TASK 6: DRAFT SUMMARY REPORT

for

SITE CHARACTERIZATION AT THE GENESEE RIVER SEDIMENT SITE, ROCHESTER EMBAYMENT AOC, ROCHESTER, NEW YORK

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ABBREVIATIONS AND ACRONYMS

AA	atomic absorption
AOC	area of concern
ASTM	American Society for Testing and Materials
BUI	beneficial use impairment
CAS	Columbia Analytical Services
CO_2	carbon dioxide
COI	contaminant of interest
DGPS	differential global positioning system
DQO	data quality objective
DRO	diesel range organics
ECD	electron capture detection
ERDC	U.S. Army Engineer Research and Development Center
ER-L	effects range-low
ER-M	effects range-median
ESB	equilibrium partitioning sediment benchmark
ESBTU	estimated ESB toxic unit
GC	gas chromatography
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
ID	identification
NWI	National Wetland Inventory
NYSDEC	New York State Department of Environmental Conservation
ORO	oil range organics
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effect concentration
QA/QC	quality assurance and quality control
QAPP	Quality Assurance Project Plan
RM	river mile
RRO	residual range organics
SQG	sediment quality guideline
TCDD	tetrachlorodibenzo-p-dioxin
TEC	threshold effects concentration
TEF	toxicity equivalency factor
TEQ	toxicity equivalent

TOC	total organic carbon
TRE	toxicity reduction evaluation
USACE	U.S. Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WA	Work Assignment
WHO	World Health Organization

1.0 INTRODUCTION

Under contract to the Chicago-based Great Lakes National Program Office (GLNPO) of the United States Environmental Protection Agency (U.S. EPA), Battelle has completed a characterization of the nature and extent of potential contaminants in the Genesee River from the mouth of the river at Lake Ontario upstream 5.1 miles to the Veteran's Memorial Bridge (NY State Route 104) in Rochester, New York. Specifically, under Task 6 of U.S. EPA Work Assignment (WA) 2-09, Contract Number EP-W-09-024, Battelle developed a Quality Assurance Project Plan (QAPP), performed the environmental assessment, and prepared this summary report. Battelle developed the *Quality Assurance Project Plan (QAPP) for Contaminated Sediment Support; Task 6: Site Characterization at the Genesee River Sediment Site, Rochester Embayment AOC, Rochester, New York*, hereafter referred to as the QAPP (Battelle, 2011), which specifically defines the sampling and analysis procedures utilized during the sediment characterization.

The Great Lakes are among the largest and most complex freshwater ecosystems in the world, providing a home, water, and food to millions of aquatic plants, animals, and people. Harmful pollutants to the Great Lakes include polychlorinated biphenyls (PCBs), heavy metals, oil and grease, and polycyclic aromatic hydrocarbons (PAHs). Contaminants such as PCBs settle into the sediment and enter the food chain when they are ingested by fish, causing adverse effects in human health and the environment. Although discharges of toxic chemicals to the Great Lakes have been reduced in the last 30 years, high concentrations of contaminants persist in the sediment (mud) of some rivers, harbors, and bays as a "legacy" of North America's industrialization.

To help address the contaminated sediment problem, the Great Lakes Legacy Act (GLLA) of 2002 was signed into law on November 27, 2002. The Act authorized $270 million in funding over five years, beginning in 2004, to specifically assist with the cleanup of contaminated sediment in America's 31 Areas of Concern (AOCs). AOCs are designated by the United States and Canada as locations where beneficial consumption, dredging activities, or drinking water consumption have been impaired or restricted. For most of these AOCs, the driving factor causing the impairment is contaminated sediment. U.S. EPA's GLNPO administers the Legacy Act. As of June 2011, 10 remediation projects have been largely completed and several more are scheduled to get under way in 2012. Nearly 1,300,000 cubic yards of sediment have been cleaned up. The GLLA of 2002 is part of a larger strategy to provide a healthy, natural Great Lakes environment for swimming and fishing, as well as a source of clean water for drinking and industrial uses.

As the GLLA remediation project sites are completed, it is important to be able to monitor the overall program effectiveness. The Statement of Work for this project provides the basis for support for site characterization at locations under the reauthorization of the GLLA. The approach outlined below to characterize the sediment quality will allow GLNPO to make rigorous, qualitative assessments based on quantitative data to support upcoming remedial actions at this site as well as provide a baseline of conditions prior to remediation.

The Rochester Embayment of Lake Ontario was identified as a Class B AOC in 1981 by the International Joint Commission due to moderate violations of water quality objectives, some indications of fish contamination, and some sediments being heavily polluted with metals and phosphorus. In 1985, the area was designated a Category 4 AOC. This AOC includes approximately 9.6 km (6 miles) of the Genesee River that is influenced by lake levels from the river mouth to the Lower Falls. While a number of point sources have been reduced or eliminated in the years since the AOC designation, sediment removal has been limited to the U.S. Army Corps of Engineers (USACE) navigation projects in the port area. The purpose of this site characterization project is to evaluate contamination in areas contiguous to the navigation channel to see if remedial action is necessary to delist or move forward delisting of the dredging beneficial use impairments and to evaluate surface sediments with respect to potential impacts to benthos and fish. A limited habitat assessment was also conducted to evaluate opportunities for integrating habitat restoration with potential remediation.

1.1 Project Area

The Rochester Embayment AOC, Rochester, New York, is formed by the indentation of the Monroe County shoreline between Bogus Point in the town of Parma and Nine Mile Point in the town of Webster. The northern boundary of the embayment is delineated by the straight line between these two points. The southern boundary includes approximately 9.6 km (6 miles) of the Genesee River that is influenced by lake levels, from the river's mouth to the Lower Falls. The drainage area of the embayment is approximately 2,500 square miles (6,475 km^2) in area. More information about the AOC can be found at http://epa.gov/greatlakes/aoc/rochester.html. Figure 1-1 provides an overview of the site location.

In the 1981 report of the Water Quality Board of the International Joint Commission, the Rochester Embayment of Lake Ontario was identified as a Class B AOC with "... moderate violations of water quality objectives and some indications of fish contamination in Rochester Harbor and Irondequoit Bay. Surveys of the harbor from 1967 to 1973 found some of the sediments to be heavily polluted with metals and phosphorus" (Great Lakes Water Quality Board, 1981). In its 1985 report, the Water Quality Board designated the Rochester Embayment a Category 4 AOC, indicating "causative factors known, but remedial action plan not developed and remedial measures not fully implemented," identifying embayment problems as conventional pollutants, heavy metals, toxic organic substances, contaminated sediments, and fish consumption advisories. The report also identified pollutant sources as municipal and industrial point sources, combined sewage overflows, and in-place pollutants. While action in intervening years has resulted in reductions in point sources and near-elimination of combined sewage overflows, sediment mitigation in the lower river has been limited to removal of material as part of the USACE navigation project in the port area.

When the restriction on dredging beneficial use impairment (BUI) was proposed for delisting, one reviewer objected, indicating that sediments outside the federal navigation channel were too contaminated for open lake disposal, the delisting criteria for the BUI. This site characterization was proposed based on this objection and on discussions between U.S. EPA, USACE, New York State Department of Environmental Conservation (NYSDEC), the City of Rochester and the AOC Remedial Action Plan Coordinator.

This site characterization evaluates contamination in areas contiguous to the navigation channel, focusing on shoreline areas likely to be dredged in the foreseeable future.

Additional sediment-related BUIs in the Genesee River are, among others, degradation of fish and wildlife populations and degradation of benthos. This site characterization will generate data that can be used to evaluate sediment contamination potentially impacting benthos and fish, especially reintroduced sturgeon in this area, within the approximately 3-mile upstream stretch of the Genesee River.

Figure 1-1. Site Location Map

1.2 Project Objectives

The primary objectives of this WA task are to:

- Characterize contamination in sediments outside of the navigation channel within the Genesee River
- Evaluate surface sediments with respect to potential impacts to benthos and fish.
- Analyze 15 fish collected by U.S. Fish and Wildlife Service (USFWS) in May 2011 for contaminants of concern.

To achieve these objectives, the following WA objectives were identified:

- Evaluate both historical and recently collected data to determine any data gaps, define a list of chemicals of interest based on the data results with respect to BUI delisting, and evaluate the need to supplement existing data for both surface and subsurface sediment in the Genesee River. The data generated from this study will be summarized in a GLNPO-formatted database.
- Formulate a statistical sampling design based on the data gap assessment and data needs for characterizing sediment contamination in sediments adjacent to the dredge channel that may be dredged in the future and in surface sediments upstream of the dredge channel up to the Veteran's Memorial Bridge (NY State Route 104).

- Collect surface and subsurface sediments and analyze them for chemical, physical and bioavailability/toxicological parameters of interest in the river.
- Perform a limited habitat assessment of the Genesee River nearshore/riparian habitat to identify the major habitat types present and the extent of their coverage to provide information that will help assess future remediation opportunities and options.
- Evaluate the sampling results including, but not limited to:
    a. Estimate the horizontal extent of and concentration of contaminated surface (top 6 inches) sediments upstream of the dredged channel area.
    b. Estimate the vertical and horizontal extent of contaminated sediments outside the navigation channel from Lake Ontario to the terminus of the dredge channel.
    c. Characterize the toxicology, bioaccumulation and bioavailability of contaminants as they currently exist in contaminated sediments.
    d. Summarize the results of the fish tissue samples collected by USFWS and analyzed under this WA.
    e. Summarize the habitat assessment information.
    f. Determine that the project qualitative and quantitative quality objectives and limits have been achieved.
- Present the results in a site characterization report that includes recommendations for next steps should data gaps be evident and/or remedial action be warranted.

The third objective, "Analyze 15 fish collected by USFWS in May 2011 for contaminants of concern" was not addressed during this phase of the study (see Section 2.4).

The overall approach for establishing the sampling plan for the Genesee River was to follow U.S. EPA's data quality objective (DQO) process, which is documented at the following Web site (http://www.epa.gov/quality/qs-docs/g4-final.pdf). This is a systematic planning tool that first targets one or more management decisions that need to be made for the site in question, and then considers the quantitative information needed to support those decisions, the risk (i.e., consequences and probabilities) of making incorrect decisions, and the minimum amount of data required to support the decisions and adequately control the risks. For Genesee River, the goal of sampling is to characterize the nature and extent of contamination in sediments along the shorelines adjacent to the navigation channel from surface sediments down to the depths of potential dredging and in surface sediments upstream of the navigation channel. Data were reviewed and qualitatively assessed with respect to potential impacts to benthos and fish by comparing contaminant concentrations to sediment quality guidelines such as the probable effect concentration (PEC) and incorporating the toxicology data produced by this study. In the case of a contaminant of interest (COI) without an associated PEC, an alternative sediment quality guideline was used. For silver, the effects range-low (ER-L) and the effects range-median (ER-M) was used (Long and Morgan, 1990). For total toxicity equivalent (TEQ) of dioxins and furans, definitions of Class A, B, and C from the NYSDEC Technical and Operational Guidance Series 5.1.9 (NYSDEC, 2004) were used. The benchmarks used are further defined in Section 3.1. The project sample design was developed to provide sufficient data to address this objective within bounds defined by DQOs.

The specific applications of each of the analyses used to derive the sampling plan are detailed in Appendix A of the QAPP, Genesee River Sampling Design (Battelle, 2011). QAPP Appendix A also details the power analysis used to derive the sampling plan. As discussed in QAPP Appendix A, the major limitation of the historical data used to establish the sampling design is that the easting and northing coordinates were either unknown or unable to be incorporated during the short timeframe due to not existing in a database. The analytical results were averaged based on sampling areas but spatial correlation analysis could not be performed. The data report for the study phase presented here details the results of field sampling activities, and summarizes the results of laboratory analyses so that GLNPO can evaluate sediment contamination within the project area. Sample collection and laboratory analyses are described in Section 2. Results of analyses are summarized in Section 3.0. Discussion of results and recommendations are presented in Section 4. Appendix A contains a summary table of sample collection information and copies of field records (log books, chain-of-custody forms). Appendix B provides analytical laboratory results for sediment chemical and physical analyses (data tables, narratives, and quality assurance and quality control [QA/QC] summaries). Appendix C contains the whole sediment toxicity testing results (data summary tables and laboratory report). Appendix D contains summaries of the statistical analyses. Appendix E contains habitat assessment photographs. Appendix F contains sediment chemical concentration figures.

2.0 FIELD SAMPLE COLLECTION

Sample collection in support of characterizing the nature and extent of contamination in sediments within the Genesee River AOCs (see Figure 1-1) was performed during a single field sampling event in September 2011. Sampling sites occupied for the collection of sediment samples are shown in Figures 2-1a and 2-1b. The locations and analytical approach were developed by GLNPO and Battelle. Overall sampling design and details of the analyses and methods are described in the QAPP (Battelle, 2011). Field survey activities, including mobilization and demobilization, extended over a 7-day period. The first day included staff and equipment mobilization; days two through five included sediment core collection and processing; and day six included the collection of a single sediment core followed by staff and equipment demobilization. Table 2-1 provides the field schedule and a brief summary of daily activities.

Table 2-1. Schedule of Field Activity

Activity	Date
Staff and Equipment Mobilization to Rochester, New York	September 11, 2011
Sediment Sample Collection – three surface grabs and three cores	September 12, 2011
Sediment Sample Collection – four surface grabs and five cores	September 13, 2011
Sediment Sample Collection – 10 surface grabs and 10 cores	September 14, 2011
Sediment Sample Collection – nine surface grabs and nine cores	September 15, 2011
Sediment Sample Collection – 11 surface grabs and one core; habitat survey	September 16, 2011
Habitat Photo Collection Staff and Equipment Demobilization	September 17, 2011

2.1 Sediment Collection

Sediment sampling began on September 12, 2011, and continued through September 16, 2011. Sediment core and surface grab sample collections were performed from U.S. EPA R/V *Mudpuppy II*. The Battelle boat (*Gale Force*) was used in support of operations and habitat photography. Surface sediment samples were collected from all 33 proposed locations plus the required four field duplicate samples (collected at GR-03, GR-13, GR-14, and GR-32) for a total of 37 surface sediment samples (Figures 2-1a and 2-1b). Sediment core samples were collected from all 24 proposed locations (co-located with 24 grab samples) plus one additional location (labeled GR-23M) as well as the required three field duplicate cores (collected at GR-03, GR-13, and GR-14), resulting in a total of 28 cores (Figure 2-1b). Sediment cores collected via vibracore ranged in length from 0.9 at GR-11 to 19.9 ft at GR-16. Ten of the 25 sediment cores did not reach a hard-bottom refusal point during collection.

Table 2-2 provides the coordinates of each sample station as well as the water depth, sediment thickness and elevation. Sediment cores that did not penetrate to refusal are identified. Differential global positioning system (DGPS) coordinates for each sample station were acquired from the on-board unit of the R/V *Mudpuppy II* Trimble Pathfinder Pro XRS system with differential corrections provided by the USACE Beacon to provide sub-meter real-time accuracy. Coordinates were hand recorded into the field logs.

Figure 2-1a. Actual Sediment Sample Locations Adjacent to Dredged Navigation Channel and within Marinas

Figure 2-1b. Actual Sediment Sample Locations South of Dredged Navigation Channel

Table 2-2. Summary of Core Sample Station Coordinates and Water/Sediment Measurements

Station ID	Samples Collected	Observation Date	Latitude (WGS84; DecDeg)	Longitude (WGS84; DecDeg)	Water Depth (ft)	Sediment Thickness (ft)	Water/Sediment Interface Elevation (ft)	Refusal Elevation (ft)
GR-01	Surface/Core	9/12/2011	43.255253	-77.604240	6.9	15.0	238.3	223.3[(a)]
GR-02	Surface/Core	9/12/2011	43.253450	-77.605307	10.1	no data	235.1	no data
GR-03	Surface/Core	9/15/2011	43.253920	-77.608308	14.9	9.5	230.3	220.8[(a)]
GR-03D	Surface Core	9/15/2011	43.253918	-77.608313	14.9	10.0	230.3	220.8[(a)]
GR-04	Surface/Core	9/12/2011	43.252333	-77.607265	7.3	10.0	237.9	227.9
GR-05	Surface/Core	9/16/2011	43.250695	-77.609078	5	8.0	240.2	232.2
GR-06	Surface/Core	9/15/2011	43.250982	-77.610175	15.7	3.5	229.5	226.0
GR-07	Surface/Core	9/15/2011	43.249522	-77.610390	5.5	15.0	239.7	224.7[(a)]
GR-08	Surface/Core	9/15/2011	43.248120	-77.612227	7.1	14.0	238.1	224.1
GR-09	Surface/Core	9/15/2011	43.246865	-77.611680	1.3	15.0	243.9	228.9[(a)]
GR-10	Surface/Core	9/15/2011	43.244952	-77.613137	16.8	7.5	228.4	220.9
GR-11	Surface/Core	9/15/2011	43.243113	-77.613225	18.5	2.0	226.7	224.7
GR-12	Surface/Core	9/15/2011	43.241772	-77.613898	3.8	20.0	241.4	221.4[(a)]
GR-13	Surface/Core	9/14/2011	43.241237	-77.615162	4.8	12.5	240.4	227.9
GR-13D	Surface/Core	9/14/2011	43.241237	-77.615162	4.8	14	240.4	227.9
GR-14	Surface/Core	9/14/2011	43.240265	-77.613087	11.4	9.0	233.8	224.8
GR-14D	Surface/Core	9/14/2011	43.240257	-77.613093	11.4	9.0	233.8	224.8
GR-15	Surface/Core	9/14/2011	43.239162	-77.614210	13.6	15.0	231.6	216.6[(a)]
GR-16	Surface/Core	9/14/2011	43.237257	-77.614522	7.5	20.0	237.7	217.7[(a)]
GR-17	Surface/Core	9/14/2011	43.236040	-77.616453	12.8	5.0	232.4	227.4
GR-18	Surface/Core	9/14/2011	43.234515	-77.616653	13.6	13.0	231.6	218.6
GR-19	Surface/Core	9/13/2011	43.232280	-77.618243	2.3	20.0	242.9	222.9[(a)]
GR-20	Surface/Core	9/14/2011	43.231958	-77.615945	11.8	15.0	233.4	218.4[(a)]
GR-21	Surface/Core	9/13/2011	43.229248	-77.616382	8.7	15.0	236.5	221.5[(a)]
GR-22	Surface/Core	9/14/2011	43.227615	-77.615493	7.2	17.5	238.0	220.5
GR-23	Surface/Core	9/13/2011	43.225798	-77.616123	17.7	6.5	227.5	221.0
GR-23M	Core	9/13/2011	43.225798	-77.615782	13.3	2.0	231.9	229.9
GR-24	Surface/Core	9/13/2011	43.223673	-77.615618	17.1	6.0	228.1	222.1
GR-25	Surface	9/16/2011	43.221803	-77.615030	23.2	NA	222.0	NA
GR-26	Surface	9/16/2011	43.217552	-77.616688	8.3	NA	236.9	NA
GR-27	Surface	9/16/2011	43.214360	-77.620217	14.3	NA	230.9	NA
GR-28	Surface	9/16/2011	43.212535	-77.624558	18.3	NA	226.9	NA
GR-29	Surface	9/16/2011	43.209708	-77.626502	14.6	NA	230.6	NA
GR-30	Surface	9/16/2011	43.205383	-77.626537	17.3	NA	227.9	NA
GR-31	Surface	9/16/2011	43.201927	-77.623957	18.4	NA	226.8	NA
GR-32	Surface	9/16/2011	43.198422	-77.620870	15.6	NA	229.6	NA
GR-32D	Surface	9/16/2011	43.198415	-77.620015	15.6	NA	229.6	NA
GR-33	Surface	9/16/2011	43.193893	-77.620015	15.0	NA	230.2	NA

Note: WGS84 - World Geodetic System 1984

Elevations are based on the assumption that the water surface elevation was 245.24 ft where the Genesee River meets Lake Ontario.

(a) Indicated that refusal was not encountered; therefore, actual sediment thickness is unknown.

2.2 Sediment Processing

Individual cores were transferred to an on-shore staging area where Battelle field staff took sample custody. Upon receipt, the identification of each sediment core was verified, and the core was securely stored in an on-site refrigerated trailer pending processing.

Each core was processed independently and the core segments that were generated were transferred into designated sample containers prior to processing the next core. Sediment core processing activities were conducted as follows:

- The core was positioned lengthwise on a clean processing table that was coated with a piece of disposal plastic. The polycarbonate core tube was cut lengthwise on opposing sides with an electric shear to expose the sediment core. The exposed sediment core was then split lengthwise down the middle with a clean knife.
- Each sediment core was measured with a tape measure and marked at 3-foot intervals for identification, evaluation, and segmenting determination.
- The split core was photographed starting at the top of the core (sediment surface) and continuing to the bottom of the core. Each photograph included a placard with the project name, date, sample station identification (ID), and the measuring tape showing the core interval that was documented. Photographs of each core are provided in Appendix A4.
- Core features were described following American Society for Testing and Materials (ASTM) Procedure D2488-93 (ASTM, 1993). Features such as sediment type (silt, clay, sand, etc.), color, consistency, sedimentary structure, and odor were documented. This information was recorded on a core characterization log (Appendix A2). Significant changes or inclusions, such as wood debris, shell hash, and sand layers, were documented at the core depth in which they occurred.
- Cores were segmented into 3-foot sections, e.g., 0 to 3 ft, 3 to 6 ft, 6 to 9 ft, 9 to 12 ft, 12 to 15 ft, 15 to 18 ft, 18 to 21 ft.
    - The target core depth was an elevation equivalent to a dredge depth of -23 ft, or refusal.
    - The final depth interval was adjusted to the final recovery at >9 inches past the previous interval.
    - If the final penetration was <9 inches past the previous interval, that material was combined with the previous interval.
- Sediment from each selected interval was sampled in a manner representative of the entire interval length.
- Each sample was mixed to a uniform color and consistency using an electric mixer equipped with an aluminum paddle.
- After homogenization, samples were transferred into the appropriate pre-labeled, certified-clean containers, stored in the on-site refrigerated trailer or placed on ice and prepared for overnight shipment to the appropriate laboratory.
- The processing table was decontaminated and recoated with a piece of disposable plastic sheeting and the next core was processed in a similar manner.

Table 2-3 summarizes the segmenting and processing of each core and the number of samples that were generated for the following laboratory analyses:

- Total metals (Al, Ag, As, Cd, Cr, Cu, Pb, Hg, Mn, Ni, Se, Zn)
- Dioxins and furans (bottom segment only)
- PAHs (Modified Analysis; n = 17)
- Pesticides (including Mirex)
- Herbicides
- PCBs as Aroclors
- Diesel range organics (DRO) and residual range organics (RRO)
- Total organic carbon (TOC)
- Total Solids (%)
- Acute/chronic toxicity: 10-day survival and growth test with the amphipod *Hyalella azteca*. Each toxicity sample was produced from specific depth intervals from one to three separate cores (e.g., [3] 0 to 3 ft sections = one sample, [3] 3 to 6 ft sections = a second sample, etc.). The target was three core segments per sample; however, cores were not necessarily the same length, so three segments were not always available for homogenization into the test sample.

Table 2-3. Summary of Sampling and Analyses by Sampling Station

Sample ID	Station ID	Collection Date	Collection Time	Collection Method	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total Metals	Dioxins and Furans [a]	Pesticides, PCBs (Aroclors), PAHs (N=17)	Herbicides	DRO/RRO	TOC, Percent Solids	Toxicity Composite	Archive
LA-001	GR-01	9/12/2011	16:53	Grab	0	0.5	X	X				X		
LA-107			16:45	Vibracore	0	3	X		X	X	X	X	A1	
LA-108					3	6	X		X	X	X	X	A2	
LA-109					6	9	X		X	X	X	X	A3	
LA-110					9	12	X		X	X	X	X		X
LA-111					12	14.9	X	X	X	X	X	X		X
LA-002	GR-02	9/12/2011	16:00	Grab	0	0.5	X	X				X		
LA-104			15:51	Vibracore	0	3	X		X	X	X	X	A1	
LA-105					3	6	X		X	X	X	X	A2	
LA-106					6	7.4	X	X	X	X	X	X	A3	
LA-003	GR-03	9/15/2011	11:28	Grab	0	0.5	X	X				X		
LA-162			11:15	Vibracore	0	3	X		X	X	X	X	B1	X
LA-163					3	6	X		X	X	X	X	B2	X
LA-164					6	8.7	X	X	X	X	X	X	B3	X
LA-003D	GR-03 Duplicate	9/15/2011	11:31	Grab	0	0.5	X	X				X		
LA-159			11:22	Vibracore	0	3	X		X	X	X	X		X
LA-160					3	6	X		X	X	X	X		X
LA-161					6	9.4	X	X	X	X	X	X		X
LA-004	GR-04	9/12/2011	15:10	Grab	0	0.5	X	X				X		
LA-101			14:59	Vibracore	0	3	X		X	X	X	X	A1	
LA-102					3	6	X		X	X	X	X	A2	
LA-103					6	9.8	X	X	X	X	X	X	A3	

Table 2-3. Summary of Sampling and Analyses by Sampling Station (Continued)

Sample ID	Station ID	Collection Date	Collection Time	Collection Method	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total Metals	Dioxins and Furans [a]	Pesticides, PCBs (Aroclors), PAHs (N=17)	Herbicides	DRO/RRO	TOC, Percent Solids	Toxicity Composite	Archive
LA-005	GR-05	9/16/2011	08:23	Grab	0	0.5	X	X				X		
LA-181			08:20	Vibracore	0	3	X		X	X	X	X	B1	X
LA-182					3	6	X		X	X	X	X	B2	X
LA-183					6	8.0	X	X	X	X	X	X	B3	X
LA-006	GR-06	9/15/2011	17:44	Grab	0	0.5	X	X				X		
LA-173			17:40	Vibracore	0	1.5	X	X	X	X	X	X	B1	X
LA-007	GR-07	9/15/2011	17:07	Grab	0	0.5	X	X				X		
LA-184			16:58	Vibracore	0	3	X		X	X	X	X	C1	X
LA-185					3	6	X		X	X	X	X	C2	X
LA-186					6	9	X		X	X	X	X	C3	X
LA-187					9	12	X		X	X	X	X	C4	X
LA-188					12	14.4	X	X	X	X	X	X	C5	X
LA-008	GR-08	9/15/2011	16:28	Grab	0	0.5	X	X				X		
LA-189			16:18	Vibracore	0	3	X		X	X	X	X	C1	X
LA-190					3	6	X		X	X	X	X	C2	X
LA-191					6	9	X		X	X	X	X	C3	X
LA-192					9	12	X		X	X	X	X	C4	X
LA-193					12	13.8	X	X	X	X	X	X	C5	X
LA-009	GR-09	9/15/2011	15:53	Grab	0	0.5	X	X				X		
LA-194			15:45	Vibracore	0	3	X		X	X	X	X	C1	X
LA-195					3	6	X		X	X	X	X	C2	X
LA-196					6	9	X		X	X	X	X	C3	X
LA-197					9	12	X		X	X	X	X	C4	X
LA-198					12	13.8	X	X	X	X	X	X	C5	X
LA-010	GR-10	9/15/2011	14:35	Grab	0	0.5	X	X				X		
LA-165			14:21	Vibracore	0	3	X		X	X	X	X	D1	X
LA-166					3	6	X		X	X	X	X	D2	X
LA-167					6	6.9	X	X	X	X	X	X	D3	X
LA-011	GR-11	9/15/2011	09:09	Grab	0	0.5	X	X				X		
LA-152			09:01	Vibracore	0	0.9	X	X	X	X	X	X	D1	X
LA-012	GR-12	9/15/2011	13:46	Grab	0	0.5	X	X				X		
LA-199			13:22	Vibracore	0	3	X		X	X	X	X	D1	
LA-200					3	6	X		X	X	X	X	D2	
LA-201					6	9	X		X	X	X	X	D3	
LA-202					9	12	X		X	X	X	X	D4	
LA-203					12	15	X		X	X	X	X	D5	
LA-204					15	16.4	X	X	X	X	X	X	D6	
LA-013	GR-13	9/14/2011	09:09	Grab	0	0.5	X	X				X		
LA-126			08:47	Vibracore	0	3	X		X	X	X	X	E1	X
LA-127					3	6	X		X	X.	X	X	E2	X
LA-128					6	9	X		X	X	X	X	E3	X
LA-129					9	11.9	X	X	X	X	X	X	E4	X
LA-013D	GR-13 Duplicate	9/14/2011	09:10	Grab	0	0.5	X	X				X		
LA-130			09:00	Vibracore	0	3	X		X	X	X	X		X
LA-131					3	6	X		X	X	X	X		X
LA-132					6	9	X		X	X	X	X		X
LA-133					9	12	X		X	X	X	X		X
LA-134					12	13.1	X	X	X	X	X	X		

Table 2-3. Summary of Sampling and Analyses by Sampling Station (Continued)

Sample ID	Station ID	Collection Date	Collection Time	Collection Method	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total Metals	Dioxins and Furans [a]	Pesticides, PCBs (Aroclors), PAHs (N=17)	Herbicides	DRO/RRO	TOC, Percent Solids	Toxicity Composite	Archive
LA-014	GR-14	9/14/2011	17:25	Grab	0	0.5	X	X				X		
LA-153			17:10	Vibracore	0	3	X		X	X	X	X	E1	X
LA-154					3	6	X		X	X	X	X	E2	X
LA-155					6	8.2	X	X	X	X	X	X	E3	X
LA-014D	GR-14 Duplicate	9/14/2011	17:27	Grab	0	0.5	X	X				X		
LA-156			17:22	Vibracore	0	3	X		X	X	X	X		X
LA-157					3	6	X		X	X	X	X		X
LA-158					6	7.7	X	X	X	X	X	X		X
LA-015	GR-15	9/14/2011	16:33	Grab	0	0.5	X	X				X		
LA-168			16:24	Vibracore	0	3	X		X	X	X	X	E1	X
LA-169					3	6	X		X	X	X	X	E2	X
LA-170					6	9	X		X	X	X	X	E3	X
LA-171					9	12	X		X	X	X	X	E4	X
LA-172					12	13.2	X	X	X	X	X	X	E5	X
LA-016	GR-16	9/14/2011	15:44	Grab	0	0.5	X	X				X		
LA-144			15:40	Vibracore	0	3	X		X	X	X	X	F1	X
LA-145					3	6	X		X	X	X	X	F2	X
LA-146					6	9	X		X	X	X	X	F3	X
LA-147					9	12	X		X	X	X	X	F4	X
LA-148					12	15	X		X	X	X	X	F5	X
LA-149					15	18	X		X	X	X	X	F6	X
LA-150					18	19.9	X	X	X	X	X	X	F7	X
LA-017	GR-17	9/14/2011	14:54	Grab	0	0.5	X	X				X		
LA-151			14:48	Vibracore	0	3.1	X	X	X	X	X	X	F1	X
LA-018	GR-18	9/14/2011	11:51	Grab	0	0.5	X	X				X		
LA-135			11:38	Vibracore	0	3	X		X	X	X	X	F1	X
LA-136					3	6	X		X	X	X	X	F2	X
LA-137					6	9	X		X	X	X	X	F3	X
LA-138					9	12.7	X	X	X	X	X	X	F4	X
LA-019	GR-19	9/13/2011	12:00	Grab	0	0.5	X	X				X		
LA-117			11:46	Vibracore	0	3	X		X	X	X	X	G1	X
LA-118					3	6	X		X	X	X	X	G2	X
LA-119					6	9	X		X	X	X	X	G3	X
LA-120					9	12	X		X	X	X	X	G4	X
LA-121					12	15	X		X	X	X	X	G5	X
LA-122					15	18.2	X	X	X	X	X	X	G6[b]	X
LA-020	GR-20	9/14/2011	10:58	Grab	0	0.5	X	X				X		
LA-139			10:52	Vibracore	0	3	X		X	X	X	X	G1	X
LA-140					3	6	X		X	X	X	X	G2	X
LA-141					6	9	X		X	X	X	X	G3	X
LA-142					9	12	X		X	X	X	X	G4	X
LA-143					12	14.9	X	X	X	X	X	X	G5	X
LA-021	GR-21	9/13/2011	11:07	Grab	0	0.5	X	X				X		
LA-112			11:05	Vibracore	0	3	X		X	X	X	X	G1	X
LA-113					3	6	X		X	X	X	X	G2	X
LA-114					6	9	X		X	X	X	X	G3	X

Table 2-3. Summary of Sampling and Analyses by Sampling Station (Continued)

Sample ID	Station ID	Collection Date	Collection Time	Collection Method	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total Metals	Dioxins and Furans [(a)]	Pesticides, PCBs (Aroclors), PAHs (N=17)	Herbicides	DRO/RRO	TOC, Percent Solids	Toxicity Composite	Archive
LA-115	GR-21	9/13/2011	11:05	Vibracore	9	12	X		X	X	X	X	G4	X
LA-116					12	14.2	X	X	X	X	X	X	G5	X
LA-022	GR-22	9/14/2011	10:00	Grab	0	0.5	X	X				X		
LA-174			09:57	Vibracore	0	3	X		X	X	X	X	H1	X
LA-175					3	6	X		X	X	X	X	H2	X
LA-176					6	9	X		X	X	X	X	H3	X
LA-177					9	12	X		X	X	X	X	H4	
LA-178					12	15	X		X	X	X	X	H5	
LA-179					15	16.2	X	X	X	X	X	X	H6	
LA-023	GR-23	9/13/2011	10:31	Grab	0	0.5	X	X				X		
LA-124			10:22	Vibracore	0	2.2	X	X	X	X	X	X	H1	X
LA-123	GR-23M	9/13/2011	09:56	Vibracore	0	1.1	X	X	X	X	X	X		X
LA-024	GR-24	9/13/2011	08:57	Grab	0	0.5	X	X				X		
LA-125			08:50	Vibracore	0	2.3	X	X	X	X	X	X	H1	X
LA-025	GR-25	9/16/2011	10:56	Grab	0	0.5	X	X	X	X	X	X		
LA-026	GR-26	9/16/2011	10:44	Grab	0	0.5	X	X	X	X	X	X		
LA-027	GR-27	9/16/2011	10:34	Grab	0	0.5	X	X	X	X	X	X		
LA-028	GR-28	9/16/2011	10:24	Grab	0	0.5	X	X	X	X	X	X		
LA-029	GR-29	9/16/2011	10:16	Grab	0	0.5	X	X	X	X	X	X		
LA-030	GR-30	9/16/2011	10:00	Grab	0	0.5	X	X	X	X	X	X		
LA-031	GR-31	9/16/2011	09:46	Grab	0	0.5	X	X	X	X	X	X		
LA-032	GR-32	9/16/2011	09:27	Grab	0	0.5	X	X	X	X	X	X		
LA-032D	GR-32 Duplicate	9/16/2011	09:30	Grab	0	0.5	X	X	X	X	X	X		
LA-033	GR-33	9/16/2011	09:15	Grab	0	0.5	X	X	X	X	X	X		
TOTAL – Surface Grab Samples							37	37	10	10	10	37	0	0
TOTAL – Core Samples							103	28	103	103	103	103	40	87

(a) Dioxin/furans in core samples were measured only in surface grab samples and the deepest core interval.

(b) Volume of sample collected inadequate for toxicity testing.

▨ Field duplicate samples

2.3 In-Field Data

In-field sample collection and processing information, including sediment collection logs for each surface sediment grab and sediment core, photo documentation of individual cores and sample chain-of-custody logs, are provided in Appendix A. Each sample collection log includes a description of the sampling location, observations, number and type(s) of samples collected and any comments. Each core characterization log includes a detailed description of the entire core, sediment core segmenting details, and the assigned sample identification. More specifically, Appendix A1 contains daily operation logs and sediment sample collection observations. Appendix A2 contains core processing logs which provide information on core IDs, collection date and time, core lithology, the core segmentation, and individual sample (core segment) IDs. Appendix A3 provides a record of sample chain of custody forms. Appendix A4 provides photograph documentation of each core. Photographs were collected at 1-ft core intervals. Core photos contain the core identification and length is referenced with a tape measure. Core photos are then collated by core and digitally stitched together into one image of the core. The core photographs, individual and merged, are also provided on a CD-ROM, as Appendix A5.

2.4 Deviations from the QAPP

The following deviations from the QAPP occurred:

- Sediments for three composite samples for toxicity testing were not collected from the surface grabs at nine locations (GR-25 through GR-33). Adequate data were provided from the other 42 toxicity tests and, therefore, this deviation is not deemed to significantly affect the project goals. Levels of contamination in surface sediments at these nine locations were less than core samples that were tested for toxicity and did not show significant toxicity.
- The analysis of the 30 tissue samples from 15 fish collected by USFWS in May 2011 for contaminants of concern was not performed due to project budget constraints.
- In calculating the dioxin TEQs for evaluation of results, toxicity equivalency factors (TEFs) developed by the World Health Organization (WHO) in 2005 (Van den Berg et al., 2006) were used rather than the 1998 International TEFs developed by the North Atlantic Treaty Organization (1998) that were used to develop the sediment guidance in (NYSDEC, 2004). Use of the 2005 TEFs represents the most up-to-date evaluation of dioxin toxicity and are considered best practice.
- The QAPP listed the hydrocarbon analyte groups of DRO and oil range organics (ORO) for analysis and quantification. However, the petroleum hydrocarbon group RRO was quantified rather than ORO. The DRO method covers the carbon groups of C10 through C28, the ORO method covers C20 through C35, and the RRO method covers C24 through C36. The results reported cover similar ranges (RRO has one extra carbon range included). The overlap between the two groups was reduced by reporting RRO instead of ORO, thus increasing the resolution of the results. This change is not considered to have any significant impact on the data quality.
- The QAPP listed percent solids as an analyte. CAS and this report are presenting moisture data as percent solids. Percent solids converts to percent moisture essentially as % Moisture = 100 - % Solids. There are some minor measuring differences, but these differences do not significantly impact the use of these data.

3.0 SUMMARY OF SITE CHARACTERIZATION RESULTS

This section presents a summary of the analytical, toxicological, and habitat assessment results. Sediment cores were analyzed for physical and chemical parameters as outlined in Table 3-1. Analyses were performed by Columbia Analytical Services (CAS) at its labs in Houston, Texas and Kelso, Washington. The USACE Engineer Research and Development Center (ERDC) provided toxicological testing following the methods listed in Table 3-1. The analytical methods used are standard U.S. EPA or ASTM methods that have been slightly modified for environmental matrices and improved detection limits. Laboratory reports for each individual parameter are presented as Appendices B1 (CAS Houston data) and B2 (CAS Houston data). Toxicity data from the USACE ERDC laboratory are summarized in Appendix C1; complete reports for toxicity testing are provided in Appendix C2. In addition to the chemical, physical, and biological testing, a limited habitat assessment using available information with field verification using digital photographs was performed by Battelle.

Table 3-1. Methods for Laboratory Analysis

Parameter	Base Method	Lab
Sediments		
Dioxins and Furans	8290A	CAS-Houston
PCBs as Aroclors	8082A (LL)$^{(a)}$	CAS-Kelso
PAHs (n = 17)	8270D	CAS-Kelso
Pesticides	8081A (LL)	CAS-Kelso
Herbicides	8151a	CAS-Kelso
TPH (DRO/RRO)	8015C	CAS-Kelso
TOC	ASTM D4129-82	CAS-Kelso
Total Metals (Al, Ag, As, Cd, Cr, Cu, Pb, Hg, Mn, Ni, Se, Zn)	6010C (LL)	CAS-Kelso
Mercury (Hg)	7471A	
Moisture Content	ASTM D2216	CAS-Kelso
Porewater		
Ammonia	NA	ERDC
Toxicity Testing		
10 Day solid phase survival (%) and growth with the amphipod *Hyalella azteca*	U.S. EPA 100.1 (U.S. EPA, 2000)	ERDC

NA =

(a) LL method modified for low level analysis.

3.1 Sediment Chemistry Data

Sediment chemistry results have been evaluated for the range and average of detected concentrations, location of the maximum concentration, and, where available, against sediment quality guidelines (SQGs). Sediment chemistry summary data tables are provided in Appendix B. Consensus-based SQGs have been created by several groups of researchers. For this project, the values reported in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* by MacDonald et al. (2000) were utilized. MacDonald et al. (2000) defines two benchmarks: the threshold effects concentration (TEC; below which adverse effects are not expected to occur) and the probable effect concentration (PEC; above which adverse effects are likely). These two benchmarks are calculated using the geometric mean of three to six TEC/PEC-type values from published sediment quality guidelines.

One objective of this study is to use the benchmarks to determine the likelihood that a contaminant is below a concentration of potential concern. The data can be expressed within a hypothesis test to demonstrate that the arithmetic mean sediment contaminant concentration for a particular COI is lower than the applicable TEC or PEC. MacDonald et al. (2000) provides consensus-based SQGs for freshwater sediments for 27 analytes measured in this study. The MacDonald SQGs do not include two contaminants of high interest for the Genesee River — silver and dioxins and furans. For silver, the SQGs provided in Long and Morgan (1990) were used. Long and Morgan (1990) provide two benchmarks, the ER-L and the ER-M, which are similar to the MacDonald et al. (2000) TEC/PEC benchmarks. For dioxins and furans, the TEQ was calculated using the WHO 2005 methods (Van den Berg, 2006; Section 2.4). The TEQ was then compared to the NYSDEC Technical and Operational Guidance Series 5.1.9, which lists three classes of sediment quality thresholds for dredged material proposed for in-water/riparian placement (NYSDEC, 2004). The classes are:

- Class A - No appreciable contamination (no toxicity to aquatic life)
- Class B - Moderate contamination (chronic toxicity to aquatic life)
- Class C - High contamination (acute toxicity to aquatic life).

Class A and Class C criteria were selected as most comparable to the TEC and PEC criteria, respectively, and were used in evaluating total TEQ results.

Table 3-2 lists all of the benchmark values used and their source. For data evaluation, non-detects have been calculated using one-half of the method detection limit value for all analytes except total TEQ for dioxins and furans, and PCB Aroclors. In these two cases, non-detects were considered zero. Field duplicate data are not included in the tabular, graphic, or statistical analyses of data.

3.1.1 Dioxins and Furans (Modified Analysis). CAS analyzed 65 sediment samples (58 primary samples and seven field duplicate samples) for dioxins and furans using methods defined in U.S. EPA SW-846 8290A. A 10-g sample was spiked with internal standards and extracted using toluene by either Soxhlet extraction apparatus or accelerated solvent extractor. Following solvent exchange to hexane, sample cleanup procedures (sulfuric acid, column chromatography using silica gel and activated carbon) were used to remove interferences. The final extract was spiked with recovery internal standards and analyzed by high-resolution gas chromatograph/high-resolution mass spectrometer. The results were reported for the 17 individual 2,3,7,8-substituted dioxins and furans, total congener classes, and total TEQs. Total TEQ was calculated by multiplying the concentration of each of the 17 2,3,7,8-substituted dioxins and furans by a toxicity factor (WHO, 2005) used to equate each individual congener to the toxicity of the most toxic congener 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and adding them together for a total TEQ. All results were reported as ng/kg dry weight.

Dioxins and furans were only analyzed in the surface sediments and in the deepest 3-foot segment of each core. Dioxins were detected in 100% of the samples analyzed. Table 3-3 and Figures 3-1a and 3-1b summarize the total TEQ results by depth. The largest percentage of samples with total TEQ results above the NYSDEC Class A benchmark (4.5 ng/kg) occurred in the 12 to 15 ft core segments (71%). Two samples, one each from the 12 to 15 ft core segment of Stations GR-20 and GR-21, also had results above the Class C limit of 50 ng/kg (80.4 ng/kg for GR-21 and 69.8 ng/kg for GR-20). The GR-21 (12 to 15 ft) segment also had the highest concentration of 11 of the 17 2,3,7,8-substituted dioxins and furans (80.4 ng/kg), including the highest concentration of 2,3,7,8-TCDD (3.37 ng/kg).

Table 3-2. Sediment Quality Guidelines Used for Data Evaluation

Analyte	Class	SQG TEC	SQG PEC	Units	Reference
Arsenic	Metal	9.79	33.0	mg/kg dry wt	MacDonald et al., 2000
Cadmium	Metal	0.99	4.98	mg/kg dry wt	MacDonald et al., 2000
Chromium	Metal	43.4	111	mg/kg dry wt	MacDonald et al., 2000
Copper	Metal	31.6	149	mg/kg dry wt	MacDonald et al., 2000
Lead	Metal	35.8	128	mg/kg dry wt	MacDonald et al., 2000
Mercury	Metal	0.18	1.06	mg/kg dry wt	MacDonald et al., 2000
Nickel	Metal	22.7	48.6	mg/kg dry wt	MacDonald et al., 2000
Anthracene	PAH	57.2	845	µg/kg dry wt	MacDonald et al., 2000
Fluorene	PAH	77.4	536	µg/kg dry wt	MacDonald et al., 2000
Naphthalene	PAH	176	561	µg/kg dry wt	MacDonald et al., 2000
Phenanthrene	PAH	204	1170	µg/kg dry wt	MacDonald et al., 2000
Benz(a)anthracene	PAH	108	1050	µg/kg dry wt	MacDonald et al., 2000
Benzo(a)pyrene	PAH	150	1450	µg/kg dry wt	MacDonald et al., 2000
Chrysene	PAH	166	1290	µg/kg dry wt	MacDonald et al., 2000
Dibenz(a,h)anthracene	PAH	33.0	135	µg/kg dry wt	MacDonald et al., 2000
Fluoranthene	PAH	423	2230	µg/kg dry wt	MacDonald et al., 2000
Pyrene	PAH	195	1520	µg/kg dry wt	MacDonald et al., 2000
Total PAHs	PAH	1610	22800	µg/kg dry wt	MacDonald et al., 2000
Total PCBs as Total Aroclors	PCB	59.8	676	µg/kg dry wt	MacDonald et al., 2000
gamma-BHC (lindane)	Pesticide	2.37	4.99	µg/kg dry wt	MacDonald et al., 2000
Chlordane	Pesticide	3.24	17.6	µg/kg dry wt	MacDonald et al., 2000
Dieldrin	Pesticide	1.90	61.8	µg/kg dry wt	MacDonald et al., 2000
Sum of DDT +DDD + DDE (Total DDx)	Pesticide	5.28	572	µg/kg dry wt	MacDonald et al., 2000
Endrin	Pesticide	2.22	207	µg/kg dry wt	MacDonald et al., 2000
Heptachlor Epoxide	Pesticide	2.47	16	µg/kg dry wt	MacDonald et al., 2000
Analyte	**Class**	**ER-L**	**ER-M**	**Units**	**Reference**
Silver	Metal	1.0	3.7	mg/kg dry wt	Long and Morgan, 1990
Analyte	**Class**	**Class A**	**Class C**	**Units**	**Reference**
Dioxin TEQ	Dioxin	<4.5	>50	ng/kg dry wt	NYSDEC, 2004

Table 3-3. Total TEQ– Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (ng/kg dry wt) Minimum	Concentration (ng/kg dry wt) Maximum	Concentration (ng/kg dry wt) Mean	Standard Deviation	Location of Maximum	Percent above NYSDEC Benchmark (Class A) (4.5 ng/kg)	Percent above NYSDEC Benchmark (Class C) (50 ng/kg)
0-0.5	33	33	0.143	38.4	2.3	6.7	GR-12	9	0
0-3	6	6	0.079	10.1	3.5	3.9	GR-17	33	0
3-6	0	0	NA	NA	NA	NA	NA	NA	NA
6-9	6	6	0.020	22.6	10.2	11.2	GR-14	50	0
9-12	2	2	0.076	39.5	19.8	27.9	GR-18	50	0
12-15	7	7	0.069	80.4	26.1	34.0	GR-21	71	29
15-18	3	3	0.007	5.7	3.6	3.1	GR-22	67	0
18+	1	1	0.051	0.051	0.051	NA	GR-16	0	0

NA = not applicable

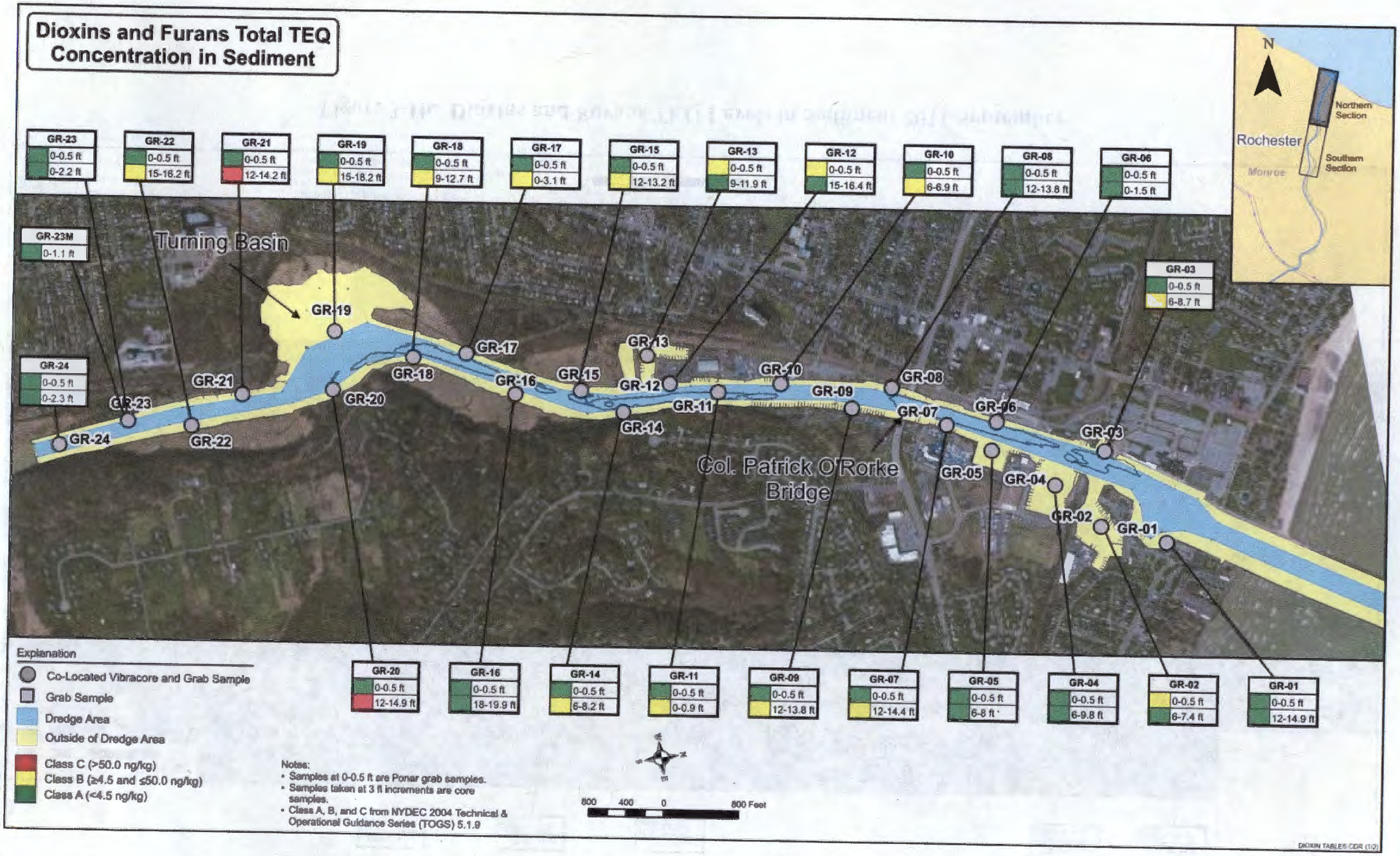


Figure 3-1a. Dioxins and Furans TEQ Levels in Sediment 2011-September

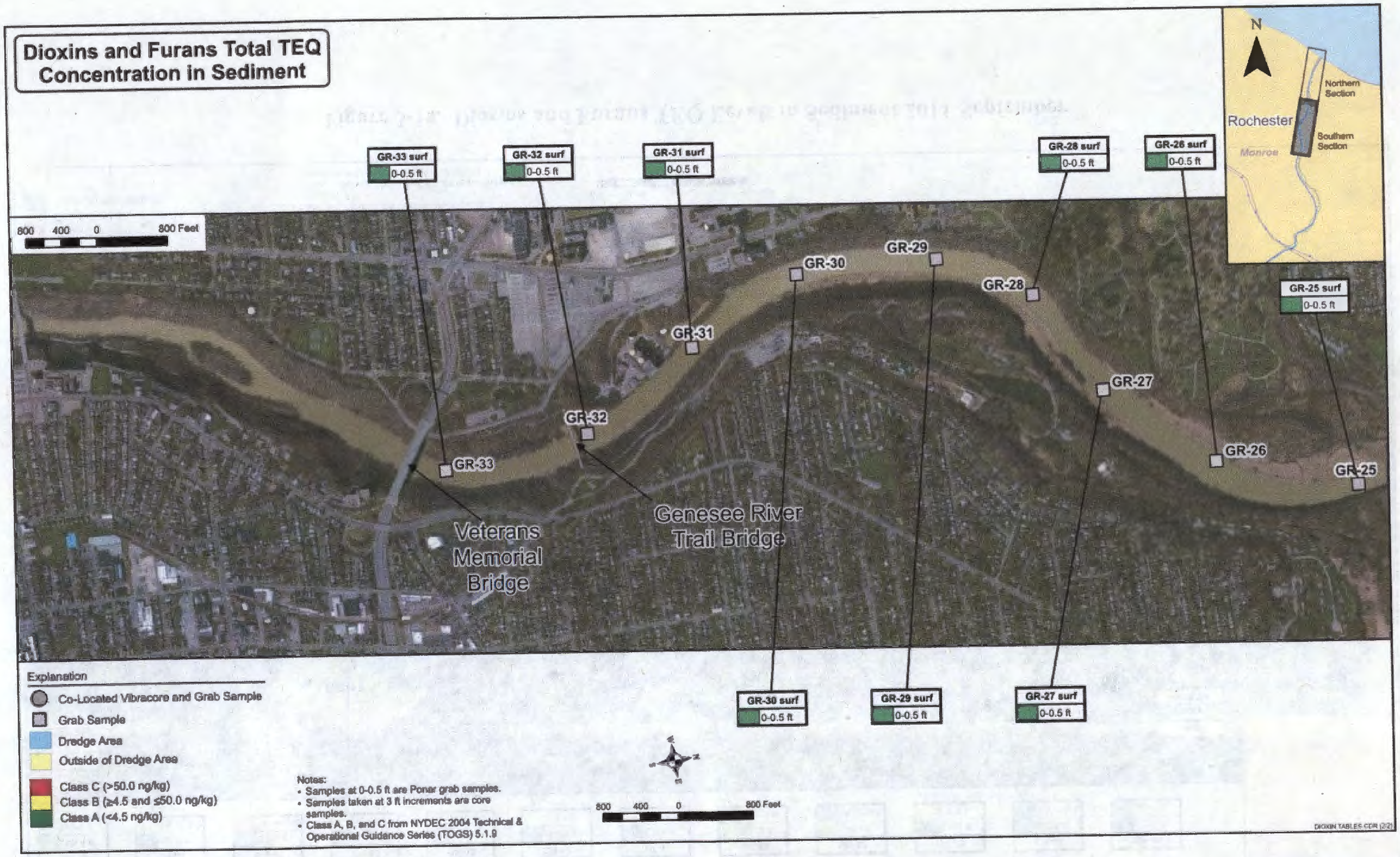


Figure 3-1b. Dioxins and Furans TEQ Levels in Sediment 2011-September

3.1.2 PCBs as Aroclors (Modified Analysis). CAS analyzed 113 sediment samples (101 primary samples and 12 field duplicate samples) for PCB Aroclors using methods defined in U.S. EPA SW-846 8082A. A 40-g sample was spiked with internal standards and extracted using Soxhlet (Method 3540), automated Soxhlet (Method 3541) or ultrasonic extraction (Method 3550) procedures. Sample cleanup procedures were used to remove interferences. Samples were analyzed by gas chromatography (GC) with electron capture detection (ECD). Aroclors were identified by comparing the retention times of three to six peaks with the respective retention times of an authentic standard and by comparison of elution patterns to those of Aroclor standards. The results are reported as Aroclors as µg/kg dry weight.

PCB laboratory data were reported as nine individual Aroclors. Of the nine Aroclors, only four were detected above the reporting detection limit (Aroclors 1248, 1254, 1260, and 1268). Out of 101 samples analyzed, Aroclor 1260 was the most frequently detected (84% of samples), followed by Aroclor 1254 (67% of samples), and 1248 (39% of samples). Aroclor 1268 was detected in only one sample. The range of Aroclor concentrations detected are shown in Table 3-4.

Table 3-4. Summary of Aroclor Detections

Quantity of Samples	Quantity of Detects	Chemical Name	Concentration (µg/kg)			Standard Deviation	Location of Maximum	Percent above TEC	Percent above PEC
			Minimum	Maximum	Mean				
101	84	Aroclor 1260	ND	120	38	38	GR-14 (3-6 ft) GR-14 (6-9 ft) GR-22 (12-15 ft)	NA	NA
101	67	Aroclor 1254	ND	230	54	65	GR-21 (9-12 ft) GR-18 (6-9 ft) GR-20 (9-12 ft)	NA	NA
101	39	Aroclor 1248	ND	240	38	65	GR-20 (9-12 ft)	NA	NA
101	1	Aroclor 1268	ND	40	NA	NA	GR-08 (6-9 ft)	NA	NA

ND = non-detect
NA = not applicable

For graphical and tabular presentation and further discussion within this report, PCB concentrations are expressed as total Aroclors, which were calculated by summing the Aroclor concentrations detected above the reporting limits. If an individual Aroclor was reported below the detection limit, a value of 0 was used for that Aroclor in the summation. Table 3-5 shows a basic statistical summary of total Aroclor concentrations detected in each segment interval across the project area. Total Aroclors were not detected above the PEC in any of the samples. Concentrations above the TEC occurred between 0 to 15 ft, with the largest percentage of detects above TEC (79% of samples) occurring in the 6 to 9 ft segment. Additionally, total Aroclor concentrations are summarized graphically as a function of depth per each sample station in Figures 3-2a and 3-2b.

Table 3-5. Total Aroclors – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (µg/kg dry wt)			Standard Deviation	Location of Maximum	Percent above TEC (60 µg/kg)	Percent above PEC (676 µg/kg)
			Minimum	Maximum	Mean				
0-0.5	9	9	2.1	15.2	7.7	5.1	GR-31	0	0
0-3	25	22	ND	410	69	98.2	GR-06	28	0
3-6	19	19	6	530	189	162	GR-14	63	0
6-9	19	15	ND	570	179	164	GR-18	79	0
9-12	13	10	ND	570	222	226	GR-21	62	0
12-15	11	8	ND	365	122	142	GR-20	55	0
15-18	4	1	ND	24	6.0	12	GR-19	0	0
18+	1	0	ND	ND	ND	NA	NA	0	0

ND = non-detect
NA = not applicable

3.1.3 Pesticides (Modified Analysis). CAS analyzed 113 sediment samples (101 primary samples and 12 field duplicate samples) for pesticides using the methods defined in U.S. EPA SW-846 8081A. Samples were spiked with internal standards and extracted using Soxhlet (Method 3540) or automated Soxhlet extraction (Method 3541) procedures. Sample cleanup procedures were used to remove interferences, then extracts were spiked with reference internal standards and analyzed by GC/ECD. Results are reported as µg/kg dry weight.

Table 3-6 shows a summary of the individual pesticides identified, the minimum and maximum concentrations, and the number of samples resulting in pesticide detection. Non-detects were given the value of one-half of the detection limit. The predominant pesticides reported were 4,4'-DDD, 4,4'-DDE and 2,4'-DDD.

Due to the prevalent detection of DDE, DDD and DDT, additional data evaluation was conducted to determine the segment intervals at which detections of these analytes occurred. For the purpose of this evaluation, the sum of all six DDE, DDD, and DDT isomers that were measured was used and is referred to as Total DDx. These data are shown in Table 3-7. The maximum concentration of DDx was detected at Station GR-22 within the 3 to 6 ft segment.

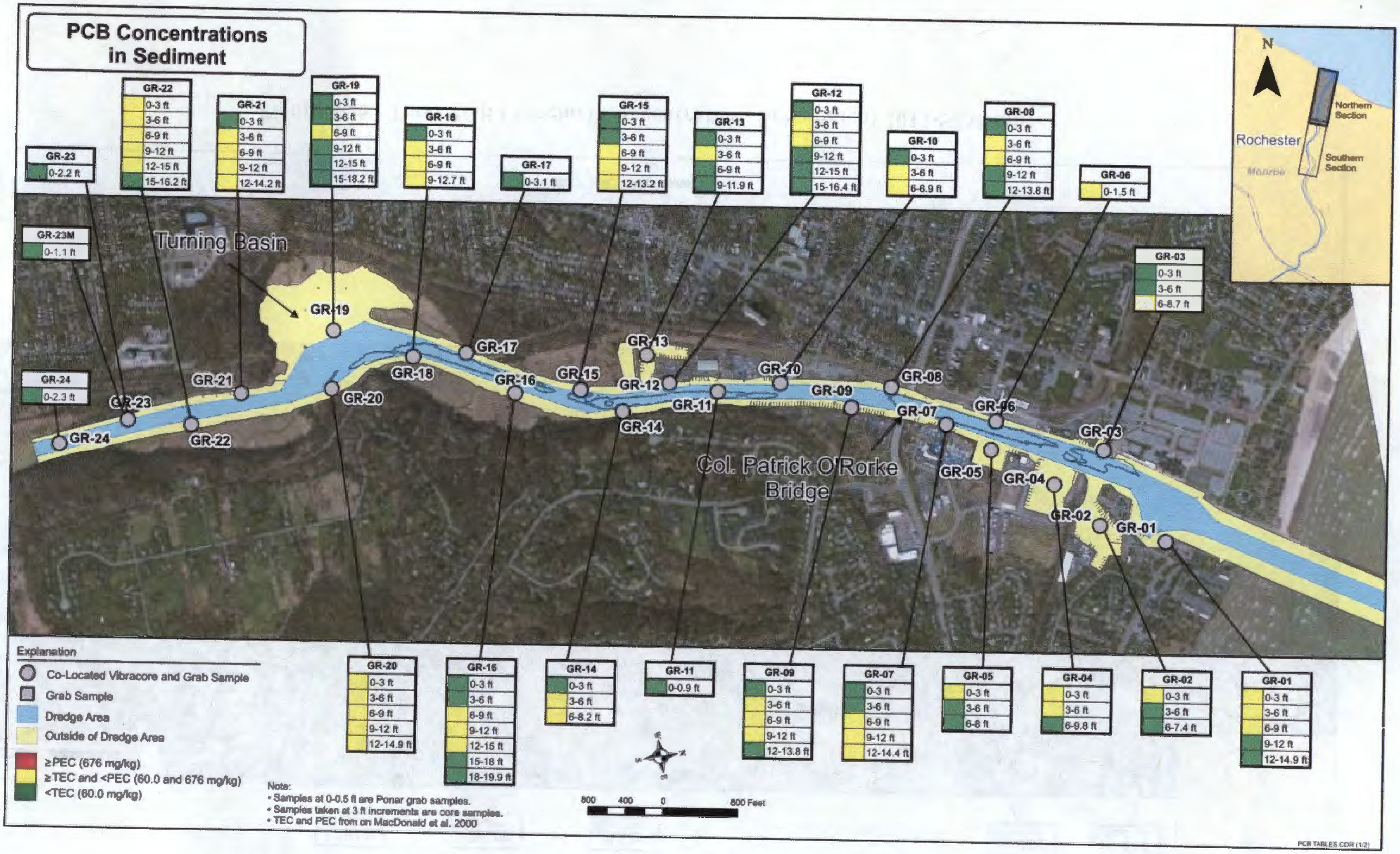
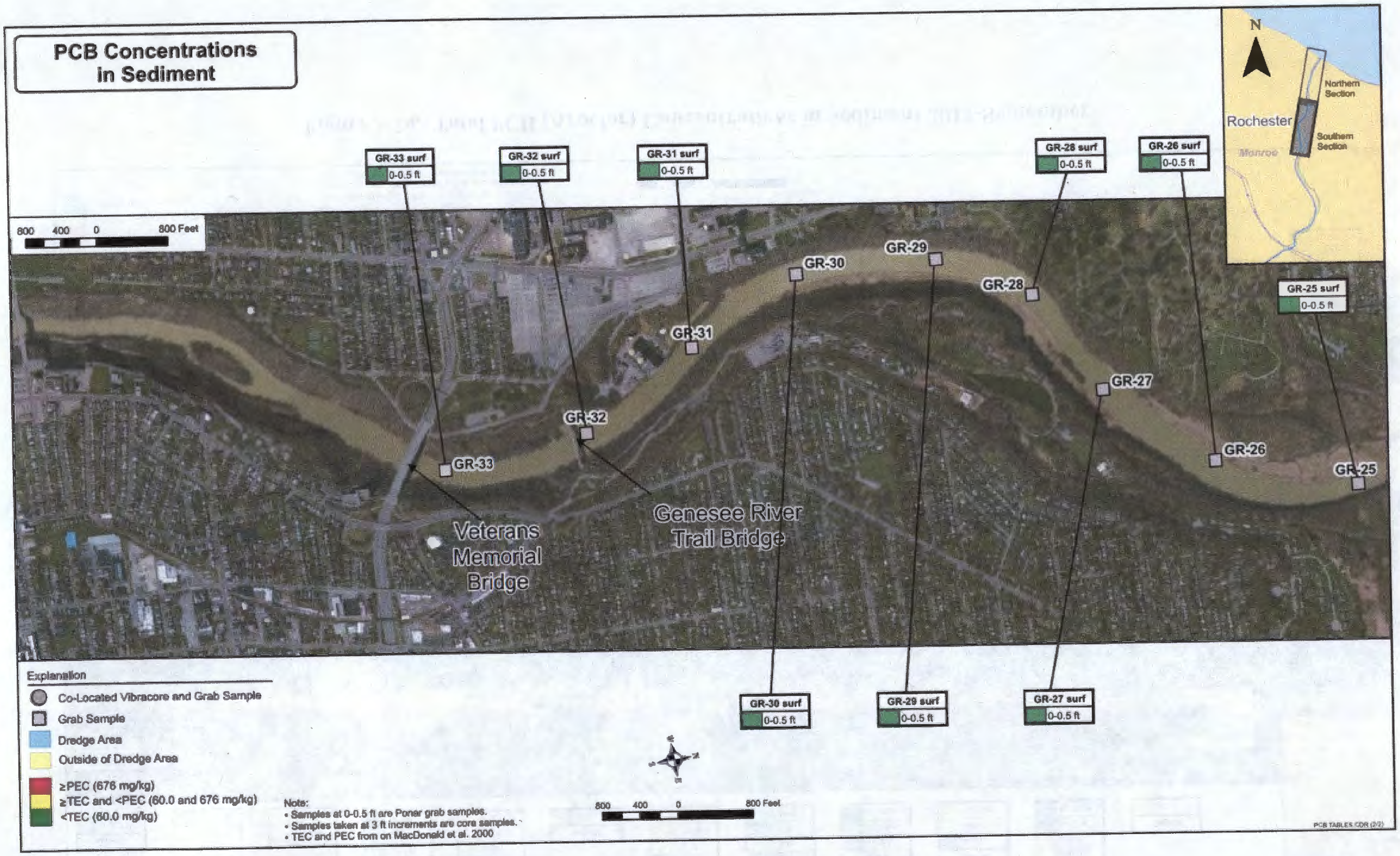


Figure 3-2a. Total PCB (Aroclor) Concentrations in Sediment 2011-September



Note:
- Samples at 0-0.5 ft are Ponar grab samples.
- Samples taken at 3 ft increments are core samples.
- TEC and PEC from on MacDonald et al. 2000

Figure 3-2b. Total PCB (Aroclor) Concentrations in Sediment 2011-September

Table 3-6. Summary of Pesticide Detections

Quantity of Samples	Quantity of Detects	Chemical Name	Concentration (µg/kg)			Standard Deviation	Location of Maximum	Percent above TEC$^{(a)}$	Percent above PEC$^{(a)}$
			Minimum	Maximum	Mean				
101	78	4,4'-DDD	0.055	72	4.07	8.76	GR-22 (3-6 ft)	NA	NA
101	72	4,4'-DDE	0.055	14	2.42	2.65	GR-22 (3-6 ft)	NA	NA
101	63	2,4'-DDD	0.065	35	1.94	4.30	GR-22 (3-6 ft)	NA	NA
101	31	Methoxychlor	0.095	4.7	0.82	0.97	GR-20 (9-12 ft)	NA	NA
101	27	gamma-Chlordane	0.045	5.7	0.23	0.67	GR-13 (3-6 ft)	NA	NA
101	22	cis-Nonachlor	0.06	1.3	0.23	0.33	GR-06 (0-3 ft)	NA	NA
101	13	4,4'-DDT	0.085	8.5	0.48	1.11	GR-20 (12-15 ft)	NA	NA
101	10	Endrin aldehyde	0.06	2.9	0.34	0.64	GR-07 (9-12 ft)	NA	NA
101	7	Chlorpyrifos	0.075	0.89	0.13	0.14	GR-13 (0-3 ft)	NA	NA
101	6	Endrin ketone	0.047	0.88	0.14	0.17	GR-06 (0-3 ft)	NA	NA
101	6	gamma-BHC (Lindane)	0.04	2.9	0.31	0.32	GR-13 (0-3 ft)	1	0
101	5	delta-BHC	0.037	0.88	0.13	0.15	GR-14 (3-6 ft)	NA	NA
101	4	2,4'-DDT	0.029	1.7	0.19	0.27	GR-14 (6-9 ft)	NA	NA
101	4	Endosulfan sulfate	0.055	0.55	0.12	0.12	GR-14 (3-6 ft)	NA	NA
101	4	Hexachlorobutadiene	0.105	1.85	0.14	0.18	GR-03 (0-3 ft)	NA	NA
101	3	trans-Nonachlor	0.044	2.6	0.24	0.36	GR-14 (3-6 ft)	NA	NA
101	3	Chlordane	0.95	38	3.45	5.37	GR-22 (12-15 ft)	43	3
101	2	alpha-Chlordane	0.05	4.1	0.32	0.54	GR-13 (3-6 ft)	NA	NA
101	2	alpha -BHC	0.055	0.38	0.07	0.05	GR-07 (0-3 ft)	NA	NA
101	2	Hexachlorobenzene	0.1	0.86	0.12	0.09	GR-14 (3-6 ft)	NA	NA
101	1	Aldrin	0.08	0.53	0.10	0.07	GR-09 (9-12 ft)	NA	NA
101	0	Oxychlordane	0.0425	0.38	0.06	0.06	ND^{b}	NA	NA
101	0	alpha-Endosulfan	0.0315	0.90	0.15	0.18	ND^{b}	NA	NA
101	0	beta-BHC	0.09	0.38	0.11	0.06	ND^{b}	NA	NA
101	0	beta-Endosulfan	0.07	2.65	0.27	0.55	ND^{b}	NA	NA
101	0	Dieldrin	0.07	2.60	0.36	0.46	ND^{b}	2^{c}	0^{c}
101	0	Endrin	0.047	1.25	0.08	0.16	ND^{b}	0	0
101	0	Heptachlor	0.06	0.1	0.06	0.004	ND^{b}	NA	NA
101	0	Heptachlor Epoxide	0.042	0.16	0.05	0.02	ND^{b}	0	0
101	0	Hexachloroethane	0.165	0.265	0.17	0.01	ND^{b}	NA	NA
101	0	Isodrin	0.085	0.375	0.11	0.07	ND^{b}	NA	NA
101	0	Mirex	0.0495	25.5	0.60	2.81	ND^{b}	NA	NA
101	0	2,4'-DDE	0.08	1.85	0.25	0.25	ND^{b}	NA	NA
101	0	Toxaphene	2.4	80	18.6	17.1	ND^{b}	NA	NA

(a) TEC and PEC values are included in Table 3-2.

(b) Compounds not detected, Min/Max/Mean calculated from detection limit data

(c) Indicates percent of detection limit values above the benchmark.

Not Applicable. Benchmark not established for this compound

Table 3-7. Total DDx– Statistical Summary

Segment Interval (ft.)	Quantity of Samples	Quantity of Detects	Concentration (µg/kg) Minimum	Concentration (µg/kg) Maximum	Concentration (µg/kg) Mean	Standard Deviation	Location of Maximum	Percent above TEC[a] (5 µg/kg)	Percent above PEC[a] (572 µg/kg)
0-0.5	9	9	1.03	2.03	1.55	0.29	GR-31	0	0
0-3	25	25	0.92	11.8	4.03	3.19	GR-06	32	0
3-6	19	19	0.50	122	19.6	29.6	GR-22	68	0
6-9	19	15	0.37	37.8	11.9	10.8	GR-18	74	0
9-12	13	11	0.37	22.6	10.3	8.48	GR-22	62	0
12-15	11	8	0.37	25.7	7.86	9.25	GR-20	45	0
15-18	4	2	0.37	6.23	2.63	2.83	GR-19	25	0
18+	1	0	0.37	0.37	0.37	NA	NA	0	0

(a) TEC and PEC values are included in Table 3-2.

3.1.4 Herbicides (Modified Analysis). CAS analyzed 113 sediment samples (101 primary samples and 12 field duplicate samples) for 10 herbicides using the methods defined in U.S. EPA SW-846 8151A. The 10 herbicides included Dalapon, Dicamba, MCPP, MCPA, Dichlorprop, 2,4-D, 2,4,5-T, Silvex, 2,4-DB, and Dinoseb. A 30-g sample was spiked with internal standard, adjusted to a pH less than 2 and the herbicides in both acid and derivatized forms were extracted with ethyl ether. Derivatives of the phenoxy acid herbicides in the extract were hydrolyzed to the acid form by the addition of sodium hydroxide. The samples were acidified, and the acid herbicides extracted. The acids were then converted to their methyl esters using diazomethane. Samples were analyzed by GC/ECD and reported as µg/kg. None of the 10 herbicides were detected in any of the samples, thus there is no tabular, graphical, or analytical treatment of the data.

3.1.5 Polycyclic Aromatic Compounds (Modified Analysis). CAS analyzed 113 sediment samples (101 primary samples and 12 field duplicate samples) for PAHs using the methods defined in U.S. EPA SW-846 8270D-SIM-PAHs. Samples were spiked with internal standards, extracted, cleaned up using gel permeation chromatography, and spiked with recovery internal standards. The extracts were analyzed by GC/MS in the selective ion monitoring mode. Identification of the analytes of interest was performed by comparing the retention times of the analytes with the respective retention times of an authentic standard, and by comparing mass spectra of analytes with mass spectra of reference materials. Quantitative analysis was performed by using the authentic standard to produce a response factor and calibration curve, and using the calibration data to determine the concentration of an analyte in the extract. The concentration in the sample is reported as µg/kg dry weight.

PAH laboratory data are reported as 18 individual PAH compounds and as a total of the 16 priority PAHs (total PAH). Table 3-8 provides the results for individual and total PAHs. The maximum concentration of individual PAHs was most commonly measured in two core segments, GR-13 (0 to 3 ft) and GR-16 (12 to 15 ft). Table 3-9 gives an indication of the distribution of total PAHs by depth. Sixty-nine percent of the samples (71/101) exceeded the TEC for the total of 16 priority PAHs, while only one sample exceeded the PEC for total PAHs (GR-13, 0 to 3 ft).

Table 3-8. Summary of PAH Detections

Quantity of Samples	Quantity of Detects	Chemical Name	Concentration (µg/kg)				Location of Maximum	Percent above TEC(a)	Percent above PEC(a)
			Minimum	Maximum	Mean	Standard Deviation			
101	101	Pyrene	1.1	4500	572	764	GR-13 (0-3 ft)	79	7
101	101	1-Methylnaphthalene[b]	0.5	760	49	107	GR-16 (12-15 ft)	NA	NA
101	100	Phenanthrene	0.7	4200	419	616	GR-16 (12-15 ft)	51	7
101	100	Fluoranthene	0.5	5700	566	791	GR-13 (0-3 ft)	38	5
101	100	Benzo(g,h,i)perylene	0.4	1700	148	202	GR-13 (0-3 ft)	NA	NA
101	100	Naphthalene	0.3	810	62	124	GR-22 (15-18 ft)	11	2
101	100	2-Methylnaphthalene(b)	0.2	750	57	97	GR-16 (12-15 ft)	NA	NA
101	99	Chrysene	0.4	2900	277	378	GR-13 (0-3 ft)	56	3
101	99	Benzo(a)anthracene	0.4	1800	251	312	GR-13 (0-3 ft)	72	5
101	98	Fluorene	0.3	730	74	109	GR-16 (12-15 ft)	26	1
101	97	Anthracene	0.3	1300	121	186	GR-16 (12-15 ft)	50	2
101	95	Benzo(a)pyrene	0.4	2300	244	315	GR-13 (0-3 ft)	54	1
101	94	Acenaphthene	0.4	760	63	106	GR-16 (12-15 ft)	NA	NA
101	93	Benzo(k)fluoranthene	0.4	1200	105	147	GR-13 (0-3 ft)	NA	NA
101	92	Dibenz(a,h)anthracene	0.4	430	39	55	GR-13 (0-3 ft)	32	4
101	92	Acenaphthylene	0.3	200	33	36	GR-16 (12-15 ft)	NA	NA
101	101	Total PAH (N=16)	10	29083	3450	4479	GR-13 (0-3 ft)	69	1

(a) TEC and PEC values are included in Table 3-2.
(b) Not included in Total PAH
NA = not available

As part of the evaluation of the PAH concentrations throughout the sediment profile, equilibrium partitioning sediment benchmarks (ESBs) for PAH mixtures were calculated for each sediment sample following U.S. EPA (2003). The U.S. EPA guidance describes the theoretical aspects and application of this procedure in evaluating the potential for direct toxicological effects to benthic organisms associated with exposure to 34 individual PAH compounds in a given sediment sample. The approach is based on a number of assumptions including additivity of toxicological response, presence of equilibrium conditions between the sediment matrix and porewater, and that only the fraction of a compound that is dissolved interstitially is relevant in terms of benthic exposures (U.S. EPA, 2003).

Table 3-9. Total PAHs – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (µg/kg) Minimum	Concentration (µg/kg) Maximum	Concentration (µg/kg) Mean	Standard Deviation	Location of Maximum	Percent above TEC (1610 µg/kg)	Percent above PEC (22,800 µg/kg)
0-0.5	9	9	526	16739	3200	5142	GR-31	56	0
0-3	25	25	739	29083	3157	5541	GR-13	60	4
3-6	19	19	1189	15048	2765	3062	GR-13	79	0
6-9	19	19	16.8	6585	2675	1927	GR-01	74	0
9-12	13	13	19.5	15490	4411	4034	GR-01	77	0
12-15	11	11	16.7	20670	6137	6545	GR-16	82	0
15-18	4	4	9.90	10330	3108	4898	GR-22	50	0
18+	1	1	35.6	35.6	NA	NA	GR-16	0	0

As the sample analysis quantified only 16 of the 34 PAHs identified in the guidance document, $\sum ESBTU_{FCV}$ was calculated as the sum of the ESBTU values for 13 of the 34 PAHs. This sum was then multiplied by an uncertainty factor of 11.5, a 95% confidence level adjustment factor used to correct for the contributions of the unmeasured PAHs in order estimate the toxicological contributions of all 34 PAHs (U.S. EPA, 2003). The estimated adjusted ESB toxic units ($\sum ESBTU_{FCV}$) for each sample station are presented in Table 3-10. The adjusted $\sum ESBTU_{FCV}$ ranged from 0.007 to 51.8 and were greater than one at all but 14 of the sample collection stations. Sums exceeding one indicate that sensitive benthic organisms could be unacceptably affected. Of the 14 sample stations that had sums less than one, all but one were from sampling depths deeper than 6 feet.

It is important to recognize that the ESBTUs do not consider the potential for bioaccumulation hazards to higher trophic level organisms or interactive effects (e.g., antagonistic, additive or synergistic) between PAHs and other potential chemical constituents in sediment (U.S. EPA, 2003). Other factors, including the presence of other partitioning phases (e.g., soot carbon), the existence of non-equilibrium conditions, and potential photo-toxicological effects may also be important under specific circumstances (U.S. EPA, 2003).

3.1.6 Total Petroleum Hydrocarbons: Diesel Range Organics and Residual Range Organics.

CAS analyzed 113 sediment samples (101 primary samples and 12 field duplicate samples) for TPH/RRO and DRO following CAS methods based on U.S. EPA Method 8015C. A 30-g sample was spiked with internal standard, extracted by sonication using methylene chloride, cleaned up to remove interferences, and analyzed by GC/flame ionization detector for individual alkanes (n-C10 through C36), which were summed to determine DRO (C10-C28) and RRO (C25-C36). DRO and RRO results are reported as mg/kg. Tables 3-11 and 3-12 provide the results of DRO and RRO analysis by depth. On average, the DRO and RRO concentrations increased with depth through the 9 to 12 ft segment interval and then decreased again at depths lower than 12 ft.

Table 3-10. Total PAH 16 Concentrations and Adjusted PAH ESB Toxic Unit

Sample ID	Station ID	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total PAH 16 (µg/kg)	Adjusted ESBTU
LA-107	GR-01	0	3	5472	3.492
LA-108		3	6	4215	3.616
LA-109		6	9	6585	6.611
LA-110		9	12	15490	12.395
LA-111		12	14.9	14930	15.057
LA-104	GR-02	0	3	3085	2.886
LA-105		3	6	2619	1.337
LA-106		6	7.4	916	1.330
LA-162	GR-03	0	3	1750	2.398
LA-163		3	6	1999	3.177
LA-164		6	8.7	2187	2.906
LA-101	GR-04	0	3	1879	2.300
LA-102		3	6	1762	1.066
LA-103		6	9.8	26	**0.022**
LA-181	GR-05	0	3	1835	2.149
LA-182		3	6	1189	1.085
LA-183		6	8.0	17	**0.017**
LA-173	GR-06	0	1.5	4089	5.481
LA-184	GR-07	0	3	1820	1.463
LA-185		3	6	1760	1.563
LA-186		6	9	4011	3.911
LA-187		9	12	5264	6.047
LA-188		12	14.4	6535	6.127
LA-189	GR-08	0	3	825	1.061
LA-190		3	6	1959	2.560
LA-191		6	9	5342	5.233
LA-192		9	12	6605	10.262
LA-193		12	13.8	36	**0.087**
LA-194	GR-09	0	3	4427	4.336
LA-195		3	6	1914	2.295
LA-196		6	9	2957	3.060
LA-197		9	12	6170	5.132
LA-198		12	13.8	9645	6.758
LA-165	GR-10	0	3	1765	2.552
LA-166		3	6	2904	3.767
LA-167		6	6.9	3608	4.477
LA-152	GR-11	0	0.9	1663	2.571
LA-199	GR-12	0	3	1177	1.442
LA-200		3	6	1385	1.903
LA-201		6	9	1844	1.966
LA-202		9	12	19	**0.041**
LA-203		12	15	17	**0.040**
LA-204		15	16.4	10	**0.021**
LA-126	GR-13	0	3	29083	14.857
LA-127		3	6	15048	6.175
LA-128		6	9	170	**0.018**
LA-129		9	11.9	21	**0.007**
LA-153	GR-14	0	3	1627	2.860
LA-154		3	6	3066	3.427
LA-155		6	8.2	6500	5.559
LA-168	GR-15	0	3	1014	1.325
LA-169		3	6	1912	2.800
LA-170		6	9	3059	3.017
LA-171		9	12	2423	2.838
LA-172		12	13.2	4866	6.991
LA-168		0	3	1014	1.325
LA-144	GR-16	0	3	970	1.550
LA-145		3	6	1263	**0.982**
LA-146		6	9	2439	3.859
LA-147		9	12	5566	5.259
LA-148		12	15	20670	24.520
LA-149		15	18	121	**0.225**
LA-150		18	19.9	36	**0.054**
LA-151	GR-17	0	3.1	1449	2.297
LA-135	GR-18	0	3	1288	2.047
LA-136		3	6	1555	2.342
LA-137		6	9	2657	2.425
LA-138		9	12.7	3301	3.294
LA-117	GR-19	0	3	985	1.441
LA-118		3	6	1955	2.718
LA-119		6	9	2283	2.892
LA-120		9	12	1413	2.065
LA-121		12	15	1770	2.691
LA-122		15	18.2	1970	2.553
LA-139	GR-20	0	3	1835	3.060
LA-140		3	6	1804	2.523
LA-141		6	9	2802	5.249
LA-142		9	12	2044	2.139
LA-143		12	14.9	2294	2.534

Table 3-10. Total PAH 16 Concentrations and Adjusted PAH ESB Toxic Unit (Continued)

Sample ID	Station ID	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total PAH 16 (µg/kg)	Adjusted ESBTU
LA-112	GR-21	0	3	1488	1.893
LA-113		3	6	2579	2.420
LA-114		6	9	2175	3.264
LA-115		9	12	3064	3.097
LA-116		12	14.2	2391	1.985
LA-174	GR-22	0	3	1546	1.636
LA-175		3	6	1653	2.149
LA-176		6	9	1244	1.510
LA-177		9	12	5967	5.035
LA-178		12	15	4357	2.888
LA-179		15	16.2	10330	2.393
LA-124	GR-23	0	2.2	739	2.724
LA-123	GR-23M	0	1.1	3748	1.957
LA-125	GR-24	0	2.3	3360	22.819

Bold indicates adjusted ESBTU values < 1.0.

Sample ID	Station ID	Sediment Depth Top (ft)	Sediment Depth Bottom (ft)	Total PAH 16 (µg/kg)	Adjusted ESBTU
LA-025	GR-25	0	0.5	526	2.843
LA-026	GR-26	0	0.5	1279	1.949
LA-027	GR-27	0	0.5	728	2.852
LA-028	GR-28	0	0.5	602	2.941
LA-029	GR-29	0	0.5	1647	4.666
LA-030	GR-30	0	0.5	2809	5.454
LA-031	GR-31	0	0.5	16739	20.103
LA-032	GR-32	0	0.5	2428	8.575
LA-033	GR-33	0	0.5	2045	3.786

Table 3-11. DRO – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg)				Location of Maximum	Percent above TEC	Percent above PEC
			Minimum	Maximum	Mean	Standard Deviation			
0-0.5	9	9	28	250	67	70	GR-31	NA	NA
0-3	25	25	24	510	135	105	GR-13	NA	NA
3-6	19	19	54	590	290	166	GR-13	NA	NA
6-9	19	19	44	920	364	244	GR-08	NA	NA
9-12	13	13	26	680	382	204	GR-01	NA	NA
12-15	11	11	29	570	348	220	GR-16	NA	NA
15-18	4	4	24	490	196	220	GR-22	NA	NA
18+	1	1	27	27	27	NA	GR-16	NA	NA

NA = not applicable

Table 3-12. RRO – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg)				Location of Maximum	Percent above TEC	Percent above PEC
			Minimum	Maximum	Mean	Standard Deviation			
0-0.5	9	9	77	930	224	270	GR-31	NA	NA
0-3	25	25	35	2200	362	403	GR-13	NA	NA
3-6	19	19	160	2100	582	428	GR-13	NA	NA
6-9	19	19	140	1200	640	305	GR-14	NA	NA
9-12	13	13	68	1500	658	361	GR-01	NA	NA
12-15	11	11	70	1000	553	346	GR-22	NA	NA
15-18	4	4	62	800	335	350	GR-22	NA	NA
18+	1	1	72	72	72	NA	GR-16	NA	NA

NA = not applicable

3.1.7 Metals. CAS analyzed 140 sediment samples (125 primary samples and 15 field duplicate samples) for total metals using the methods defined in U.S. EPA Method SW-846 6010C. A representative aliquot of sample was digested and analyzed by inductively coupled plasma atomic emission spectrometry. Data are reported for aluminum, arsenic, cadmium, total chromium, copper, lead, manganese, nickel, selenium, silver, and zinc. Mercury was determined using the methods defined in U.S. EPA Method SW-846 7471A. Mercury was reduced to its elemental state and aerated from solution and measured with an atomic absorption (AA) spectrometer. The samples were extracted by treating 0.5 grams of well-homogenized sample with reagent water, heat and potassium permanganate solution and reduced with sodium chloride-hydroxylamine hydrochloride. Samples were spiked prior to acidification and analyzed by AA where the mercury vapor passes through a cell positioned in the light path of the AA; absorbance was measured as a function of mercury concentration. Results for metals are reported as mg/kg dry weight.

Table 3-13 summarizes the results for each of the metals. Only silver, cadmium, lead, and mercury were detected above the PEC (or ER-M for Ag), with silver having the highest percent exceedance. A closer evaluation of the distribution of these four metals by depth is included in Tables 3-14, 3-15, 3-16, and 3-17. Silver concentrations in sediment are shown in Figures 3-3a and 3-3b, depicting levels above the ER-M on both sides of the Genesee River, in most depth intervals from locations GR-01 to G-23, and in the surface sample from GR-26. Cadmium was the only other metal notably exceeding its PEC. Cadmium data are provided graphically in Figures 3-4a and 3-4b, showing concentrations above the PEC in core samples on both sides of the river from GR-03 to GR-22. Graphics for all metals are provided Appendix F.

Table 3-13. Summary of Metals Detections

Quantity of Samples	Quantity of Detects	Chemical Name	Concentration (mg/kg) Minimum	Maximum	Mean	Standard Deviation	Location of Maximum	Percent above TEC[(a,b)]	Percent above PEC[(a,b)]
125	125	Aluminum	3920	16400	9716	2296	GR-02	NA	NA
125	125	Arsenic	3.5	19	7.8	2.8	GR-14	14	0
125	116	Cadmium	0.02	15	2.7	3.5	GR-18	50	20
125	125	Total Chromium	6.1	43	20	7.9	GR-14	0	0
125	125	Copper	7.8	89	33	15	GR-08	43	0
125	125	Lead	10	201	35	27	GR-05	38	2
125	125	Manganese	198	683	437	97	GR-02	NA	NA
125	125	Mercury	0.01	3.3	0.2	0.3	GR-28	31	1
125	125	Nickel	11	35	23	4.7	GR-02	54	0
125	81	Selenium	0.3	1.7	0.8	0.4	GR-15	NA	NA
125	113	Silver[2]	0.1	35	10	9.0	GR-14	84	67
125	125	Zinc	38	317	124	67	GR-18	NA	NA

(a) TEC and PEC values are included in Table 3-1.
(b) For silver, ER-L replaces TEC and ER-M replaces PEC.

Table 3-14. Silver – Statistical Summary

Segment Interval (ft.)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg) Minimum	Maximum	Mean	Standard Deviation	Location of Maximum	Percent above ER-L (1 mg/kg)	Percent above ER-M (3.7 mg/kg)
0-0.5	33	31	0.1	25.3	4.4	6.4	GR-12	79	27
0-3	25	25	0.2	15.5	8.2	4.2	GR-18	88	84
3-6	19	19	2.6	25.4	12.8	6.2	GR-14	100	95
6-9	19	16	0.1	35.2	15.2	11.3	GR-14	84	79
9-12	13	11	0.1	34.6	16.3	11.9	GR-20	85	85
12-15	11	9	0.1	30.3	13.5	10.0	GR-21	82	73
15-18	4	2	0.1	8.3	3.7	4.3	GR-22	50	50
18+	1	0	0.1	0.1	0.1	NA	NA	0	0

Table 3-15. Cadmium – Statistical Summary

Segment Interval (ft.)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg)			Standard Deviation	Location of Maximum	Percent above TEC (1 mg/kg)	Percent above PEC (5 mg/kg)
			Minimum	Maximum	Mean				
0-0.5	33	28	0.02	10.5	0.51	1.8	GR-12	3	3
0-3	25	25	0.07	11.1	1.94	2.5	GR-20	56	12
3-6	19	19	0.28	11	4.64	3.3	GR-20	79	42
6-9	19	19	0.14	15.1	4.50	4.5	GR-18	79	32
9-12	13	12	0.02	12.7	4.47	4.6	GR-21	69	31
12-15	11	10	0.02	9.04	2.74	3.1	GR-21	64	27
15-18	4	2	0.02	2.44	0.94	1.7	GR-19	50	0
18+	1	1	0.04	0.04	0.04	NA	GR-16	0	0

Table 3-16. Lead – Statistical Summary

Segment Interval (ft.)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg)			Standard Deviation	Location of Maximum	Percent above TEC (35.8 mg/kg)	Percent above PEC (128 mg/kg)
			Minimum	Maximum	Mean				
0-0.5	33	33	10	49	20	10	GR-12	9	0
0-3	25	25	12	69	26	13	GR-13	12	0
3-6	19	19	16	201	56	48	GR-05	58	11
6-9	19	19	12	87	43	20	GR-08	68	0
9-12	13	13	11	82	43	20	GR-01	69	0
12-15	11	11	11	70	41	19	GR-09	64	0
15-18	4	4	10	85	35	35	GR-22	25	0
18+	1	1	12	12	12	NA	GR-16	0	0

Table 3-17. Mercury – Statistical Summary

Segment Interval (ft.)	Quantity of Samples	Quantity of Detects	Concentration (mg/kg)			Standard Deviation	Location of Maximum	Percent above TEC (0.18 mg/kg)	Percent above PEC (1.06 mg/kg)
			Minimum	Maximum	Mean				
0-0.05	33	33	0.01	3.32	0.15	0.57	GR-28	9	3
0-3	25	25	0.02	0.54	0.09	0.10	GR-02	4	0
3-6	19	19	0.03	0.76	0.18	0.17	GR-02	37	0
6-9	19	19	0.02	0.59	0.21	0.15	GR-14	58	0
9-12	13	13	0.02	0.48	0.22	0.15	GR-01	69	0
12-15	11	11	0.01	0.37	0.21	0.14	GR-09	64	0
15-18	4	4	0.01	0.24	0.10	0.10	GR-22	25	0
18+	1	1	0.03	0.03	0.03	NA	GR-16	0	0

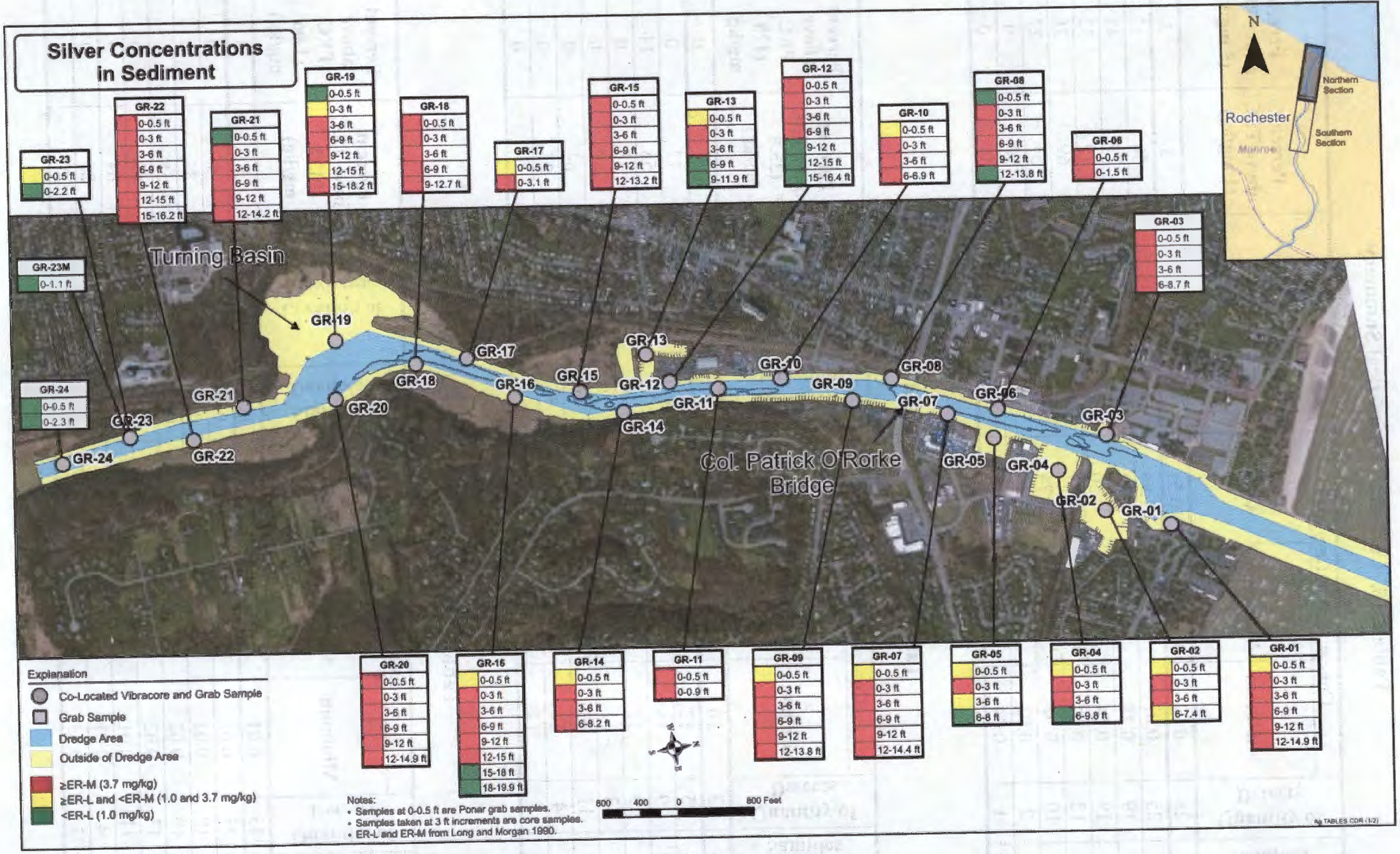


Figure 3-3a. Silver Concentrations in Sediment 2011-September

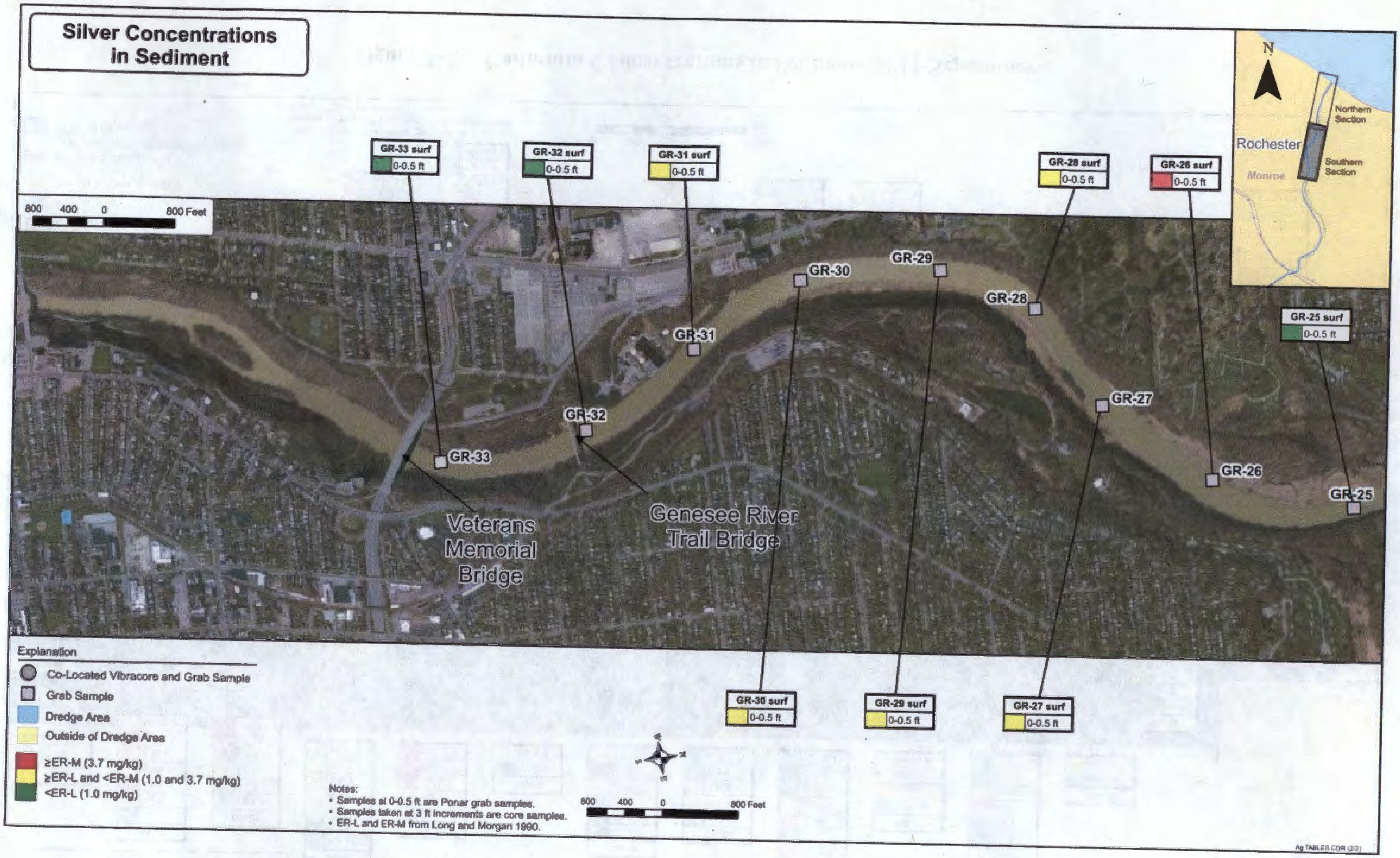
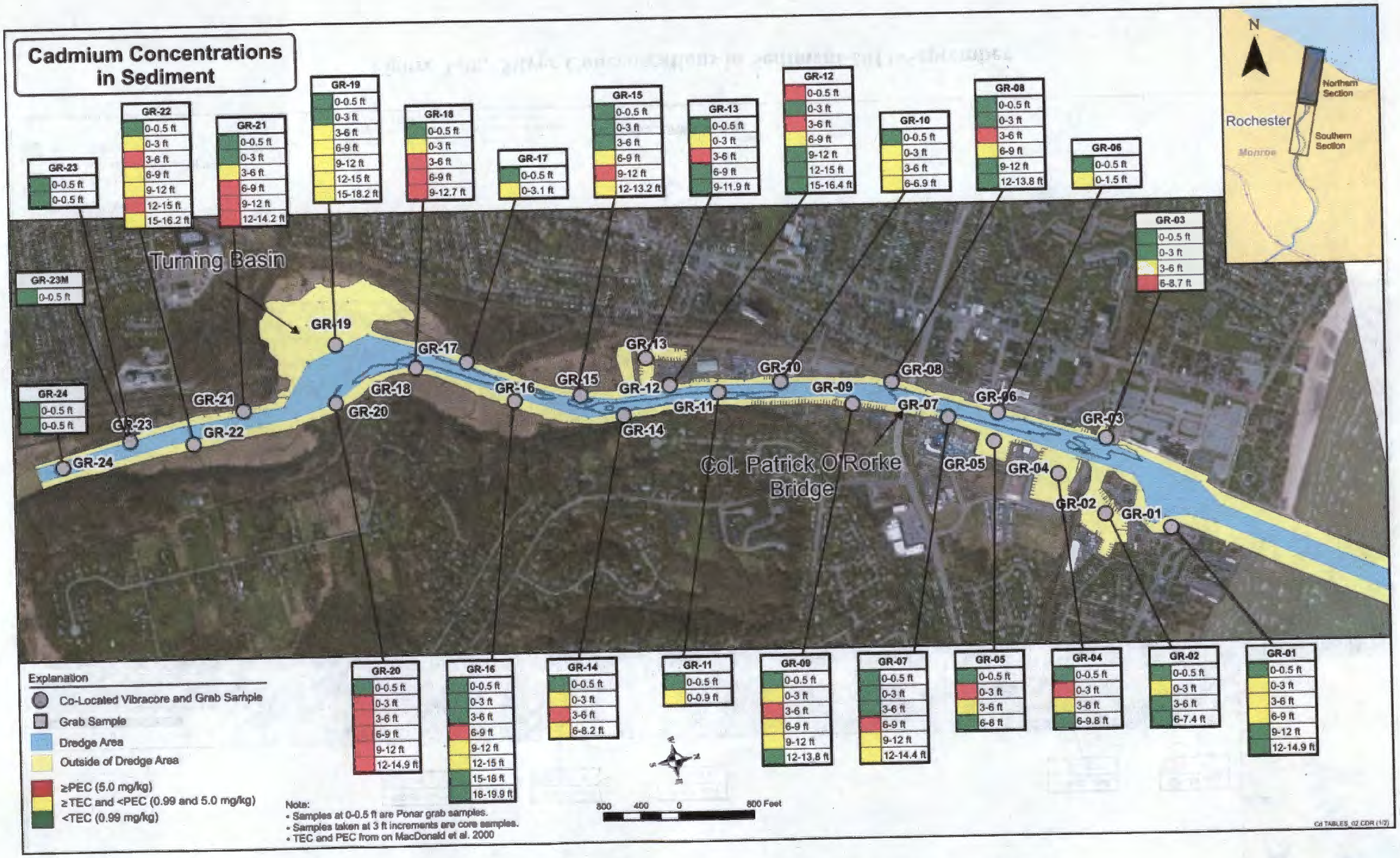


Figure 3-3b. Silver Concentrations in Sediment 2011-September



Note:
- Samples at 0-0.5 ft are Ponar grab samples.
- Samples taken at 3 ft increments are core samples.
- TEC and PEC from on MacDonald et al. 2000

Figure 3-4a. Cadmium Concentrations in Sediment 2011-September

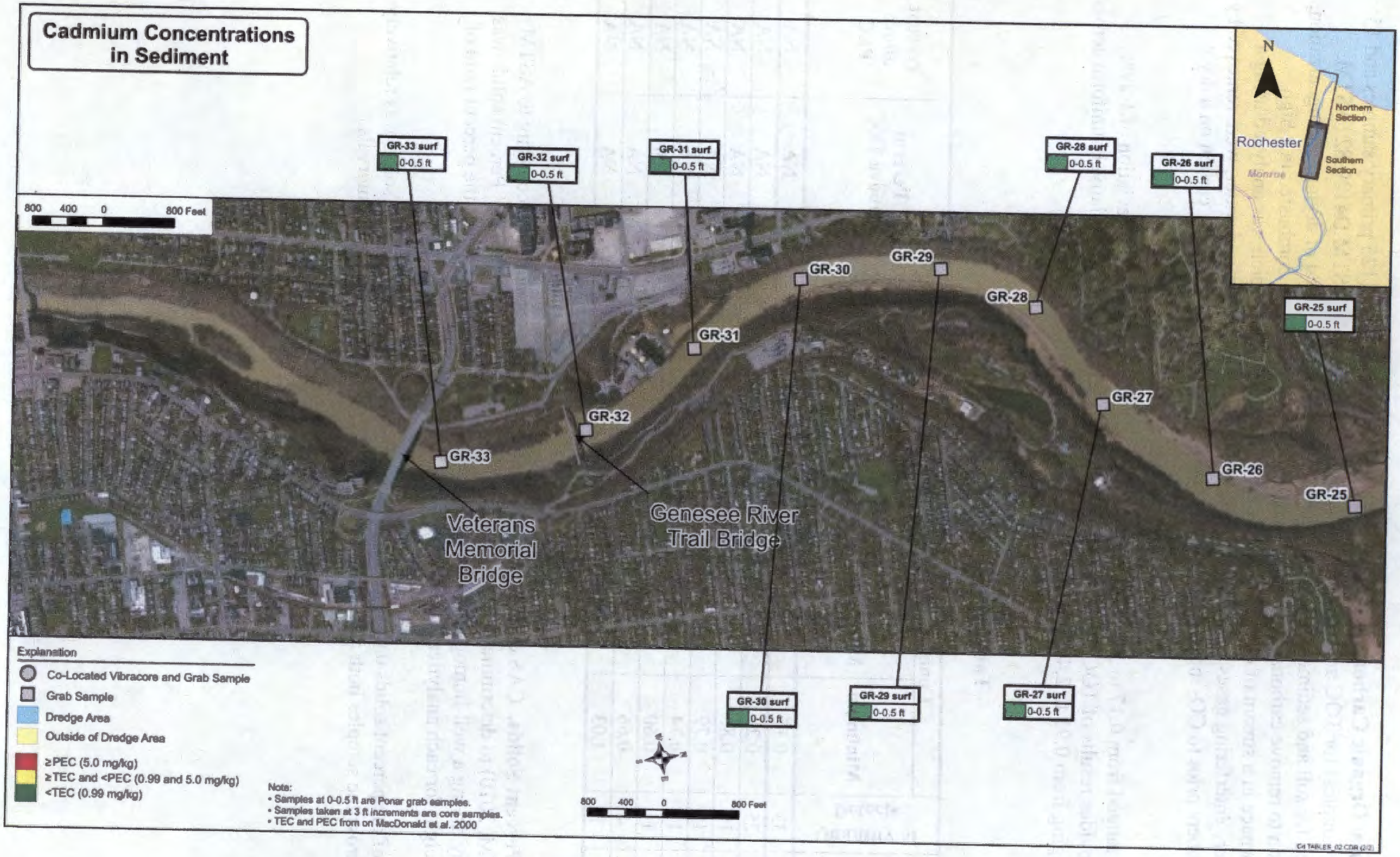


Figure 3-4b. Cadmium Concentrations in Sediment 2011-September

3.1.9 Total Organic Carbon. CAS analyzed 140 sediment samples (125 primary samples and 15 field duplicate samples) for TOC analyses following procedures based on ASTM D4129-82 (ASTM, 2005), modified for soil and sediment matrices. Sample preparation consisted of drying, homogenization, and acidification to remove carbonates and bicarbonates. The samples were combusted in a high-temperature furnace in a stream of oxygen to form carbon dioxide (CO_2), which was analyzed using a CO_2 coulometer. Interfering gases, such as halogens, sulfur, nitrogen oxides, and water, were removed by chemical scrubbers prior to CO_2 measurement. All results were reported as percent carbon on a dry weight basis.

Overall, TOC ranged from 0.17 to 12.6% with an average of 1.37% and standard deviation of 1.29%. Table 3-18 provides results of TOC by depth. On average, the percent TOC was relatively uniform across all depths, ranging from 0.91 to 2.41%.

Table 3-18. TOC – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Concentration (%)			Standard Deviation	Location of Maximum	Percent above TEC	Percent above PEC
			Minimum	Maximum	Mean				
0-0.5	33	33	0.17	2.76	0.91	0.49	GR-13	NA	NA
0-3	25	25	0.21	2.83	1.17	0.60	GR-23M	NA	NA
3-6	19	19	0.86	3.17	1.47	0.65	GR-13	NA	NA
6-9	19	19	0.79	12.6	1.91	2.60	GR-13	NA	NA
9-12	13	13	0.74	4.45	1.63	0.92	GR-13	NA	NA
12-15	11	11	0.60	2.28	1.39	0.57	GR-22	NA	NA
15-18	4	4	0.66	7.01	2.41	3.07	GR-22	NA	NA
18+	1	1	1.03	1.03	1.03	NA	GR-16	NA	NA

3.1.10 Percent Solids. CAS determined percent solids in sediment samples according to ASTM D2216 (ASTM, 2010) to determine the amount of water present in sample aliquots. Percent solids was determined by drying a well-homogenized aliquot of sample and was calculated as the percent ratio of wet to dry weight for each analytical aliquot.

A summary of the percent solids data is shown in Table 3-19. The average percent solids was relatively consistent across the samples both along the length of the river and the core depth intervals.

Table 3-19. Total Solids – Statistical Summary

Segment Interval (ft)	Quantity of Samples	Quantity of Detects	Percent Solids (%)			Standard Deviation	Location of Maximum	Percent above TEC	Percent above PEC
			Minimum	Maximum	Mean				
0-0.5	33	33	47	77	65	8	GR-32	NA	NA
0-3	25	25	56	83	70	6	GR-24	NA	NA
3-6	19	19	56	74	69	4	GR-18	NA	NA
6-9	19	19	31	77	68	9	GR-10	NA	NA
9-12	13	13	47	76	70	7	GR-12	NA	NA
12-15	11	11	66	76	72	3	GR-15 GR-12	NA	NA
15-18	4	4	70	79	74	4	GR-12	NA	NA
18+	1	1	70	70	70	NA	GR-16	NA	NA

3.2 Data Analyses

In addition to the sample by sample comparison of sediment contamination data to benchmarks presented in Section 3.1, a summary of the benchmark results are presented in Section 3.2.1. Data were also analyzed using benchmark quotients (Section 3.2.1) and compared statistically several ways (Section3.2.2).

3.2.1 Benchmark Results

3.2.1.1 Threshold and Probable Effects Benchmark Results. Thirty metals or organic compounds were analyzed during this study and were compared to SQG benchmarks (28 with TEC/PEC values; silver was compared against the ER-L/ER-M and dioxin/furan TEQ was compared against the NYSDEC [2004] benchmarks for Class A and Class C). Nineteen of the 30 benchmark analytes had at least one measurement exceeding their specific probable effects benchmark, but of those 19 analytes, only three analytes (silver, cadmium, and Total DDE) had more than 10% of the samples analyzed exceeding the probable effects benchmark. Table 3-20 provides a summary of the analytes that exceeded the probable effects benchmarks, with their associated threshold effects exceedance results.

Table 3-20. Summary of Benchmark Exceedances

Analyte	Analyte Group	No. of Samples	No. of Samples >Threshold Effects Benchmark	% of Samples >Threshold Effects Benchmark	No. of Samples >Probable Effects Benchmark	% of Samples >Probable Effects Benchmark
Silver	Metal	125	105	84	84	67
Cadmium	Metal	125	63	50	25	20
DDE_sum	Pesticide	101	46	46	13	13
Pyrene	PAH	101	80	79	7	7
Phenanthrene	PAH	101	52	51	7	7
Fluoranthene	PAH	101	38	38	5	5
Benzo_a_anthracene	PAH	101	73	72	5	5
Dibenz_a_h_anthracene	PAH	101	32	32	4	4
Total_TEQ	Dioxin/Furan	58	16	28	2	3
DDD_sum	Pesticide	101	30	30	3	3
Chrysene	PAH	101	57	56	3	3
CHLORDANE	Pesticide	101	43	43	3	3
Anthracene	PAH	101	50	50	2	2
Naphthalene	PAH	101	11	11	2	2
Lead	Metal	125	47	38	2	2
PAH	Metal	101	70	69	1	1
Benzo_a_pyrene	PAH	101	55	54	1	1
Fluorene	PAH	101	26	26	1	1
Mercury	Metal	125	39	31	1	1

3.2.1.2 ***Benchmark Quotient Results***. The SQG benchmark quotient approach, calculating mean values for a set of benchmarks for a single sample, has been defined and described by several publications, e.g., SQGs developed for the National Status and Trends Program (National Oceanic and Atmospheric Administration, 1999) and MacDonald et al., 2000. Benchmark quotients were developed to improve on the predictability of individual chemical benchmarks by evaluating the combined effects of multiple contaminants often found in sediment. Benchmark quotients were calculated for this study by dividing each contaminant by its respective SQG benchmark value, then summing the results for all contaminants (using one-half the detection limit for non detected samples), and then dividing the result of the summation by the number of contaminants summed. For this calculation, only the TEC/PEC value associated with the sum of PAH (N=16) was used, individual PAH compounds were not included in the quotient calculation to avoid double counting PAH compounds (MacDonald et al., 2000). MacDonald et al., 2000 reported the following predicitive power assocaitated with four quotient benchmark levels:

Quotient Level	Prediction	Predictive Ability (%)
<0.1	Not toxic	90.2
<0.5	Not toxic	82.8
>0.5	Toxic	85.0
>1.0	Toxic	93.3
>1.5	Toxic	94.4

Quotients were calculated in two manners, first with only chemicals having TEC/PEC consensus values, and secondly with TEC/PEC chemicals plus the ER-L/ER-M value for silver and the NYSDEC value for Total TEQ included. A summary of the quotient results are provided in Table 3-21; quotient values for each sample are provided in Table 3-22.

Table 3-21. Summary of Benchmark Quotient Results

Statistic	Quotient Source			
	TEC Only	PEC Only	TEC/Ag/TEQ	PEC/Ag/TEQ
Average	0.98	0.19	1.61	0.35
Min	0.21	0.06	0.19	0.05
Max	3.01	0.60	5.72	1.31

While silver often exceeded its individual threshold and probable effects benchmarks, and total TEQ often exceeded the threshold effects benchmark, overall contamination in Genesee River sediment within the study area is relatively lower based on SQG quotient analyses. The average threshold benchmark quotient was 1.61 with silver and TEQ benchmarks included. The average PEC quotient was 0.35. Only one sample exceeded 1.0 for the probable effects quotient (the max of 1.31 in the surface sediment grab sample at GR-12). Thirty four out of 125 samples (27.2%) exceeded a PEC quotient of 0.5. These quotient values indicate relatively low probability of negative biological effects from sediment, and this prediction is supported by the toxicity testing results reported in Section 3.3.

3.2.2 ***Statistical Testing Results.*** To investigate the nature and extent of contamination Genesee River sediment within the study area the likelihood that the overall average contaminant concentration for a given chemical was below the applicable thresholds of concern (as defined by established benchmarks described earlier) was assessed through statistical testing. Data were statistically compared to the SQG benchmarks as described in Appendix A of the QAPP. This translated to the following hypothesis test:

Null hypothesis H_0: AM $\geq$ Benchmark

Alternative hypothesis H_1: AM < Benchmark

where
AM= Arithmetic mean sediment contamination concentration

Chemicals with significant p-values ($p<0.05$) will lead to the rejection of the null hypothesis in favor of the alternative hypothesis, i.e. the arithmetic mean sediment contamination concentration for the COI is less than its respective benchmark value. If a p-value was found to be insignificant, we cannot conclude that the arithmetic mean sediment concentration is less than the benchmark value.

Table 3-22. Sediment Quality Guideline Quotients

Sample Location	Sample Segment (ft)	No.of SQG Chemicals (TEC/PEC only)	TEC Quotient	PEC Quotient	No.of SQG Chemicals (TEC/PEC/ Ag/TEQ)	TEC/Ag/TEQ Quotient	PEC/Ag/TEQ Quotient
GR-01	0-0.5	7	0.57	0.18	9	0.68	0.20
GR-01	0-3	15	0.88	0.14	16	1.16	0.22
GR-01	3-6	15	1.46	0.23	16	2.31	0.48
GR-01	6-9	15	1.26	0.23	16	2.18	0.48
GR-01	9-12	15	1.35	0.22	16	2.47	0.54
GR-01	12-15	15	1.12	0.18	17	1.84	0.39
GR-02	0-0.5	7	0.82	0.25	9	1.11	0.30
GR-02	0-3	15	1.12	0.24	16	1.94	0.47
GR-02	3-6	15	0.96	0.22	16	1.61	0.40
GR-02	6-9	15	0.44	0.11	17	0.59	0.15
GR-03	0-0.5	7	0.44	0.14	9	0.86	0.24
GR-03	0-3	15	0.52	0.11	16	1.19	0.29
GR-03	3-6	15	0.83	0.17	16	1.27	0.29
GR-03	6-9	15	1.18	0.23	17	1.74	0.35
GR-04	0-0.5	7	0.57	0.18	9	0.59	0.18
GR-04	0-3	15	1.14	0.22	16	1.63	0.35
GR-04	3-6	15	0.85	0.16	16	1.05	0.22
GR-04	6-9	15	0.27	0.09	17	0.24	0.08
GR-05	0-0.5	7	0.56	0.18	9	0.63	0.19
GR-05	0-3	15	1.13	0.22	16	1.61	0.35
GR-05	3-6	15	1.15	0.24	16	1.24	0.26
GR-05	6-9	15	0.27	0.09	17	0.25	0.08
GR-06	0-0.5	7	0.60	0.19	9	1.85	0.51
GR-06	0-3	15	1.42	0.20	17	1.90	0.34
GR-07	0-0.5	7	0.55	0.17	9	0.69	0.20
GR-07	0-3	15	0.47	0.10	16	0.81	0.20
GR-07	3-6	15	0.48	0.10	16	1.05	0.26
GR-07	6-9	15	2.05	0.30	16	2.91	0.55
GR-07	9-12	15	1.47	0.25	16	2.73	0.60
GR-07	12-15	15	1.27	0.21	17	2.37	0.50
GR-08	0-0.5	7	0.41	0.13	9	0.39	0.12
GR-08	0-3	15	0.35	0.10	16	0.64	0.17
GR-08	3-6	15	1.83	0.31	16	2.95	0.62
GR-08	6-9	15	1.79	0.32	16	3.52	0.79
GR-08	9-12	15	0.66	0.12	16	0.92	0.20
GR-08	12-15	15	0.25	0.08	17	0.23	0.07
GR-09	0-0.5	7	0.48	0.15	9	0.58	0.17
GR-09	0-3	15	0.67	0.14	16	1.20	0.28
GR-09	3-6	15	2.22	0.35	16	3.60	0.74
GR-09	6-9	15	1.40	0.24	16	2.77	0.62
GR-09	9-12	15	1.08	0.19	16	2.04	0.46
GR-09	12-15	15	1.09	0.21	17	2.39	0.55
GR-10	0-0.5	7	0.44	0.14	9	0.73	0.21
GR-10	0-3	15	0.53	0.12	16	1.27	0.32
GR-10	3-6	15	1.23	0.23	16	1.79	0.39
GR-10	6-9	15	1.17	0.21	17	2.00	0.39
GR-11	0-0.5	7	0.73	0.22	9	2.60	0.71
GR-11	0-3	15	0.66	0.13	17	1.51	0.35
GR-12	0-0.5	7	2.53	0.60	9	5.72	1.31
GR-12	0-3	15	0.38	0.09	16	0.78	0.20
GR-12	3-6	15	1.43	0.25	16	2.42	0.52
GR-12	6-9	15	1.22	0.18	16	1.68	0.32
GR-12	9-12	15	0.21	0.06	16	0.20	0.06

Table 3-22. Sediment Quality Guideline Quotients (Continued)

Sample Location	Sample Segment (ft)	No.of SQG Chemicals (TEC/PEC only)	TEC Quotient	PEC Quotient	No.of SQG Chemicals (TEC/PEC/ Ag/TEQ)	TEC/Ag/TEQ Quotient	PEC/Ag/TEQ Quotient
GR-12	12-15	15	0.22	0.07	16	0.21	0.07
GR-12	15-18	15	0.21	0.06	17	0.19	0.06
GR-13	0-0.5	7	0.99	0.28	9	1.33	0.34
GR-13	0-3	15	2.47	0.37	16	2.98	0.52
GR-13	3-6	15	2.64	0.44	16	2.95	0.54
GR-13	6-9	15	0.28	0.08	16	0.28	0.08
GR-13	9-12	15	0.29	0.09	17	0.26	0.08
GR-14	0-0.5	7	0.35	0.11	9	0.55	0.16
GR-14	0-3	15	0.62	0.12	16	1.26	0.30
GR-14	3-6	15	2.05	0.33	16	3.51	0.74
GR-14	6-9	15	1.86	0.32	17	4.01	0.87
GR-15	0-0.5	7	0.49	0.15	9	0.93	0.27
GR-15	0-3	15	0.41	0.11	16	0.87	0.23
GR-15	3-6	15	0.49	0.11	16	1.45	0.37
GR-15	6-9	15	1.08	0.21	16	2.65	0.64
GR-15	9-12	15	1.77	0.31	16	2.90	0.63
GR-15	12-15	15	0.84	0.15	17	1.31	0.25
GR-16	0-0.5	7	0.33	0.11	9	0.37	0.11
GR-16	0-3	15	0.30	0.08	16	0.65	0.17
GR-16	3-6	15	0.34	0.08	16	1.17	0.31
GR-16	6-9	15	1.30	0.23	16	2.65	0.60
GR-16	9-12	15	1.86	0.29	16	2.83	0.56
GR-16	12-15	15	1.64	0.24	16	2.56	0.50
GR-16	15-18	15	0.24	0.07	16	0.23	0.07
GR-16	18+	15	0.24	0.07	17	0.22	0.07
GR-17	0-0.5	7	0.42	0.14	9	0.70	0.21
GR-17	0-3	15	0.69	0.15	17	1.16	0.26
GR-18	0-0.5	7	0.48	0.15	9	1.43	0.40
GR-18	0-3	15	0.44	0.10	16	1.38	0.36
GR-18	3-6	15	1.80	0.27	16	2.33	0.43
GR-18	6-9	15	2.98	0.46	16	4.65	0.94
GR-18	9-12	15	2.36	0.38	17	4.61	0.93
GR-19	0-0.5	7	0.45	0.15	9	0.45	0.14
GR-19	0-3	15	0.36	0.08	16	0.55	0.14
GR-19	3-6	15	0.51	0.11	16	1.00	0.25
GR-19	6-9	15	0.74	0.14	16	1.37	0.32
GR-19	9-12	15	0.56	0.12	16	0.95	0.23
GR-19	12-15	15	0.60	0.13	16	0.78	0.18
GR-19	15-18	15	0.79	0.16	17	1.13	0.25
GR-20	0-0.5	7	0.63	0.19	9	3.19	0.87
GR-20	0-3	15	1.69	0.30	16	2.30	0.48
GR-20	3-6	15	2.51	0.33	16	3.13	0.51
GR-20	6-9	15	2.50	0.41	16	4.13	0.87
GR-20	9-12	15	2.50	0.41	16	4.50	0.97
GR-20	12-15	15	1.79	0.28	17	3.86	0.70
GR-21	0-0.5	7	0.36	0.12	9	0.35	0.11
GR-21	0-3	15	0.33	0.08	16	0.88	0.23
GR-21	3-6	15	1.09	0.20	16	1.61	0.35
GR-21	6-9	15	2.01	0.34	16	2.70	0.54
GR-21	9-12	15	2.53	0.41	16	4.19	0.88
GR-21	12-15	15	1.77	0.32	17	4.40	0.86
GR-22	0-0.5	7	0.43	0.14	9	1.03	0.29
GR-22	0-3	15	0.90	0.18	16	1.46	0.33
GR-22	3-6	15	3.01	0.30	16	4.00	0.60
GR-22	6-9	15	0.70	0.13	16	0.96	0.21

Table 3-22. Sediment Quality Guideline Quotients (Continued)

Sample Location	Sample Segment (ft)	No.of SQG Chemicals (TEC/PEC only)	TEC Quotient	PEC Quotient	No.of SQG Chemicals (TEC/PEC/ Ag/TEQ)	TEC/Ag/TEQ Quotient	PEC/Ag/TEQ Quotient
GR-22	9-12	15	1.58	0.23	16	1.94	0.34
GR-22	12-15	15	2.62	0.42	16	3.25	0.60
GR-22	15-18	15	1.16	0.21	17	1.59	0.32
GR-23	0-0.5	7	0.46	0.15	9	0.66	0.19
GR-23	0-3	15	0.22	0.06	17	0.21	0.05
GR-23M	0-3	15	0.36	0.07	17	0.35	0.07
GR-24	0-0.5	7	0.24	0.08	9	0.23	0.07
GR-24	0-3	15	0.40	0.07	17	0.41	0.08
GR-25	0-0.5	15	0.22	0.06	17	0.25	0.06
GR-26	0-0.5	15	0.33	0.08	17	0.55	0.14
GR-27	0-0.5	15	0.23	0.06	17	0.31	0.08
GR-28	0-0.5	15	1.47	0.26	17	1.37	0.25
GR-29	0-0.5	15	0.31	0.07	17	0.39	0.09
GR-30	0-0.5	15	0.38	0.08	17	0.41	0.09
GR-31	0-0.5	15	1.15	0.16	17	1.11	0.17
GR-32	0-0.5	15	0.33	0.07	17	0.30	0.06
GR-33	0-0.5	15	0.39	0.09	17	0.36	0.09

🟥	Benchmark Quotient >1.0
🟨	Benchmark Quotient > 0.5

Chemicals included in the analyses:

Metals: Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Silver

PAH: Anthracene, Fluorene, Naphthalene, Phenanthrene, Benz(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene and Total PAHs

PCB: Total PCBs as Total Aroclors

Pesticides: gamma-BHC (lindane), Chlordane, Dieldrin, Sum of DDT +DDD + DDE (Total DDx), Endrin, Heptachlor Epoxide

Dioxins and furans: dioxin total TEQ

A one-sample t-test to test the above hypothesis was utilized. All chemical concentrations were transformed on the natural log scale in order uphold the assumption of normally distributed data. The log transformed arithmetic mean sediment concentrations were compared to a lower and higher benchmark (also transformed on the natural log scale). The lower benchmark used for most chemicals was the consensus-based threshold effect concentration (TEC) (MacDonald 2000). The exceptions were silver and dioxin total TEQ, which used ER-L (Long and Morgan 1990) and NYSDEC Class A (NYSDEC 2004), respectively. The higher benchmark for most chemicals was the probable effects concentration (PEC) (MacDonald 2000). The exceptions were silver and dioxin total TEQ, which used ER-M (Long and Morgan 1990) and NYSDEC Class C (NYSDEC 2004) benchmarks, respectively. The one-sample t-test was performed over all depth intervals and then by depth interval (0-0.5 ft, 0-3 ft, 3-6 ft, 6-9 ft, 9-12 ft, 12-15 ft and 15-18 ft).

Overall Analysis Results:

Threshold Effects Benchmarks: In the overall one-sample test, 11 out of the 29 chemicals were found to have higher p-values (>0.05). This means that the arithmetic mean sediment concentration could not be concluded to be less than the benchmark value. These chemicals were cadmium, nickel, silver, anthracene, phenanthrene, benzo (a) anthracene, benzo (a) pyrene, chrysene, pyrene, total PAHs and total PCBs. The remaining chemicals had significant p-values (<0.05). This indicated that their arithmetic means were less than their respective benchmark value. These chemicals included arsenic, chromium, copper, lead, mercury, fluorene, naphthalene, dibenz(a,h) anthracene, fluoranthene, gamma-BHC (lindane), chlordane, dieldrin, sum of DDT +DDD + DDE (total DDx), Endrin, heptachlor epoxide, and dioxin total TEQ.

Probable Effects Benchmarks: Silver was the only chemical with a non-significant p-value, meaning that its arithmetic mean could not be concluded to be lower than its benchmark value. The remaining chemicals were found to have p-values less than 0.05.

By Depth Analysis Results:

Table 3-23 (organized by depth) provides lists of the chemicals with arithmetic mean concentrations which are not significantly lower than their respective threshold and probable effects benchmark values (p-value > 0.05).

Threshold Effects Benchmarks: Many metals and organic compounds exceeded their respective threshold benmarks within each depth interval and are listed in Table 3-23.

Table 3-23. Summary of Statistical Results by Depth Interval

Depth Interval (ft)	Threshold Effects Benchmark Exceedence	Probable Effects Benchmark Exceedence
0-0.5	Silver, Phenanthrene, Benz(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene, Total PAHs	None
0-3	Cadmium, Nickel, Silver, Anthracene, Phenanthrene, Benz(a)anthracene, Benzo(a)pyrene, Chrysene, Fluoranthene, Pyrene, Total PCBs, Dioxin TEQ and Total PAHs	Silver
3-6	Cadmium, Copper, Lead, Nickel, Silver, Anthracene, Phenanthrene, Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene, PAH, Total PCBs, Chlordane and Total DDx	Silver
6-9	Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Silver, Anthracene, Phenanthrene, Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Fluoranthene, Pyrene, PAH, Total PCBs, Chlordane, Total DDx, and Dioxin TEQ	Silver
9-12	Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Silver, Anthracene, Fluorene, Phenanthrene, Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene, PAH, Total PCBs, Chlordane, Total DDx and Dioxin TEQ	Silver and Dioxin TEQ
12-15	Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Silver, Anthracene, Fluorene, Phenanthrene, Benzo(a)	Silver

Table 3-22. Sediment Quality Guideline Quotients (Continued)

Depth Interval (ft)	Threshold Effects Benchmark Exceedence	Probable Effects Benchmark Exceedence
	anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene, PAH, Total PCBs, Chlordane, Total DDx and Dioxin TEQ	
15-18	Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Silver, Anthracene, Fluorene, Naphthalene, Phenanthrene, Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Pyrene, PAH, Chlordane, Total DDx and Dioxin TEQ	Silver, Phenanthrene, Fluoranthene, Pyrene and Dioxin TEQ

Probable Effects Benchmarks: Silver was measured at concentrations signficantly above the probable effects benchmark within all six core intervals. The dioxin and furans TEQ levels exceeded the NYSDEC 2004 Class C benchmark in two intervals, 9-12ft and 15-18ft. The PAH compounds Phenanthrene, Fluoranthene, Pyrene exceeded the PEC in one interval, 15-18ft. While dioxons and furans TEQ values did not exceed probable benchmarks often, they were only measured in surface grab samples and the lowest core interval of each core. Sediment from surface grab samples was generally less contaminated compared to the 0-3ft core interval (note no probable effect benchmark exceedances) and contaminants like cadmium were reduced in lower core intervals. The distribution of dioxins and furans is not documented as well as the other COIs.

3.3 Toxicology

3.3.1 10-Day Survival Test with the Amphipod *Hyalella azteca*. The USACE ERDC laboratory in Vicksburg, MS performed 10-day acute and chronic solid phase sediment toxicity tests on 40 samples utilizing a recommended benchmark benthic amphipod *Hyalella azteca* (U.S. EPA/USACE, 1998). The euryhaline amphipod *H. azteca* was obtained from ERDC in-house cultures. Only healthy organisms were used in testing. The *H. azteca* method (U.S. EPA, 2000; Method 100.1) was conducted using eight replicate 300 mL tall-form beakers containing 10 amphipods each. Water was renewed twice daily and a feeding ration of yeast, cerophyl, and trout chow was supplied daily. Assessment endpoints were acute (survival) and chronic (growth) at the end of the 10-day exposure period. Two growth endpoints were analyzed: total biomass/initial organism and individual biomass. Biomass was measured as ash-free dry weight (mg). For acceptable tests (tests passing test acceptance criteria), a one-way analysis of variance (SPSS, Inc., Chicago, Illinois) was conducted to determine if statistically significant reductions relative to the control existed. Survival data were arc-sine square root transformed prior to analysis. Toxicologically significant amphipod mortality is defined as a statistically significant 20% reduction in survival relative to reference sediment (U.S. EPA/USACE, 1998).

Due to laboratory capacity restrictions and the high number of test samples, toxicity tests were run in four phases. Ammonia concentrations in porewater exceeded the 20 mg/L guidance for freshwater organisms (U.S. EPA/USACE, 1998) for all toxicity test sediment samples with the exception of sediment LA-H1215. The high ammonia concentrations caused concern for confounding factors as a source of mortality and lowered growth rates. To assess the effects of ammonia, the first phase of five sediment samples was performed in conjunction with a toxicity reduction evaluation (TRE) focused only on ammonia. The five sediment samples represented a range of ammonia concentrations (low to high) as determined by bulk porewater measurements. In addition to the standard toxicity test of eight replicates per test sediment sample, four replicates of each test sediment were amended with SIR-600 (zeolite) resin prior to test initiation to reduce or eliminate porewater ammonia bioavailability. Porewater ammonia concentrations were measured in the unamended and amended sediments at test initiation to verify that ammonia was reduced. A sand and SIR-600 control were also included. Clean quartz sand was added to four replicates of each site sediment to evaluate the potential for a dilution effect from the SIR-600 addition. Four replicates of SIR-600 amended control sediment were included to ensure toxicity related to the SIR-600 did not occur.

The TRE tests (Phase 1) were run from November 27, 2011 to December 2, 2011; the test design and acute survival results are summarized in Table 3-24.

Table 3-24. Summary of TRE Study Results

Test Source	No. of Samples	No. of Replicates	Average Survival (%)	Min Survival (%)	Max Survival (%)	Total Ash-free Biomass/Initial Organism (mg) % of Control	Individual Ash-free Dry Weight (mg) % of Control
Control Sediment	1	8	89	80	100	NA	NA
Control/Zeolite	1	4	93	80	100	101	98
Control/Sand	1	4	98	90	100	86	78
Test Sediment	5	8	94	70	100	99	93
Test Sediment/Zeolite	5	4	92	70	100	110	107
Test Sediment/Sand	5	4	94	70	100	101	94

NA = not applicable

All of the TRE tests passed test protocol acceptance criteria. TRE results indicated no statistically significant differences for mortality, total growth, or individual growth between the control sediment and any of the five test sediments, the five test sediments treated with Zeolite, or the five test sediments treated with sand.

As a result of the TRE test (identified as TRE), the three subsequent phases of toxicity tests were performed without any ammonia treatment beyond standard water exchanges. Following is a summary of the test phase numbers of samples and dates:

Phase	# of Test Sediments	Start Date	End Date
TRE	5	22 Nov 2011	02 Dec 2011
Phase 1	10	27 Dec 2011	06 Jan 2012
Phase 2	13	17 Jan 2012	27 Jan 2012
Phase 3	12	17 Jan 2012	27 Jan 2012

For all 40 samples, there were no statistically significant differences between any of the test samples and control sediment for any of the three endpoints (mortality, total biomass, or individual biomass). Toxicity test sample result data are summarized in Table 3-25. These results suggest Genesee River sediments are not toxic to *H. azteca* based on the 10-day test for acute and chronic endpoints. While a few chemicals of concern had concentrations greater than PEC or other benchmark values in the range of probably biological effects, the lack of toxicity is potentially due to (1) only a few COIs exceed probable effects benchmarks, and COI quotient calculations show combined levels well below probable effects levels, and (2) combinations of factors such as TOC (both level and quality) and particle size are reduce the bioavailability of the primary COIs silver, cadmium, and dioxins/furans.

Table 3-25. Summary of Toxicity Testing Results

Test Sediment Group	No. of Samples	Average Survival (%)	Min Survival (%)	Max Survival (%)	Total Ash-free Biomass/Initial Organism (mg) % of Control	Individual Ash-free Dry Weight (mg) % of Control
Control Sediment	4	93	80	100	NA	NA
Test Sediment Interval Group (ft)						
All Intervals Combined	40	92	30	100	98	102
0-3	8	95	70	100	106	105
3-6	8	90	30	100	95	99
6-9	8	91	40	100	92	96
9-12	6	90	50	100	94	98
12-15	6	91	40	100	93	97
15-18	3	94	60	100	112	115
18-21	1	90	80	100	93	98

3.4 Habitat Assessment

A general assessment of the Genesee River nearshore riparian habitat was performed to identify the major habitat types present along the lower Genesee River and the extent of their coverage along the river. The riparian zone is defined as vegetated area along both sides of a river or stream and generally supports trees, shrubs and grasses. General land use and land cover along the lower Genesee River was evaluated using U.S. Geological Survey aerial photographs to determine the extent of habitat along the riparian corridor, National Wetland Inventory (NWI) maps to identify wetland resources, and geo-referenced photographs taken during field sampling to identify where habitat changes along the Genesee River shoreline occur. The habitat assessment did not include the delineation of the riparian corridor, which is defined by soil, vegetation and hydrology characteristics; collection of water quality/chemistry, fish, or macroinvertebrate samples; or data from plant and wildlife surveys.

This habitat assessment provides a general description of site conditions along the lower Genesee River in September 2011. It is not intended to be a detailed description of habitat and wildlife in the Genesee River riparian zone, as several other studies of the ecological resources have already been or are being conducted. Table 3-26 presents some of the studies that have been conducted along with a summary of their findings. Some of these documents provide detailed species lists for fish, wildlife, aquatic invertebrates, plankton, threatened and endangered species, and invasive species that are found in and around the lower Genesee River. No detailed lists of vegetation in the riparian zone were identified.

The reach of the lower Genesee River evaluated generally ranges from 200 to 500 feet in width and stretches five river miles upstream from the mouth of the river where it flows into Lake Ontario to the Veteran's Memorial Bridge (Route 104/Keeler State Expressway) (Figure 1-1). Within this reach of the river are Turning Point Park along the west bank and Seneca County Park along the east bank, both of which contribute to habitat within the riparian zone. The lower one-quarter to one-third of the lower Genesee River is almost fully developed, lined with marinas, boat slips, businesses, a U.S Coast Guard station, residences, and shoreline protection (rip rap and bulkheading). Boat slips line both shorelines up to river mile (RM) 1.1 along the east bank and RM 1.3 along the west bank. The width of the riparian zone along each side of the river (Figures 3-5a and 3-5b) ranges from 675 ft, along the lower Genesee River, to 2,550 ft and averages approximately 1,400 ft. Nearshore habitat along both banks consists of freshwater emergent marsh, deciduous forest habitat, and forest/shrub wetlands (Figures 3-5a and 3-5b). Representative habitat photographs are linked to specific locations in Figures 3-5a and 3-5b .

Deciduous forest habitat is found throughout the riparian zone (Figures 3-5a and 3-5b). NWI data also indicate patches of freshwater emergent wetland and freshwater forested/shrub wetland. Although emergent marsh occurs along the shoreline throughout much of the lower Genesee River, larger patches of emergent marsh within the riparian corridor range from approximately 3.2 to 16 acres in size (total ~ 54 acres). Forested/shrub wetland habitat patches in the riparian corridor range from approximately 1.5 to 23 acres in size (total ~ 39 acres). The shoreline habitat along both banks of the lower Genesee River varies between emergent marsh and rocky shoreline.

Shoreline habitat along the east bank of the Genesee River from RM 1 to RM 1.1 consists of emergent marsh. From RM 1.1 to 1.4, the shoreline becomes rocky and is characterized by a steep, eroded bank. From RM 1.4 to RM 2.5, shoreline habitat again consists of dense emergent marsh. The shoreline is rocky again from RM 2.5 to RM 3.2 and is characterized by a steep eroded bank between RM 2.6 and RM 2.9. Dense emergent marsh is present from RM 3.2 to RM 4.2, and the rest of the shoreline along the east bank of the lower Genesee River from RM 4.2 up to the Veterans Memorial Bridge is rocky and characterized by a steep eroded bank (Figures 3-5a and 3-5b).

Shoreline habitat along the west bank of the Genesee River from RM 1.3 to RM 3.3 consists of dense emergent marsh with small areas of steep eroded bank and rocky shoreline near RM 1.7 and between RM 2.1 and RM 2.2. The shoreline habitat between RM 2.4 and 2.5 consists of forested/shrub wetland. From RM 3.3 to RM 4.1, the shoreline is rocky and characterized by steep eroded bank from RM 3.3 to RM 3.5. Shoreline habitat from RM 4.1 to the Veterans Memorial Bridge predominantly consists of dense emergent marsh, with a disruption in this habitat at Kodak Park and between RM 4.7 and RM 4.9 where rocky shoreline is present.

Wildlife observed during the sampling event included a mallard duck (*Anas platyrhychos*) (omnivorous bird), king salmon (*Oncorhynchus tshawytscha*), a great blue heron (*Ardea herodias)* (piscivorous bird), herring gulls (*Larus argentatus*) (omnivorous bird), and a red-tail hawk (*Buteo jamaicensis*) (carnivorous bird). Although the resolution of habitat photos taken during field sampling was not sufficient to identify all deciduous forest species present, vegetation noted in habitat photographs includes oaks, weeping willow, maples, birch, some pine, and tree of heaven (invasive). Virginia creeper is also present. Emergent marsh vegetation includes cattail (*Typha sp.*) and some common reed (*Phragmites australis*) at locations further upstream. Recreational activities observed during sampling include angling and canoeing, indicating that the lower Genesee River is a valued recreational resource.

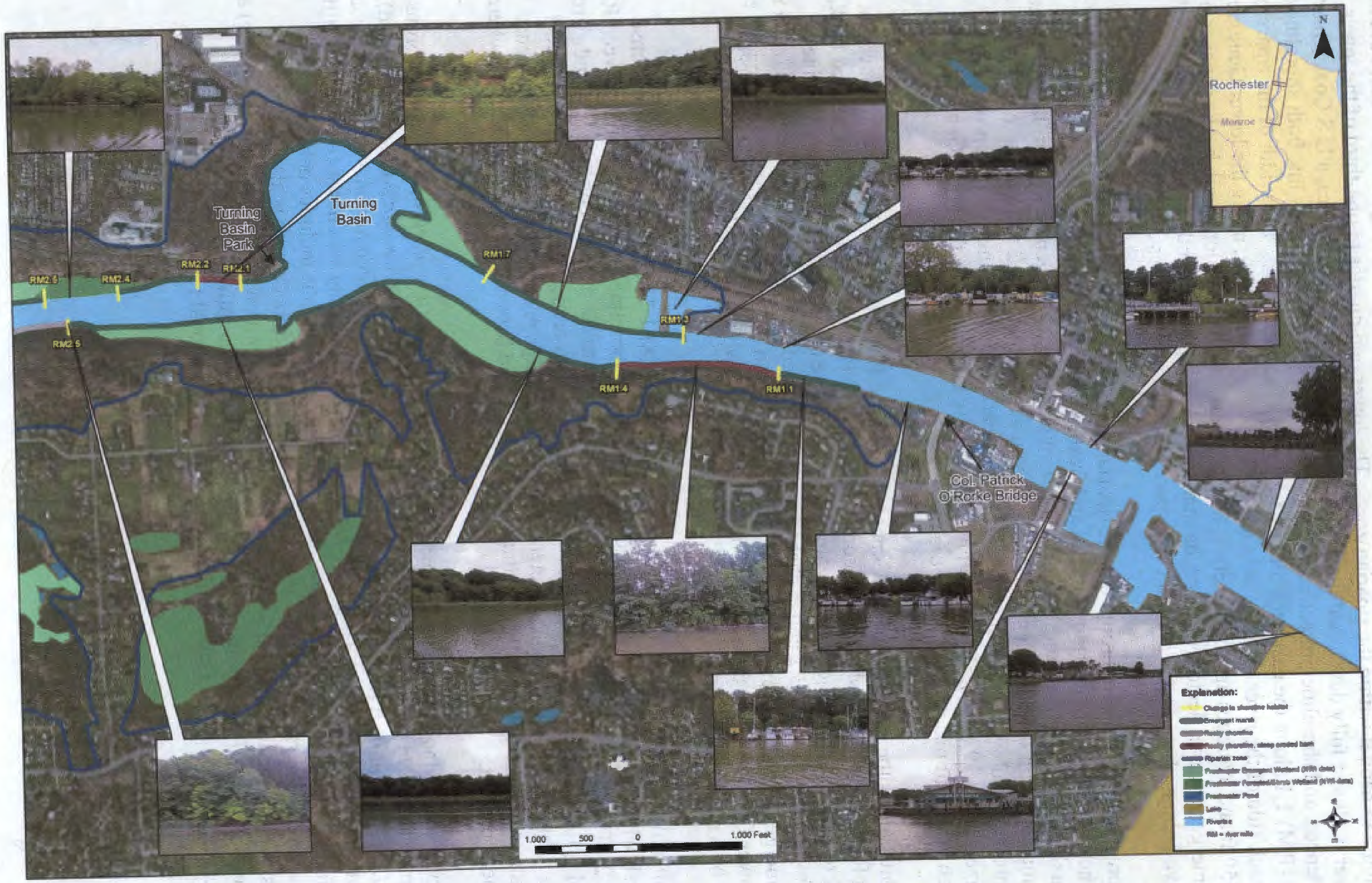


Figure 3-5a. Genesee River AOC Habitat Map

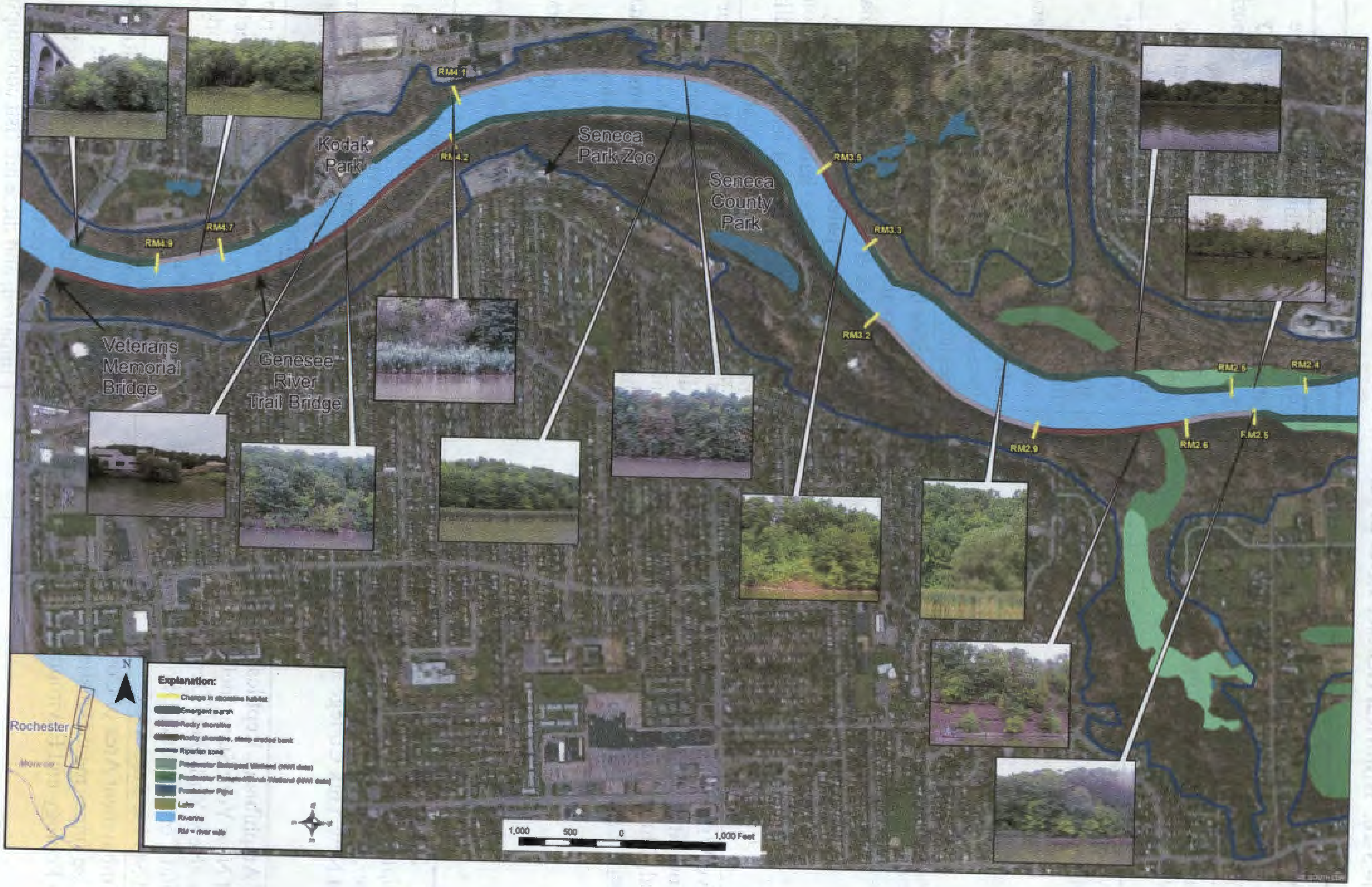


Figure 3-5b. Genesee River AOC Habitat Map

Table 3-26. Historical Genesee River Studies Characterizing Natural Resources

Document	Date	Summary of Content
U.S. Geological Survey. Final Report – Assessment of Habitat Use by Experimentally Stocked Juvenile Lake Sturgeon. Submitted to U.S. EPA Great Lakes National Program Office.	No date on report	Study determined that stocked juvenile sturgeon are successfully using nursery habitat within the Genesee River. Report presents results of a habitat quality assessment that includes list of benthic macroinvertebrate species present.
Interim Invasive Species Plant List. http://www.dec.ny.gov/animals/65408.html	Accessed October 2011	Provides a current list of invasive plant species to assist NYSDEC in incorporating invasive species management into funding, regulatory and other activities. It does not include all invasive or potentially invasive plant species.
http://www.dec.ny.gov/doc/wildlife_pdf/ontariosetbl.pdf	Accessed October 2011	Provides land cover for the Southeast Lake Ontario Basin, lists species of greatest conservation need and those that have been extirpated, provides species diversity and critical habitat information, and describes significant fish and wildlife habitats, including the Genesee River.
Comprehensive Wildlife Conservation Strategy Plan. New York State Department of Environmental Conservation, http://www.dec.ny.gov/animals/30483.html	Accessed October 2011	This document identifies data needs for determining the distribution and abundance of wildlife species and habitats, describes the problems that may impact species and their habitats, and describes conservation actions for preserving identified species and habitats. The chapter for the Southwest Lake Ontario Basin includes the lower Genesee River.
Jonahson, M. 2010. Movement of lake sturgeon (*Acipenser fulvescens*) in the lower Genesee River, New York. M.S. Thesis, State University of New York College at Brockport.	July 2010	Tracked movement of stocked lake sturgeon within the Genesee River and compared with behavior of naturally occurring lake sturgeon in other systems. Concluded that movement of stocked fish is similar to that of native fish.
Checklist of Amphibians, Reptiles, Birds and Mammals of New York State, Including Their Legal Status. New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources.	April 2010	Provides a list of 32 amphibian, 39 reptile, 375 bird, and 92 mammal species believed to be a part of the fauna of New York and their present legal status.
Rochester Embayment Area of Concern Beneficial Use Impairment Delisting Criteria. Prepared by Ecology and Environment, Inc.	March 2009	Reports delisting criteria for the Rochester Embayment AOC. Currently, the Rochester Embayment, including the lower Genesee River, is listed as impaired, and there are fish consumption advisories, reproductive effects on mink,

Table 3-25. Historical Genesee River Studies Characterizing Natural Resources (Continued)

Document	Date	Summary of Content
		impacts to phytoplankton and zooplankton populations, the presence of zebra mussels, and loss of riparian and shoreline habitat.
Summary Report – Lower Genesee River Data Evaluation, Eastman Business Park, Rochester, New York. Prepared by Arcadis for Eastman Business Park.	February 2009	Summarizes available information on the status of the lower Genesee River to determine whether historic releases from Kodak Park may pose a threat to human health and the environment. Concluded that potential impacts from historic operations appear to be localized and are sediment-related, most studies reviewed show no apparent site effects, and screening criteria exceedances were low and do not support impact to human health and the environment.
Neuderfer, G.N. 2007. Contaminant Analysis in the Rochester Embayment Area of Concern, Final Report. USEPA-GLNPO, Project Number GL97582701.	May 18, 2007	Reports data on sediment chemistry, toxicity, benthic macroinvertebrate community condition, and bioaccumulation in lake sturgeon. Concludes benthic macroinvertebrate community is slightly to moderately impacted and lake sturgeon released to the river have elevated tissue concentrations of contaminants after one year.
The Genesee River Basin Action Strategy. Genesee/Finger Lakes Regional Planning Council and U.S. Army Corps of Engineers.	October 2004	Provides a compilation of currently available information about the state of the Genesee River watershed and ongoing assessment, outreach and implementation activities. Includes information on land use, impairment, listed species, and fish stocking, as well as other important information for developing an action strategy.
Final Report – Benthic Macroinvertebrate Survey of the Lower Genesee River in the Vicinity of the CSXT Derailment and Chemical Spill at Charlotte, New York. Prepared by IT Corporation for CSX Transportation.	April 1, 2002	Presents results of sediment sampling and benthic macroinvertebrate community assessment to evaluate potential impacts from a CSX train derailment on December 23, 2001 that spilled acetone and methylene chloride into the Genesee River. Concluded that the benthic macroinvertebrate community does not appear to have been impacted by the spill. A species list is provided.
NYSDEC. 1995. Phase II Final Report – Lower Genesee River Study, Summary of 1992, 1993 and 1994 Results. New York State Department of Environmental Conservation.	August 1995	Presents an assessment of aquatic condition based on toxicity tests, chemistry and fish, invertebrate and plankton populations. The lower Genesee River is listed as impaired for fishing and

Table 3-25. Historical Genesee River Studies Characterizing Natural Resources (Continued)

Document	Date	Summary of Content
		aesthetics, and there are low to high impacts to benthic populations throughout the lower river, as well as bioaccumulation of metals and pesticides in fish and invertebrate tissue and microbial and invertebrate toxicity near site 4 (near Kodak Park). The report contains lists of fish, invertebrate and zooplankton species observed and identified.
A Biological Survey of the Genesee River System. State of New York Conservation Department.	1926	Presents a survey of the Genesee River system to determine the most practical methods of increasing fish production. Provides species lists for fish, submerged aquatic vegetation, plankton and benthic macroinvertebrates.
Baker, Frank C. 1920. Animal Life and Sewage in the Genesee River, New York. *American Society of Naturalists,* 54(631): 152 – 161.	1920	Compares collections of species data before, during and after pollution, showing a decline in animal life populations resulting from pollution and recovery after pollution abatement.

Note: This list is not comprehensive.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Discussion

The purpose of this site characterization project is to evaluate contamination in areas contiguous to the navigation channel and upstream of the navigation channel in the final approximately 6 miles of the Genesee River in Rochester, New York, to see if remedial action is necessary to delist the AOC or move forward in the process of determining measures necessary for delisting of the dredging beneficial use impairments. The specific goals of the study are to provide GLNPO with the tools to make rigorous, qualitative assessments based on quantitative data to support the design and performance of necessary remedial actions at this site as well as provide a baseline of conditions prior to any necessary remedial actions. To attain the objectives, the project collected sediment samples from 34 locations and analyzed a total of 126 sediment samples (140 samples including field duplicates).

SQGs were compiled from three sources to estimate the potential environmental effects of contamination levels. The primary source is the TEC/PEC and quotient approach provided in Macdonald et al. (2000). NYSDEC (2004) was not used as the primary source of benchmark data since it is not as comprehensive as is necessary for this broadly scoped study, in addition, many of the TEC/PEC values are more conservative compared to NYSEDC 2004 values. The MacDonald 2000 TEC/PEC calculations do not include silver as a metal or dioxins and furans. Therefore, the approach of using MacDonald et al. (2000) TEC/PEC benchmarks and adding the Long and Morgan (1990) ER-L/ER-M benchmark for silver and the NYSDEC (2004) dioxin TEQ benchmark was developed. This modified benchmark approach allows for some comparison to the NYSDEC 2004 system, with levels below the threshold benchmarks being analogous to Class A sediment, levels measured between threshold and probable quotients are analagous to Class B, and levels greater than the probable benchmark are analagous to Class C. The data suggest that average sediment contamination levels essentially fall within the definition of a Class B AOC as defined by the NYSDEC (2004).

The study confirmed that the primary COI in the study area is silver, with cadmium being a secondary COI. Other metal and organic compounds were typically measured well below proabable effects benchmarks. Due to the reduced frequency that dioxins and furans were measured, their vertical and horizontal distribution is not as well documented.

Silver: Silver was measured at levels above the probable effects ER-M benchmark at the combined core/grab locations GR-01 to GR-22. Of those 22 sample locations within the northern portion of the study area, 14 of the 0-0.5' intervals did not exceed the ER-M benchmark, with 11 of those 14 exceeding the ER-L threshold benchmark and three below the two benchmark levels. Only only one 0-3' core segment did not exceed the probable effects benchmark. At seven locations, one or more bottom intervals of the cores did not exceed the probable effects benchmark, sugesting the sediments at those elevations pre-date silver discharge into the Genesee River. Only one of the the samples within stations GR-23 to GR-33 had a measured concentration exceeding the probable effects benchmark. These samples were from 0-0.5 surface sample grab (all 11 locations) or the first core interval (0-3' or less; GR-23 and GR-24). These results agree with the northern sample pattern that in general, there is less silver contamination in the upper sediment intervals, suggesting that silver input may be reducing in the study area.

Cadmium: Cadmium is the second most prevelant COI, with 15 of the 22 cores from GR-01 to GR-22 having one or more intervals with Cd concentrations exceeding the probable effects benchmark (PEC). The cadmium concentration pattern was similar to silver, in that levels were, in general, higher in the middle intervals compared to the upper and lower intervals, and were reduced in upstream surface grab samples (all <TEC). Only one surface sediment grab sample (GR-12; >PEC) exceeded the TEC or PEC.

Dioxins furans: Dioxins and furans were measured in all the surface grabs, and the lowest interval of each core. Data for each sample was compared to the NYSDEC (2004) benchmark using the TEQ calculation. Dioxins were a primary COI within the workplan based on historical information. The total TEQ exceeded the NYSDEC Class C benchmark in only two of the 58 samples, suggesting that dioxins and furans are no longer a primary COI . However, the mean concentration at two depth intervals was signifcanlty greater than their probable effects benchmark at two depth intervals. Conclusions regarding TEQ are difficult because of the limited number of samples analyzed. With only the surface and lowest interval of each core being analyzed, the concentrations in the middle remain unknown. Because other analytes such as silver and cadmium showed contaminant levels higher in the middle intervals compared to the upper and lower intervals, it cannot be assumed that the TEQ levels in the upper and lower intervals are indicative of the levels through the entire core.

Sediment Contamination Quotients: Contaminant quotients were calculated for each sample. The average PEC quotient was 0.35. Only one sample exceeded a quotient value of 1.0 for the probable effects quotient while 27% of the samples (24/125) exceeded a PEC quotient of 0.5. Sediment samples with quotient levels above 0.5 had an 85% capability to predict environmental effects based on MacDonald 2000. Assuming the 85% predictability, it follows that only 20 of the 24 samples measured above the quotient of 0.5 or 16% of the total samples (20/125) would cause toxicity. Thererefore, quotient values indicate relatively low probability of negative biological effects from the sediment analyzed in the study.

Toxicity: There were no significiant differences between the test samples and control samples for mortality, total biomass, or individual organism biomass from the 40 ten-day solid phase toxicity tests carried out using the amphipod *Hyalella axteca*. These results are not incompatible with the complete set of benchmark analyses, while they are not expected based on silver concentrations being generally above the ER-M, the quotient analyses confirm that a relative few number of contaminant are of high concern, thus the quotients are relatively,low and in the region where biological effects are generally not encountered.

4.2 Conlusions

Based on the results of this study, only two compounds, Ag and Cd, were considered to be primary COIs.While dioxins were historically considered to be primary COIs, results from the current evaluation indicate only minimal SQG exceedances, though the vertical and horizontal distribution is not well documented due to limited sampling. Low sediment contamination quotients indicate a low probability for negative biological impacts. This conclusion is supported by the lack of toxicity observed in the 10-day solid phase amphipod tests. Overall, the ldata suggest that the average sediment contamination levels fall within the definition of a Class B AOC as defined by the NYSDEC (2004).

4.3 Recommended Approach for Further Investigation

This section to be completed during draft report review process based on discussion with U.S. EPA staff.

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APPENDIX A

Daily Operation Logs, Sediment Collection Logs, COCs

A1	**Daily Operations Logs**
A2	**Sediment Collection Logs**
A3	**COCs**
A4	**Core Photos**
A5	**Core Photos – Digital on DVD only**

APPENDIX B

Analytical Chemistry Data

B1	Columbia Analytical Services Houston TX - Dioxins and Furans
B2	Columbia Analytical Services Kelso WA - Polycyclic Aromatic Compounds, PCBs, Pesticides, Herbicides, Total Petroleum Hydrocarbons (DRO/RRO), Metals, TOC

APPENDIX C

USACE ERDC Whole Sediment Toxicity Data

APPENDIX D

Statistical Data Analysis of the Baseline Characterization Results

APPENDIX E

Habitat Assessment Photographs

APPENDIX F

Sediment Chemical Concentration Figures