 10 LV: sediment organic carbon:organism dry weight 50:1
12.	Number replicates:	4
13.	Feeding:	HA: YCT LV: not fed during test
14.	Aeration:	None, if DO >40% of saturation in overlying water
15.	Overlying water:	Well water (280 mg/L as $CaCO_3$)
16.	Chamber cleaning:	Gently brush screens on <u>outside</u> of chambers as needed
17.	Water quality:	Hardness, alkalinity, conductivity, pH, ammonia at start and end. Temperature and dissolved oxygen daily.
18.	Test duration:	HA: 10 d LV: 28 d
19.	Endpoints:	HA: survival and growth LV: bioaccumulation
20.	Test acceptability:	HA: Minimum mean control survival of 80% and performance-based criteria (Table 2). LV: Number of organisms in a 4-d toxicity screening test should not be significantly reduced in the test sediment relative to the control sediment. Test organisms should burrow into test sediment (Table 2).

Table 2. Recommended performance-based criteria for test acceptability as described in EPA (1994) and ASTM (1997).

Hyalella azteca 10-d toxicity test:

1. Age at the start of the test must be between 7- to 14-d old.
2. Average survival in the control sediment must be ≥80% at the end of the test.

Lumbriculus variegatus 28-d bioaccumulation test:

1. Numbers in a 4-d toxicity screening test should not be significantly reduced in the test sediment relative to the control sediment.
2. Test organisms should burrow into test sediment. Avoidance of test sediment by *L. variegatus* may decrease bioaccumulation.

Culturing test organisms:

1. Laboratories should perform monthly 96-h water-only reference-toxicity tests. If these tests are not conducted monthly, the lot of organisms used to start a sediment test must be evaluated using a reference toxicant.
2. Laboratories should track parental survival of *H. azteca* and the frequency of populations doubling for *L. variegatus* cultures. Records should also be kept on the frequency of restarting cultures.
3. Laboratories should record the following water quality characteristics of the cultures at least quarterly and the day before the start of a sediment test: (1) pH, (2) hardness, (3) alkalinity, and (4) ammonia. Dissolved oxygen should be measured weekly. Temperature should be recorded daily.
4. Laboratories should characterize and monitor background contamination and nutrient quality of food if problems are observed in culturing or testing organisms. Food used to culture organisms should be analyzed before the start of a test for compounds to be evaluated in the bioaccumulation test.
5. Physiological measurements such as lipid content might provide useful information regarding the health of the cultures.

Additional requirements:

1. All organisms in a test must be from the same source.
2. It is desirable to start tests soon after collection of sediment from the field.
3. All test chambers (and compartments) should be identical and should contain the same amount of sediment and overlying water.
4. Negative-control sediment and appropriate solvent controls must be tested. Concentration of solvent must not adversely affect test organisms.
5. Test organisms must be cultured and tested at 23°C (daily mean test temperature 23±1EC and instantaneous test temperature 23±3EC).
6. Hardness, alkalinity, pH, and ammonia in the water above the sediment within a treatment should not vary by more than 50% during the test.
7. Natural physico-chemical characteristics of test sediment collected from the field should be within the tolerance limits of the test organisms.

References cited:

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American Society for Testing and Materials (ASTM). 1997. Standard test methods for measuring the toxicity of sediment-associated contaminants with freshwater invertebrates. E1706-95b. In *ASTM Annual Book of Standards*, Vol. 11.05, Philadelphia, PA, USA, pp. 1138-1220.