Prepared in cooperation with the U.S. Army Corps of Engineers, Memphis District

Bed-Sediment Sampling and Analysis for Physical and Chemical Properties of the Lower Mississippi River near Memphis, Tennessee

Open-File Report 2010-1113

U.S. Department of the Interior
U.S. Geological Survey

Front cover. Left photograph – Dredger Hurley on lower Mississippi River near Memphis, Tennessee (Photograph by U.S. Army Corps of Engineers, Memphis District). Right photograph – Barge traffic on lower Mississippi River near Memphis, Tennessee (Photograph by Robert A. Blanchard, U.S. Geological Survey).

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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
millimeter (mm)	0.03937	inch (in.)
kilometer (km)	0.6214	mile (mi)
	Mass	
gram (g)	0.03527	ounch, avoirdupois (oz)
kilogram (kg)	2.205	pound, avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Bed-Sediment Sampling and Analysis for Physical and Chemical Properties of the Lower Mississippi River near Memphis, Tennessee

By Robert A. Blanchard, Daniel M. Wagner, and Dennis A. Evans

Abstract

In February 2010, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, Memphis District, investigated the presence of inorganic elements and organic compounds in bed sediments of the lower Mississippi River. Selected sites were located in the navigation channel near river miles 737, 773, and 790 near Memphis, Tennessee. Bed-sediment samples were collected using a Shipek grab sampler mounted to a boom crane with a motorized winch. Samples then were processed and shipped to the U.S. Geological Survey Sediment Laboratory in Rolla, Missouri, the USGS National Water Quality Laboratory in Denver, Colorado, and to TestAmerica Laboratory, Inc. in West Sacramento, California. Samples were analyzed for grain size, inorganic elements (including mercury), and organic compounds. Chemical results were tabulated and listed with sediment-quality guidelines and presented with the physical property results. All of the bed material samples collected during this investigation yielded concentrations that were less than the Consensus-Based Probable Effect Concentration guidelines. The physical properties were tabulated and listed using a standard U.S. Geological Survey scale of sizes by class for sediment analysis. All of the samples collected during this investigation indicated a percent composition mostly comprised of sand, ranging from less than 0.125 millimeters to less than 2 millimeters.

Introduction

The U.S. Army Corps of Engineers (USACE) regularly dredges the navigation channel on the Mississippi River. Dredging performed by the USACE is covered by a nationwide permit; however, to ensure that each State's water-quality standards are followed, the USACE must obtain permits from individual States that are affected by dredging activities.

The Tennessee Department of Environment and Conservation (TDEC) is the chief environmental and natural resource regulatory agency in Tennessee. The U.S. Environmental Protection Agency (USEPA) has delegated the responsibility of regulating seven main sources of waste, including the dredged bed sediment from the Mississippi River, to the TDEC. The TDEC is concerned that disturbance of bed sediment in the Mississippi River during dredging may cause chemical constituents attached to the bed sediment to be released into the waters of the Mississippi River. To determine the type and concentration of chemical constituents attached to the bed sediment, the U.S. Geological Survey (USGS) collected bed-sediment samples on the Mississippi River near Memphis, Tennessee.

In February 2010, the USGS, in cooperation with the USACE, Memphis District, investigated the presence of inorganic elements and organic compounds in bed sediments of the lower Mississippi River. A total of three samples were collected, one from each site, and analyzed for grain size, inorganic elements (including mercury) and organic compounds. Chemical results were tabulated and listed with sediment-quality guidelines and presented with the physical property results.

Description of Study Area

The study area is located within a 53-mile reach of the lower Mississippi River between river miles 737 (near Memphis, Tennessee) and 790 (near Osceola, Arkansas). Three sampling sites were located in the navigation channel near river miles 737, 773, and 790 (fig. 1). The sampling sites were assigned the following station numbers and names in the USGS National Water Information System (NWIS) database: 351002090034301 MISSISSIPPI RIVER RM 737, 353302089540002 MISSISSIPPI RIVER RM 773, and 354359089541903 MISSISSIPPI RIVER RM 790. These sites are hereinafter referred to as MISS-RM737, MISS-RM773, and MISS-RM790. Station numbers were derived from latitude and longitude coordinates at the respective sampling sites.

Figure 1. Location of study area.

Purpose and Scope

The purpose of this report is to present the analytical results of the physical and chemical properties of bed-sediment samples collected at MISS-RM737, MISS-RM773, and MISS-RM790. The physical properties were tabulated and listed with data collected in 1989 (Nordin and Queen, 1992) near the sampling locations for this study. Chemical properties were tabulated and listed with the sediment-quality guidelines set forth in the Consensus-Based Probable Effect Concentration (McDonald and others, 2000).

Sample Collection and Preparation

Bed-sediment samples were collected following methods described by Radtke (2005) using a Shipek grab sampler (fig. 2). The sampler was deployed with a boom and motorized winch and was lowered from a boat to the river bottom (fig. 3). Upon impact, the sampler automatically closes to capture the bed sediment (Radtke, 2005).

Figure 2. Shipek grab sampler (Photograph by Robert A. Blanchard, U.S. Geological Survey).

Figure 3. Boom and winch system mounted on the deck of the T.E. Anderson sampling boat (Photograph by Robert A. Blanchard, U.S. Geological Survey).

At each site, one bed-sediment sample was collected, wet sieved (when necessary), subdivided into sample containers, and shipped to the appropriate analytical laboratory. Photographs of the sampling equipment used, methods and procedures for sample collection and the bed-sediment collected are included in appendix 1. Chain of custody procedures for samples submitted to USGS laboratories were followed according to protocol described by Murphy and others (1997). Chain of custody procedures for samples submitted to TestAmerica Laboratories, Inc., West Sacramento, California, was followed according to their protocol (TestAmerica, 2010). Copies of the chain of custody forms are included in appendix 2. Subsamples were analyzed for grain size at the USGS Sediment Laboratory, Rolla, Missouri; subsamples for inorganic elements (including mercury) and select organic compounds were analyzed at the USGS National Water Quality Laboratory, Denver, Colorado; subsamples for the organic compounds of dioxins and furans were analyzed by TestAmerica Laboratories, Inc. Inorganic samples were wet-sieved with a 2-millimeter (mm) nylon sieve. Mercury samples were prepared according to the methods described in Olson and DeWild (1999). Samples for organic compounds (including total carbon, pesticides, dioxins, and furans) were collected and prepared for analysis according to the methods described in Shelton and Capel (1994). Total carbon samples were processed according to the methods described in McGee and Demcheck (1995); samples were wet sieved using a 2-mm nylon sieve to remove detritus, debris and other larger particles prior to shipping.

Bed-Sediment Analysis

Physical

Grain size analysis was performed by the USGS Sediment Laboratory, Rolla, Missouri. Methods used for the determination of particle size are described by Guy (1969). Results for analysis of grain size from sites MISS-RM737, MISS-RM773, and MISS-RM790 are shown in table 1 along with grain size distribution results from Nordin and Queen (1992). The Nordin and Queen (1992) samples were collected in close proximity to the 2010 sample sites and were dry sieved. Using a standard U.S. Geological Survey scale of sizes by class for sediment analysis, wherein 62.5 µm to 2 mm is considered very fine to very coarse sand and 2 mm to 8 mm is considered very fine to fine gravel (Guy, 1969), the physical properties of the samples collected during this investigation indicated a percent composition mostly comprised of sand, ranging from less than 0.125 mm to less than 2 mm (table 1).

Chemical

Analysis for 41 inorganic elements (including mercury) and 134 organic compounds were performed at the USGS National Water Quality Laboratory (NWQL), Denver, Colorado. Analytical methods used by the NWQL for the analysis of inorganic elements are described by Skougstad and others (1979). Methods used for the analysis of organic compounds and total carbon and total organic carbon are described by Foreman and others (1995), Furlong and others (1996), and Arbogast (1990). Analysis for 25 dioxins and furans were performed by TestAmerica Laboratory, Inc., and followed the methods described by the U.S. Environmental Protection Agency (1994). Results of the chemical analyses and associated method reporting limits (MRL) and units for the 200 analytes are shown in table 2. The MRL is defined as the smallest measured concentration of a substance that can be reliably measured by using a given analytical method. It is the "less-than" value reported when an analyte is not detected or is detected at a concentration less than the MRL. The MRL for a particular analyte in a sample may be increased because of matrix interference during analysis while the reported MRL for that analyte may actually be lower in other samples that lack the matrix interference.

Sample analytes and the sediment-quality guidelines that are set forth in the Consensus Based Probable Effect Concentration or PEC (MacDonald and others, 2000) are listed in table 3. The consensus-based guidelines were developed from published sediment-quality guidelines that have been derived from a variety of approaches. These guidelines consist of a probable effect concentration (PEC) above which adverse effects are expected to occur more often than not. The analytical results of this study indicated that all of the bed material samples yielded chemical concentrations that were less than the guidelines set forth in the Consensus-Based Probable Effect Concentration (table 3).

Table 1. Grain size analysis for bed-sediment samples collected on the Mississippi River.

[Included are gain size distribution results collected by Nordin and Queen (1992). The samples were collected in close proximity to the 2010 sample sites and were dry sieved. %, percent; MISS-RM, Mississippi River river mile; <, less than; mm, millimeter; µm, micrometer; NC, not collected]

River mile	Site name	Sampler type	Sample date	Bed sediment, dry sieved, sieve diameter % < 8 mm	Bed sediment, dry sieved, sieve diameter % < 4 mm	Bed sediment, dry sieved, sieve diameter % < 2 mm	Bed sediment, fall diameter (deionized water), % < 2 mm	Bed sediment, fall diameter (deionized water), % < 1 mm	Bed sediment, fall diameter (deionized water), % < 0.5 mm	Bed sediment, fall diameter (deionized water), % < 0.25 mm	Bed sediment, fall diameter (deionized water), % < 0.125 mm	Bed sediment, fall diameter (deionized water), % < 62.5 µm
737	MISS-RM737	Shipek Grab	2/22/2010	NC	100	98	98	92	33	0	0	0.0
773	MISS-RM773	Shipek Grab	2/23/2010	NC	NC	NC	NC	100	99	55	1	0.0
790	MISS-RM790	Shipek Grab	2/23/2010	NC	NC	NC	100	99	46	2	0	0.0

River mile	Site name	Sampler type	Sample date	Bed sediment, dry sieved, sieve diameter % < 16 mm	Bed sediment, dry sieved, sieve diameter % < 8 mm	Bed sediment, dry sieved, sieve diameter % < 4 mm	Bed sediment, dry sieved, sieve diameter % < 2 mm	Bed sediment, dry sieved, sieve diameter % < 1 mm	Bed sediment, dry sieved, sieve diameter % < 0.5 mm	Bed sediment, dry sieved, sieve diameter % < 0.25 mm	Bed sediment, dry sieved, sieve diameter % < 0.125 mm	Bed sediment, dry sieved, sieve diameter % < 62.5 µm
741	-	BM-54	9/1989[1]	100	99.0	98.6	97.5	91.7	46.0	2.6	0.0	0.0
773	-	BM-54	9/1989[1]	100	99.8	99.6	99.3	99.2	92.0	7.3	0.2	0.0
822	-	BM-54	9/1989[1]	100	100	100	100	99.8	91.3	7.9	0.1	0.0

[1] Samples collected between September 4-25, 1989.

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Inorganic elements					
Aluminum	µg/g	25	1,410	1,560	1,510
Antimony	µg/g	0.3	<0.3	<0.3	<0.3
Arsenic	µg/g	0.1	1.0	1.3	1.1
Barium	µg/g	0.2	13.4	15.5	13.4
Beryllium	µg/g	0.03	0.08	0.10	0.09
Bismuth	µg/g	0.2	<0.2	<0.2	<0.2
Boron	µg/g	1.8	<1.8	<1.8	<1.8
Cadmium	µg/g	0.001	0.02	0.02	0.02
Calcium	µg/g	100	720	1,890	910
Cerium	µg/g	0.1	11.0	20.5	13.3
Cesium	µg/g	0.003	0.10	0.15	0.11
Chromium	µg/g	0.1	2.93	4.20	3.58
Cobalt	µg/g	0.1	3.13	2.03	2.29
Copper	µg/g	0.1	1.19	0.96	0.99
Gallium	µg/g	0.02	0.80	1.00	0.84
Iron	µg/g	2.1	3,330	4,590	3,370
Lanthanum	µg/g	0.05	5.73	9.50	6.78
Lead	µg/g	0.001	1.7	2.5	1.9
Lithium	µg/g	0.3	1.9	1.7	1.7
Magnesium	µg/g	6.0	470	690	500
Manganese	µg/g	0.3	81.8	69.8	70.2
Mercury	µg/g	0.0072	<0.0072	<0.0072	<0.0072
Molybdenum	µg/g	0.001	0.04	0.07	0.04
Nickel	µg/g	0.001	7.8	5.0	6.1
Niobium	µg/g	0.2	<0.2	<0.2	<0.2
Phosphorus	µg/g	5.0	80	200	100
Potassium	µg/g	20	200	200	200
Rubidium	µg/g	0.01	1.37	1.75	1.56
Scandium	µg/g	0.6	<0.6	0.7	<0.6
Selenium	µg/g	0.1	<0.1	<0.1	<0.1
Silver	µg/g	3.0	<3.0	<3.0	<3.0
Sodium	µg/g	500	<500	<500	<500
Strontium	µg/g	0.80	5.96	12.60	7.80
Sulfate	µg/g	2.0	<2.0	<2.0	<2.0

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.—Continued

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Thallium	µg/g	0.1	<0.1	<0.1	<0.1
Thorium	µg/g	0.10	1.38	1.54	1.39
Titanium	µg/g	40.0	<40.0	113	58.9
Uranium	µg/g	0.02	0.18	0.28	0.21
Vanadium	µg/g	0.10	3.74	11.60	5.08
Yttrium	µg/g	0.05	2.71	5.70	3.33
Zinc	µg/g	0.1	10.0	10.6	9.1
Organic carbon					
Carbon, Total	g/kg	0.1	0.3	0.3	0.4
Selected PAHs and total PCBs					
1,2-dimethylnaphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
1,6-dimethylnaphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
1-methyl-9H-fluorene	µg/kg	50.0	<50.0	<50.0	<50.0
1-methylphenanthrene	µg/kg	50.0	<50.0	<50.0	<50.0
1-methylpyrene	µg/kg	50.0	<50.0	<50.0	<50.0
2,3,6-trimethylnaphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
2,6-dimethylnaphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
2-ethylnaphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
2-fluorobiphenyl	pct	NA	60.8	65.4	62.5
2-methylanthracene	µg/kg	50.0	<50.0	<50.0	<50.0
4H-cyclopenta[def]phenanthrene	µg/kg	50.0	<50.0	<50.0	<50.0
Acenaphthene	µg/kg	50.0	<50.0	<50.0	<50.0
Acenaphthylene	µg/kg	50.0	<50.0	<50.0	<50.0
Anthracene	µg/kg	50.0	<50.0	<50.0	<50.0
Benz[a]anthracene	µg/kg	50.0	<50.0	<50.0	<50.0
Benzo[a]pyrene	µg/kg	50.0	<50.0	<50.0	<50.0
Benzo[b]fluoranthene	µg/kg	50.0	<50.0	<50.0	<50.0
Benzo[ghi]perylene	µg/kg	50.0	<50.0	<50.0	<50.0
Benzo[k]fluoranthene	µg/kg	50.0	<50.0	<50.0	<50.0
Chrysene	µg/kg	50.0	<50.0	<50.0	<50.0
Dibenz[a,h]anthracene	µg/kg	50.0	<50.0	<50.0	<50.0
Fluoranthene	µg/kg	50.0	<50.0	<50.0	<50.0
Fluorene	µg/kg	50.0	<50.0	<50.0	<50.0
Indeno[1,2,3-cd]pyrene	µg/kg	50.0	<50.0	<50.0	<50.0
Isophorone	µg/kg	50.0	<50.0	<50.0	<50.0

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.—Continued

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Naphthalene	µg/kg	50.0	<50.0	<50.0	<50.0
Nitrobenzene-d5	pct	NA	52.0	56.6	52.7
Nonachlorobiphyenyl	pct	0.1	92.7	91.4	79.2
P-cresol	µg/kg	50.0	<50.0	<50.0	<50.0
Phenanthrene	µg/kg	50.0	<50.0	<50.0	<50.0
Phenanthridine	µg/kg	50.0	<50.0	<50.0	<50.0
Pyrene	µg/kg	50.0	<50.0	<50.0	<50.0
Terphenyl-d14	pct	NA	122.0	118.5	122.8
Total PCBs	µg/kg	5.0	<5.0	<5.0	<5.0
Pesticides					
1- napthol	µg/kg	1.5	<1.5	<1.5	<1.5
2,6-diethylaniline	µg/kg	1.5	<1.5	<1.5	<1.5
2-chloro-2,6-diethylacetanilid	µg/kg	1.5	<1.5	<1.5	<1.5
2-Chloro-4-isopropylamino-6-amino-s-triazine	µg/kg	1.5	<1.5	<1.5	<1.5
2-ethyl-6-methylaniline	µg/kg	1.5	<1.5	<1.5	<1.5
3,4-dichloroaniline	µg/kg	1.5	<1.5	<1.5	<1.5
3,5-dichloroaniline	µg/kg	1.5	<1.5	<1.5	<1.5
4-chloro-2-methylphenol	µg/kg	1.5	<1.5	<1.5	<1.5
Acetochlor	µg/kg	1.5	<1.5	<1.5	<1.5
Alachlor	µg/kg	1.5	<1.5	<1.5	<1.5
Alpha-Endosulfan	µg/kg	1.5	<1.5	<1.5	<1.5
Alpha-HCH-d6	pct	NA	23.6	61.0	58.3
Atrazine	µg/kg	1.5	<1.5	<1.5	<1.5
Azinphos-methyl	µg/kg	1.5	<1.5	<1.5	<1.5
Azinphos-methyl-oxon	µg/kg	1.5	<1.82[1]	<1.5	<1.5
Benfluralin	µg/kg	1.5	<1.5	<1.5	<1.5
Carbaryl	µg/kg	1.5	<1.5	<1.5	<1.5
Carbofuran	µg/kg	1.5	<1.5	<1.5	<1.5
Carbophenothion	µg/kg	2.0	<2.0	<2.0	<2.0
Chlorpyrifos	µg/kg	1.5	<1.5	<1.5	<1.5
Chlorpyrifos, oxygen analog	µg/kg	1.5	<7.46[1]	<1.5	<1.5
cis-Permethrin	µg/kg	1.5	<1.5	<1.5	<1.5
cis-Propiconazole	µg/kg	1.5	<1.5	<1.5	<1.5
Cyanazine	µg/kg	1.5	<1.5	<1.5	<1.5

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.—Continued

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location MISS-RM737	Site location MISS-RM773	Site location MISS-RM790
Cylfuthrin	µg/kg	1.5	<1.5	<1.5	<1.5
Cypermethrin	µg/kg	1.5	<1.5	<1.5	<1.5
Dacthal	µg/kg	1.5	<1.5	<1.5	<1.5
Desulfinylfipronil	µg/kg	1.5	<1.5	<1.5	<1.5
Desulfinylfipronil amide	µg/kg	1.5	<1.5	<1.5	<1.5
Diazinon	µg/kg	1.5	<1.5	<1.5	<1.5
Diazinon, oxygen analog	µg/kg	1.5	<1.5	<1.5	<1.5
Diazinon-d10	pct	NA	48.6	110.7	104.1
Dichlorvos	µg/kg	1.5	<1.5	<1.5	<1.5
Dicrotophos	µg/kg	1.5	ND	ND	ND
Dieldrin	µg/kg	1.5	<1.5	<1.5	<1.5
Dimethoate	µg/kg	1.5	<1.5	<1.5	<1.5
Disulfoton	µg/kg	1.5	<1.5	<1.5	<1.5
Disulfoton sulfone	µg/kg	1.5	<1.5	<1.5	<1.5
Endosulfan I	µg/kg	5.0	<5.0	<5.0	<5.0
Endosulfan sulfate	µg/kg	1.5	<1.5	<1.5	<1.5
EPTC (Eptam)	µg/kg	1.5	<1.5	<1.5	<1.5
Ethion	µg/kg	1.5	<1.5	<1.5	<1.5
Ethion monoxon	µg/kg	1.5	<1.5	<1.5	<1.5
Ethoprophos	µg/kg	1.5	<1.5	<1.5	<1.5
Fenamiphos	µg/kg	1.5	<1.5	<1.5	<1.5
Fenamiphos sulfone	µg/kg	1.5	<1.5	<1.5	<1.5
Fenamiphos sulfoxide	µg/kg	1.5	ND	ND	ND
Fenthion	µg/kg	3.0	<3.0	<3.0	<3.0
Fipronil	µg/kg	1.5	<1.5	<1.5	<1.5
Fipronil sulfide	µg/kg	1.5	<1.5	<1.5	<1.5
Fipronil sulfone	µg/kg	1.5	<1.5	<1.5	<1.5
Fonofos	µg/kg	1.5	<1.5	<1.5	<1.5
Hexazinone	µg/kg	1.5	<1.5	<1.5	<1.5
Iambda-Cyhalothrin	µg/kg	1.5	<1.5	<1.5	<1.5
Iprodione	µg/kg	1.5	<1.5	<1.5	<1.5
Isofenphos	µg/kg	1.5	<1.5	<1.5	<1.5
Malaoxon	µg/kg	1.5	<16.3[1]	<1.5	<1.5
Malathion	µg/kg	1.5	<1.5	<1.5	<1.5

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.—Continued

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Metalaxyl	µg/kg	1.5	<4.85[1]	<1.5	<1.5
Methidathion	µg/kg	1.5	<1.5	<1.5	<1.5
Methyl azinphos	µg/kg	5.0	<5.0	<5.0	<5.0
Methyl parathion	µg/kg	5.0	<5.0	<5.0	<5.0
Metolachlor	µg/kg	1.5	<1.5	<1.5	<1.5
Metribuzin	µg/kg	1.5	<1.5	<1.5	<1.5
Molinate	µg/kg	1.5	<1.5	<1.5	<1.5
Myclobutanil	µg/kg	1.5	<1.5	<1.5	<1.5
O-Ethyl-O-methyl-S-propylphosphorothioate	µg/kg	3.0	<3.0	<3.0	<3.0
Oxyfluorfen	µg/kg	1.5	<1.5	<1.5	<1.5
Paraoxon-methyl	µg/kg	1.5	<1.5	<1.5	<1.5
Parathion	µg/kg	2.0	<2.0	<2.0	<2.0
Parathion-methyl	µg/kg	1.5	<1.5	<1.5	<1.5
Pendimethalin	µg/kg	1.5	<1.5	<1.5	<1.5
Phorate	µg/kg	1.5	<1.5	<1.5	<1.5
Phorate oxon (Phorate oxygen analog)	µg/kg	1.5	<1.5	<1.5	<1.5
Phosmet	µg/kg	1.5	<1.5	<1.5	<1.5
Phosmet oxon	µg/kg	1.5	<1.5	<1.5	<1.5
Profenofos	µg/kg	2.0	<2.0	<2.0	<2.0
Prometon	µg/kg	1.5	<1.5	<1.5	<1.5
Prometryn	µg/kg	1.5	<1.5	<1.5	<1.5
Pronamide	µg/kg	5.0	<5.0	<5.0	<5.0
Propanil	µg/kg	1.5	<1.5	<1.5	<1.5
Propargites	µg/kg	1.5	<1.5	<1.5	<1.5
Propetamphos	µg/kg	2.0	<2.0	<2.0	<2.0
Propyzamide	µg/kg	1.5	<1.5	<1.5	<1.5
Simazine	µg/kg	1.5	<1.5	<1.5	<1.5
Sulfone + Fenamiphos sulfoxide	µg/kg	1.5	ND	ND	ND
Sulfotepp	µg/kg	2.0	<2.0	<2.0	<2.0
Sulprofos	µg/kg	3.0	<3.0	<3.0	<3.0
Tebuconazole	µg/kg	1.5	<3.66[1]	<1.5	<1.5
Tebuthiuron	µg/kg	1.5	<1.5	<1.5	<1.5
Tefluthrin	µg/kg	1.5	<1.5	<1.5	<1.5
Terbufos	µg/kg	1.5	<1.5	<1.5	<1.5

Table 2. Analytical results for chemical constituents of bed-sediment samples collected on the Mississippi River, February 22-23, 2010.—Continued

[MISS-RM, Mississippi River river mile; g/kg, grams per kilogram; µg/g, micrograms per gram; PAHs, polycyclic aromatic hydrocarbons; PCBs, polychlorinated biphenyls; µg/kg, micrograms per kilogram; pg/g, picograms per gram; pct, percent recovery; <, less than; NA, not applicable; ND, no detection]

Chemical constituents	Units	Method reporting limit	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Terbufos oxygen analog sulfone	µg/kg	1.5	<1.5	<1.5	<1.5
Terbuthylazine	µg/kg	1.5	<1.5	<1.5	<1.5
Thiobencarb	µg/kg	1.5	<2.94[1]	<1.5	<1.5
Trans-permethrin	µg/kg	1.5	<1.5	<1.5	<1.5
Trans-propiconazole	µg/kg	1.5	<1.5	<1.5	<1.5
Tribufos	µg/kg	1.5	<1.5	<1.5	<1.5
Trifluralin	µg/kg	1.5	<1.5	<1.5	<1.5
Dioxins/Furans					
2,3,7,8-TCDD	pg/g	1.2	<1.2	<1.2	<1.2
Total TCDD	pg/g	1.2	<1.2	<1.2	<1.2
1,2,3,7,8-PeCDD	pg/g	6.0	<6.0	<6.0	<6.0
Total PeCDD	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,4,7,8-HxCDD	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,6,7,8-HxCDD	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,7,8,9-HxCDD	pg/g	6.0	<6.0	<6.0	<6.0
Total HxCDD	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,4,6,7,8-HpCDD	pg/g	6.0	<6.0	<6.0	<6.0
Total HpCDD	pg/g	6.0	<6.0	<6.0	<6.0
OCDD	pg/g	12	<12	<12	<12
2,3,7,8-TCDF	pg/g	1.2	<1.2	<1.2	<1.2
Total TCDF	pg/g	1.2	<1.2	<1.2	<1.2
1,2,3,7,8-PeCDF	pg/g	6.0	<6.0	<6.0	<6.0
2,3,4,7,8-PeCDF	pg/g	6.0	<6.0	<6.0	<6.0
Total PeCDF	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,4,7,8-HxCDF	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,6,7,8-HxCDF	pg/g	6.0	<6.0	<6.0	<6.0
2,3,4,6,7,8-HxCDF	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,7,8,9-HxCDF	pg/g	6.0	<6.0	<6.0	<6.0
Total HxCDF	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,4,6,7,8-HpCDF	pg/g	6.0	<6.0	<6.0	<6.0
1,2,3,4,7,8,9-HpCDF	pg/g	6.0	<6.0	<6.0	<6.0
Total HpCDF	pg/g	6.0	<6.0	<6.0	<6.0
OCDF	pg/g	12	<12	<12	<12

Table 3. Consensus Based Probable Effect Concentration (PEC) guidelines (MacDonald and others, 2000) and associated bed-sediment concentrations from samples collected on the Mississippi River.

[mg/kg DW, milligrams per kilogram dry weight; µg/kg DW, micrograms per kilogram dry weight; MISS-RM, Mississippi River river mile; <, less than]

Checmial constituents	Consensus-based PEC (mg/kg DW)	Consensus-based PEC (µg/kg DW)	Site location		
			MISS-RM737	MISS-RM773	MISS-RM790
Trace element (concentrations in mg/kg DW)					
Arsenic	33	--	1.0	1.3	1.1
Cadmium	4.98	--	0.02	0.02	0.02
Chromium	111	--	2.93	4.2	3.58
Copper	149	--	1.19	0.96	0.99
Lead	128	--	1.7	2.5	1.9
Mercury	1.06	--	<0.0072	<0.0072	<0.0072
Nickel	48.6	--	7.8	5.0	6.1
Zinc	459	--	10.0	10.6	9.1
Polycyclic aromatic hydrocarbons (PAH) (concentrations in µg/kg DW)					
Anthracene	--	845	<50.0	<50.0	<50.0
Fluorene	--	536	<50.0	<50.0	<50.0
Naphthalene	--	561	<50.0	<50.0	<50.0
Phenanthrene	--	1,170	<50.0	<50.0	<50.0
Benz[a]anthracene	--	1,050	<50.0	<50.0	<50.0
Benzo(a)pyrene	--	1,450	<50.0	<50.0	<50.0
Chrysene	--	1,290	<50.0	<50.0	<50.0
Fluoranthene	--	2,230	<50.0	<50.0	<50.0
Pyrene	--	1,520	<50.0	<50.0	<50.0
Total PAHs	--	22,800	<450	<450	<450
Polychlorinated biphenyls (PCB) (concentrations in µg/kg DW)					
Total PCBs	--	676	<5.0	<5.0	<5.0
Organochlorine pesticides (concentrations in µg/kg DW)					
Chlordane	--	17.6	<1.5	<1.5	<1.5
Dieldrin	--	61.8	<1.5	<1.5	<1.5
Sum DDD	--	28.0	<2.5	<2.5	<2.5
Sum DDE	--	31.3	<1.5	<1.5	<1.5
Sum DDT	--	62.9	<1.0	<1.0	<1.0
Total DDTs	--	572	<5.0	<5.0	<5.0
Endrin	--	207	<1.0	<1.0	<1.0
Heptachlor Epoxide	--	16.0	<1.5	<1.5	<1.5
Lindane (gamma-BHC)	--	4.99	<0.5	<0.5	<0.5

Summary

In February 2010, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, Memphis District, investigated the presence of inorganic elements and organic compounds in bed-sediment samples of the lower Mississippi River. Selected sites were located in the navigation channel near river miles 737, 773 and 790 near Memphis, Tennessee. Bed-sediment samples were collected using a Shipek grab sampler mounted to a boom crane with a motorized winch. Samples then were processed and shipped to the U.S. Geological Survey Sediment Laboratory in Rolla, Missouri, the USGS National Water Quality Laboratory in Denver, Colorado, and to TestAmerica Laboratory, Inc. in West Sacramento, California. Three samples were collected, one from each site, and analyzed for grain size, inorganic elements (including mercury) and organic compounds. Chemical results for the 200 analytes measured were tabulated and listed with sediment-quality guidelines and presented with the physical property results. All of the bed -sediment samples collected during this investigation yielded chemical concentrations that were less than the Consensus-Based Probable Effect Concentration guidelines (MacDonald and others, 2000). The physical properties were tabulated and listed using a standard U.S. Geological Survey scale of sizes by class for sediment analysis. All three of the bed-sediment samples collected during this investigation indicated a percent composition mostly comprised of sand, ranging from less than 0.125 mm to less than 2 mm.

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Appendixes 1-2

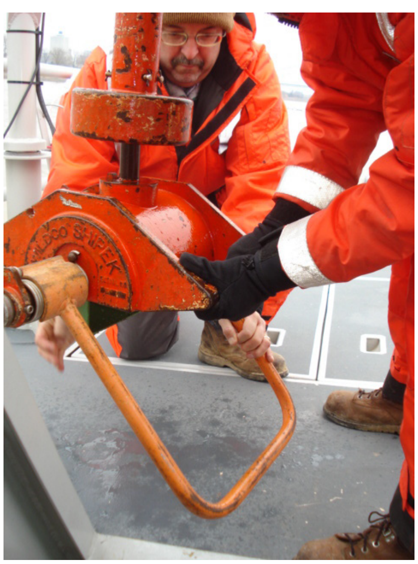
Appendix 1. Photographs showing sampling equipment, sampling methods and procedures, and bed-sediment samples.

Testing the boom and winch system before departure on the Mississippi River (Photograph by Daniel M. Wagner, U.S. Geological Survey).

The T.E. Anderson sampling boat used for collection of bed sediment on the Mississippi River (Photograph by Robert A. Blanchard, U.S. Geological Survey).

Preparing chain of custody forms for sample collection (Photograph by Robert A. Blanchard, U.S. Geological Survey).

Preparing labels for sample bottles (Photograph by Robert A. Blanchard, U.S. Geological Survey).

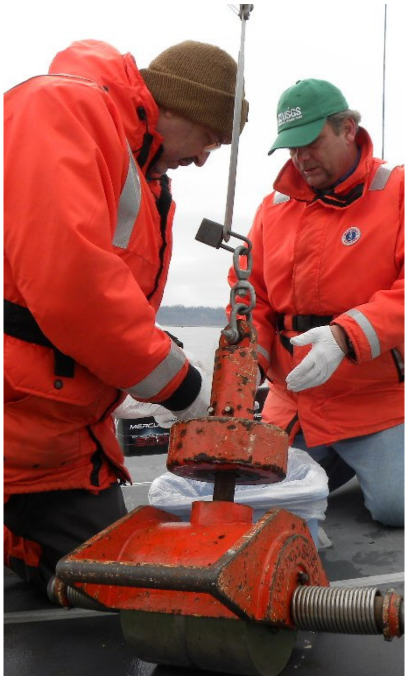


Preparing the Shipek grab sampler for collection of bed sediment (Photograph by Robert A. Blanchard, U.S. Geological Survey).

Deployment of the Shipek grab sampler for collection of bed sediment (Photograph by Robert A. Blanchard, U.S. Geological Survey).

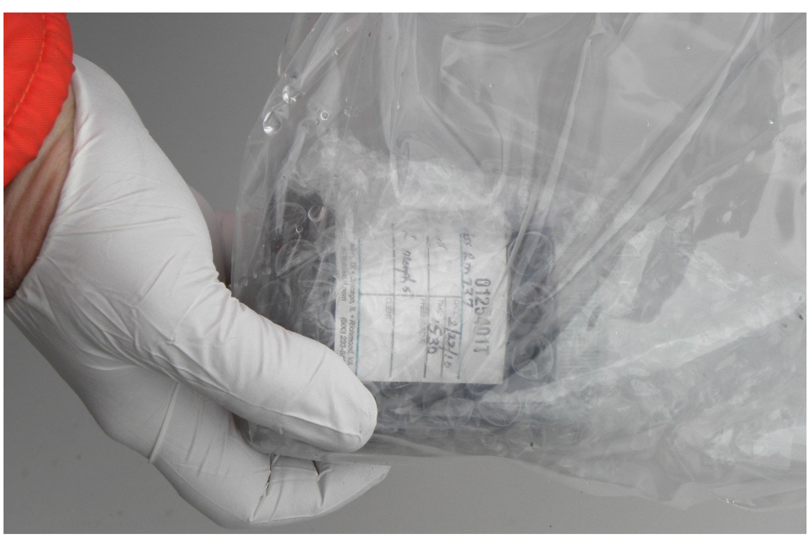
Retrieval of the Shipek grab sampler with bed-sediment sample (Photograph by Robert A. Blanchard, U.S. Geological Survey).

Preparing to collect bed-sediment sample from the Shipek grab sampler (Photograph by Daniel M. Wagner, U.S. Geological Survey).



Collection of bed-sediment sample from the Shipek grab sampler (Photograph by Daniel M. Wagner, U.S. Geological Survey).

Collection of bed-sediment sample using 2-millimeter nylon sieve (Photograph by Daniel M. Wagner, U.S. Geological Survey).



Packaging of bed-sediment sample (Photograph by Daniel M. Wagner, U.S. Geological Survey).

Bed-sediment sample collected at MISS-RM737 (Photograph by Daniel M. Wagner, U.S. Geological Survey).

Bed-sediment sample collected at MISS-RM773 (Photograph by Daniel M. Wagner, U.S. Geological Survey).

Bed-sediment sample collected at MISS-RM790 (Photograph by Daniel M. Wagner, U.S. Geological Survey).

Appendix 2. Chain of custody forms used by U.S. Geological Survey laboratories and TestAmerica Laboratory, Inc.

Chain of Custody Record

USGS science for a changing world

STL-4124 (0901)

Client	USGS Arkansas WSC
Project Manager	Bob Blanchard
Date	2/24/10
Chain of Custody Number	
Address	401 Hardin Rd
Telephone Number (Area Code)/Fax Number	(501) 228-3662 (501) 228-3601
Lab Number	
Page	1 of 1
City	Little Rock
State	AR
Zip Code	72211
Site Contact	Same
Lab Contact	
Project Name and Location (State)	Arkansas
Carrier/Waybill Number	
Contract/Purchase Order/Quote No.	CL10035

Analysis (Attach list if more space is needed)

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	sch 2504	sch 1404	sch 2275	LC 9019	LC 8512	LC 133	LC 4000	Special Instructions/ Conditions of Receipt
miss-Rm 737	2/22/10	1530			X		X						X	X	X	X	X	X		
miss-Rm 737	2/22/10	1540			X		X						X	X		X			X	
miss-Rm 773	2/23/10	1100			X		X						X	X	X	X	X	X		
Miss-Rm 773	2/23/10	1110			X		X						X	X	X	X	X	X		
miss-Rm 790	2/23/10	1430			X		X						X	X	X	X	X	X		
miss-Rm 790	2/23/10	1440			X		X						X	X	X	X	X	X		

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☒ Archive For 1 Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other 2 months

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: Bob A Blanchard	2/24/10	1330	1. Received By		
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

TAL-4124 (1007)

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Dennis Evans - USGS

Project Manager: Dennis Evans

Date: 2/24/10

Chain of Custody Number: 133168

Address: 401 Hardin Rd

Telephone Number (Area Code)/Fax Number: (501) 228-3644

Lab Number

Page 1 of 1

City: Little Rock | State: AR | Zip Code: 72211

Site Contact: Same | Lab Contact

Project Name and Location (State): Mississippi River Bed Sediments

Carrier/Waybill Number

Contract/Purchase Order/Quote No.

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		Analysis (Attach list if more space is needed): 8290	Special Instructions/Conditions of Receipt
Miss-RM 737	2/22/10	1530			X			X							X	
Miss-RM 773	2/23/10	1100			X			X							X	
Miss-RM 773	2/23/10	1110			X			X							X	
Miss-RM 790	2/23/10	1430			X			X							X	
Miss-RM 790	2/23/10	1440			X			X							X	

Possible Hazard Identification: ☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☒ Archive For 1 Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☒ 21 Days ☐ Other ______

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: Robert A. Blanchard	2/24/10	1330	1. Received By		
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

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