Interim Report R&D Project 331

METAL CONTAMINATION OF SEDIMENTS AND STATUTORY QUALITY OBJECTIVES

WRc plc

November 1991

R&D 331/2/N

Metal Contamination of Sediments and Statutory Quality Objectives

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EXECUTIVE SUMMARY

The overall objective of the project is to establish typical concentrations of EC Dangerous Substances Directive List I and List II metals in sediments within UK estuarine and coastal waters and to use these data as a basis for classifying such waters into four classes based on the extent of sediment contamination. This is to be achieved by means of a desk study.

An extensive literature search has been conducted and sources of unpublished data approached, from whom data is still being received. The initial conclusions drawn from these data are that there is a lack of information from uncontaminated sites from which background levels could be derived and that there is no standardisation of sampling, analytical and data management techniques.

Following a review of the information already collated a plan for future work is outlined.

KEY WORDS

Metals, Sediment, Statutory Quality Objectives

1. INTRODUCTION

The overall objective of the project is to establish typical concentrations of EC Dangerous Substances Directive List I and List II metals (in particular Hg, Cd, Cu, Pb, Cr, Ni, As and Zn) in sediments within UK estuarine and coastal waters. These data will be utilised as a basis for classifying such waters into four classes based upon the extent of sediment contamination.

The initial classification is to be achieved by means of a desk study to review existing information on List I and List II metal levels in surface sediments from UK estuaries and coastal waters. The review must consider the comparability between sites of different granulometric composition and identify any metals for which there is insufficient information to provide a basis for the classification scheme.

The information gathered above will be used to establish a typical "uncontaminated" background level for each metal and propose an incremental scale of classification. The scale will be based on multiples of the background levels to represent three further classes: elevated, substantially elevated and grossly elevated.

The implications of the proposed class determining values for a representative cross section of estuaries and coastal waters will then be determined, and a standardised sampling and analysis strategy defined.

2. METHOD OF STUDY

The first stage of the study was to review existing information on List I and List II metals in surface sediments from UK estuaries and coastal waters.

An extensive literature search has been carried out and all the relevant articles obtained, reviewed. Most of the thirty five articles found date from the early to mid 1970s, although some papers have been published recently and the subject seems to be receiving increasing attention in recent years. A full list of the areas for which data have been found is shown in Figure A.1.

Unpublished data are a potential source of information, consequently a range of organisations have been approached including the NRA regions, Scottish RPBs, MAFF, SOAFD, Lothian and Grampian Regional Councils and the British Geological Survey. Letters and questionnaires requesting data and information regarding sampling and analytical techniques were sent out in late September and early October. Follow up meetings were held with representatives from the following NRA regions:

- North West
- Northumbrian
- Severn Trent
- Southern
- Wessex
- Yorkshire

The response to the data requests varied greatly between the regions, but was generally positive. Some information has been received already and we hope to complete the data collection by the end of November. Areas for which recent data have been obtained are shown in Figure A.2. Attempts are being made to fill any gaps. The British Geological Survey, for example, has been approached as a source of coastal data.

Most of the data available from the literature and from information from the NRA and other sources, cover waters that are expected to have a heavy metal contamination problem, for example, the Mersey and Severn estuaries. Very few data are available that could be used to establish typical "uncontaminated" levels of the metals in sediments. A contact in Eire has been approached as a possible source of background data and although no information has yet been received, the initial response was favourable. It may be necessary for some sampling of uncontaminated sites to be conducted in order to establish a firm base for the classification scheme. However, even using this information it may not be possible to identify the background levels because of insufficiently sensitive analytical techniques. This is illustrated by some of the data we have already collated. Another problem arising because most of the monitoring has been conducted in contaminated waters is that there will be an inevitable bias towards the higher classes of contamination.

3. INTERIM RESULTS

3.1 Data handling

Each region has its own data handling facilities and therefore the data available is being sent in several different formats. We have asked for data to be sent on disc wherever possible and are currently processing these discs into a common format. Data which have arrived as hard copy are being entered into the 20/20 spreadsheet package, so that all the data sets are in the same format. Examples of this are shown in Appendix B.

3.2 Analysis and sampling strategy

From the data obtained from the literature search and from the NRA and other sources, it would appear that there is no standard sampling or analytical procedure. The two critical factors affecting analytical results appear to be the granulometry of the sample and the extraction technique used to prepare the samples for metal determination. These must be considered when data are examined to construct the statutory quality objective.

It has been shown by many authors that metals associate most strongly with the finer sediment factions and reports show that correction for differences in grain size composition is best effected by isolating and analysing the <63 µm grain size fraction. Despite this there is a wide variation in the granulometry of the sample analysed.

The method employed to extract the metals from the sediments has an effect on the proportion of the metal extracted. A mixture of hydrofluoric, perchloric and nitric acids, for example, will completely destroy the silicate matrix and release all metals present in the sediment. Perchloric acid will liberate only some of the metal that is fixed in the silicate matrix of the sediment whereas cold extraction techniques using weaker chemicals (e.g. EDTA and acetic acid) give a measure of the 'available' metal content of the sediment by extracting those metals which are weakly bound.

4. FUTURE WORK PROGRAMME

4.1 Data handling

As an initial step the distribution of metal levels for individual estuarine and coastal sites will be analysed in an attempt to identify the variables will affect the metal levels. Once this is completed, the most comparable data will be reviewed.

4.2 Analysis and sampling strategy

There is a need for the wide range of analysis and sampling techniques currently in use to be rationalised and standardised and Alistair Gunn is currently developing a sampling and analysis strategy. Findings from the NRA Laboratory Managers Group and details of techniques currently being employed in this area will be taken into account in the assessment of the data.

APPENDIX A - AREAS FOR WHICH DATA HAVE BEEN OBTAINED

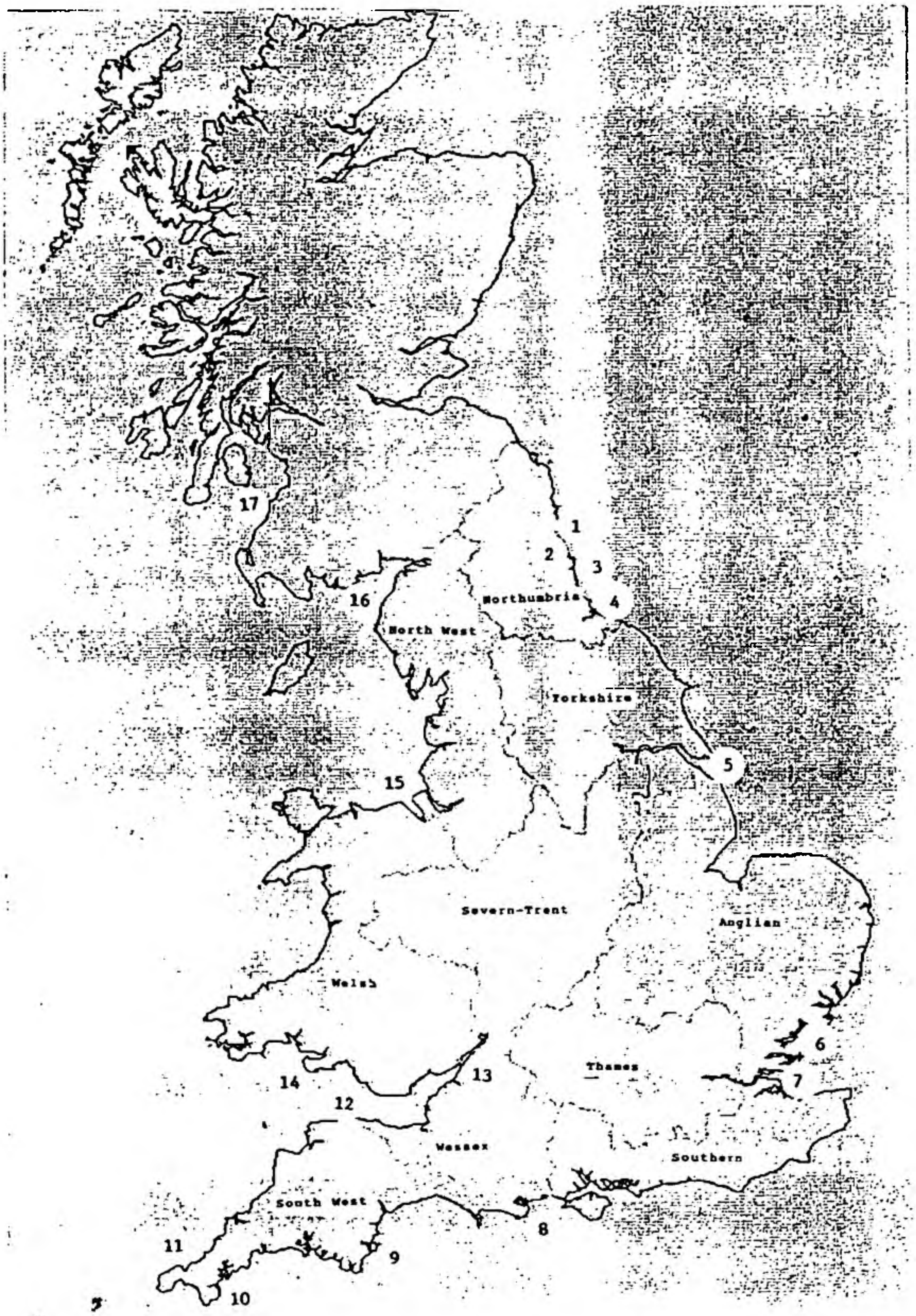

Figure A.1 Areas covered by literature

Key to Figure A.1

Nº	Estuary or Coastal Stretch	Year/s of Report
1	River Blyth	1974
2	River Tyne	1979(x2) 1990
3	River Wear	1979
4	River Tees	1974 1979
5	Humber Estuary	(1961-1981) 1973 1977 1979(x2) 1989 1990(x2)
6	River Colne	1975
7	Thames Estuary	1973 1979 1989
8	Poole Harbour	1975
9	Tor Bay	1974
10	River Helford	1975 1979
10	Restronguet Creek	1975 1979
11	River Hayle	1976 1976
12	Bristol Channel (and	1972 1975
13	Severn Estuary)	
14	Swansea Bay	1972
15	Mersey Estuary	1974-1983 1986
16	Solway Firth	1973 1976
17	Firth of Clyde	1972
	Firth of Forth	c. 1990
	River Neath	1972
	River Tawe	1972 1977
	West Coast of Scotland	1983

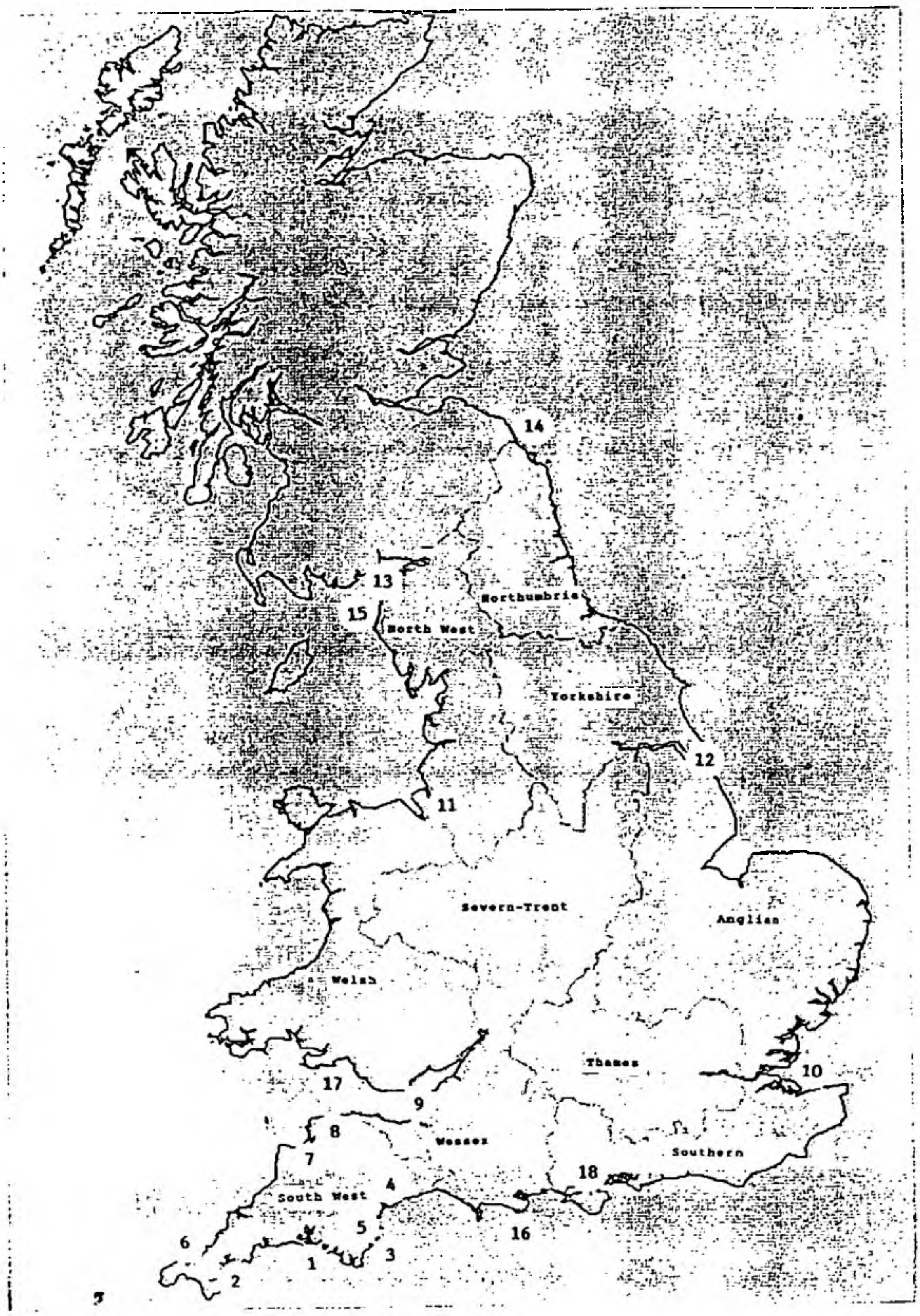

Figure A.2 Areas covered by unpublished data

Key to Figure A.2

Nº	Estuary or Coastal Stretch
1	Tamar Estuary and Plymouth Sound
2	Fal Estuary and Tributaries
3	Teignmouth and area
4	Axe
5	Exe
6	Hayle
7	River Caen
8	Taw
9	Severn Estuary and Bristol Channel
10	Thames
11	Mersey
12	Humber
13	Solway Firth
14	St Abbs Head and Bell Rock
15	Whitehaven Area
16	Poole Harbour and Portland
17	Swansea Bay
18	Southampton Water and the Solent

APPENDIX B - EXAMPLES OF DATA

Table B.1 Data for the Thames Estuary

SITE NAME	GRID. REF	DATE	SIZE FRA
HAMMERSMITH BRIDGE	TQ 230 780	1ST QUARTER 1990	-
HAMMERSMITH BRIDGE	TQ 230 780	15-05-90	-
HAMMERSMITH BRIDGE	TQ 230 780	24-07-90	-
KEW	TQ 191 779	1ST QUARTER 1990	-
KEW	TQ 191 779	15-05-90	-
KEW	TQ 191 779	24-07-90	-
TEDDINGTON	TQ 168 715	1ST QUARTER 1990	-
TEDDINGTON	TQ 168 715	15-05-90	-
TEDDINGTON	TQ 168 715	24-07-90	-
ALLHALLOWS	TQ 838 792	1ST QUARTER 1990	-
ALLHALLOWS	TQ 838 792	30-05-90	-
ALLHALLOWS	TQ 838 792	29-08-90	-
GRAVESEND	TQ 648 745	1ST QUARTER 1990	-
GRAVESEND	TQ 648 745	30-05-90	-
GRAVESEND	TQ 648 745	29-08-90	-
CANVEY BEACH	TQ 800 824	1ST QUARTER 1990	-
CANVEY BEACH	TQ 800 824	28-06-90	-
CANVEY BEACH	TQ 800 824	25-09-90	-
GREENWICH	TQ 383 780	1ST QUARTER 1990	-
GREENWICH	TQ 383 780	13-06-90	-
GREENWICH	TQ 383 780	28-07-90	-
SOUTH BANK CENTRE	TQ 308 803	1ST QUARTER 1990	-
SOUTH BANK CENTRE	TQ 308 803	13-06-90	-
SOUTH BANK CENTRE	TQ 308 803	26-07-90	-
SEA REACH NO.2 BUOY	TQ 955 810	1ST QUARTER 1990	-
SEA REACH NO.2 BUOY	TQ 955 810	01-05-90	-
SEA REACH NO.2 BUOY	TQ 955 810	14-08-90	-
SOUTHEND	TQ 901 828	1ST QUARTER 1990	-
SOUTHEND	TQ 901 828	01-05-90	-
SOUTHEND	TQ 901 828	14-08-90	-
GRAIN FLATS	TQ 877 795	1ST QUARTER 1990	-
GRAIN FLATS	TQ 877 795	01-05-90	-
GRAIN FLATS	TQ 877 795	14-08-90	-
CHAPMAN BUOY	TQ 809 813	1ST QUARTER 1990	-
CHAPMAN BUOY	TQ 809 813	01-05-90	-
CHAPMAN BUOY	TQ 809 813	14-08-90	-
BLYTHE SANDS	TQ 757 805	1ST QUARTER 1990	-
BLYTHE SANDS	TQ 757 805	01-05-90	-
BLYTHE SANDS	TQ 757 805	14-08-90	-
MUCKING	TQ 707 808	1ST QUARTER 1990	-
MUCKING	TQ 707 808	01-05-90	-
MUCKING	TQ 707 808	14-08-90	-
LONDON BRIDGE	TQ 327 805	1ST QUARTER 1990	-
LONDON BRIDGE	TQ 327 805	17-05-90	-
LONDON BRIDGE	TQ 327 805	09-08-90	-
CADOGAN PIER	TQ 274 776	1ST QUARTER 1990	-
CADOGAN PIER	TQ 274 776	17-05-90	-
CADOGAN PIER	TQ 274 776	09-08-90	-
WOOLWICH	TQ 427 793	1ST QUARTER 1990	-
WOOLWICH	TQ 427 793	05-06-90	-
WOOLWICH	TQ 427 793	27-09-90	-
BECKTON	TQ 456 815	1ST QUARTER 1990	-
BECKTON	TQ 456 815	05-06-90	-
BECKTON	TQ 456 815	27-09-90	-
CROSSNESS	TQ 494 809	1ST QUARTER 1990	-
CROSSNESS	TQ 494 809	05-06-90	-
CROSSNESS	TQ 494 809	27-09-90	-
PURFLEET	TQ 580 761	1ST QUARTER 1990	-
PURFLEET	TQ 580 761	05-06-90	-
PURFLEET	TQ 580 761	27 -9-90	-
WEST THURROCK	TQ 593 770	1ST QUARTER 1990	-
WEST THURROCK	TQ 593 770	05-06-90	-
WEST THURROCK	TQ 593 770	27-09-90	-

ACTION	COPPER	CADMIUM	MERCURY	CHROMIUM	IRON	NICKEL	ZINC	LEAD	ARSENIC	MANGANESE
90 um	124	3.6	1.37	126	47800	83	538	383	21.14	1490
90 um	289	5.5	0.62	240	52900	154	976	775	25.4	4390
90 um	100	2.6	0.73	87	29430	52	343	194	17.7	803
90 um	100	2.6	0.89	89	31000	56	357	330	11.74	710
90 um	94	1.8	2.1	67	29700	46	323	287	11.1	800
90 um	96	1.8	0.56	88	28400	51	303	199	14.8	778
90 um	87	1.5	0.52	49	32600	35	314	399	4.64	690
90 um	50	0.9	0.39	33	23300	25	234	273	15.3	384
90 um	138	2.1	0.39	40	25500	31	344	589	15.3	726
90 um	21	-0.5	0.24	36	21500	22	93	37	11.9	343
90 um	28	-0.5	0.21	42	27000	23	124	97	15.6	340
90 um	32	1.2	0.27	47	28500	26	144	75	15.8	370
90 um	37	-0.5	0.38	50	24100	29	139	76	11.78	467
90 um	36	0.7	0.3	39	23000	20	130	130	13.1	358
90 um	48	0.6	0.48	51	27600	28	182	110	16.8	439
90 um	21	-0.5	0.34	38	21000	22	97	40	12.06	337
90 um	24	-0.5	0.2	36	24600	22	107	89	15.3	320
90 um	29	-0.5	0.34	44	22600	24	136	65	15.7	460
90 um	61	0.9	0.76	70	29900	37	217	134	11.26	610
90 um	60	1.2	0.65	58	29800	31	214	174	16.6	500
90 um	68	1.9	0.47	64	30600	34	236	157	12	564
90 um	176	2.2	3.04	26	41500	39	227	1634	6.56	293
90 um	83	1.6	0.57	83	37000	42	292	262	16.6	790
90 um	156	4.5	3.04	89	37000	67	605	990	21.1	1460
90 um	6.7	-0.5	0.07	21	13200	12	48	4.9	6.34	234
90 um	14	-0.5	0.1	23	17600	13	139	73	10.2	284
90 um	18	1.1	0.07	31	20400	18	108	65	13.9	390
90 um	14	-0.5	0.17	33	18900	18	83	23	9.76	273
90 um	16	-0.5	0.11	25	20400	15	86	57	11.7	218
90 um	18	1.5	0.06	30	19100	16	121	65	13.5	293
90 um	9	-0.5	0.09	22	12900	12	45	20	4.78	211
90 um	20	-0.5	0.14	32	22100	18	99	64	15.5	292
90 um	26	1.2	0.21	41	25500	23	127	65	14.2	410
90 um	20	-0.5	0.16	38	25000	23	98	34	12.5	403
90 um	35	0.7	0.12	40	26300	23	143	100	18.2	350
90 um	28	2.9	0.07	45	40300	31	176	78	45.1	616
90 um	11	-0.5	0.16	21	11570	10	55	32	7.5	194
90 um	27	0.8	0.21	34	21600	18	109	77	11.2	312
90 um	47	2.7	0.47	57	26300	29	200	103	19.8	460
90 um	28	-0.5	0.31	47	22670	24	111	58	2.14	347
90 um	38	0.7	0.29	46	27900	24	139	104	13.4	400
90 um	45	1.8	0.38	58	29900	34	185	102	15.8	488
90 um	78	1.1	1.08	58	28200	34	248	334	19.72	560
90 um	348	7.4	5.7	196	35600	71	1050	749	35	324
90 um	94	1.7	0.59	70	43000	50	296	453	13.6	725
90 um	34	-0.5	0.06	68	41900	54	140	115	15.4	370
90 um	89	1.5	0.82	82	36200	48	312	226	18.5	790
90 um	83	2.2	0.6	83	34300	45	315	179	15.8	825
90 um	71	1.1	1.11	81	34900	45	242	152	12.84	750
90 um	82	1.9	0.88	82	35300	42	293	211	18.1	725
90 um	229	9.8	2.79	165	34600	61	800	298	24.4	449
90 um	42	0.7	0.58	53	26570	30	153	99	10.64	486
90 um	51	1	0.55	56	29900	29	178	156	15.5	499
90 um	67	-0.5	0.39	70	31600	36	233	136	15.7	654
90 um	47	1.1	0.73	48	24900	28	155	120	11	454
90 um	48	1.1	0.44	52	27700	27	172	120	14.1	480
90 um	66	-0.5	0.6	71	31800	36	240	139	16	574
90 um	34	-0.5	0.37	49	26700	30	116	73	10.88	318
90 um	63	1.4	0.93	69	32500	34	247	145	19.5	582
90 um	76	0.6	0.6	83	28200	42	326	172	18.2	684
90 um	35	-0.5	0.58	49	24500	26	119	58	9.66	453
90 um	61	0.7	0.57	69	30400	34	233	147	16.8	670
90 um	52	1	0.57	54	28200	29	191	104	14.7	575

Table B.1 continued

GRAVESEND	TQ 649 746	1ST QUARTER 1990
GRAVESEND	TQ 649 746	05-06-90
GRAVESEND	TQ 649 746	27-09-90
PURFLEET	TQ 548 786	1ST QUARTER 1990
PURFLEET	TQ 548 786	26-06-90
PURFLEET	TQ 548 786	12-09-90
WEST THURROCK	TQ 592 770	1ST QUARTER 1990
WEST THURROCK	TQ 592 770	26-06-90
WEST THURROCK	TQ 592 770	12-09-90
SHOEBURYNESS EAST	TQ 949 850	1ST QUARTER 1990
SHOEBURYNESS EAST	TQ 949 850	18-06-90
SHOEBURYNESS EAST	TQ 949 850	11-09-90
SOUTHEND	TQ 888 844	1ST QUARTER 1990
SOUTHEND	TQ 888 844	18-06-90
SOUTHEND	TQ 888 844	11-09-90
WOOLWICH	TQ 427 793	1ST QUARTER 1990
WOOLWICH	TQ 427 793	12-06-90
WOOLWICH	TQ 427 793	25-09-90
CROSSNESS	TQ 492 809	1ST QUARTER 1990
CROSSNESS	TQ 492 809	12-06-90
CROSSNESS	TQ 492 809	25-09-90
HAMMERSMITH BRIDGE	TQ 230 780	1ST QUARTER 1990
HAMMERSMITH BRIDGE	TQ 230 780	15-05-90
KEW	TQ 191 770	1ST QUARTER 1990
KEW	TQ 191 770	15-05-90
TEDDINGTON	TQ 168 715	1ST QUARTER 1990
TEDDINGTON	TQ 168 715	15-05-90
ALLHALLOWS	TQ 838 792	1ST QUARTER 1990
ALLHALLOWS	TQ 838 792	30-05-90
GRAVESEND	TQ 648 745	1ST QUARTER 1990
GRAVESEND	TQ 648 745	30-05-90
CANVEY BEACH	TQ 800 824	1ST QUARTER 1990
CANVEY BEACH	TQ 800 824	20-06-90
GREENWICH	TQ 383 780	1ST QUARTER 1990
GREENWICH	TQ 383 780	13-06-90
SOUTH BANK CENTRE	TQ 308 803	1ST QUARTER 1990
SOUTH BANK CENTRE	TQ 308 803	13-06-90
SEA REACH NO.2 BUOY	TQ 955 810	1ST QUARTER 1990
SEA REACH NO.2 BUOY	TQ 955 810	01-05-90
SOUTHEND	TQ 901 828	1ST QUARTER 1990
SOUTHEND	TQ 901 828	01-05-90
GRAIN FLATS	TQ 877 795	1ST QUARTER 1990
GRAIN FLATS	TQ 877 795	01-05-90
CHAPMAN BUOY	TQ 809 813	1ST QUARTER 1990
CHAPMAN BUOY	TQ 809 813	01-05-90
BLYTHE SANDS	TQ 757 805	1ST QUARTER 1990
BLYTHE SANDS	TQ 757 805	01-05-90
MUCKING	TQ 707 808	1ST QUARTER 1990
MUCKING	TQ 707 808	01-05-90
LONDON BRIDGE	TQ 327 805	1ST QUARTER 1990
LONDON BRIDGE	TQ 327 805	17-05-90
CADOGAN PIER	TQ 274 776	1ST QUARTER 1990
CADOGAN PIER	TQ 274 776	17-05-90
WOOLWICH	TQ 429 794	1ST QUARTER 1990
WOOLWICH	TQ 429 794	05-06-90
BECKTON	TQ 456 815	1ST QUARTER 1990
BECKTON	TQ 456 815	05-06-90
CROSSNESS	TQ 494 809	1ST QUARTER 1990
CROSSNESS	TQ 494 809	05-06-90
PURFLEET	TQ 580 761	1ST QUARTER 1990
PURFLEET	TQ 580 761	05-06-90
WEST THURROCK	TQ 593 770	1ST QUARTER 1990
WEST THURROCK	TQ 593 770	05-06-90

-90 um	19	-0.5	0.24	32	17400	18	76	44	9.01	314
-90 um	46	0.6	0.57	54	28700	28	170	120	14.3	455
-90 um	54	-0.5	0.55	56	29200	29	183	101	14.5	521
-90 um	43	1.2	0.64	60	28700	36	158	88	12.43	526
-90 um	58	-0.5	0.44	59	31100	30	198	148	16.6	544
-90 um	66	-0.5	0.6	68	32600	36	231	135	17.4	679
-90 um	52	1.4	0.68	73	34100	40	184	110	16.53	560
-90 um	60	-0.5	0.47	64	32600	33	210	155	15.1	560
-90 um	68	-0.5	0.6	68	32600	36	231	135	17.4	679
-90 um	13	1	0.15	25	13200	16	60	29	6.2	164
-90 um	21	0.5	0.2	29	17900	15	119	98	10.9	207
-90 um	27	1	0.34	37	23200	21	160	60	16.9	241
-90 um	24	1.3	0.03	37	21600	21	104	45	12.13	323
-90 um	23	0.8	0.22	38	24100	32	116	88	13.4	260
-90 um	31	-0.5	0.32	37	23400	20	137	51	15.3	294
-90 um	46	0.7	0.95	59	27900	35	163	99	12.13	527
-90 um	60	0.8	0.42	62	31000	32	213	155	14.6	540
-90 um	61	-0.5	0.85	68	26700	35	227	133	15.6	566
-90 um	64	0.6	0.8	80	36000	42	202	105	19.24	649
-90 um	64	0.8	0.56	66	32400	33	225	155	17.8	590
-90 um	65	-0.5	0.6	69	29700	35	230	135	15.3	630
90-500 um	48	1.1	0.48	31	13670	18	166	170	6.63	286
90-500 um	18	0.9	0.13	24	1350	15	89	81	7.8	207
90-500 um	62	1.3	0.43	23	20400	23	162	267	10.64	224
90-500 um	48	-0.5	0.63	25	26400	24	141	193	13	283
90-500 um	31	-0.5	0.37	15	17400	17	125	157	10.16	198
90-500 um	17	-0.5	0.05	22	27400	19	100	156	16.7	240
90-500 um	16	-0.5	0.28	20	15200	14	88	32	10.4	173
90-500 um	7	-0.5	0.14	12	10600	7	53	33	11.1	146
90-500 um	25	0.6	0.24	15	12670	11	103	117	5.2	247
90-500 um	30	-0.5	1.71	11	11600	13	98	390	5.4	219
90-500 um	7.5	-0.5	0.11	11	9400	7.9	54	18	6.8	174
90-500 um	-5	-0.5	0.09	9	8600	5	36	35	6.7	158
90-500 um	80	1.6	1.03	40	27000	29	244	313	13.52	677
90-500 um	71	0.6	0.65	21	21900	20	184	360	6.6	402
90-500 um	36	0.6	0.26	19	10800	14	121	162	8.08	180
90-500 um									-0.5	
90-500 um	1.1	-0.5	0.01	33	6900	3.9	27	6.7	6.48	119
90-500 um	-5	0.5	0.03	7	8130	-5	28	23	8.2	140
90-500 um	-1	-0.5	0.04	7	7100	4.3	25	6.6	10.24	120
90-500 um	-5	-0.5	0.04	7	7200	-5	24	17	5.2	105
90-500 um	2.7	0.6	0.06	12	8900	11	39	12	8.74	152
90-500 um	-5	0.5	0.11	8	8770	-5	32	29	6.6	160
90-500 um	1.7	-0.5	0.02	9.8	13000	7.9	40	19	19.68	152
90-500 um	-5	-0.5	0.04	9	10300	9	31	26	9	119
90-500 um	2.8	-0.5	0.06	10	7500	6.5	41	10	6.72	139
90-500 um	-5	0.7	0.07	8	7700	-5	32	25	4.4	139
90-500 um	11	-0.5	0.17	20	11400	10	71	27	7.52	191
90-500 um	-5	-0.5	0.05	8	8300	-5	32	27	4.6	138
90-500 um	104	0.6	2.06	25	34400	25	465	489	17.84	330
90-500 um	205	7.1	3.8	41	32000	29	570	804	76	248
90-500 um	46	0.5	4.99	31	25670	23	143	662	19.44	770
90-500 um									16.2	
90-500 um	79	1.5	2.2	67	31800	36	284	175	14.32	770
90-500 um									7	
90-500 um	38	0.8	1.75	22	16100	13	131	90	10.96	423
90-500 um	31	1	0.4	19	19400	16	135	88	6.8	690
90-500 um	36	1.2	0.38	22	16000	12	142	71	14.24	479
90-500 um	42	1.5	0.48	20	15500	14	147	100	14.8	429
90-500 um	13	0.7	0.23	13	11500	6.8	63	29	6.4	318
90-500 um	18	1.2	0.25	15	10900	10	107	58	5.9	236
90-500 um	18	0.8	0.29	17	13300	10	92	35	7.04	403
90-500 um	42	2	0.56	36	21900	23	230	94	5.1	975

Table B.1 continued

GRAVESEND	TQ 649 746	1ST QUARTER 1990	90-500 um	11	0.8	0.16	13	10400	8.5	68	28	5.69	246
GRAVESEND	TQ 649 746	05-06-90	90-500 um	10	1.5	0.2	10	10700	6	59	43	16.8	302
PURFLEET	TQ 548 786	1ST QUARTER 1990	90-500 um	84	1.9	1.17	78	39500	39	317	155	22	832
PURFLEET	TQ 548 786	26-06-90	90-500 um									15.7	
WEST THURROCK	TQ 592 770	1ST QUARTER 1990	90-500 um	63	0.9	0.55	66	39000	37	220	127	22.72	588
WEST THURROCK	TQ 592 770	26-06-90	90-500 um									23.1	
SHOEBURYNESS EAST	TQ 949 850	1ST QUARTER 1990	90-500 um	2.2	-0.5	0.03	7.2	5600	4.2	30	10	4.21	77
SHOEBURYNESS EAST	TQ 949 850	18-06-90	90-500 um	-5	-0.5	0.04	6	5600	-5	28	19	4.7	67
SOUTHEND	TQ 888 844	1ST QUARTER 1990	90-500 um	8.8	0.7	0.08	6.7	5130	4.3	51	41	4.22	61
SOUTHEND	TQ 888 844	18-06-90	90-500 um	-5	-0.5	0.07	10	7900	6	36	23	4.9	105
WOOLWICH	TQ 427 793	1ST QUARTER 1990	90-500 um	61	1.4	0.78	47	26600	26	239	153	12.8	680
WOOLWICH	TQ 427 793	12-06-90	90-500 um	58	3.1	0.47	31	34000	23	282	182	14.9	1260
CROSSNESS	TQ 492 809	1ST QUARTER 1990	90-500 um	68	0.9	0.73	76	40000	55	227	135	19.28	588
CROSSNESS	TQ 492 809	12-06-90	90-500 um									28.1	

All data are mg/kg dry weight. No information regarding analytical techniques has been received yet.

Table B.2 Data for the Mersey Estuary

SITE GRID REF	DATE	SIZE FRACTION	COPPER	CADMIUM
SJ 5145 8420	AUGUST 1989	TOTAL	22.72	0.77
SJ 5170 8305	AUGUST 1989	TOTAL	5.85	0.21
SJ 5190 8380	AUGUST 1989	TOTAL	9.35	0.19
SJ 5215 8360	AUGUST 1989	TOTAL	3.47	0.14
SJ 5235 8340	AUGUST 1989	TOTAL	22.72	0.74
SJ 4820 5150	AUGUST 1989	TOTAL	164.55	5.65
SJ 4835 5150	AUGUST 1989	TOTAL	3.48	0.11
SJ 4850 5148	AUGUST 1989	TOTAL	2.9	0.05
SJ 4865 5145	AUGUST 1989	TOTAL	3.35	0.13
SJ 4880 5143	AUGUST 1989	TOTAL	2.57	0.06
SJ 4895 5140	AUGUST 1989	TOTAL	5.07	0.11
SJ 4915 5136	AUGUST 1989	TOTAL	2.17	0.07
SJ 4925 5135	AUGUST 1989	TOTAL	15	0.45
SJ 4740 5085	AUGUST 1989	TOTAL	75.07	1.31
SJ 4760 5080	AUGUST 1989	TOTAL	19.63	0.78
SJ 4780 5075	AUGUST 1989	TOTAL	4.6	0.19
SJ 4805 5070	AUGUST 1989	TOTAL	2.53	0.06
SJ 4825 5060	AUGUST 1989	TOTAL	5.3	0.14
SJ 4845 5055	AUGUST 1989	TOTAL	5.62	0.15
SJ 4865 5050	AUGUST 1989	TOTAL	16.28	0.3
SJ 4890 5040	AUGUST 1989	TOTAL	17.31	0.49
SJ 4910 5035	AUGUST 1989	TOTAL	15.79	0.33
SJ 4935 5030	AUGUST 1989	TOTAL	17.6	0.45
SJ 4955 5025	AUGUST 1989	TOTAL	79.89	1.09
SJ 4975 5015	AUGUST 1989	TOTAL	60.81	1.15
SJ 4995 5010	AUGUST 1989	TOTAL	43.89	0.93
SJ 5000 5010	AUGUST 1989	TOTAL	34.99	0.84
SJ 4975 5010	AUGUST 1989	TOTAL	28.49	0.64
SJ 4955 5008	AUGUST 1989	TOTAL	16.57	0.25
SJ 4935 5007	AUGUST 1989	TOTAL	9.82	0.28
SJ 4910 5007	AUGUST 1989	TOTAL	3.31	0.03
SJ 4890 5005	AUGUST 1989	TOTAL	2.77	-0.01
SJ 4865 4999	AUGUST 1989	TOTAL	2.57	-0.01
SJ 4845 4997	AUGUST 1989	TOTAL	2.26	-0.01
SJ 4825 4995	AUGUST 1989	TOTAL	4.35	0.06
SJ 4800 4995	AUGUST 1989	TOTAL	3.13	0.04
SJ 4780 4992	AUGUST 1989	TOTAL	2.92	0.03
SJ 4757 4990	AUGUST 1989	TOTAL	3.25	0.08
SJ 4735 4990	AUGUST 1989	TOTAL	2.55	0.05
SJ 4715 4987	AUGUST 1989	TOTAL	1.71	-0.01
SJ 4690 4985	AUGUST 1989	TOTAL	1.85	-0.01
SJ 5000 5010	AUGUST 1989	TOTAL	48.95	0.99
SJ 4960 4985	AUGUST 1989	TOTAL	79.1	1.19
SJ 4922 4965	AUGUST 1989	TOTAL	63.49	1.26
SJ 4890 4945	AUGUST 1989	TOTAL	89.89	1.28
SJ 4855 4920	AUGUST 1989	TOTAL	100.3	1.29
SJ 4820 4900	AUGUST 1989	TOTAL	74.87	1.19
SJ 4785 4880	AUGUST 1989	TOTAL	76.47	1.2
SJ 4750 4860	AUGUST 1989	TOTAL	90.74	1.46
SJ 4715 4835	AUGUST 1989	TOTAL	70.53	1.04
SJ 4720 5090	AUGUST 1989	TOTAL	71.09	1.59
SJ 4723 5065	AUGUST 1989	TOTAL	3.73	0.09
SJ 4725 5035	AUGUST 1989	TOTAL	2.94	0.04
SJ 4727 5005	AUGUST 1989	TOTAL	2.75	0.05
SJ 4730 4980	AUGUST 1989	TOTAL	1.81	-0.01
SJ 4735 4995	AUGUST 1989	TOTAL	5.54	0.03
SJ 4737 4925	AUGUST 1989	TOTAL	3.28	0.08
SJ 4740 4900	AUGUST 1989	TOTAL	1.81	0.04
SJ 4743 4870	AUGUST 1989	TOTAL	122.01	1.79
SJ 4745 4840	AUGUST 1989	TOTAL	65.72	1.32

MERCURY	CHROMIUM	ZINC	LEAD	ARSENIC	% SILT CONTENT
0.7	20.4	287.6	41.97	30.88	19.1
0.2	5.9	123.54	15.1	-4.96	1.9
0.2	7.86	98.01	15.69	-5	7.9
0.09	4.46	76.88	9.49	-4.91	1.2
0.7	18.98	219.8	38.69	-5.63	23.1
2.8	119.07	1130	303.92	162.5	87.2
0.2	4.47	72.5	10.07	-4.91	2.3
0.2	3.97	61.3	8.26	-4.96	0.9
0.2	4.33	70.47	12.93	-4.91	1.1
0.1	3.11	50.32	7.83	-4.88	1.5
0.2	4.68	78.06	11.6	-4.96	2
0.09	3.78	57.38	8.65	-4.88	1.2
0.5	11.63	173.65	31.8	-5.41	18.5
2.3	79.34	399.83	113.92	11.29	89.2
0.6	20.81	261.08	33.51	-5.41	12.8
0.2	6.01	123.43	16.36	-5.19	5.9
0.09	3.81	54.22	8.15	-4.68	2.3
0.2	6.86	91.07	15.13	-5.32	3.8
0.2	6.33	94.18	14.94	-5.32	12
0.6	16.13	125.92	29.61	-5.56	28.5
0.6	15.08	164.15	32.42	-5.24	14
0.5	15.24	159.93	32.72	-5.56	18.5
0.6	16.72	159.63	35.16	-5.32	16.9
1.8	77.23	377.48	126.39	-8.37	81.6
1.3	57.16	228.68	97.47	10.14	80.7
1.2	37.82	306.51	69.22	-6.29	52.2
1.1	29.2	252.07	56.91	31.16	47
1.1	23.29	221.08	48.58	6.18	32
0.5	48.73	151.45	32.29	-5.43	12.9
0.4	9.57	148.5	24.74	-5.24	6.7
0.09	4.65	65.18	10.28	-5.12	4.1
0.08	3.65	42.94	6.64	-4.91	0.5
0.06	5.19	46.93	8.27	-4.88	0.5
0.09	3.87	43.06	8.84	-4.91	1.5
0.1	5.24	74.92	10.72	-5.08	2.8
0.05	4.03	59.43	9.36	-4.91	0.6
0.1	4.47	63.03	10.6	-4.96	2.2
0.07	4.6	77.71	10.93	-5.08	1.8
0.06	4.63	61.28	8.74	-5	2.2
0.06	3.59	47.88	7.57	-5	0.2
0.06	3.87	43.84	7.84	-4.88	0.7
1.4	41.81	298.14	78.41	8.69	66
1.8	72.48	389.56	128.62	12.26	88.5
1.3	54.78	334.66	97.24	11.47	82.7
1.6	83.66	418.01	138.86	19.1	96.1
2	96.16	440.7	154.62	15.77	97.8
1.7	69.73	350.51	118.85	14.65	89.4
1.8	62.81	325.48	112.37	11.47	92.5
2	82.95	416.79	146.36	15.71	93.5
1.5	63.28	321.63	112.45	13.54	93.8
1.4	71.68	441.32	121.06	44.74	75.5
0.1	4.86	82.85	12.62	-5.12	1.7
0.08	4.32	57.35	9.24	-4.98	2.6
0.06	4	59.63	7.78	-5.08	1.4
0.04	3.18	41.05	7.17	-5	1.7
0.2	8.47	57.37	13.61	-4.88	1.1
0.06	5.66	52.52	9.76	-4.96	1.6
0.06	4.04	43.79	8.31	-4.88	0.7
2.2	80.1	461.87	165.13	23.99	74.5
1.9	45.66	373.92	94.36	9.59	77.1

Table B.2 continued

SJ 4747 4815	AUGUST 1989	TOTAL	32.27
SJ 4750 4790	AUGUST 1989	TOTAL	85.94
SJ 4425 5140	AUGUST 1989	TOTAL	81.73
SJ 4420 5115	AUGUST 1989	TOTAL	8.88
SJ 4410 5095	AUGUST 1989	TOTAL	4.98
SJ 4400 5070	AUGUST 1989	TOTAL	2.1
SJ 4390 5055	AUGUST 1989	TOTAL	4.14
SJ 4380 5030	AUGUST 1989	TOTAL	3.98
SJ 4375 5005	AUGUST 1989	TOTAL	5.8
SJ 4365 4987	AUGUST 1989	TOTAL	11
SJ 4355 4965	AUGUST 1989	TOTAL	8.97
SJ 4345 4940	AUGUST 1989	TOTAL	3.44
SJ 4335 4915	AUGUST 1989	TOTAL	3.24
SJ 4325 4900	AUGUST 1989	TOTAL	2.44
SJ 4315 4875	AUGUST 1989	TOTAL	5.6
SJ 4305 4855	AUGUST 1989	TOTAL	2.62
SJ 4295 4830	AUGUST 1989	TOTAL	5.3
SJ 4285 4810	AUGUST 1989	TOTAL	3.22
SJ 4275 4785	AUGUST 1989	TOTAL	22.92
SJ 4265 4765	AUGUST 1989	TOTAL	23.09
SJ 4160 5225	AUGUST 1989	TOTAL	54.09
SJ 4115 5215	AUGUST 1989	TOTAL	2.2
SJ 4075 5205	AUGUST 1989	TOTAL	1.99
SJ 4030 5195	AUGUST 1989	TOTAL	1.63
SJ 3995 5180	AUGUST 1989	TOTAL	3.26
SJ 3950 5170	AUGUST 1989	TOTAL	1.5
SJ 3910 5160	AUGUST 1989	TOTAL	3.22
SJ 3865 5145	AUGUST 1989	TOTAL	2.46
SJ 3830 5135	AUGUST 1989	TOTAL	1.86
SJ 3785 5125	AUGUST 1989	TOTAL	2.47
SJ 3745 5115	AUGUST 1989	TOTAL	2.29
SJ 3700 5100	AUGUST 1989	TOTAL	13.53
SJ 3210 9605	AUGUST 1989	TOTAL	15.41
SJ 3490 8755	AUGUST 1989	TOTAL	19.52
SJ 3775 8550	AUGUST 1989	TOTAL	64.65
SJ 4017 8327	AUGUST 1989	TOTAL	73.72
SJ 3650 8190	AUGUST 1989	TOTAL	53.53
SJ 3355 8680	AUGUST 1989	TOTAL	38.33
SJ 3215 9050	AUGUST 1989	TOTAL	14.32
SJ 3130 9425	AUGUST 1989	TOTAL	1.5
SJ 6075 8645	AUGUST 1989	TOTAL	57.33
SJ 3690 5120	AUGUST 1989	TOTAL	36.81

All data are in mg/kg dry weight. The metals

0.49	0.8	29.87	197.9	36.04	-6.64	53.4
1.26	1.9	78.02	374.16	135.7	14.54	93
1.31	1.3	91.4	375.58	120.35	9.13	85.7
0.15	0.3	10.42	95.73	21.72	-5.48	15.8
0.14	0.2	6.51	90.26	14.07	-5.08	6
-0.01	0.05	3.63	45.48	6.1	-5.04	1.9
0.05	0.3	5.22	71.15	11.81	-5.08	1.7
0.05	0.09	5.43	87.52	13.22	-5.19	3.5
0.19	0.2	7.46	135.66	20.7	-5.28	6.7
0.27	0.3	11.78	135.63	22.9	-5.28	9.5
0.21	0.3	8.77	138.01	20.95	-5.32	9.7
0.14	0.06	5.18	65.87	13.38	12.97	2.4
0.01	0.06	4.19	54.67	8.97	-5	2.2
0.03	0.06	4.72	55.15	11.05	-4.96	0.7
0.11	0.2	5.77	106.45	13.94	-5.04	4.5
0.03	0.06	3.43	57.76	7.6	-5	1.8
0.05	0.2	7.05	78.75	13.06	-5	12
0.02	0.09	5.76	68.43	9.38	-4.91	1.5
0.32	0.7	24.47	144.06	38.92	5.02	70.1
0.36	0.7	22.7	164.95	41.4	-4.96	28.2
0.82	1	97.62	287.2	86.82	8.99	78
-0.01	0.1	5.59	45.3	8.19	-5	0.2
-0.01	0.04	9.18	42.47	9.04	-5	0.1
-0.01	0.04	3.74	42.91	8	-4.91	0.1
-0.01	0.05	3.6	46.2	9.53	-5	9.2
-0.01	0.05	2.94	39.3	5.38	-5.04	0.3
-0.01	0.08	4.13	54.82	8.18	-5	4.1
-0.01	0.08	4.46	53.18	8.84	-4.52	2.9
-0.01	0.04	3.25	34.69	5.66	-4.8	0.1
-0.01	0.04	4.57	45.94	10.47	-4.91	0.4
-0.01	0.1	3.73	53.15	8.43	-5.15	3.5
0.1	0.5	14.15	76.56	28.16	-5.52	37.3
0.2	0.6	15.22	125.72	41.51	-5.8	43.5
0.44	0.8	16.49	186.56	37.1	-6.12	30.4
1.23	1.5	64.27	394.54	111.78	12.37	77.5
0.96	2.4	63.91	345.94	122.55	14.31	84.8
0.9	1.3	53.98	347.37	92.18	10.84	66.9
0.32	0.9	43.73	188.46	88.03	-6.6	34.5
0.1	0.5	15.28	115.91	31.47	-6.12	45.2
-0.01	0.04	2.34	24.34	4.98	-5	0.8
1.05	1.4	45.97	355.81	82.03	11.47	69.2
0.57	1.4	37.26	245.88	70.09	12.68	54.3

were extracted from the sediment by an aqua regia (3:1 HCl:HNO3) digestion.