CHEMICAL ANALYSIS OF MAINTENANCE DREDGE MATERIAL FROM THE MARCUS HOOK, DEEPWATER POINT, AND NEW CASTLE NAVIGATIONAL RANGES

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EXECUTIVE SUMMARY

This report summarizes the results of chemical and geotechnical analysis of sediment collected from the lower Delaware River for a USACE sponsored maintenance dredging project. Field crews collected sediment samples from 15 stations in the study area on September 4 and 5, 2003. The study was initiated under a contract with the U.S. Army Corps of Engineers to assess potential impacts from maintenance dredging in the Marcus Hook, Deepwater Point, and New Castle range of the Philadelphia to the Sea navigation channel. The analyses summarized in this report address the potential for impacts associated with human health issues when the material is placed in upland disposal sites. To address these concerns bulk sediment analyses were performed on sediment cores taken in the project area. The fifteen bulk sediment samples were analyzed for inorganic and organic contaminants. Comparisons of the current data to historical data were also conducted to evaluate whether contaminant concentrations within these ranges changed relative to previous studies.

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is responsible for maintenance dredging of the navigational channels in the lower Delaware River. Maintenance dredging for the portion of the River between Philadelphia, PA and the C&D Canal is scheduled to occur in the late fall of 2003. This study was designed to collect sediments in the areas intended to be dredged in the Marcus Hook, Deepwater Point, and New Castle navigational ranges for maintenance dredging based on recent bathymetric surveys conducted by the USACE. The sediments tested for this project are scheduled for disposal in New Jersey CDFs (e.g., Killcohook, Pedricktown, or Oldmans). The study was initiated under a contract with the Philadelphia District of the USACE, to assess potential impacts associated with human health effects when the material is placed in a CDF. The sediments were collected in September 2003 from 15 stations positioned in the Marcus Hook, Deepwater Point, and New Castle navigational ranges (Figs. 1-1 through 1-3).

Concerns over the environmental effects of dredging in the Delaware River stem from the current and past use of the estuary. The upper portion of the Delaware estuary is one of the world's largest freshwater ports and has one of the world's greatest concentrations of heavy industry, including oil refining and petrochemical processing. The estuary is affected by a multitude of point sources of contaminants, including 90 municipal and industrial dischargers, a dozen power plants, and more than 300 combined sewer overflows (Albert 1988). Although the 1972 Clean Water Act produced significant reductions in pollutants, historical toxic loadings in the estuary justify concerns that dredging may mobilize contaminants buried in the sediments. Recent reviews of the status of the estuary have noted that river sediments contain contaminants at concentrations that are toxic to biota (Costa and Sauer 1993) and that the estuary continues to receive significant amounts of potentially toxic contaminants from point and nonpoint sources (Frithsen et al. 1995).

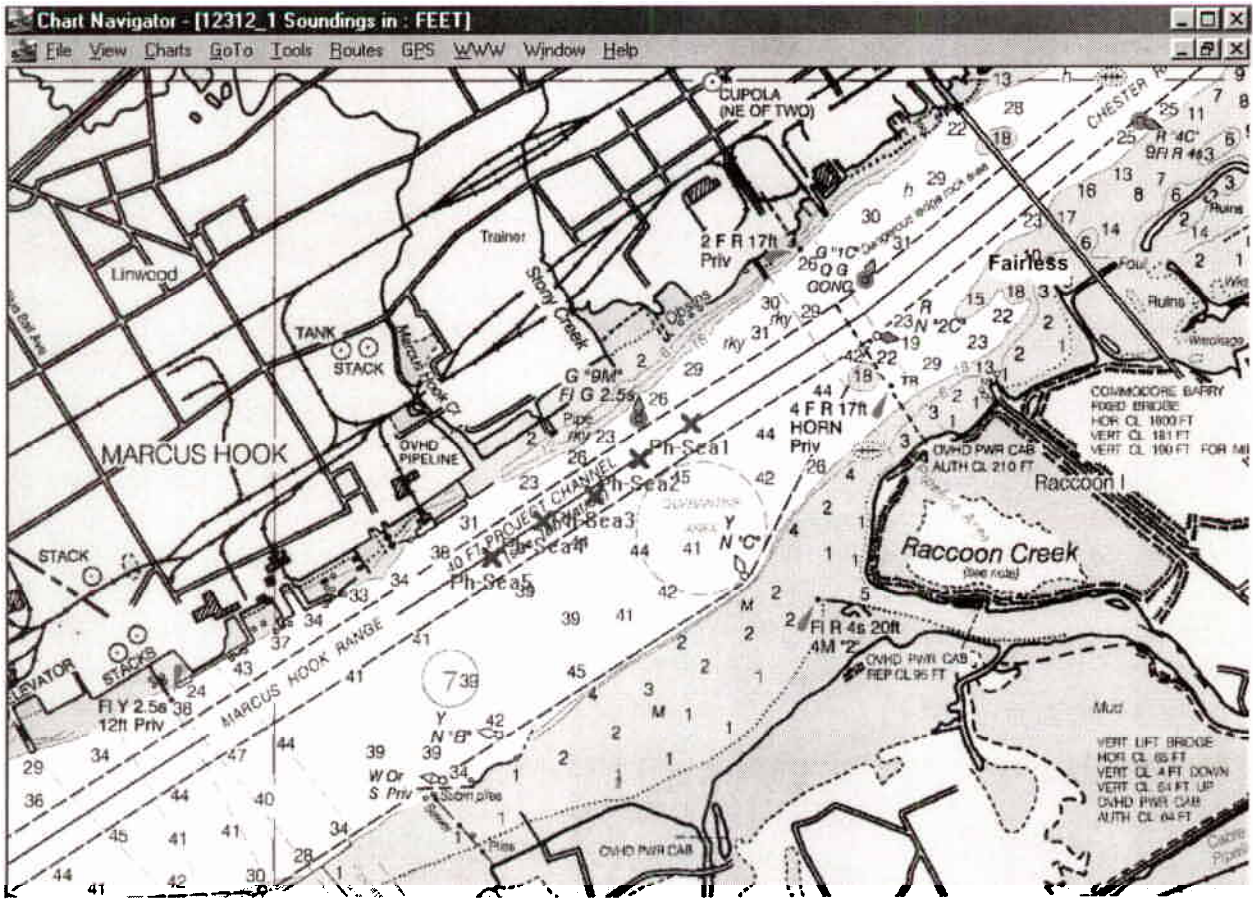

Figure 1-1. Study area map showing the sampling site locations within the Marcus Hook navigational range.

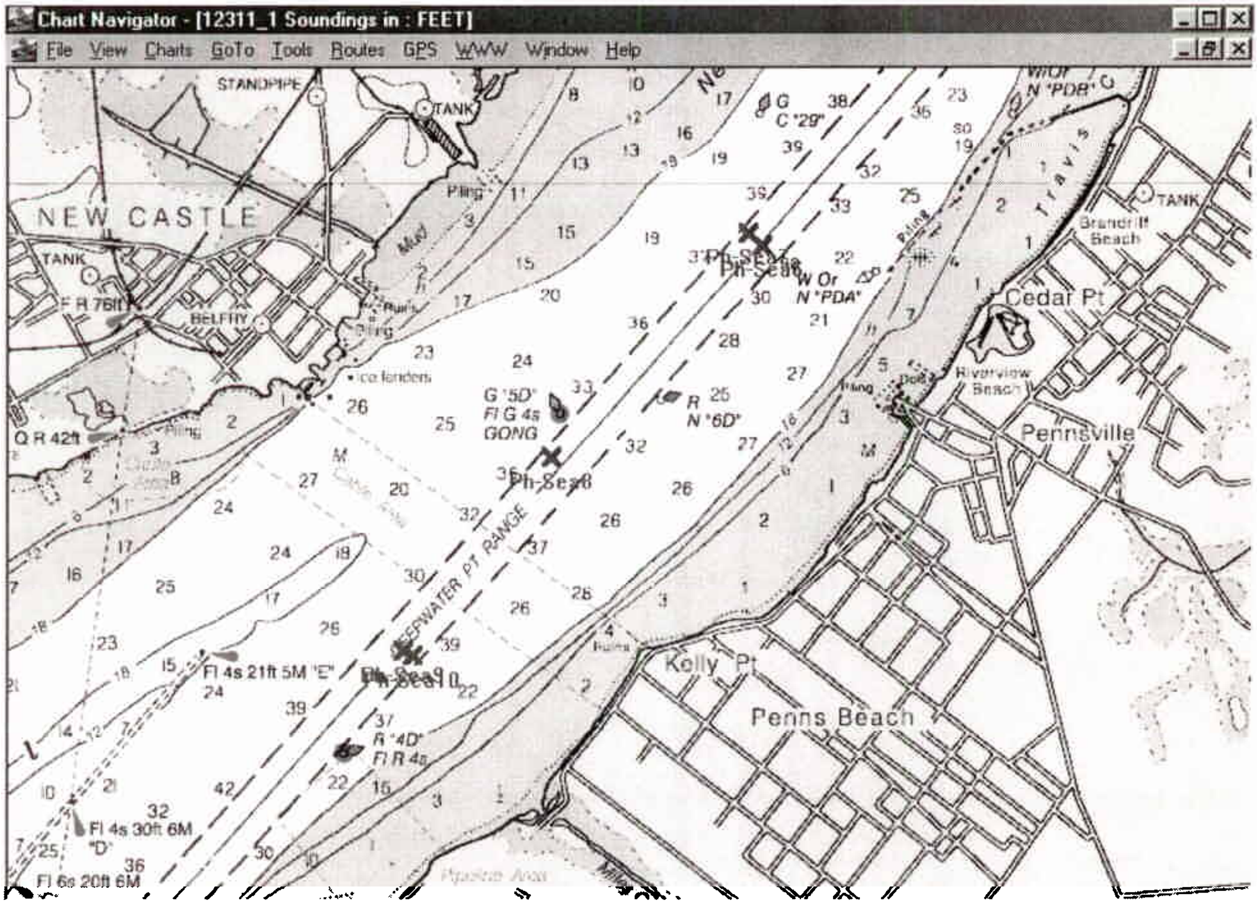

Figure 1-2. Study area map showing the sampling site locations within the Deepwater Point navigational range.

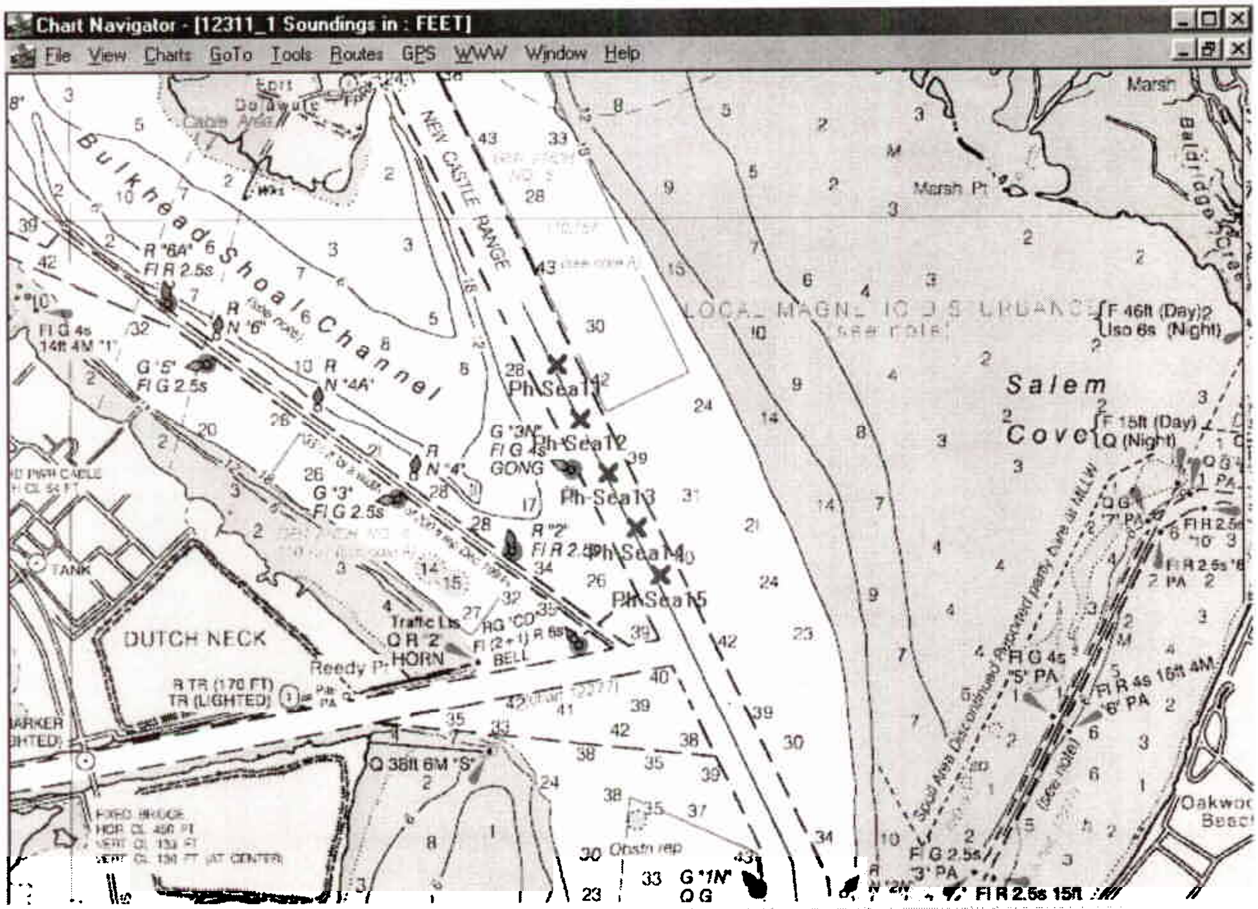

Figure 1-3. Study area map showing the sampling site locations within the New Castle navigational range.

2.0 METHODS

FIELD METHODS

Field crews collected sediment cores from fifteen stations in the Delaware River (Figs. 1-1 through 1-3) on September 4 and 5, 2003. Sediment coring locations were recorded with differential GPS. Sediment samples were collected with a 10-foot vibracore. The removable plastic liner of the vibracore allowed the sediment core to be removed from the device intact for sectioning. After retrieving the core, the plastic liners were cut longitudinally to remove sediment sub-samples. Material on the inside of the core that had not come in contact with the inner liner were extracted for laboratory analysis. The sediment samples were then homogenized in a decontaminated stainless steel bowl on-board and transferred to appropriate sample containers. The stainless steel handling equipment was decontaminated using a alocnox detergent wash, clean water rise, nitric acid rinse, isopropyl alcohol rinse, and clean water rinse. All samples were stored in the dark at 4 °C until analysis.

LABORATORY METHODS

Bulk sediment chemical analysis was performed on the samples derived from the sediment cores. Chemical analytical methods were consistent with New Jersey Department of Environmental Protection (NJDEP) and federal guidelines. The analytical methods and method detection limits for all parameters in the bulk sediment are presented in Tables 2-1 and 2-2. The chemical parameters for the bulk sediment analysis included organic and inorganic contaminants, and total organic carbon (TOC). All sediment contaminant concentrations are expressed as dry weights. Sample-specific detection limits varied because of matrix interference due to the moisture content of the sediments and the conversion from wet weight to dry weight for the bulk sediment tests.

Table 2-1. Parameter list, analytical methods, and detection limits for bulk sediment tests for inorganics.		
Parameter	**Bulk Analysis**	
	Analytical Test Method	**Method Detection Limit (mg/kg)**
Antimony	6010B	1.7
Arsenic	6010B	1.29
Beryllium	6010B	0.152
Cadmium	6010B	0.139
Chromium	6010B	0.516
Copper	6010B	0.49
Cyanide	9012	0.47
Lead	6010B	2.04
Mercury	6010B	0.0069
Nickel	6010B	0.516
Selenium	6010B	1.21
Silver	6010B	0.387
Thallium	6010B	2.4
Zinc	6010B	0.464
Total Organic Carbon (TOC)	415.1	200

Table 2-2. Parameter list, analytical methods, and detection limits for bulk sediment organic analytes.

Organic Analyte	Method	Method Detection Limit Bulk Analysis (µg/kg)	Organic Analyte	Method	Method Detection Limit Bulk Analysis (µg/kg)
Aldrin	8081A	13	4-Methylphenol	8270 C	870
Alpha BHC	8081A	4.5	4-Nitroaniline	8270 C	870
Alpha Chlordane	8081A	4.5	4-Nitrophenol	8270 C	2200
Beta BHC	8081A	4.5	Acenaphthene	8270 C	450
Delta BHC	8081A	4.5	Acenaphthylene	8270 C	450
Dieldrin	8081A	8.7	Anthracene	8270 C	450
Endosulfan I	8081A	12	Benzo(a)anthracene	8270 C	450
Endosulfan II	8081A	8.7	Benzo(a)pyrene	8270 C	450
Endosulfan Sulfate	8081A	8.7	Benzo(b)fluoranthene	8270 C	450
Endrin	8081A	13	Benzo(g,h,i)perylene	8270 C	450
Endrin Aldehyde	8081A	26	Benzo(k)fluoranthene	8270 C	450
Endrin Ketone	8081A	8.7	bis(2-Chloroethoxy)methane	8270 C	450
Gamma BHC - Lindane	8081A	4.5	bis(2-Chloroethyl)ether	8270 C	450
Gamma Chlordane	8081A	7.9	bis(2-Ethylhexyl)phthalate	8270 C	450
Heptachlor	8081A	4.5	Butylbenzylphthalate	8270 C	870
Heptachlor Epoxide	8081A	4.5	Carbazole	8270 C	870
p,p-DDD	8081A	15	Chrysene	8270 C	450
p,p-DDE	8081A	8.7	Dibenz(a,h)anthracene	8270 C	450
p,p-DDT	8081A	8.7	Dibenzofuran	8270 C	450
PCB-1016	8081A	87	Diethylphthalate	8270 C	870
PCB-1221	8081A	260	Dimethylphthalate	8270 C	870
PCB-1232	8081A	110	Di-n-butylphthalate	8270 C	870
PCB-1242	8081A	110	Di-n-octylphthalate	8270 C	870
PCB-1248	8081A	160	Fluoranthene	8270 C	450
PCB-1254	8081A	87	Fluorene	8270 C	450
PCB-1260	8081A	87	Hexachlorobenzene	8270 C	450
Toxaphene	8081A	290	Hexachlorobutadiene	8270 C	870
1,2,4-Trichlorobenzene	8270 C	450	Hexachlorocyclopentadiene	8270 C	2200
1,2-Dichlorobenzene	8270 C	450	Hexachloroethane	8270 C	450
1,3-Dichlorobenzene	8270 C	450	Indeno(1,2,3-cd)pyrene	8270 C	450
1,4-Dichlorobenzene	8270 C	450	Isophorone	8270 C	450
2,2'-oxybis(1-Chloropropane)	8270 C	450	Methoxychlor	8270 C	110
2,4,5-Trichlorophenol	8270 C	450	Naphthalene	8270 C	450
2,4,6-Trichlorophenol	8270 C	450	Nitrobenzene	8270 C	450
2,4-Dichlorophenol	8270 C	450	N-Nitroso-di-n-propylamine	8270 C	450
2,4-Dimethylphenol	8270 C	450	N-Nitrosodiphenylamine	8270 C	450
2,4-Dinitrophenol	8270 C	8700	Pentachlorophenol	8270 C	2200
2,4-Dinitrotoluene	8270 C	870	Phenanthrene	8270 C	450
2,6-Dinitrotoluene	8270 C	450	Phenol	8270 C	450
2-Chloronaphthalene	8270 C	450	Pyrene	8270 C	450
2-Chlorophenol	8270 C	450	1,1,1-Trichloroethane	8260 B	3
2-Methylnaphthalene	8270 C	450	1,1,2,2-Tetrachloroethane	8260 B	3
2-Methylphenol	8270 C	450	1,1,2-Trichloroethane	8260 B	3
2-Nitroaniline	8270 C	450	1,1-Dichloroethane	8260 B	3
2-Nitrophenol	8270 C	450	1,1-Dichloroethene	8260 B	3
3,3'-Dichlorobenzidine	8270 C	870	1,2-Dichloroethane	8260 B	3
3-Nitroaniline	8270 C	870	1,2-Dichloropropane	8260 B	3
4,6-Dinitro-2-methylphenol	8270 C	2200	2-Butanone	8260 B	11
4-Bromophenyl-phenylether	8270 C	450	2-Hexanone	8260 B	8
4-Chloro-3-methylphenol	8270 C	870	4-Methyl-2-pentanone	8260 B	8
4-Chloroaniline	8270 C	450	Acetone	8260 B	18
4-Chlorophenyl-phenylether	8270 C	450	Benzene	8260 B	3

Table 2-2. Cont'd					
Organic Analyte	Method	Method Detection Limit Bulk Analysis (µg/kg)	Organic Analyte	Method	Method Detection Limit Bulk Analysis (µg/kg)
Bromodichloromethane	8260 B	3	Ethylbenzene	8260 B	3
Bromoform	8260 B	3	Methylene Chloride	8260 B	5
Bromomethane	8260 B	5	Styrene	8260 B	3
Carbon Disulfide	8260 B	3	Tetrachloroethene	8260 B	3
Carbon Tetrachloride	8260 B	3	Toluene	8260 B	3
Chlorobenzene	8260 B	3	trans-1,2-Dichloroethene	8260 B	3
Chloroethane	8260 B	5	trans-1,3-Dichloropropene	8260 B	3
Chloroform	8260 B	3	Trichloroethene	8260 B	3
Chloromethane	8260 B	5	Vinyl Chloride	8260 B	3
cis-1,2-Dichloroethene	8260 B	3	Xylene (Total)	8260 B	3
cis-1,3-Dichloropropene	8260 B	3	Benzyl alcohol	8250 B	2200
Dibromochloromethane	8260 B	3	Dibenzofuran	8250 B	450

3.0 RESULTS AND DISCUSSION

CHARACTERIZATION OF SEDIMENT COLLECTED IN SEPTEMBER 2003

To assess the potential risks to human health once the dredged material is deposited in the upland disposal site, sediment contaminant concentrations were compared to the NJDEP Residential Direct Contact Soil Cleanup Criteria (residential) and Non-residential Direct Contact Soil Cleanup Criteria (non-residential). Total chromium was present at concentrations exceeding the non-residential for chromium at all sampling locations (Table 3-1). To be conservative total chromium concentrations were compared to the lower chromium VI soil cleanup criteria (if there was any chromium VI present in the sediments, it would be a smaller percentage of the total chromium). The total chromium levels were over the lowest value for non-residential soils published by NJDEP (20 mg/kg), and this value was established to protect humans with dermatitis from an allergic reaction. Thallium was present at concentrations exceeding both the residential and non-residential criteria in all but one sample (Ph-Sea2; Table 3-1).

Of the 126 sediment organic contaminant concentrations, 3 exceeded the residential criteria (Benzo(a)anthracene, Benzo(k)fluoranthene, and Indeno(1,2,3-cd)pyrene) and 3 exceeded the non-residential soil cleanup criteria (Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenz(a,h) anthracene). All these organic exceedances were observed in one samples from the Marcus Hook Navigational channel (Ph-Sea 1). This samples also had high levels of Benzo(g,h,i)perylene, Chrysene, Fluoranthene and Pyrene (Table 3-1). Organic detections below soil cleanup criteria in concentrations averaging about 200 μg/Kg were also observed in the remaining 14 samples for Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Fluoranthene, Phenanthrene, and Pyrene. Low levels of DDT breakdown components (DDE) were detected in most of the cores, while the PCB Aroclor 1260 was detected in two cores (Ph-Sea 9 and Ph-Sea 10) taken from the Deepwater Point range at concentrations of 160 and 110 μg/Kg, respectively.

COMPARISON OF CURRENT CONTAMINANT LEVELS TO HISTORICAL DATA

To evaluate any potential changes in the contaminant levels observed in maintenance dredge material slated for dredging in the fall of 2003 to levels observed in previous studies we compared the inorganic data to samples collected in the early 1990's for the Delaware Deepening Project (Table 3-2). From that database, the USACE Philadelphia District compiled the results of sediment testing conducted in 1991 and 1994 for the samples taken in the Marcus Hook, Deepwater Point, and New Castle ranges. The average concentrations and standard errors between the historical data and the current study are presented in Figures 3-1, 3-2, and 3-3 for each respective range. In addition, statistical tests were conducted to evaluate whether the

Table 3-1. Results of bulk sediment inorganic and organic analysis (dry weight) for the 15 samples collected from the Marcus Hook, Deepwater Point, and New Castle ranges of the Delaware River in September 2003.

		Marcus Hook					Deepwater					New Castle					New Jersey Residential SCC	**New Jersey Non-Residential SCC**
		Ph-Sea 1	Ph-Sea 2	Ph-Sea 3	Ph-Sea 4	Ph-Sea 5	Ph-Sea 6	Ph-Sea 7	Ph-Sea 8	Ph-Sea 9	Ph-Sea 10	Ph-Sea 11	Ph-Sea 12	Ph-Sea 13	Ph-Sea 14	Ph-Sea 15		
Antimony	MG/KG	<1.23	<0.781	<1.44	<1.71	<1.80	<1.42	<1.39	<1.32	<1.34	<1.39	<1.27	<1.44	<1.32	<1.31	<1.34	14	340
Arsenic	MG/KG	10.7	0.954	15.1	14.5	17.7	15.8	14.4	12.9	16.2	13.7	12.8	14.3	12.5	11.9	12.7	20	20
Beryllium	MG/KG	0.927	1.43	1.15	1.18	1.37	1.18	1.04	0.993	1.19	1.17	0.896	1	0.899	0.839	0.948	2	2
Cadmium	MG/KG	0.919	0.183	1.01	1.07	1.1	1.09	0.876	0.9	1.58	1.16	0.752	0.81	0.756	0.777	0.787	39	100
Chromium	MG/KG	**48.8**	**45.7**	**64.5**	**61.8**	**75.8**	**64.8**	**58.0**	**53.9**	**76.3**	**60.7**	**49.8**	**57.5**	**50.0**	**47.7**	**52.1**	240 [(b)] 270 [(c)]	6100 [(b)] 20 [(c)]
Copper	MG/KG	30.3	5.58	39.6	40.5	44.7	39.5	33.3	33.1	47.0	44.1	26.7	31.7	27.9	26.2	29.8	600	600
Cyanide (solid)	MG/KG	<0.33	<0.21	<0.39	<0.46	<0.48	<0.39	<0.37	<0.36	<0.36	<0.36	<0.35	<0.38	<0.37	<0.35	<0.37	1,100	21,000
Lead	MG/KG	42.8	13.1	52.7	55.0	63.0	55.3	44.4	43.7	71.7	60.4	35.5	41.4	37.1	34.6	40.0	400	600
Mercury	MG/KG	0.138	0.008	0.198	0.214	0.292	0.221	0.175	0.195	0.247	0.206	0.151	0.203	0.167	0.15	0.155	14	270
Nickel	MG/KG	28.0	23.2	33.6	32.5	38.5	34.4	29.3	27.9	35.6	33.6	25.4	29.3	26.1	24.1	26.9	250	2,400
Selenium	MG/KG	1.29	<0.556	1.87	1.92	2.73	1.57	1.78	1.34	1.56	1.85	1.62	1.31	1.66	1.76	2.07	63	3,100
Silver	MG/KG	0.501	<0.178	0.405	0.404	<0.408	0.471	<0.315	0.513	0.693	<0.316	<0.288	<0.327	<0.301	<0.298	<0.305	110	4,100
Thallium	MG/KG	**2.02**	<1.10	**3.77**	**4.5**	**4.05**	**3.19**	**3.51**	**3.35**	**3.13**	**4.15**	**3.18**	**3.61**	**2.96**	**3.19**	**2.39**	2	2
Zinc	MG/KG	187.	47.0	225.	243.	263.	234.	196.	204.	269.	245.	168.	187.	173.	163.	177.	1,500	1,500
1,1,1-Trichloroethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	210,000	1,000,000
1,1,2,2-Tetrachloroethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	34,000	70,000
1,1,2-Trichloroethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	22,000	420,000
1,1-Dichloroethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	570,000	1,000,000
1,1-Dichloroethene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	8,000	150,000
1,2,4-Trichlorobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	68,000	1,200,000
1,2-Dichlorobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	95	<70.	<66.	<73.	<69.	<67.	<69.	5,100,000	10,000,000
1,2-Dichloroethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	6,000	24,000
1,2-Dichloropropane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	10,000	43,000
1,3-Dichlorobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	5,100,000	10,000,000
1,4-Dichlorobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	570,000	10,000,000
2,2'-oxybis(1-Chloropropane)	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	NL	NL
2,4,5-Trichlorophenol	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	5,600,000	10,000,000
2,4,6-Trichlorophenol	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	62,000	270,000

Table 3-1. Cont'd

		Marcus Hook					Deepwater					New Castle					New Jersey Residential SCC	New Jersey Non-Residential SCC
		Ph-Sea 1	Ph-Sea 2	Ph-Sea 3	Ph-Sea 4	Ph-Sea 5	Ph-Sea 6	Ph-Sea 7	Ph-Sea 8	Ph-Sea 9	Ph-Sea 10	Ph-Sea 11	Ph-Sea 12	Ph-Sea 13	Ph-Sea 14	Ph-Sea 15		
2,4-Dichlorophenol	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	170,000	3,100,000
2,4-Dimethylphenol	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	1,100,000	10,000,000
2,4-Dinitrophenol	UG/KG	<1,300	<790	<1,500	<1,700	<1,800	<1,500	<1,400	<1,400	<1,400	<1,400	<1,300	<1,500	<1,400	<1,300	<1,400	110,000	2,100,000
2,4-Dinitrotoluene	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	1,000	4,000
2,6-Dinitrotoluene	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
2-Butanone	UG/KG	9	<5	12	<10	<11	15	11	15	30	17	13	13	16	12	10	1,000,000	1,000,000
2-Chloronaphthalene	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
2-Chlorophenol	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	280,000	5,200,000
2-Hexanone	UG/KG	<6	<4	<7	<8	<8	<7	<6	<6	<6	<6	<6	<7	<6	<6	<6	NL	NL
2-Methylnaphthalene	UG/KG	73	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
2-Methylphenol	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	2,800,000	10,000,000
2-Nitroaniline	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
2-Nitrophenol	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
3,3'-Dichlorobenzidine	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	2,000	6,000
3-Nitroaniline	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	NL	NL
4,6-Dinitro-2-methylphenol	UG/KG	<310	<200	<370	<430	<460	<370	<350	<350	<340	<350	<330	<360	<340	<330	<350	NL	NL
4-Bromophenyl-phenylether	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
4-Chloro-3-methylphenol	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	10,000,000	10,000,000
4-Chloroaniline	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	140	<70	<66	<73	<69	<67	<69	230,000	4,200,000
4-Chlorophenyl-phenylether	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
4-Methyl-2-pentanone	UG/KG	<6	<4	<7	<8	<8	<7	<6	<6	<6	<6	<6	<7	<6	<6	<6	1,000,000	1,000,000
4-Methylphenol	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	2,800,000	10,000,000
4-Nitroaniline	UG/KG	<130	<79	<150	<170	<180	<150	<140	<140	<140	<140	<130	<150	<140	<130	<140	NL	NL
4-Nitrophenol	UG/KG	<310	<200	<370	<430	<460	<370	<350	<350	<340	<350	<330	<360	<340	<330	<350	NL	NL
Acenaphthene	UG/KG	<63	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	3,400,000	10,000,000
Acenaphthylene	UG/KG	330	<39	<74	<86	<92	<73	<70	<69	<69	<70	<66	<73	<69	<67	<69	NL	NL
Acetone	UG/KG	51	<8	61	44	45	80	49	74	150	75	67	61	73	59	49	1,000,000	1,000,000
Aldrin	UG/KG	<9.6	<6.0	<11	<13	<14	<11	<11	<11	<10	<11	<10	<11	<11	<10	<11	40	170
Alpha BHC	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	NL	NL
Alpha Chlordane	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	NL	NL

Table 3-1. Cont'd

		Marcus Hook					Deepwater					New Castle					New Jersey Residential SCC	New Jersey Non-Residential SCC
		Ph-Sea 1	Ph-Sea 2	Ph-Sea 3	Ph-Sea 4	Ph-Sea 5	Ph-Sea 6	Ph-Sea 7	Ph-Sea 8	Ph-Sea 9	Ph-Sea 10	Ph-Sea 11	Ph-Sea 12	Ph-Sea 13	Ph-Sea 14	Ph-Sea 15		
Anthracene	UG/KG	580	<39.	79	<86.	<92.	<73.	<70.	<69.	<69.	98	<66.	<73.	<69.	<67.	<69.	10,000,000	10,000,000
Benzene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	3,000	13,000
Benzo(a)anthracene	UG/KG	6,300.	<39.	140	180	180	130	100	190	130	210	84	90	92	140	120	900	4,000
Benzo(a)pyrene	UG/KG	5,700.	<39.	180	230	200	150	120	200	180	260	99	100	100	150	130	660	660
Benzo(b)fluoranthene	UG/KG	4,100.	<39.	230	320	260	210	160	260	220	330	150	150	140	200	180	900	4,000
Benzo(g,h,i)perylene	UG/KG	2,500.	<39.	110	140	120	93	83	110	110	160	<66.	<73.	<69.	84	80	NL	NL
Benzo(k)fluoranthene	UG/KG	1,400.	<39.	94	120	94	85	76	100	92	140	<66.	<73.	<69.	81	72	900	4,000
Beta BHC	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	NL	NL
bis(2-Chloroethoxy)methane	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	NL	NL
bis(2-Chloroethyl)ether	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	660	3,000
bis(2-Ethylhexyl)phthalate	UG/KG	400	<79.	270	330	240	260	200	340	550	310	<130.	<150.	<140.	180	170	49,000	210,000
Bromodichloromethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	11,000	46,000
Bromoform	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	86,000	370,000
Bromomethane	UG/KG	<4.	<2.	<4.	<5.	<6.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	79,000	1,000,000
Butylbenzylphthalate	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	1,100,000	10,000,000
Carbazole	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	NL	NL
Carbon Disulfide	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	NL	NL
Carbon Tetrachloride	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	2,000	4,000
Chlorobenzene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	37,000	680,000
Chloroethane	UG/KG	<4.	<2.	<4.	<5.	<6.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	NL	NL
Chloroform	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	19,000	28,000
Chloromethane	UG/KG	<4	<2.	<4.	<5.	<6.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	520,000	1,000,000
Chrysene	UG/KG	5,700	<39.	160	200	180	170	110	170	150	220	90	97	92	170	150	9,000	40,000
cis-1,2-Dichloroethene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	79,000	1,000,000
cis-1,3-Dichloropropene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	4,000	5,000
Delta BHC	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	NL	NL
Dibenz(a,h)anthracene	UG/KG	700.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	660	660
Dibenzofuran	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	NL	NL
Dibromochloromethane	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	110,000	1,000,000
Dieldrin	UG/KG	<6.2	<3.9	<7.3	<8.5	<9.1	<7.2	<6.9	<6.8	<6.8	<6.9	<6.5	<7.2	<6.8	<6.6	<6.8	42	180

Table 3-1. Cont'd

		Marcus Hook					Deepwater					New Castle						
		Ph-Sea 1	Ph-Sea 2	Ph-Sea 3	Ph-Sea 4	Ph-Sea 5	Ph-Sea 6	Ph-Sea 7	Ph-Sea 8	Ph-Sea 9	Ph-Sea 10	Ph-Sea 11	Ph-Sea 12	Ph-Sea 13	Ph-Sea 14	Ph-Sea 15	New Jersey Residential SCC	New Jersey Non-Residential SCC
Diethylphthalate	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	10,000,000	10,000,000
Dimethylphthalate	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	10,000,000	10,000,000
Di-n-butylphthalate	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	5,700,000	10,000,000
Di-n-octylphthalate	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	1,100,000	10,000,000
Endosulfan I	UG/KG	<8.3	<5.2	<9.8	<11.	<12.	<9.6.	<9.2	<9.1	<9.1	<9.3	<8.7	<9.6.	<9.1	<8.8	<9.1	340,000	6,200,000
Endosulfan II	UG/KG	<6.2	<3.9	<7.3	<8.5	<9.1	<7.2	<6.9	<6.8	<6.8	<6.9	<6.5	<7.2	<6.8	<6.6	<6.8	340,000	6,200,000
Endosulfan Sulfate	UG/KG	<6.2	<3.9	<7.3	<8.5	<9.1	<7.2	<6.9	<6.8	<6.8	<6.9	<6.5	<7.2	<6.8	<6.6	<6.8	NL	NL
Endrin	UG/KG	<9.4	<5.9	<11.	<13.	<14.	<11.	<11.	<10.	<10.	<11.	<9.9	<11.	<10.	<10.	<10.	17,000	310,000
Endrin Aldehyde	UG/KG	<19.	<12	<22.	<26.	<27.	<22.	<21.	<21.	<21.	<21.	<20.	<22.	<21.	<20.	<21.	NL	NL
Endrin Ketone	UG/KG	<6.2	<3.9	<7.3	<8.5	<9.1	<7.2	<6.9	<6.8	<6.8	<6.9	<6.5	<7.2	<6.8	<6.6	<6.8	NL	NL
Ethylbenzene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	1,000,000	1,000,000
Fluoranthene	UG/KG	5,500.	<39	260	380	280	260	180	300	260	400	170	160	160	250	220	2,300,000	10,000,000
Fluorene	UG/KG	81	<39	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	2,300,000	10,000,000
Gamma BHC - Lindane	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	520	2,200
Gamma Chlordane	UG/KG	<5.7	<3.6	<6.7	<7.8	<8.2	<6.6	<6.3	<6.2	<6.2	<6.3	<5.9	<6.5	<6.2	<6.0	<6.2	NL	NL
Heptachlor	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	150	650
Heptachlor Epoxide	UG/KG	<3.2	<2.0	<3.8	<4.4	<4.7	<3.7	<3.6	<3.5	<3.5	<3.6	<3.4	<3.7	<3.5	<3.4	<3.5	NL	NL
Hexachlorobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	660	2,000
Hexachlorobutadiene	UG/KG	<130.	<79.	<150.	<170.	<180.	<150.	<140.	<140.	<140.	<140.	<130.	<150.	<140.	<130.	<140.	1,000	21,000
Hexachlorocyclopentadiene	UG/KG	<310.	200.	<370.	<430.	<460.	<370.	<350.	<350.	<340.	<350.	<330.	<360.	<340.	<330.	<350.	400,000	7,300,000
Hexachloroethane	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	6,000	100,000
Indeno(1,2,3-cd)pyrene	UG/KG	1,900.	<39.	100	140	110	91	75	110	100	160	<66.	<73.	<69.	80	77	900	4,000
Isophorone	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	1,100,000	1,000,000
Methoxychlor	UG/KG	<75.	<47.	<89.	<100.	<110.	<88.	<84.	<83.	<82.	<84.	<79.	<87.	<83.	<80.	<83.	280,000	5,200,000
Methylene Chloride	UG/KG	11.	2	6	7	<6.	6	<4.	6	6	7	8	8	5	6	7	49,000	210,000
Naphthalene	UG/KG	110	<39.	<74.	94	110	90	<70.	76	110	<70.	<66.	<73.	<69.	<67.	<69.	230,000	4,200,000
Nitrobenzene	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	28,000	520,000
N-Nitroso-di-n-propylamine	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	660	660
N-Nitrosodiphenylamine	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	140,000	600,000
p,p-DDD	UG/KG	<11.	<6.9	<13.	38	34	60.	34	27	20	54.	<11.	<13.	<12.	<12.	<12.	3,000	12,000

Table 3-1. Cont'd

		Marcus Hook					Deepwater					New Castle					New Jersey Residential SCC	New Jersey Non-Residential SCC
		Ph-Sea 1	Ph-Sea 2	Ph-Sea 3	Ph-Sea 4	Ph-Sea 5	Ph-Sea 6	Ph-Sea 7	Ph-Sea 8	Ph-Sea 9	Ph-Sea 10	Ph-Sea 11	Ph-Sea 12	Ph-Sea 13	Ph-Sea 14	Ph-Sea 15		
p,p-DDE	UG/KG	29	<3.9	30	35	31	28	22	25	89.	34	12	14	13	14	10	2,000	9,000
p,p-DDT	UG/KG	<6.2	<3.9	<7.3	<8.5	<9.1	190.	33	<6.8	<6.8	<6.9	<6.5	<7.2	<6.8	<6.6	<6.8	2,000	9,000
PCB-1016	UG/KG	<62.	<39.	<73.	<85.	<91.	<72.	<69.	<68.	<68.	<69.	<65.	<72.	<68.	<66.	<68.	NL	NL
PCB-1221	UG/KG	<190.	<120.	<220.	<260.	<270.	<220.	<210.	<210.	<210.	<210.	<200.	<220.	<210.	<200.	<210.	NL	NL
PCB-1232	UG/KG	<81.	<51.	<96.	<110.	<120.	<94.	<90.	<89.	<88.	<91.	<85.	<94.	<89.	<86.	<89.	NL	NL
PCB-1242	UG/KG	<75.	<47.	<89.	<100.	<110.	<88.	<84.	<83.	<82.	<84.	<79.	<87.	<83.	<80.	<83.	NL	NL
PCB-1248	UG/KG	<110.	<71.	<130.	<160.	<160.	<130.	<130.	<120.	<120.	<130.	<120.	<130.	<120.	<120.	<120.	NL	NL
PCB-1254	UG/KG	<62.	<39.	<73.	<85.	<91.	<72.	<69.	<68.	<68.	<69.	<65.	<72.	<68.	<66.	<68.	NL	NL
PCB-1260	UG/KG	<62.	<39.	<73.	<85.	<91.	<72.	<69.	<68.	160	110	<65.	<72.	<68.	<66.	<68.	NL	NL
Pentachlorophenol	UG/KG	<310.	<200.	<370.	<430.	<460.	<370.	<350.	<350.	<340.	<350.	<330.	<360.	<340.	<330.	<350.	6,000	24,000
Phenanthrene	UG/KG	290	<39.	150	210	160	160	110	140	180	220	88	86	98	150	120	NL	NL
Phenol	UG/KG	<63.	<39.	<74.	<86.	<92.	<73.	<70.	<69.	<69.	<70.	<66.	<73.	<69.	<67.	<69.	10,000,000	10,000,000
Pyrene	UG/KG	7,100.	<39.	250	340	290	250	190	280	260	400	140	160	150	220	190	1,700,000	10,000,000
Styrene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	23,000	97,000
Tetrachloroethene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	4,000	6,000
Toluene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	4	2.	1,000,000	1,000,000
Toxaphene	UG/KG	<210.	<130.	<240.	<280.	<300.	<240.	<230.	<230.	<230.	<230.	<220.	<240.	<230.	<220.	<230.	100	200
trans-1,2-Dichloroethene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	1,000,000	1,000,000
trans-1,3-Dichloropropene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	4,000	5,000
Trichloroethene	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	23,000	54,000
Vinyl Chloride	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	2,000	7,000
Xylene (Total)	UG/KG	<2.	<1.	<2.	<3.	<3.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.	410,000	1,000,000

NL - Not listed

(a) The lower of the soil criteria for chromium III chromium VI were used – chromium VI was lower under these conditions

(b) Criterion based on the inhalation exposure pathway

(c) Site specific determination required for SCC for the allergic contact dermatitis exposure pathway

< - Not detected

Bold type indicates sample exceeds NJDEP Non-residential

Shaded cells indicate sample exceeds NJDEP Residential

Table 3-2. Historic inorganic contaminant data (mg/Kg) relative to the September 2003 samples collected in the Delaware River Philadelphia to the Sea Navigation Channel.

Sample #	Date	Lab	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Marcus Hook															
DRV-5	1991	B-H Labs	22.0	1.29	0.50	1.0	8.0	13.5	14.5	0.019	14.5	0.125	0.50	2.5	56.0
DRV-6	1991	B-H Labs	21.5	2.65	1.0	1.0	12.0	21.0	36.5	0.153	17.0	0.125	0.50	2.5	115.0
DRV-7-0.0	1994	BCM	0.437	11.6	0.727	2.970	--	21.00	44.80	0.381	21.00	90.2	0.437	0.088	126.0
DRV-7-5.0	1994	BCM	0.390	5.25	0.614	2.180	--	5.86	22.10	0.078	17.80	101.0	1.140	0.078	50.3
DRV-8-0.0	1994	BCM	0.445	9.57	0.662	2.600	--	19.80	41.80	0.196	19.90	80.1	0.445	0.089	130.0
DRV-8-5.0	1994	BCM	0.387	5.88	0.647	2.430	--	7.54	20.30	0.078	18.40	86.8	0.387	0.078	51.4
DRV-7	1991	B-H Labs	32.0	0.35	1.0	1.0	6.5	13.5	10.0	0.056	24.5	0.125	0.50	9.0	47.0
		Historical mean	11.0	5.2	0.7	1.9	8.8	14.6	27.1	0.1	19.0	51.2	0.6	2.0	82.2
		se	1.95	0.60	0.03	0.12	0.95	0.90	1.97	0.02	0.46	6.88	0.04	0.47	5.59
1	2003	Lancaster	1.23	10.70	0.93	0.92	48.80	30.30	42.80	0.14	28.00	1.29	0.50	2.02	187.00
2	2003	Lancaster	0.78	0.95	1.43	0.18	45.70	5.58	13.10	0.01	23.20	0.56	0.18	1.10	47.00
3	2003	Lancaster	1.44	15.10	1.15	1.01	64.50	39.60	52.70	0.20	33.60	1.87	0.41	3.77	225.00
4	2003	Lancaster	1.71	14.50	1.18	1.07	61.80	40.50	55.00	0.21	32.50	1.92	0.40	4.50	243.00
5	2003	Lancaster	1.80	17.70	1.37	1.10	75.80	44.70	63.00	0.29	38.5	2.73	0.41	4.05	263.00
		Current mean	1.39	11.79	1.05	0.86	59.32	32.14	45.32	0.17	29.33	1.41	0.38	3.09	193.00
		se	0.08	1.31	0.09	0.08	2.45	3.15	3.88	0.02	1.19	0.16	0.02	0.29	17.26
Deepwater Point															
DRV10-0.0	1994	BCM	0.710	26.5	0.541	4.820	--	46.60	94.30	0.470	32.60	121.0	1.410	0.202	287.0
DRV10-7.5	1994	BCM	0.481	8.96	0.875	3.650	--	9.81	32.70	0.096	25.80	136.0	1.270	0.096	72.9
DRV11-0.0	1994	BCM	0.520	13.9	0.863	3.420	--	25.30	52.40	0.104	26.30	103.0	1.190	0.104	163.0
DRV11-5.0	1994	BCM	0.477	11	0.859	3.280	--	9.35	29.20	0.096	25.20	119.0	1.110	0.096	66.8
DRV-11	1991	B-H Labs	12.5	2.32	1.0	1.0	12.5	20.0	27.5	0.172	16.5	0.125	0.50	2.5	110.0
		Historical mean	2.94	12.54	0.83	3.23	12.50	22.21	47.22	0.19	25.28	95.83	1.10	0.60	139.94
		se	1.34	2.22	0.04	0.35	--	3.81	7.04	0.04	1.44	13.69	0.09	0.27	22.67
6	2003	Lancaster	1.42	15.80	1.18	1.09	64.80	39.50	55.30	0.221	34.40	1.57	0.47	3.19	234.00
7	2003	Lancaster	1.39	14.40	1.04	0.88	58.00	33.30	44.40	0.18	29.30	1.78	0.32	3.51	196.00
8	2003	Lancaster	1.32	12.90	0.99	0.90	53.90	33.10	43.70	0.20	27.90	1.34	0.51	3.35	204.00
9	2003	Lancaster	1.34	16.20	1.19	1.58	76.30	47.00	71.70	0.247	35.60	1.56	0.69	3.13	269.00
10	2003	Lancaster	1.39	13.70	1.17	1.16	60.70	44.10	60.40	0.206	33.60	1.85	0.32	4.15	245.00
		Current mean	1.37	14.60	1.02	0.89	62.74	39.40	55.10	0.19	32.16	1.62	0.46	3.47	229.60
		se	0.01	0.28	0.02	0.01	1.71	1.25	2.34	0.01	0.67	0.04	0.03	0.08	5.99

Table 3-2. Cont'd

Sample #	Date	Lab	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
New Castle															
DRV12-0.0	1994	BCM	0.277	1.4	0.164	0.99	--	3.94	7.28	0.056	6.11	26.5	0.277	0.056	17.7
DRV12-3.0	1994	BCM	0.264	0.811	0.197	0.929	--	4.95	8.48	0.053	7.68	25.2	0.264	0.053	20.2
DRV-12	1991	B-H Labs	19.0	1.73	1.0	1.0	8.0	13.0	19.5	0.132	13.0	0.125	0.50	2.5	80.0
		Historical mean	6.51	1.31	0.45	0.97	8.00	7.30	11.75	0.08	8.93	17.28	0.35	0.87	39.30
		se	3.60	0.16	0.16	0.01	--	1.65	2.25	0.01	1.20	4.96	0.04	0.47	11.76
11	2003	Lancaster	1.27	12.80	0.90	0.75	49.80	26.70	35.50	0.15	25.40	1.62	0.29	3.18	168.00
12	2003	Lancaster	1.44	14.30	1.00	0.81	57.50	31.70	41.40	0.20	29.30	1.31	0.33	3.61	187.00
13	2003	Lancaster	1.32	12.50	0.90	0.76	50.00	27.90	37.10	0.17	26.10	1.66	0.30	2.96	173.00
14	2003	Lancaster	1.31	11.90	0.84	0.78	47.70	26.20	34.60	0.15	24.10	1.76	0.30	3.19	163.00
15	2003	Lancaster	1.34	12.70	0.95	0.79	52.10	29.80	40.00	0.16	26.90	2.07	0.31	2.39	177.00
		Current mean	1.34	12.84	0.92	0.78	51.42	28.46	37.72	0.17	26.36	1.59	0.30	3.07	173.60
		se	0.01	0.18	0.01	0.00	0.75	0.46	0.58	0.00	0.39	0.05	0.00	0.09	1.83

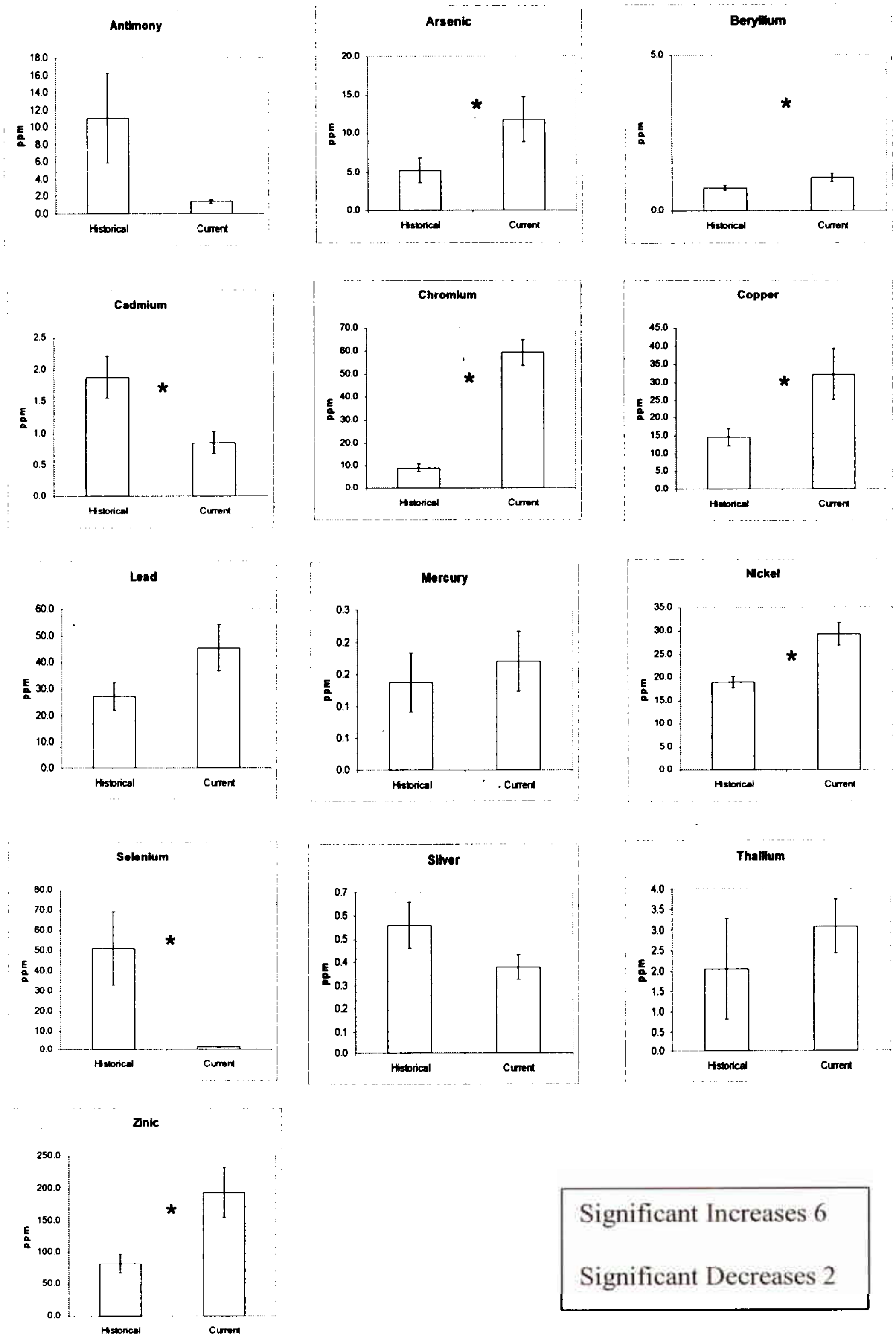

Figure 3-1. Comparison of historical and current concentrations of inorganic contaminants observed in the Marcus Hook navigational range of the Delaware River. The asterisks indicate whether the observed differences were statistically significant.

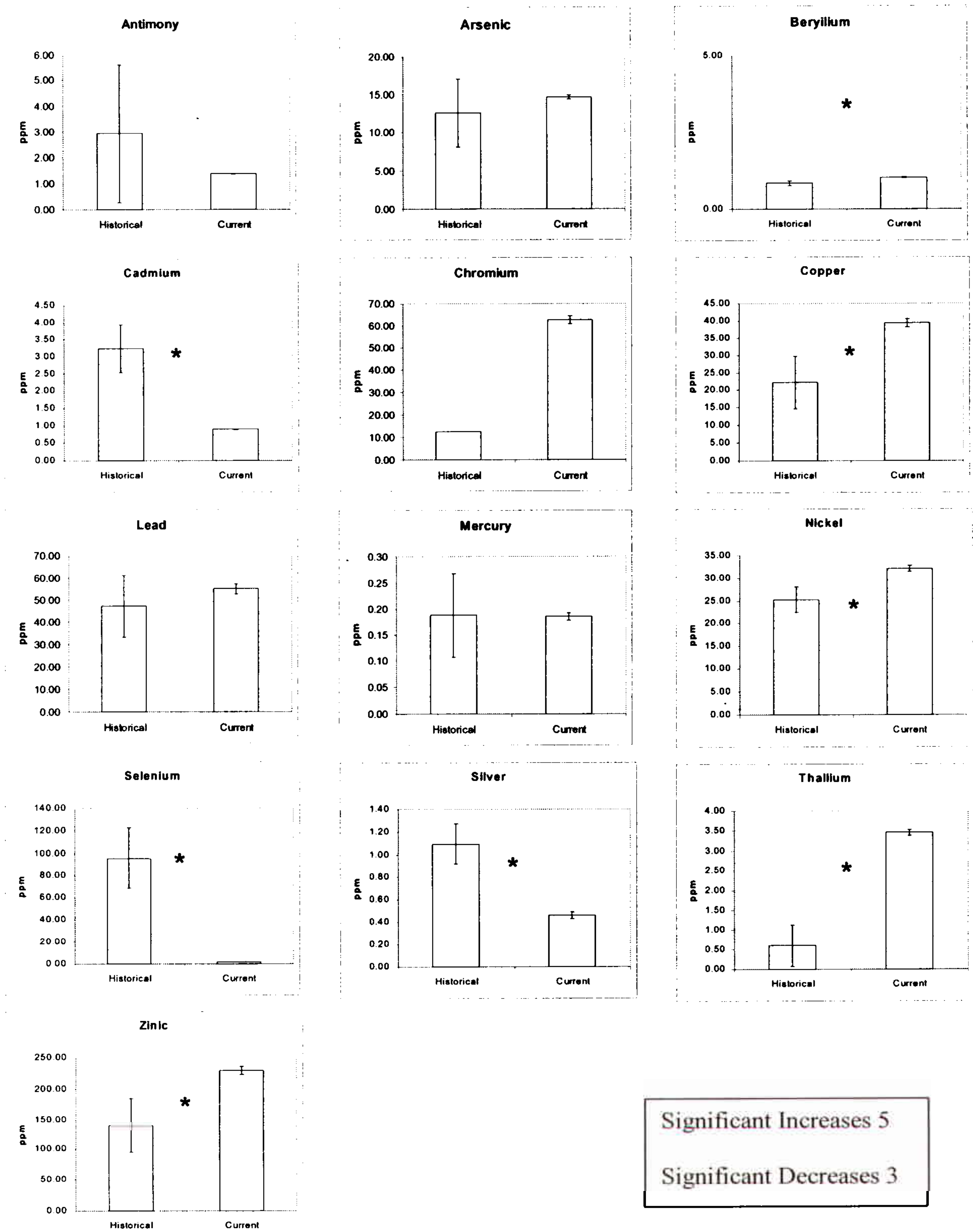

Figure 3-2. Comparison of historical and current concentrations of inorganic contaminants observed in the Deepwater Point navigational range of the Delaware River. The asterisks indicate whether the observed differences were statistically significant.

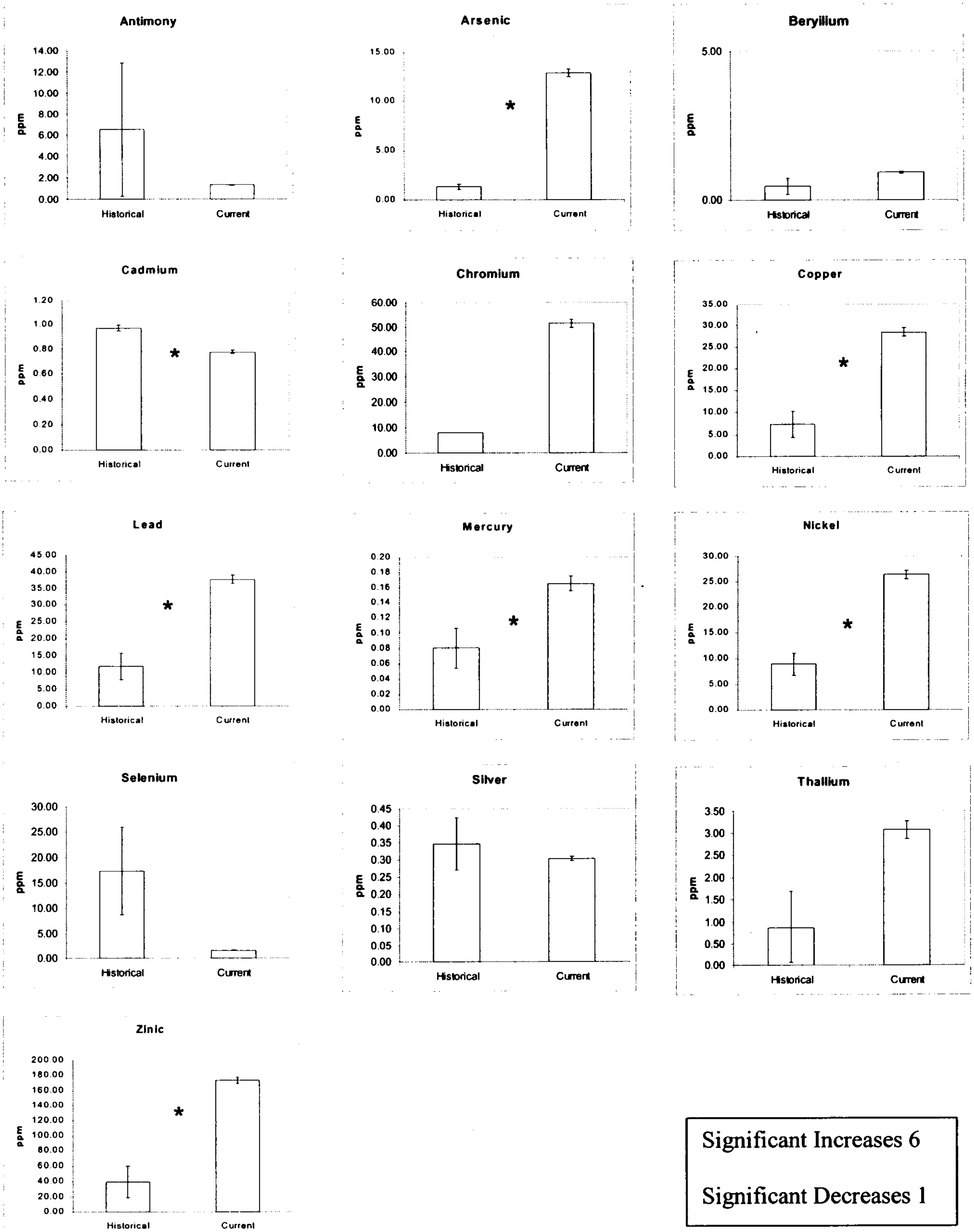

Figure 3-3. Comparison of historical and current concentrations of inorganic contaminants observed in the New Castle navigational range of the Delaware River. The asterisks indicate whether the observed differences were statistically significant.

differences among the historical and current mean concentrations observed within each navigational range were significant. In the Marcus Hook range, statistical testing suggested that the 6 inorganic contaminants increased in concentration (Arsenic, Beryllium, Chromium, Copper, Nickel, and Zinc) while Cadmium and Selenium decreased in concentration (Figure 3-1). At the Deepwater Point Range five inorganics (Beryllium, Copper, Nickel, Thallium, and Zinc) increased in the current sampling while Cadmium, Selenium, and Silver decreased (Figure 3-2). The largest number of increases were observed in the New Castle range where six inorganics (Arsenic, Copper , Lead, Mercury, Nickel, and Zinc) increased and only Cadmium significantly decreased relative to the historical data set (Figure 3-3). However, it should be noted that the number of observations within each navigational range for each time period was relatively low (≤ 5) so the statistical testing results should be viewed with caution.

Organic contaminant data from the historical studies were also compiled for comparison to the September 2003 samples (Table 3-3). However because detections limits for the historical data were about 10 times higher than the current study an evaluation of potential contaminant changes was not possible.

3.3 GRAIN SIZE ANALYSIS

Grain size analysis was performed in Versar's sediment lab. Results are presented in accordance with the Unified Soil Classification System (USCS), and grain size results graphs are provided in the Appendix. The sediment composition of the samples ranged from 14 to 91% silt clays (Table 3-4). Percent Total Organic Carbon (TOC) was generally low in all six samples ranging from 1.5 to 13%.

Table 3-3. Historical organic contaminant data (µg/Kg) collected in the Delaware River Philadelphia to the Sea Navigation Channel.

	Marcus Hook							Deepwater Point					New Castle		
	1991	1991	1994	1994	1994	1994	1991	1994	1994	1994	1994	1991	1994	1994	1991
	5	6	7-0.0	7-5.0	8-0.0	8-5.0	7	10-0.0	10-7.5	11-0.0	11-5.0	11	12-0.0	12-3.0	
PAHs															
Acenaphthylene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Anthracene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Benzo(a)anthracene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Benzo(a)pyrene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Benzo(b)fluoranthene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Benzo(g,h,I)perylene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Benzo(k)fluoranthene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Chrysene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Dibenz(a,h)anthracene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Fluoranthene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Fluorene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Indeno(1,2,3-cd)pyrene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Naphthalene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Phenanthrene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330
Pyrene	< 330	< 330	< 577	< 514	< 587	< 511	< 330	< 1340	< 635	< 683	< 630	< 330	< 365	< 348	< 330

Table 3-3. Cont'd

	Marcus Hook							Deepwater Point					New Castle		
	1991	1991	1994	1994	1994	1994	1991	1994	1994	1994	1994	1991	1994	1994	1991
	5	6	7-0.0	7-5.0	8-0.0	8-5.0	7	10-0.0	10-7.5	11-0.0	11-5.0	11	12-0.0	12-3.0	12
Lab Contaminants															
2-Butanone	NA	NA	< 17.5	< 15.6	< 17.8	< 15.5	NA	< 20.2	< 19.2	82.8	< 19.1	NA	< 11.1	< 10.5	NA
Acetone	NA	NA	< 17.5	< 15.6	85.4	< 263.0	NA	< 324.0	< 250.0	352.0	124.0	NA	16.6	< 10.5	NA
bis(2-Ethylhexyl)phthalate	NA	NA	< 577	< 514	< 587	< 511	NA	< 1340	< 635	< 683	< 630	NA	< 365	< 348	NA
Methylene Chloride	NA	NA	< 8.74	< 7.79	< 8.90	< 7.74	NA	< 10.10	< 9.62	< 10.40	< 9.54	NA	< 5.53	< 5.27	NA
Pesticides/PCBs															
p,p-DDD	NA	NA	< 28.0	< 24.9	< 28.5	< 24.8	NA	< 32.4	< 30.8	< 33.1	< 30.5	NA	< 17.7	< 16.9	NA
p,p-DDE	NA	NA	< 28.0	< 24.9	< 28.5	< 24.8	NA	< 32.4	< 30.8	< 33.1	< 30.5	NA	< 17.7	< 16.9	NA
p,p-DDT	< 100	< 100	< 28.0	< 24.9	< 28.5	< 24.8	< 100	< 32.4	< 30.8	< 33.1	< 30.5	< 100	< 17.7	< 16.9	< 100
PCB-1260	< 500	< 500	< 280	< 249	< 285	< 248	< 500	< 324	< 308	< 331	< 305	< 500	< 177	< 169	< 500
Infrequent Detections (1/2)															
1,2-Dichlorobenzene	NA	NA	< 577	< 514	< 587	< 511	NA	< 1340	< 635	< 683	< 630	NA	< 365	< 348	NA
2-Methylnaphthalene	NA	NA	< 577	< 514	< 587	< 511	NA	< 1340	< 635	< 683	< 630	NA	< 365	< 348	NA
4-Chloroaniline	NA	NA	< 577	< 514	< 587	< 511	NA	< 1340	< 635	< 683	< 630	NA	< 365	< 348	NA
Hexachlorocyclopentadiene	NA	NA	< 577	< 514	< 587	< 511	NA	< 1340	< 635	< 683	< 630	NA	< 365	< 348	NA
Toluene	NA	NA	< 8.74	< 7.79	< 8.90	< 7.74	NA	< 10.10	< 9.62	< 10.40	< 9.54	NA	< 5.53	< 5.27	NA

NA = not analyzed

Table 3-4. Silt/clay content and Total Organic Content (TOC) for samples collected from Marcus Hook, Deepwater Point, and the New Castle ranges in September 2003

Sample	Percent Silt/Clay	Percent TOC
Ph-Sea 1	14.28	2.42
Ph-Sea 2	44.54	6.16
Ph-Sea 3	81.23	7.27
Ph-Sea 4	85.09	8.41
Ph-Sea 5	90.99	7.44
Ph-Sea 6	81.21	8.00
Ph-Sea 7	61.03	5.76
Ph-Sea 8	66.80	6.99
Ph-Sea 9	71.98	12.61
Ph-Sea 10	76.26	11.08
Ph-Sea 11	46.96	5.83
Ph-Sea 12	65.73	6.98
Ph-Sea 13	48.39	6.66
Ph-Sea 14	57.29	3.96
Ph-Sea 15	49.39	1.51

3.4 EQUIPMENT BLANK

An equipment blank was taken midway through sampling by pouring deionized water into a decontaminated bowl, stirring the water with a stainless steel spoon, and then pouring the water into the sample collection container. Of the 141 inorganic and organic contaminant concentrations no contaminants were detected in the equipment blank (Table 3-5).

Table 3-5. Results of inorganic and organic analysis for the equipment blank taken during the sediment sample collection in the Marcus Hook, Deepwater Point, and New Castle ranges in September 2003. NL - Not listed

Analysis name	Equipment	DRBCFreshwater Acute	DRBC Freshwater Chronic	
Inorganics				
Antimony		< 0.0085	NL	NL
Arsenic TR		< 0.0049	0.36	0.19
Beryllium		< 0.00034	NL	NL
Cadmium		< 0.00087	0.008	0.002
Chromium		< 0.0022	0.016	0.011
Copper		< 0.0021	0.033	0.021
Cyanide (water)		< 0.0093	0.022	0.0052
Lead TR	mg/L	< 0.00016	0.048	0.016
Mercury		< 0.0038	0.002	0.000012
Nickel		< 0.0047	2.474	0.275
Selenium TR		< 0.0018	0.020	0.005
Silver		< 0.0089	0.013	NL
Thallium TR		0.0069	NL	NL
Total Suspended Solids		< 0.0085	NL	NL
Zinc		< 0.0049	0.204	0.185
Organics				
1,1,1-Trichloroethane		< 0.8	NL	NL
1,1,2,2-Tetrachloroethane		< 1	NL	NL
1,1,2-Trichloroethane		< 0.8	NL	NL
1,1-Dichloroethane		< 1	NL	NL
1,1-Dichloroethene		< 0.8	NL	NL
1,2,4-Trichlorobenzene		< 1	NL	NL
1,2-Dichlorobenzene		< 1	NL	NL
1,2-Dichloroethane		< 1	NL	NL
1,2-Dichloropropane		< 1	NL	NL
1,3-Dichlorobenzene		< 1	NL	NL
1,4-Dichlorobenzene		< 1	NL	NL
2,2'-oxybis(1-Chloropropane)		< 1	NL	NL
2,4,5-Trichlorophenol		< 1	NL	NL
2,4,6-Trichlorophenol		< 1	NL	NL
2,4-Dichlorophenol	µg/l	< 1	NL	NL
2,4-Dimethylphenol		< 1	NL	NL
2,4-Dinitrophenol		< 19	NL	NL
2,4-Dinitrotoluene		< 1	NL	NL
2,6-Dinitrotoluene		< 1	NL	NL
2-Butanone		< 3	NL	NL
2-Chloronaphthalene		< 1	NL	NL
2-Chlorophenol		< 1	NL	NL
2-Hexanone		< 3	NL	NL
2-Methylnaphthalene		< 1	NL	NL
2-Methylphenol		< 1	NL	NL
2-Nitroaniline		< 1	NL	NL
2-Nitrophenol		< 1	NL	NL
3,3'-Dichlorobenzidine		< 1	NL	NL
3-Nitroaniline		< 1	NL	NL

Table 3-5. Cont'd				
Analysis name	Equipment	DRBCFreshwater Acute	DRBC Freshwater Chronic	
4,6-Dinitro-2-methylphenol		< 5	NL	NL
4-Bromophenyl-phenylether		< 1	NL	NL
4-Chloro-3-methylphenol		< 1	NL	NL
4-Chloroaniline		< 1	NL	NL
4-Chlorophenyl-phenylether		< 1	NL	NL
4-Methyl-2-pentanone		< 3	NL	NL
4-Methylphenol		< 2	NL	NL
4-Nitroaniline		< 1	NL	NL
4-Nitrophenol		< 10	NL	NL
Acenaphthene		< 1	NL	NL
Acenaphthylene		< 1	NL	NL
Acetone		< 6	NL	NL
Aldrin		< 0.0020	1.5	NL
Alpha BHC		< 0.0020	NL	NL
Alpha Chlordane		< 0.0020	NL	NL
Anthracene		< 1	NL	NL
Benzene		< 0.5	NL	NL
Benzo(a)anthracene		< 1	NL	NL
Benzo(a)pyrene		< 1	NL	NL
Benzo(b)fluoranthene		< 1	NL	NL
Benzo(g,h,i)perylene		< 1	NL	NL
Benzo(k)fluoranthene		< 1	NL	NL
Beta BHC		< 0.012	NL	NL
bis(2-Chloroethoxy)methane		< 1	NL	NL
bis(2-Chloroethyl)ether	µg/l	< 1	NL	NL
bis(2-Ethylhexyl)phthalate		< 2	NL	NL
Bromodichloromethane		< 1	NL	NL
Bromoform		< 1	NL	NL
Bromomethane		< 1	NL	NL
Butylbenzylphthalate		< 2	NL	NL
Carbazole		< 1	NL	NL
Carbon Disulfide		< 1	NL	NL
Carbon Tetrachloride		< 1	NL	NL
Chlorobenzene		< 0.8	NL	NL
Chloroethane		< 1	NL	NL
Chloroform		< 0.8	NL	NL
Chloromethane		< 1	NL	NL
Chrysene		< 1	NL	NL
cis-1,2-Dichloroethene		< 0.8	NL	NL
cis-1,3-Dichloropropene		< 1	NL	NL
Delta BHC		< 0.0029	NL	NL
Dibenz(a,h)anthracene		< 1	NL	NL
Dibenzofuran		< 1	NL	NL
Dibromochloromethane		< 1	NL	NL
Dieldrin		< 0.0049	1.25	0.0019
Diethylphthalate		< 2	NL	NL
Dimethylphthalate		< 2	NL	NL
Di-n-butylphthalate		< 2	NL	NL
Di-n-octylphthalate		< 2	NL	NL

Table 3-5. Cont'd				
Analysis name	Equipment	DRBCFreshwater Acute	DRBC Freshwater Chronic	
Endosulfan I	µg/l	< 0.0039	0.11	0.056
Endosulfan II		< 0.0048	0.11	0.056
Endosulfan Sulfate		< 0.0088	NL	NL
Endrin		< 0.0039	0.09	0.0023
Endrin Aldehyde		< 0.020	NL	NL
Endrin Ketone		< 0.0039	NL	NL
Ethylbenzene		< 0.8	NL	NL
Fluoranthene		< 1	NL	NL
Fluorene		< 1	NL	NL
Gamma BHC - Lindane		< 0.0020	1	0.08
Gamma Chlordane		< 0.0020	NL	NL
Heptachlor		< 0.0020	0.26	0.0038
Heptachlor Epoxide		< 0.0020	NL	NL
Hexachlorobenzene		< 1	NL	NL
Hexachlorobutadiene		< 1	NL	NL
Hexachlorocyclopentadiene		< 5	NL	NL
Hexachloroethane		< 1	NL	NL
Indeno(1,2,3-cd)pyrene		< 1	NL	NL
Isophorone		< 1	NL	NL
Methoxychlor		< 0.059	NL	NL
Methylene Chloride		< 2	NL	NL
Naphthalene		< 1	NL	NL
Nitrobenzene		< 1	NL	NL
N-Nitroso-di-n-propylamine		< 1	NL	NL
N-Nitrosodiphenylamine		< 2	NL	NL
p,p-DDD		< 0.0039	NL	NL
p,p-DDE		< 0.0039	NL	NL
p,p-DDT		< 0.0039	0.55	0.001
PCB-1016		< 0.20	NL	NL
PCB-1221		< 0.39	NL	NL
PCB-1232		< 0.098	NL	NL
PCB-1242		< 0.20	NL	NL
PCB-1248		< 0.29	NL	NL
PCB-1254		< 0.20	NL	NL
PCB-1260		< < 0.29	NL	NL
Pentachlorophenol		< 3	NL	NL
Phenanthrene		< 1	NL	NL
Phenol		< 1	NL	NL
Pyrene		< 1	NL	NL
Styrene		< 1	NL	NL
Tetrachloroethene		< 0.8	NL	NL
Toluene		< 0.7	NL	NL
Toxaphene		< 0.29	0.73	0.0002
trans-1,2-Dichloroethene		< 0.8	NL	NL
trans-1,3-Dichloropropene		< 1	NL	NL
Trichloroethene		< 1	NL	NL
Vinyl Chloride		< 1	NL	NL
Xylene (Total)		< 0.8	NL	NL

4.0 CONCLUSIONS

The results of chemical analysis of sediment collected from the Marcus Hook, Deepwater Point, and New Castle ranges of the Delaware River in September 2003, suggest that the sediments scheduled for dredging contains few contaminants of concern. Only two inorganic contaminants, Chromium and Thallium, exceeded soil cleanup criteria. Thallium, exceeded the residential and non-residential soil cleanup criteria of 2 mg/kg at all but one station, with highest concentration of 4.5 mg/kg among the 15 samples. Total chromium exceeded the non-residential criteria for chromium VI at all locations. To be conservative, total chromium concentrations were compared to the lower chromium VI soil cleanup criteria (if there was any chromium VI present in the sediments, it would be a smaller percentage of the total chromium). In addition, the total chromium levels were only over the lowest value for non-residential soils published by NJDEP (20 mg/kg), and this value was established to protect humans with dermatitis from an allergic reaction. Of the 126 sediment organic contaminant concentrations, 6 exceeded NJDEP's residential and non-residential soil cleanup criteria. However, all the organic exceedances occurred in one of the five cores taken near the Marcus Hook petrochemical facility.

Based on the comparison of the September 2003 data relative to the historical testing conducting in the same navigational ranges, there is a suggestion that inorganic contaminant levels in the maintenance dredge material has increased slightly over the last 10 years. Although statistical testing confirmed the increases for some contaminants, the sample size for the tests were low (< 5 reps) limiting the usefulness of these results. Due to detection limit differences between the historical and current data no assessment of changes in organic contaminant levels could be accomplished.

5.0 REFERENCES

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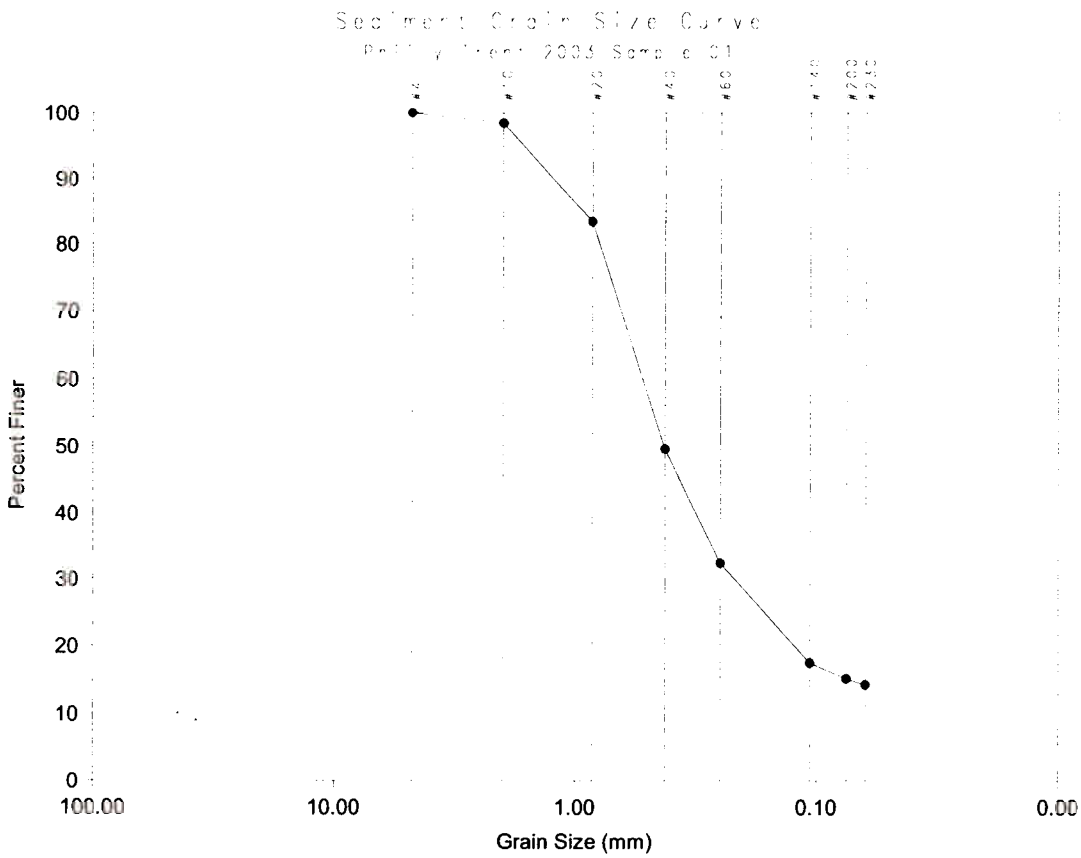
APPENDIX

SEDIMENT GRAIN SIZE DATA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#4
#10
#20
#40
#60
#140
#200
#230
Percent Finer
100
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1.00
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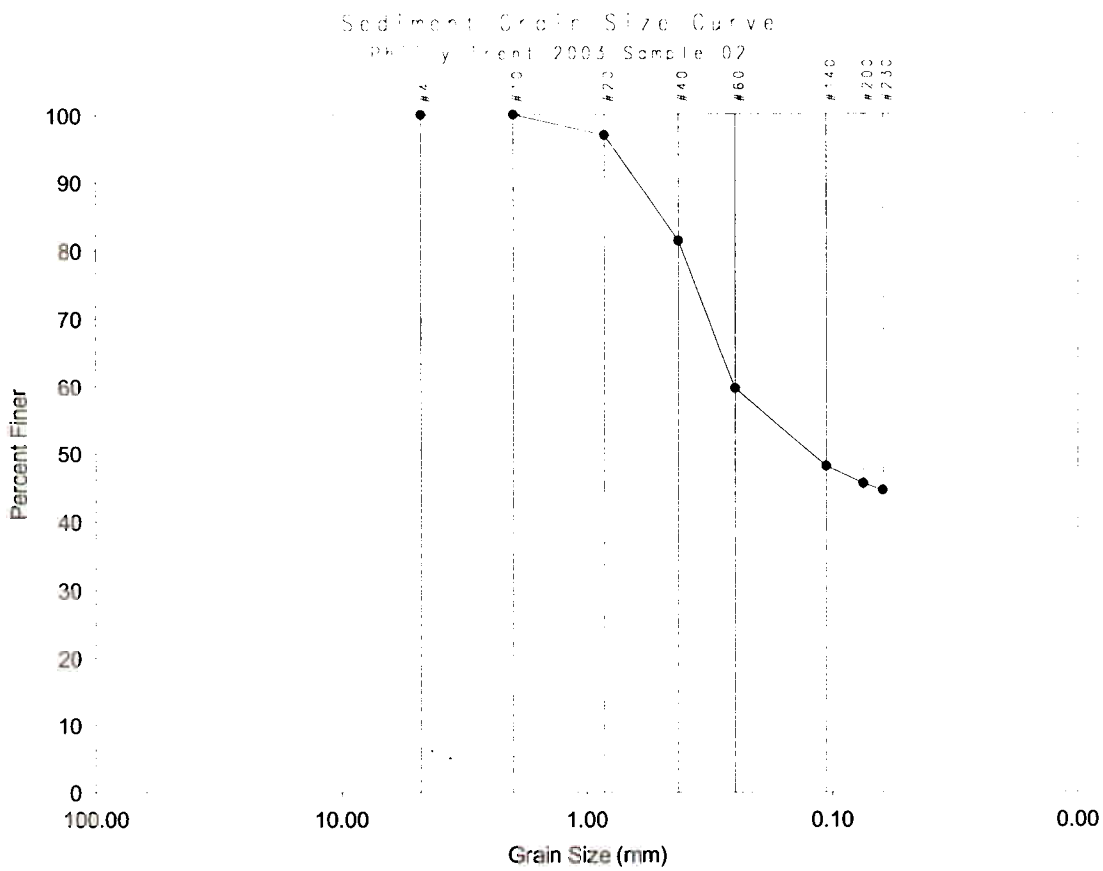
0.00
Grain Size (mm)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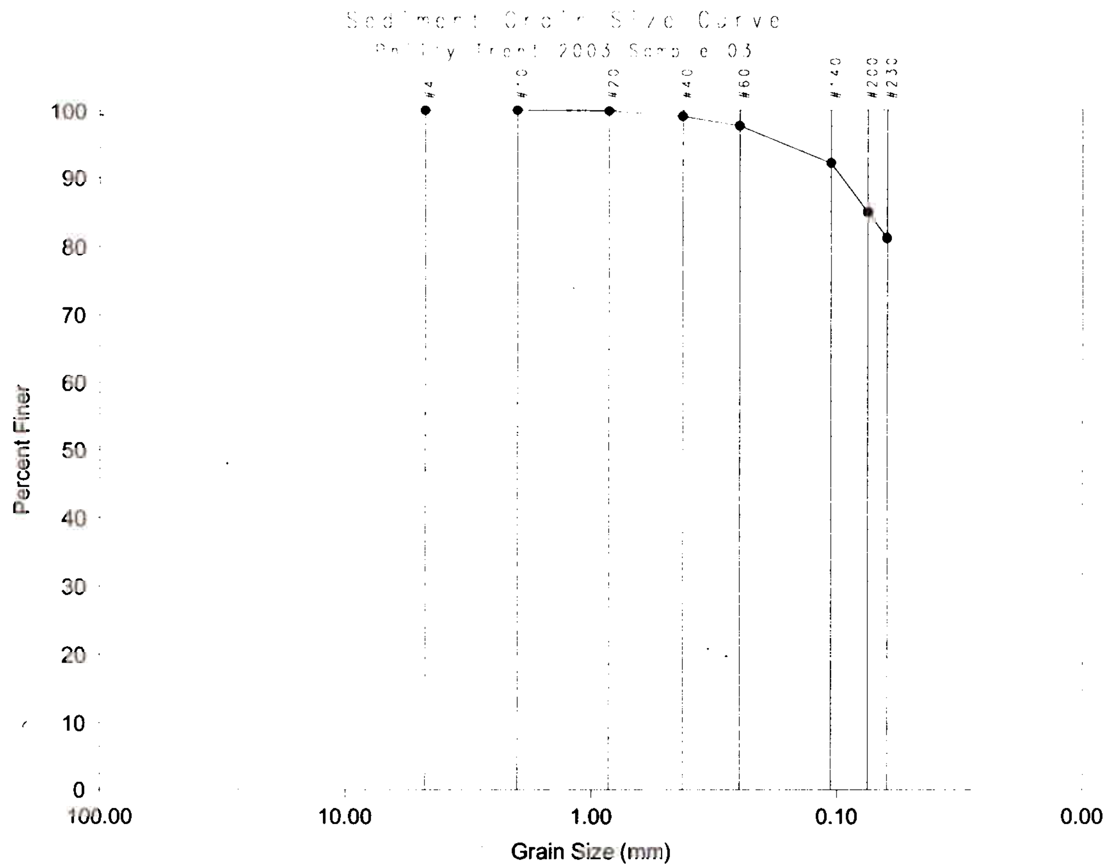
Grain Size (mm)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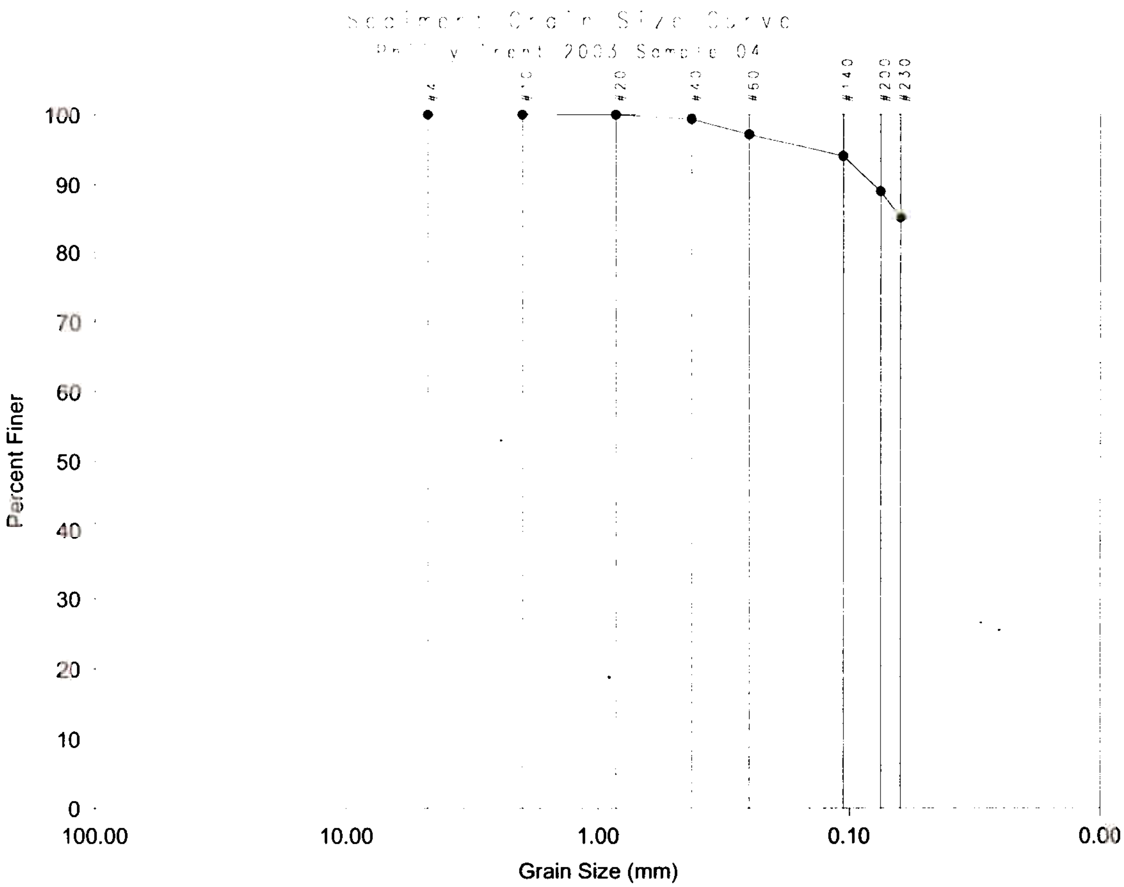
Grain Size (mm)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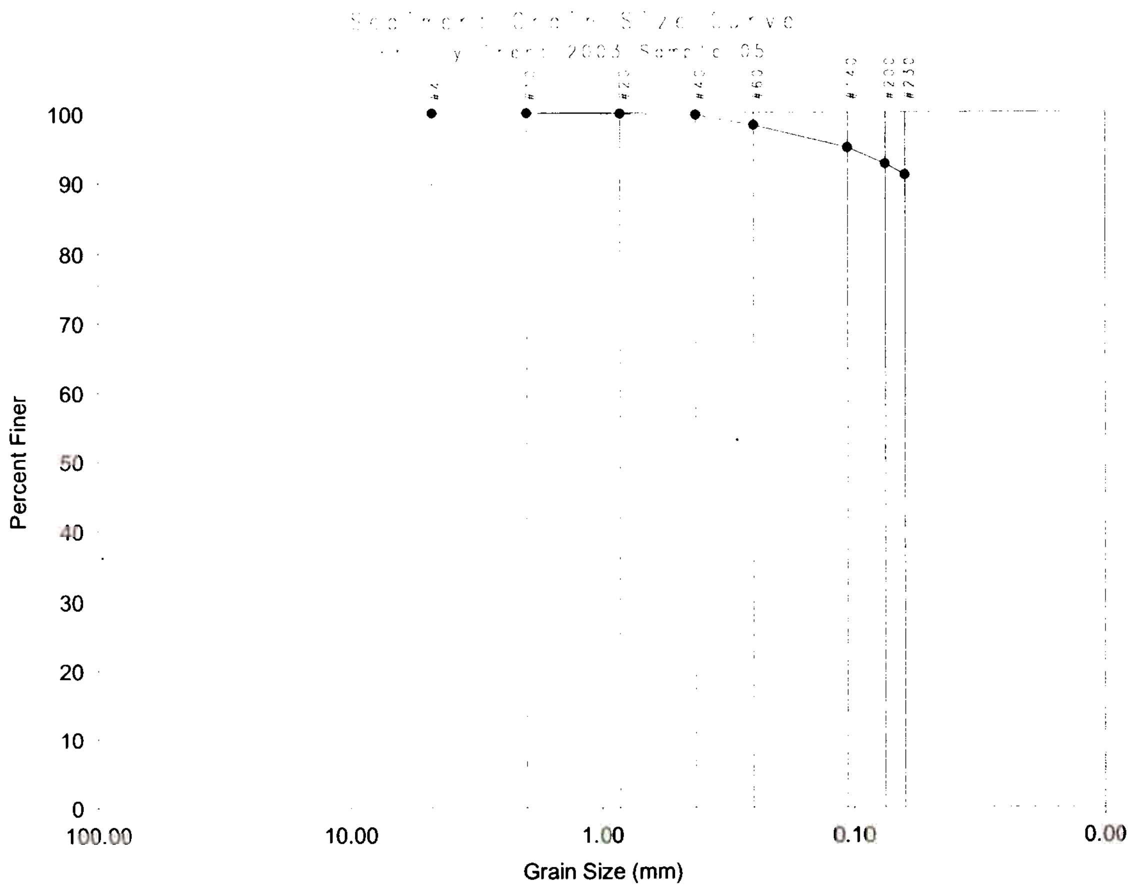
Grain Size (mm)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#200
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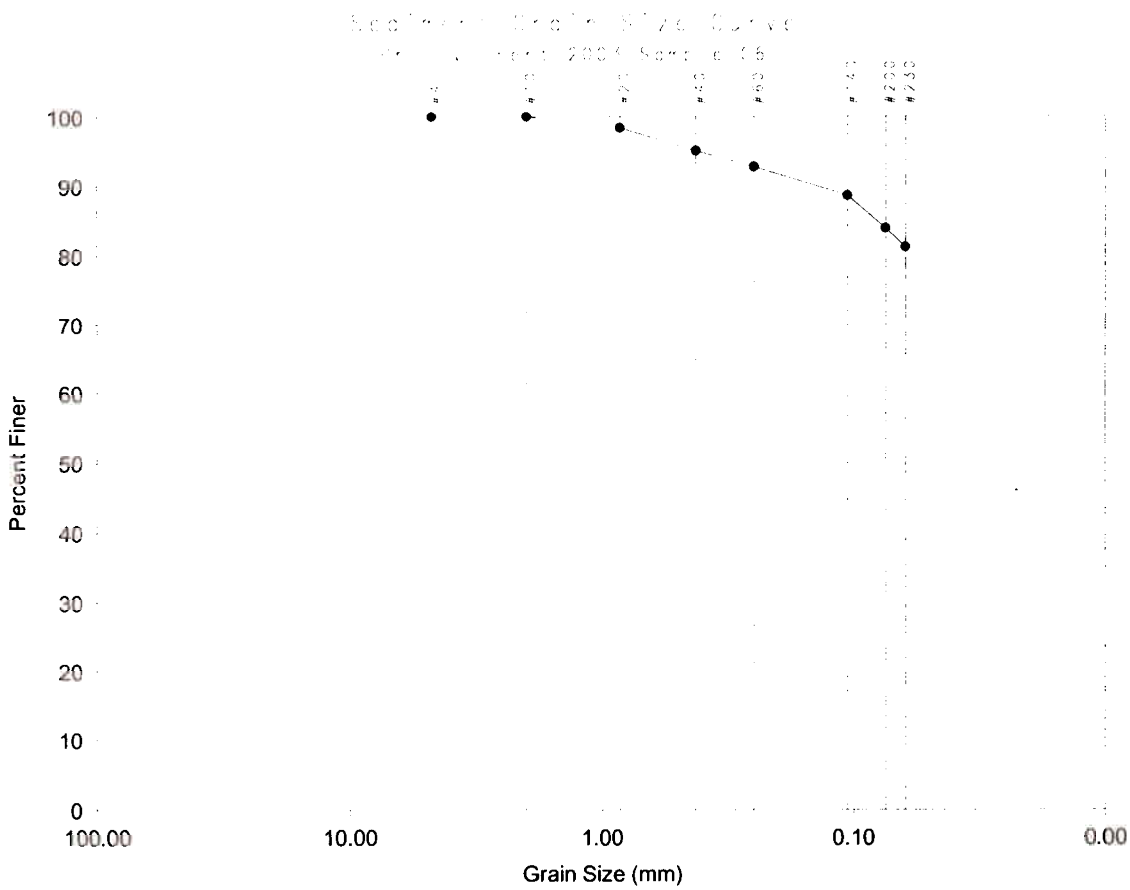
Grain Size (mm)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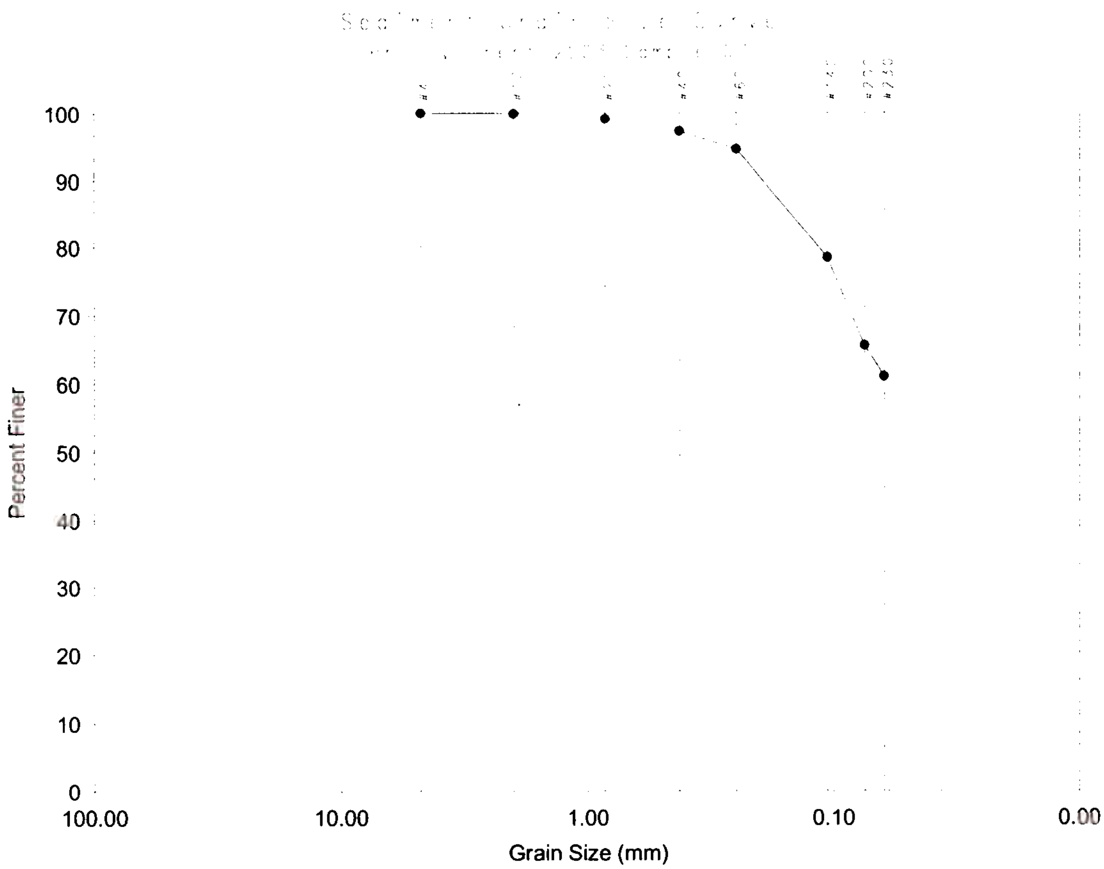
Grain Size (mm)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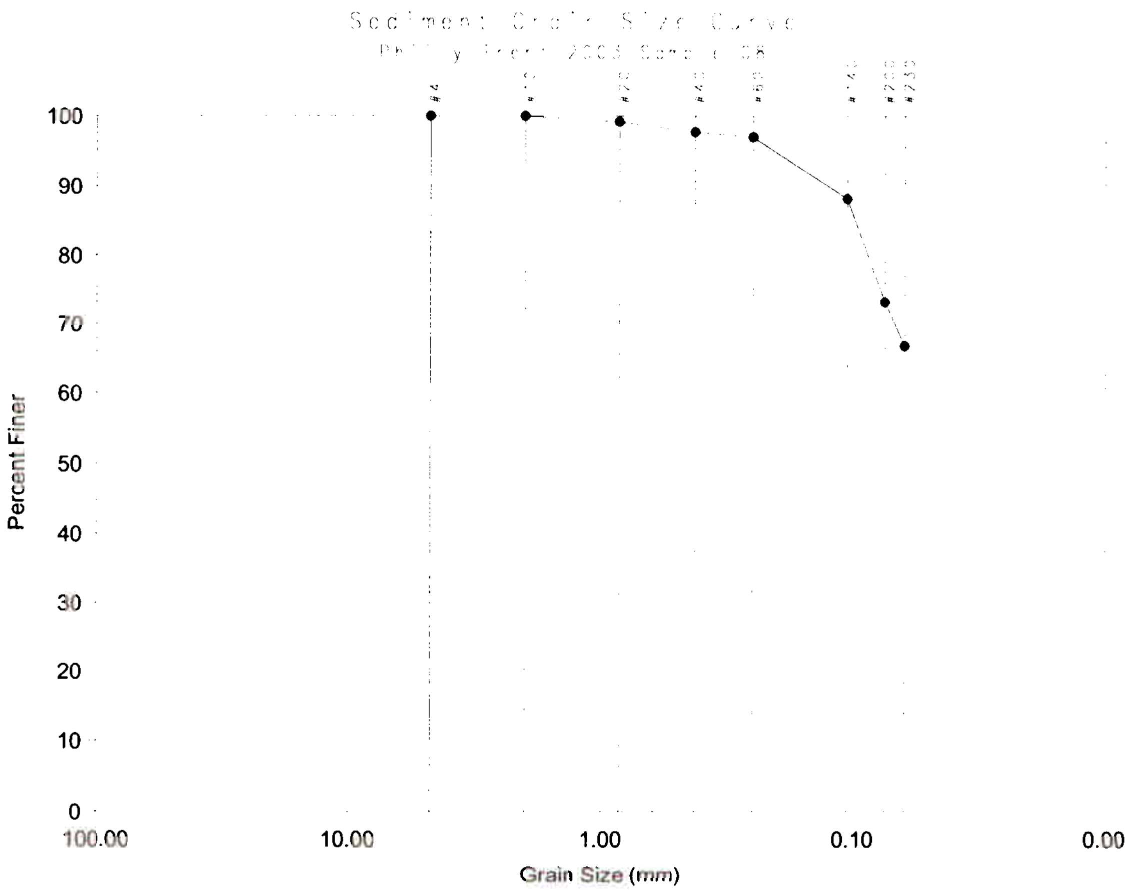
Grain Size (mm)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#200
#230
Percent Finer
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1.00
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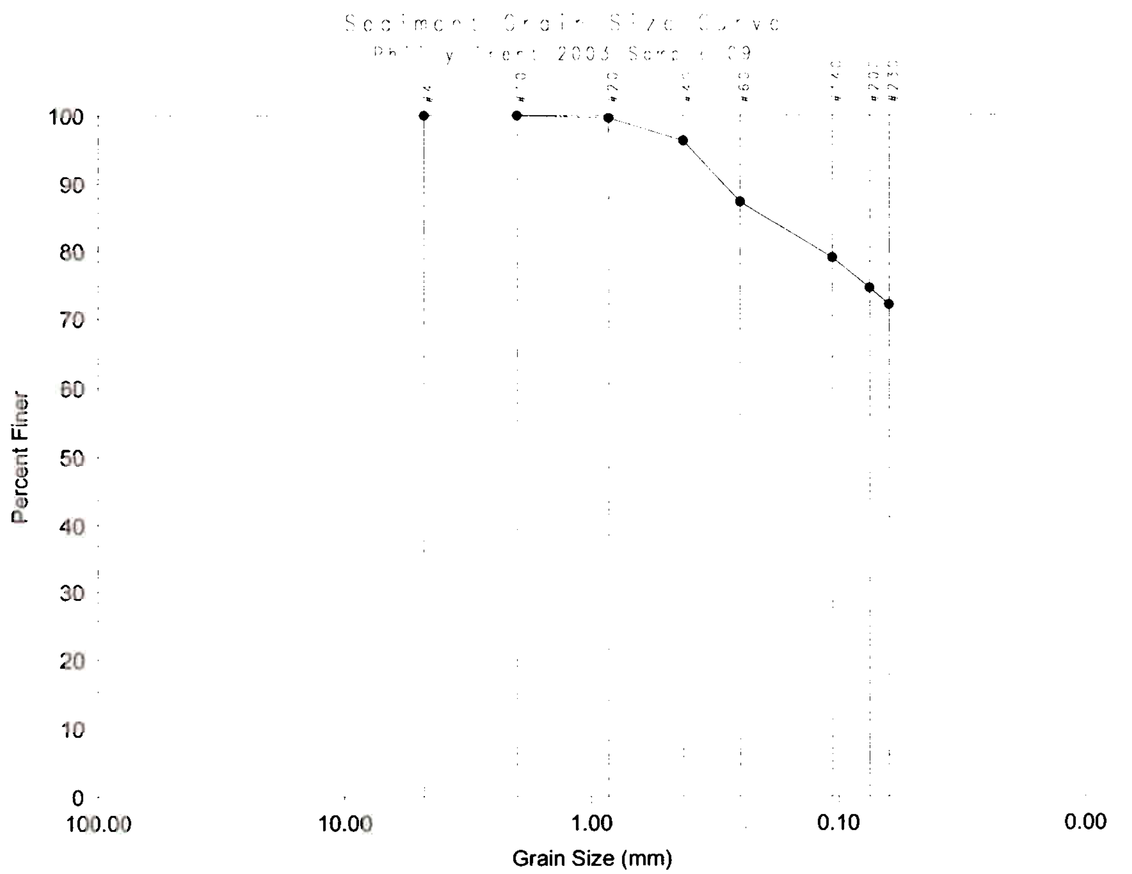
Grain Size (mm)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80
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Percent Finer
100.00
10.00
1.00
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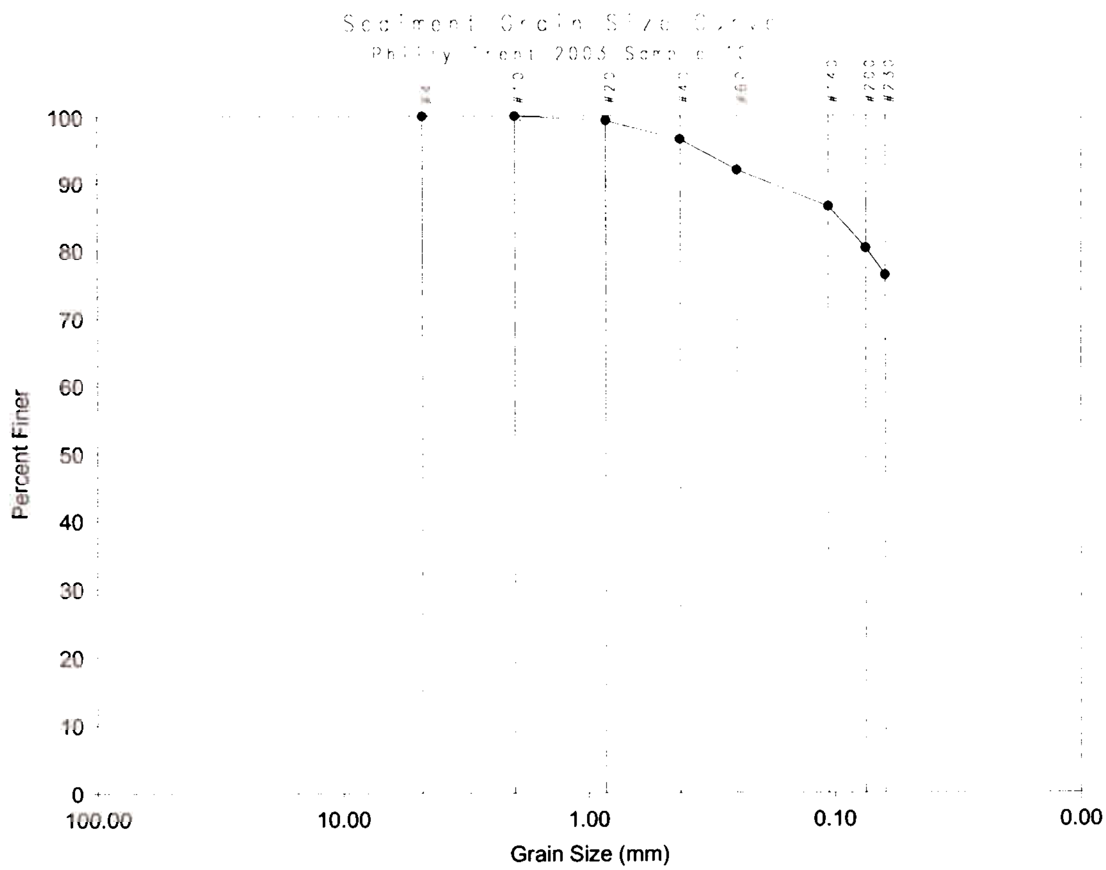
0.00
Grain Size (mm)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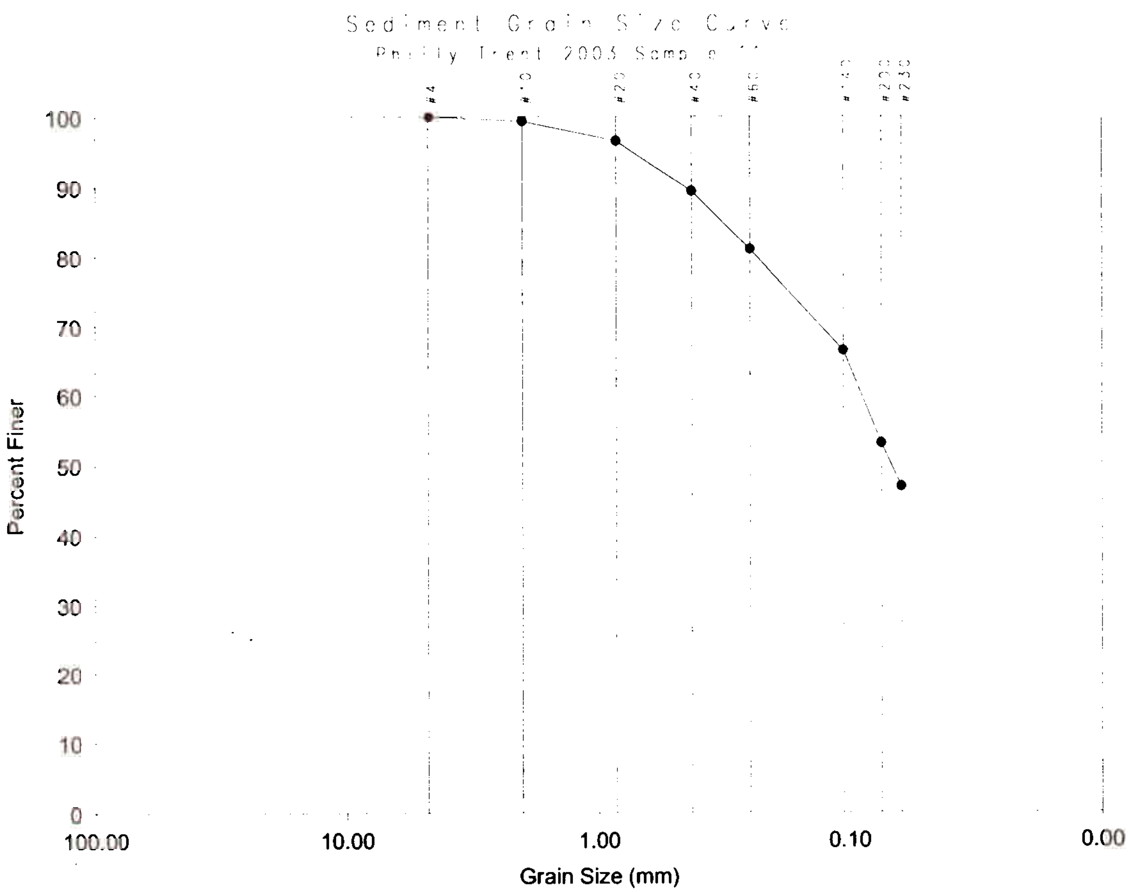
Grain Size (mm)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#40
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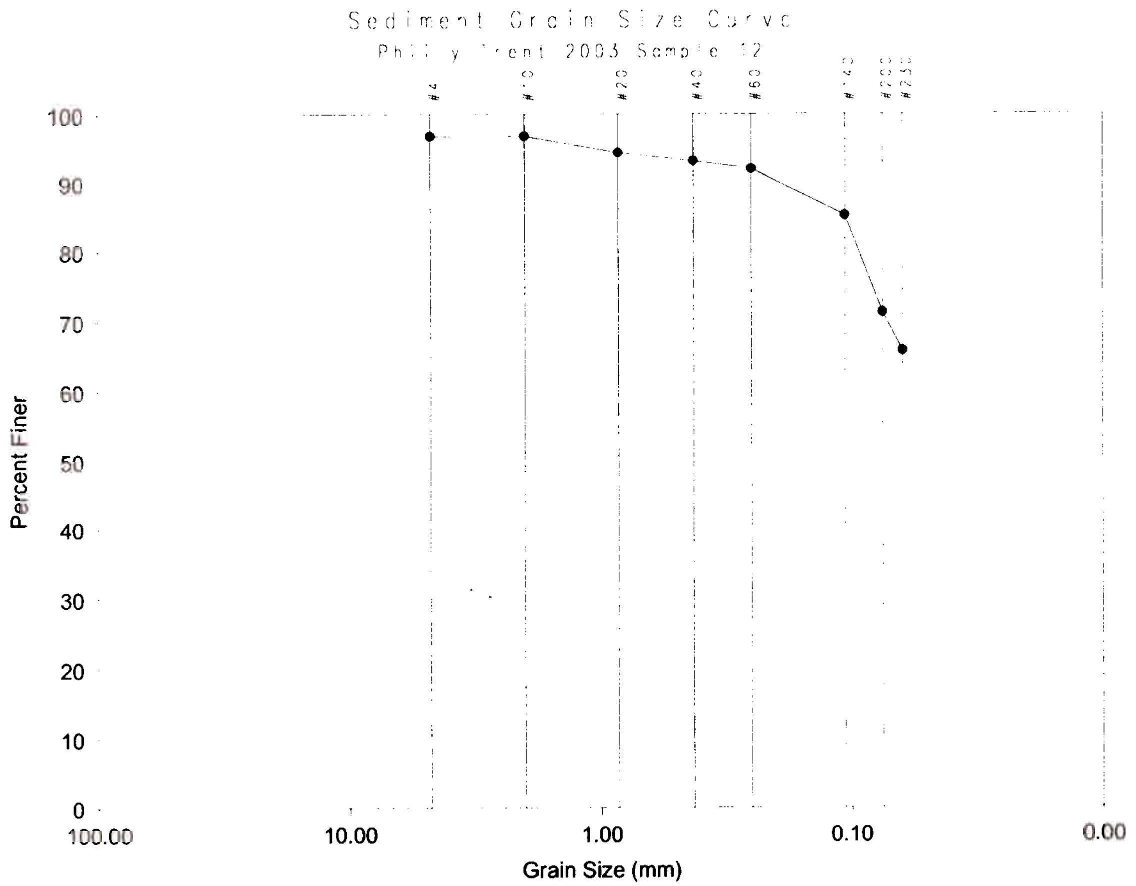
Grain Size (mm)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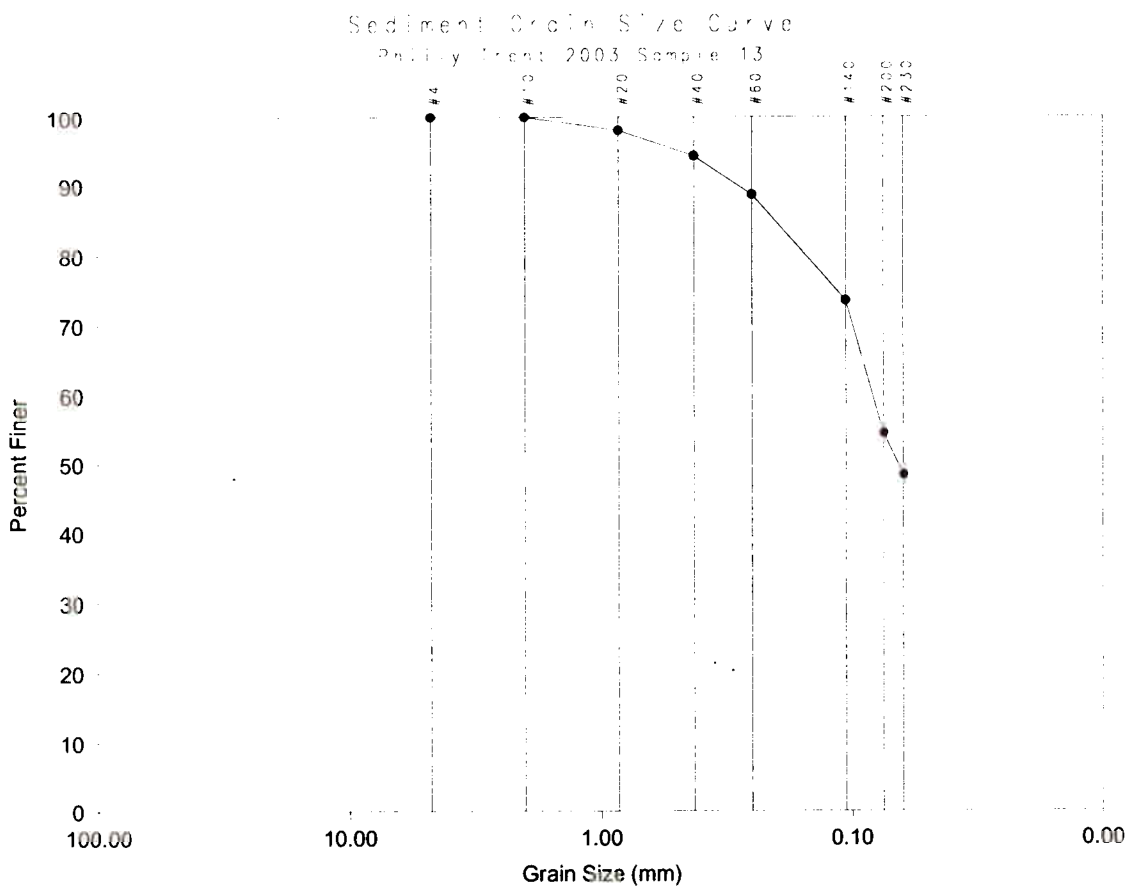
Grain Size (mm)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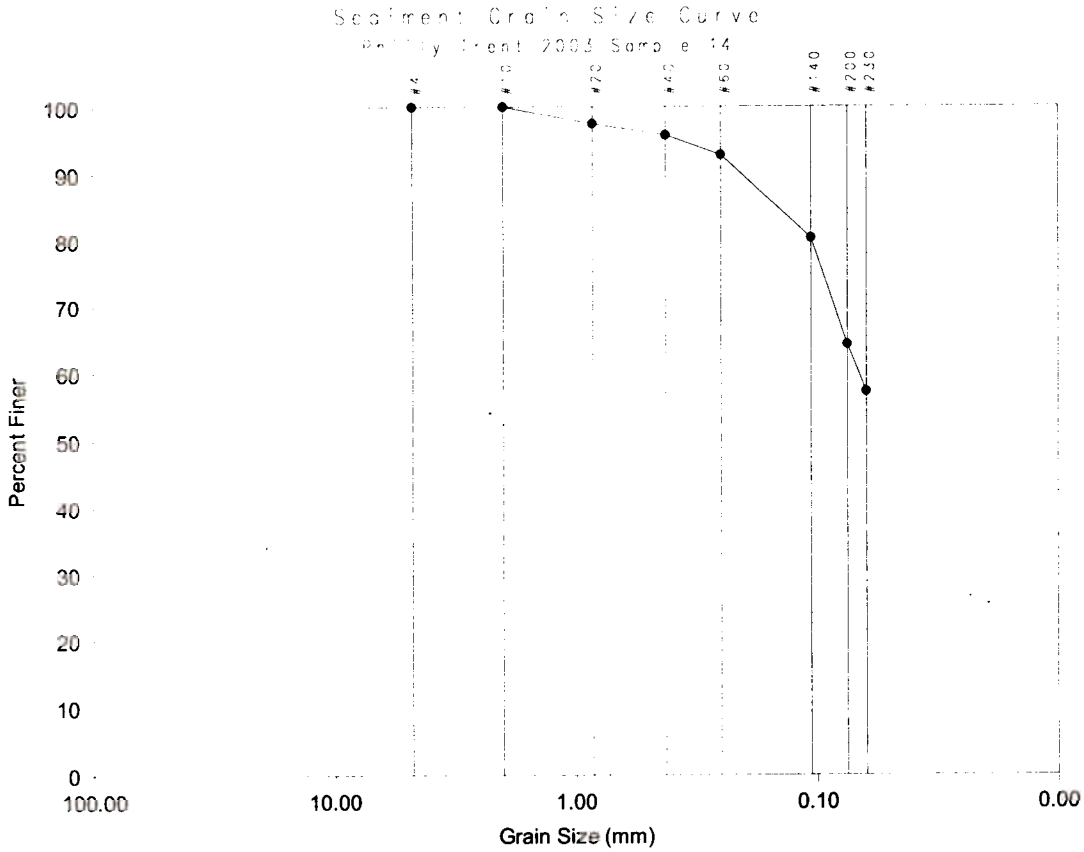
0.00
Grain Size (mm)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Percent Finer
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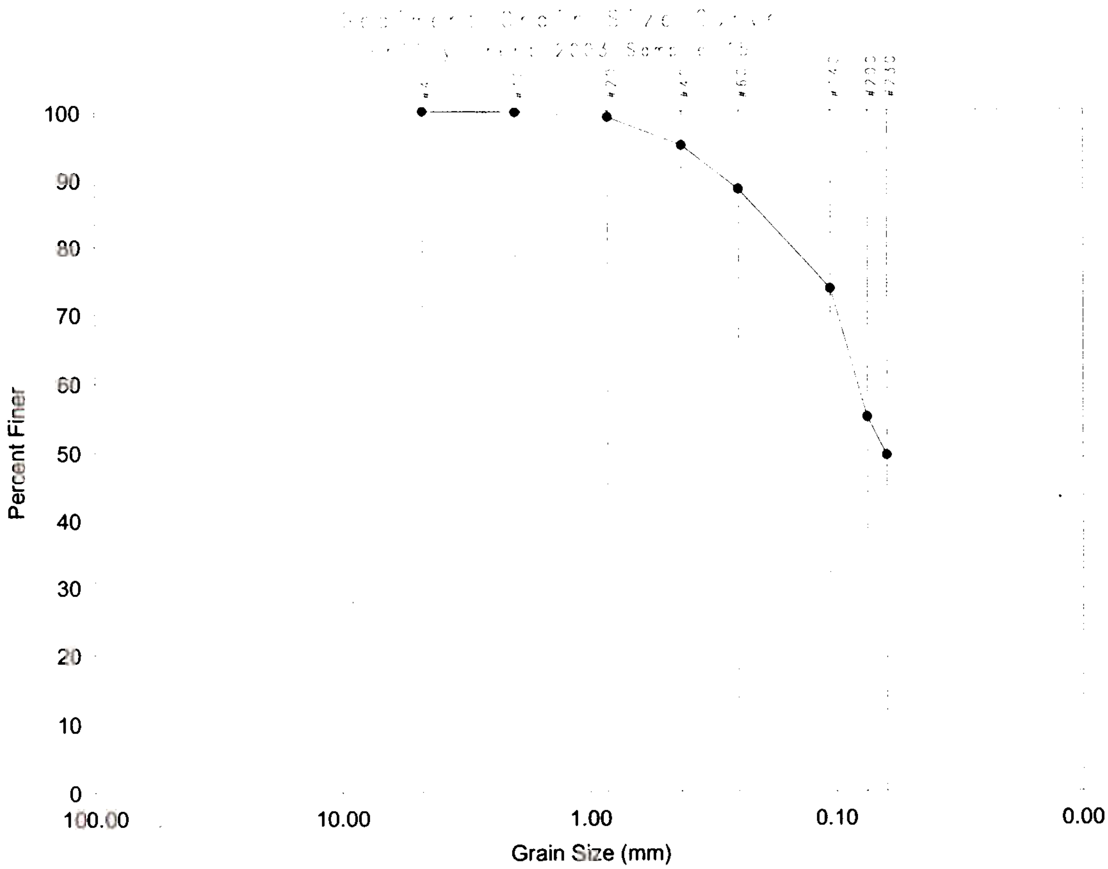
Grain Size (mm)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Grain Size (mm)