

NRA NORTH WEST 83

THE RIBBLE ESTUARY 1992 SURVEYS  
SUMMARY OF RESULTS

Marine and Special Projects  
EQ  
May 1993

Report: MSP-RIB-93-001

## THE RIBBLE ESTUARY 1992

### Introduction.

The following report summarises routine and baseline water quality surveys carried out on the Ribble estuary during 1992. The aim was to survey monthly throughout the year, although this proved impracticable during August, September and December.

Sampling locations are shown in Fig.1 and Table 1.

Baseline surveys are designed to respond to regional, national, and European requirements. During 1992 baseline surveys were carried out in January, April, June, July, and October. In 1993 this will be extended to monthly.

Table 2 and Table 3 list the suite of parameters analysed for routine and baseline surveys respectively. It should be noted that analysis for organic parameters was not carried out in 1992 but will commence in 1993.

### Interpretation

Raw data for all surveys carried out in 1992 are listed in Appendix 1 - Sanitary Parameters and Appendix 2 - Metals.

For ease of interpretation the results have been presented in graph form, using the size of symbols to indicate relative parameter concentrations. Maximum and minimum concentrations are also presented on each graph, as are the appropriate Environmental Quality Objectives (EQO) and Environmental Quality Standards (EQS).

Table 4 lists the EQSs and EQOs for estuaries and coastal waters. It is important to note that compliance with many EQSs is based on annual average values.

### Results

#### Physical parameters.

Fig. 2. The temperature profiles are as expected, increasing during the summer months. pH remains between 7.5 and 8.3 throughout the year increasing slightly in summer and with higher salinity. Suspended solids tend to be higher downstream, especially in March, October and November. In May, however, fairly high concentrations were found at station 8 and 9.

Fig. 3. Biochemical Oxygen Demand (BOD) was generally higher upstream, the highest concentration being found at station 9 (5.8mg/l) in June. Dissolved Oxygen levels decreased upstream throughout the year, noticeably above



station 9. The minimum for the year occurred at station 9 (45%) in October.

### Nutrients

Fig. 4. All nutrients tended to increase in concentration upstream.

#### Ammonia

0.03 - 1.26 mg/l mean: 0.377mg/l

The highest concentration of ammonia was found in Lytham Creek (1.26 mg/l) in July, and at station 11 (1.04 mg/l) and 12 (1.1 mg/l) in January. Although ammonia levels generally increased in concentration upstream each month, higher levels were found further downstream in May.

#### Phosphate

0.03 - 0.7 mg/l mean: 0.195 mg/l

The highest levels were found upstream, noticeably at stations 11 and 12 from February to July. In April levels started to increase upstream from station 5.

#### Nitrate

0.06 - 5.1 mg/l mean: 0.074 mg/l

The highest levels again found upstream, noticeably increasing above station 9, but further downstream in April.

Nutrient levels for other estuaries in 1992 :

mg/l	Ammonia	Phosphate	Nitrate
Ribble	0.03-1.26	0.03-0.70	0.06-5.10
Mersey	0.03-6.40	0.03-1.40	0.03-4.22
Doulton	0.08-1.58	0.01-1.68	0.05-2.88

### Metals

As part of the baseline sampling programme in 1992, metals were sampled for in January, March, June, July and October at stations 1,3,5,7,9,11.

Dissolved copper and cadmium exceeded the appropriate EQS value at certain times of the year.

Fig.5a

#### Total Mercury.

0.03µg/l - 0.43µg/l

The highest concentrations of total mercury were found in July at station 1,3 and 11.

#### Dissolved Mercury.

0.01µg/l - 0.14µg/l

All samples were below the EQS of 0.3µg/l.

The highest concentrations were found in March at Station 1 (0.11µg/l), 7 (0.14µg/l), and 11 (0.14µg/l), with no

noticeable trend up or downstream. Concentrations in March, June and July were noticeably higher than in January and October.

#### Dissolved Nickel.

0.65µg/l - 3.55µg/l

All concentrations were below EQS of 30µg/l.

Each month, the highest concentrations were recorded at station 11, with a tendency to decrease in concentration downstream.

#### Dissolved Zinc.

3.70µg/l - 27.50µg/l

All concentrations were below EQS of 40µg/l.

No obvious concentration trend upstream or downstream.

The highest value occurred in October at station 11.

Fig. 5b.

#### Dissolved Arsenic

1.45 - 4.15 µg/l mean:

Concentrations were well below EQS value of 25µg/l.

Slightly higher concentrations were found in summer months (June and July).

#### Dissolved Chromium

0.03 - 3.60 µg/l mean:

All recorded levels below the EQS value of 15µg/l.

The highest concentrations were found in July (3.6µg/l - 1.25µg/l), decreasing downstream.

Fig. 6.

#### Dissolved Copper.

1.10µg/l - 24.50µg/l

The EQS for dissolved copper (5µg/l) was quite significantly exceeded twice during 1992; at station 7 in January (24.5µg/l) and Station 11 in March (11µg/l). Fairly high values of copper (i.e. 4µg/l) were also detected at other stations.

#### Dissolved Cadmium.

0.03µg/l - 4.30µg/l

The EQS of dissolved cadmium (2.5µg/l) was also exceeded in 1992 at station 9 in July. Apart from this value, all other samples were quite low in cadmium.

#### Conclusion

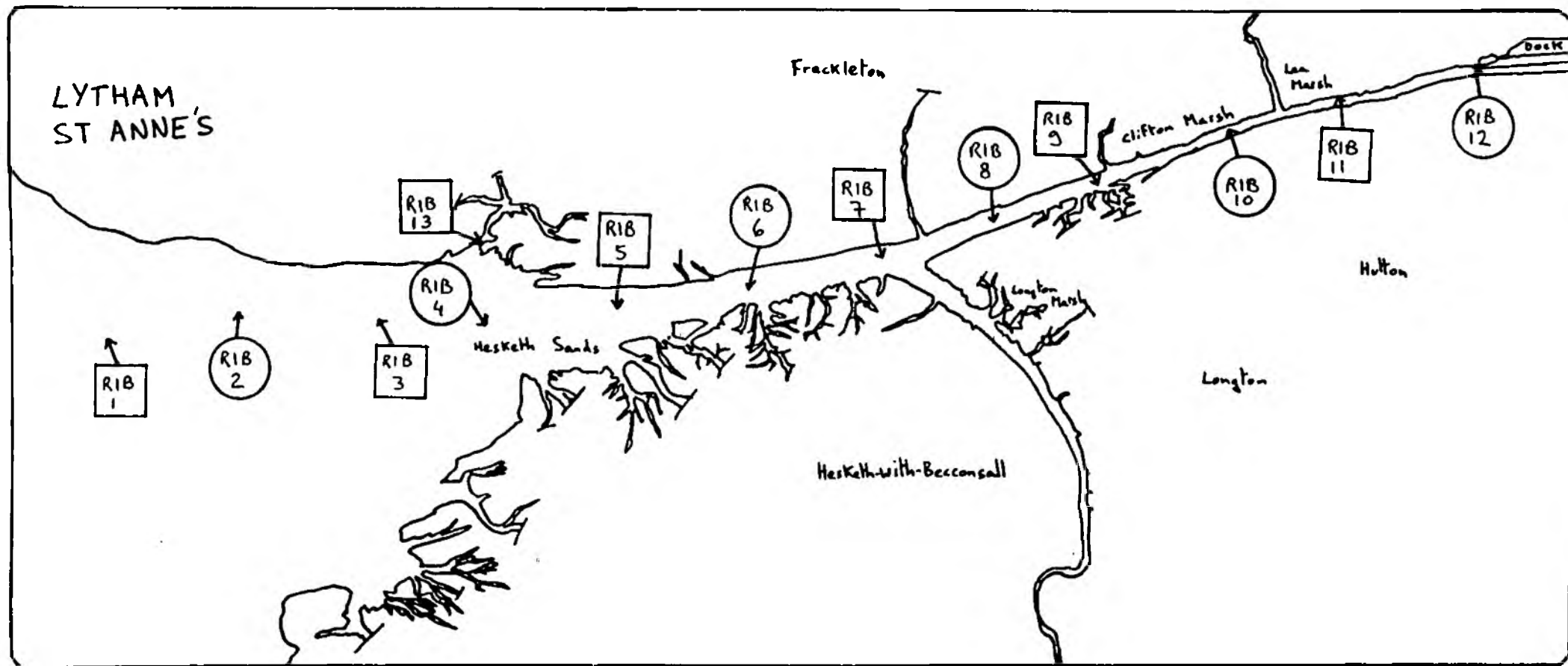
The above report summarises routine and baseline water quality surveys carried out in the Ribble Estuary during 1992. The Ribble was surveyed monthly throughout the year except August, September and December.

The upstream regions of the Ribble estuary tend to have higher nutrients, higher BOD and lower dissolved oxygen than downstream. The metal data showed no obvious trend upstream or downstream.

The dissolved copper and cadmium levels exceeded the appropriate EQS values at certain times of the year. The EQS for dissolved copper was quite significantly exceeded twice in 1992 and was approached at other times of the year. The EQS for dissolved cadmium was exceeded once but Cadmium levels were fairly low at other times of the year. It is important to note, however, that compliance with EQSs is based on annual average values.

During 1993, baseline surveys are being carried out monthly and include the analysis for organic parameters.

Please pass on any comments, suggestions or questions on this report to Elaine Fisher at Marine and Special Projects.



**Figure 1:** Schematic representation of the Ribble estuary, showing the sampling sites.



Baseline monitoring stations

TABLE 1

1993

## RIBBLE SURVEY

STATION	S.P.N.
*** 1. Ribble estuary at the 11 <sup>th</sup> Milepost	106375
2. Ribble estuary at the 10 <sup>th</sup> Milepost	106374
*** 3. Ribble estuary at the 9 <sup>th</sup> Milepost	106373
4. Ribble estuary at the 8 <sup>th</sup> Milepost	106356
*** 5. Ribble estuary at the 7 <sup>th</sup> Milepost	106351
6. Ribble estuary at the 6 <sup>th</sup> Milepost	106345
◆ *** 7. Ribble estuary at the 5 <sup>th</sup> Milepost	105612
8. Ribble estuary at the 4 <sup>th</sup> Milepost	105596
*** 9. Ribble estuary at the 3 <sup>rd</sup> Milepost	105595
10. Ribble estuary at the 2 <sup>nd</sup> Milepost	105593
◆ *** 11. Ribble estuary at the 1 <sup>st</sup> Milepost	105513
12. Ribble estuary at Bullnose	105507
13. Main drain at Lytham Creek	106352 ◆

◆ Main drain sampled once a year

◆ Sampled 12 times/year for dissolved metals (Cd, Cr, Cu, Pb, Ni, Zn)

◆ Sampled 12 times/year for pH, dissolved metals (Cr, Cu, Pb, Ni, Zn)

## \*\*\* BASELINE MONITORING STATION

DESCRIPTION	N.G.R.	S.P.N.
*** 1. Ribble estuary at the 11 <sup>th</sup> Milepost	SD 335 259	71806375
2. Ribble estuary at the 10 <sup>th</sup> Milepost	SD 350 263	71806374
*** 3. Ribble estuary at the 9 <sup>th</sup> Milepost	SD 368 263	71806373
4. Ribble estuary at the 8 <sup>th</sup> Milepost	SD 382 262	71806356
*** 5. Ribble estuary at the 7 <sup>th</sup> Milepost	SD 398 264	71806351
6. Ribble estuary at the 6 <sup>th</sup> Milepost	SD 415 265	71806345
*** 7. Ribble estuary at the 5 <sup>th</sup> Milepost	SD 433 270	71805612
8. Ribble estuary at the 4 <sup>th</sup> Milepost	SD 445 274	71805596
*** 9. Ribble estuary at the 3 <sup>rd</sup> Milepost	SD 458 279	71805595
10. Ribble estuary at the 2 <sup>nd</sup> Milepost	SD 475 285	71805593
*** 11. Ribble estuary at the 1 <sup>st</sup> Milepost	SD 488 289	71805513
12. Ribble estuary at Bullnose	SD 507 293	71805507
13. Main drain at Lytham Creek	SD 381 272	71806352

S.P.N. = Sampling Point Number

N.G.R. = National Grid Reference

F.R.N. = Feature Reference Number

**Table 2:** Parameters only analysed on baseline monitoring stations.

PARAMETER	UNIT	CODE
Lead (dissolved)	µg/l Pb	52
Mercury (dissolved)	µg/l Hg	103
Mercury	µg/l Hg	105
Cadmium (dissolved)	µg/l Cd	106
& Boron	mg/l	283
Aldrin	µg/l	483
HCH alpha	µg/l	487
HCH beta	µg/l	491
HCH gamma	µg/l	499
Dieldrin	µg/l	511
◆ Endosulphan	µg/l	519
DDT o,p'	µg/l	539
DDE p,p'	µg/l	551
DDT p,p'	µg/l	555
TDE p,p'	µg/l	559
Endrin	µg/l	562
Hexachlorobenzene	µg/l	576
DDE o,p'	µg/l	581
Pentachlorophenol	µg/l	1085
Copper (dissolved)	µg/l Cu	7213
Zinc (dissolved)	µg/l Zn	7243
Arsenic (dissolved)	µg/l As	7354
Chromium (dissolved)	µg/l Cr	7373
Nickel (dissolved)	µg/l Ni	7427
Chloroform	µg/l	9524
◆ Atrazine	µg/l	9632
◆ Simazine	µg/l	9633
Carbon tetrachloride	µg/l	9643
Hexachlorobutadiene	µg/l	9705
PCB CON28	µg/l	9768
PCB CON52	µg/l	9769
PCB CON101	µg/l	9770
PCB CON118	µg/l	9771
PCB CON138	µg/l	9772
PCB CON153	µg/l	9773
PCB CON180	µg/l	9774
PCB total congeners	µg/l	9807
! Tetrachloroethylene	µg/l	9706
! Trichloroethylene	µg/l	9707
!◆ Dichloroethane 1,2	µg/l	9712
!◆ Trichlorobenzene	µg/l	9713
◆ Trifluralin	µg/l	9714

CODE = determinand code on the water archive

& = List II substance

◆ = Red List substance

! = List I substance from 1993

All other parameters = NRA routine baseline monitoring



**Table 3:** Parameters analysed on all samples.

PARAMETER	UNIT	CODE
pH at 20°C		61
Temperature	°C (Field)	76
Conductivity $\mu\text{S}/\text{cm}$ at 25°C		77
Dissolved Oxygen	% saturation	81
Dissolved Oxygen	mg/l	82
BOD 5 day (ATU)	mg/l	85
Chemical Oxygen Demand	mg/l O	92
Suspended Solids Total	mg/l	135
Alkalinity to mo	mg/l $\text{CaCO}_3$	162
Chloride	mg/l Cl	172
Chlorophyll a	$\mu\text{g}/\text{l}$	729
Phaeophytin	$\mu\text{g}/\text{l}$	950
Nitrate - filtered - as N	mg/l N	9853
Nitrite - filtered - as N	mg/l N	9854
Ammonia - filtered - as N	mg/l N	9855
Orthophosphate - filtered - as P	mg/l P	9856
Silicate - filtered - as $\text{SiO}_2$	mg/l $\text{SiO}_2$	9857
Salinity (calculated from conductivity and temperature)		1198

CODE = determinand code on the water archive

TABLE 4

## ENVIRONMENTAL QUALITY OBJECTIVES AND STANDARDS

## FOR ESTUARIES AND COASTAL WATERS

(Information Dated September 1992)

QUALITY STANDARDS

## Protection of salt water life

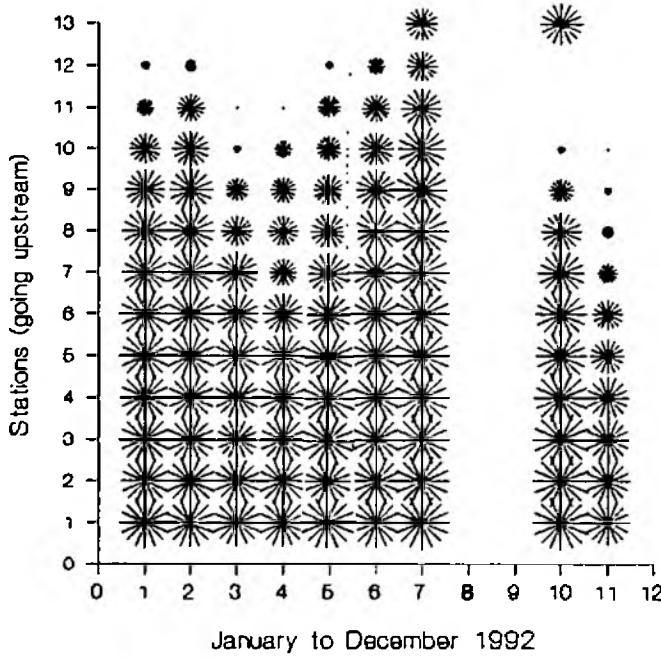
Arsenic	25 $\mu\text{g}/\text{l}$	annual mean, dissolved
Boron	7000 $\mu\text{g}/\text{l}$	annual mean, total
Chromium	15 $\mu\text{g}/\text{l}$	annual mean, dissolved
Copper	5 $\mu\text{g}/\text{l}$	annual mean, dissolved
Cyfluthrin	0.001 $\mu\text{g}/\text{l}$	total, 95%
Fluocofuron	1 $\mu\text{g}/\text{l}$	total, 95%
Iron	1000 $\mu\text{g}/\text{l}$	annual mean, dissolved
Lead	25 $\mu\text{g}/\text{l}$	annual mean, dissolved
Nickel	30 $\mu\text{g}/\text{l}$	annual mean, dissolved
PCSDs	0.05 $\mu\text{g}/\text{l}$	total, 95%
Permethrin	0.01 $\mu\text{g}/\text{l}$	total, 95%
pH	6 - 8.5	95%
Sulcofuron	25 $\mu\text{g}/\text{l}$	total, 95%
Tributyltin	0.002 $\mu\text{g}/\text{l}$	maximum, total
Triphenyltin	0.008 $\mu\text{g}/\text{l}$	maximum, total
Vanadium	100 $\mu\text{g}/\text{l}$	annual mean, total
Zinc	40 $\mu\text{g}/\text{l}$	annual mean, dissolved

QUALITY STANDARDS - endorsed  
annual mean

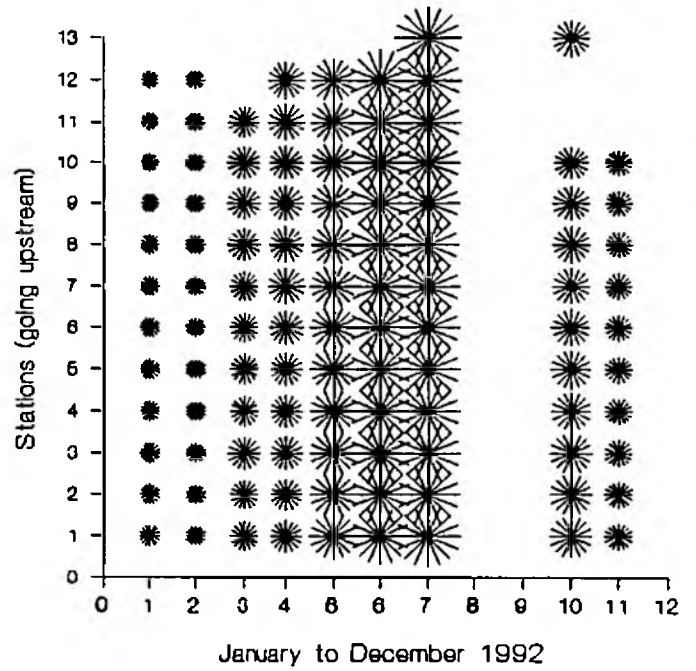
Total "drins"	0.03 $\mu\text{g}/\text{l}$	until 1994
Aldrin	0.01 $\mu\text{g}/\text{l}$	from 1.1.94
Dieldrin	0.01 $\mu\text{g}/\text{l}$	from 1.1.94
Endrin	0.005 $\mu\text{g}/\text{l}$	
Isodrin	0.005 $\mu\text{g}/\text{l}$	from 1.1.94
Cadmium	2.5 $\mu\text{g}/\text{l}$	dissolved
Carbon tetrachloride (CTC)	12 $\mu\text{g}/\text{l}$	
Chloroform	12 $\mu\text{g}/\text{l}$	
DDT	0.01 $\mu\text{g}/\text{l}$	para-para-DDT
DDT total	0.025 $\mu\text{g}/\text{l}$	
1,2-Dichloroethane (EDC)	10 $\mu\text{g}/\text{l}$	
Hexachlorobenzene (HCB)	0.03 $\mu\text{g}/\text{l}$	
Hexachlorobutadiene (HCBD)	0.1 $\mu\text{g}/\text{l}$	
Hexachlorocyclohexane (HCH)	0.02 $\mu\text{g}/\text{l}$	total of all 3 isomers
Mercury	0.3 $\mu\text{g}/\text{l}$	dissolved
Pentachlorophenol (PCP)	2 $\mu\text{g}/\text{l}$	
Trichlorobenzene (TCB)	0.4 $\mu\text{g}/\text{l}$	
Trichloroethylene (TRI)	10 $\mu\text{g}/\text{l}$	
Tetrachloroethylene (PER)	10 $\mu\text{g}/\text{l}$	

FIGURE 2 Physical Parameters of the Ribble.

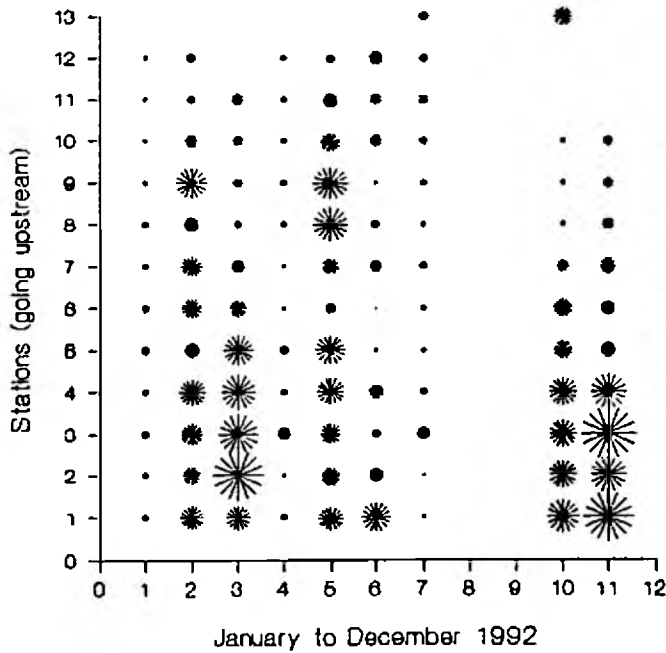
Chloride 380 - 19080 mg/l



Temperature 4.7 - 17.5 C



Suspended Solids 2.0 - 300 mg/l



pH 7.5 - 8.3

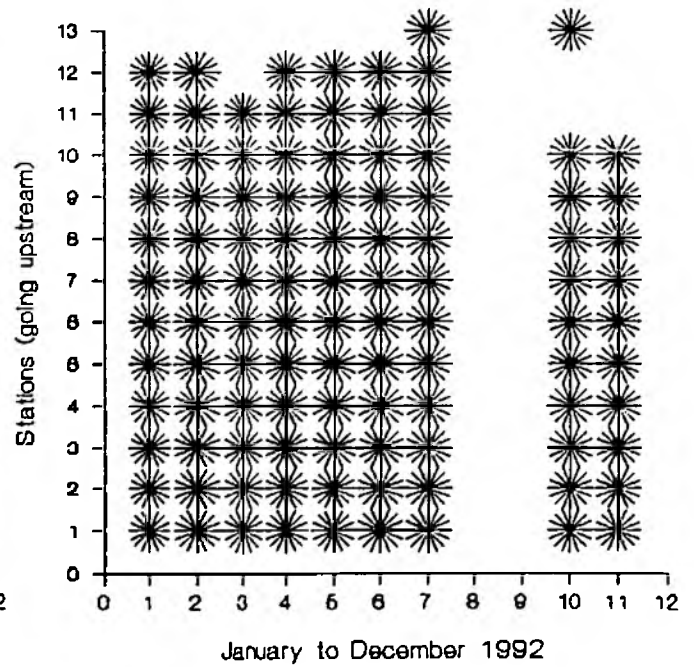


FIGURE 3 Biochemical Oxygen Demand and Dissolved Oxygen levels in the Ribble.

Biochemical Oxygen Demand  
0.6 - 5.8 mg/l

% Dissolved Oxygen  
45.5% - 111%

Dissolved Oxygen  
4.710 - 10.440 mg/l

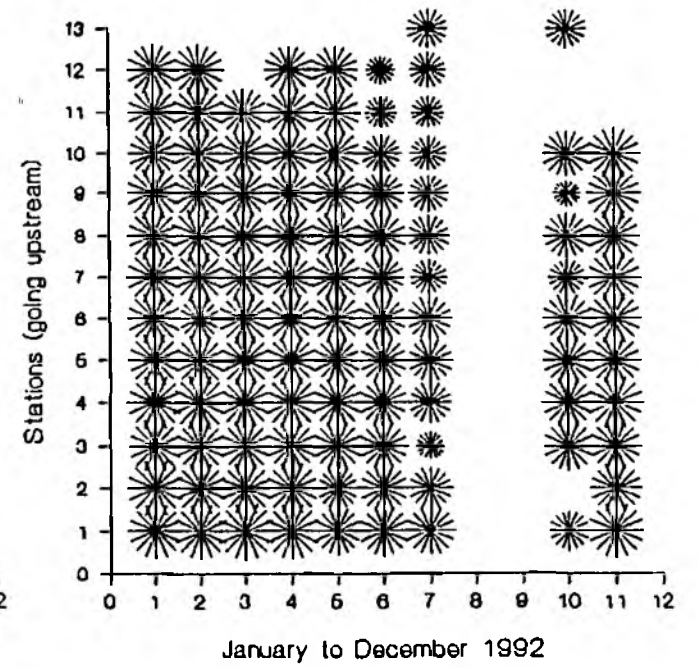
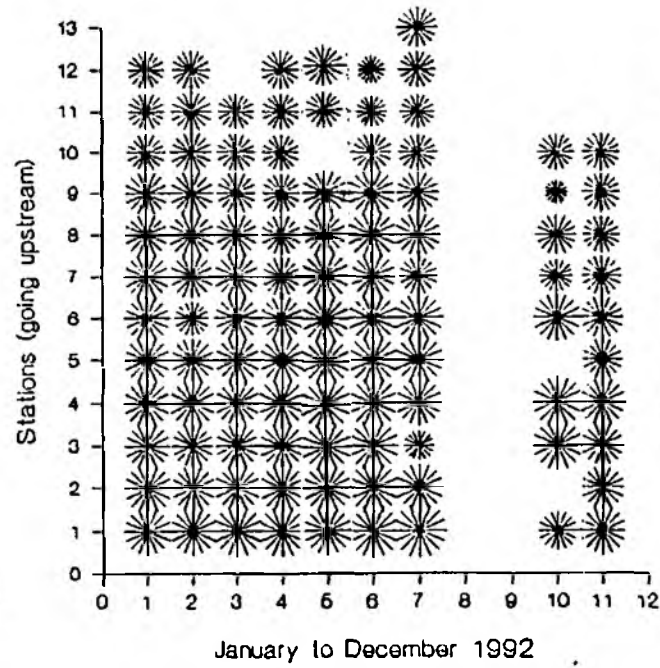
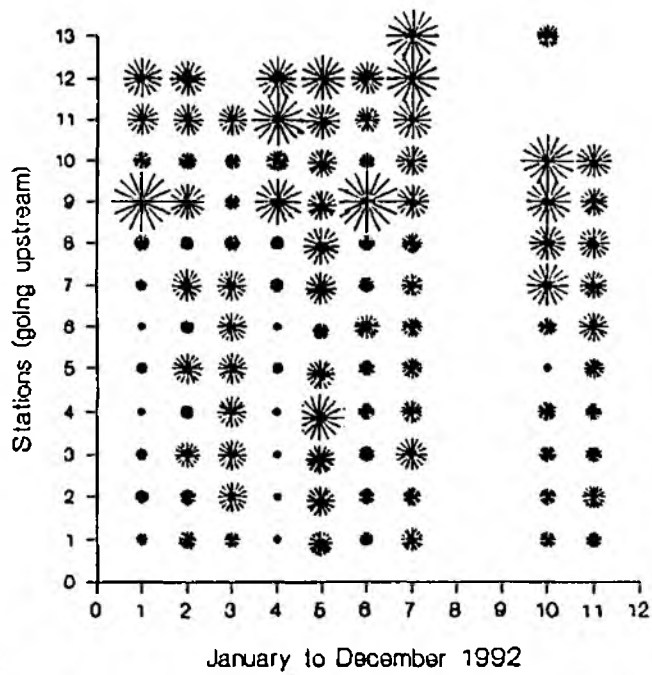
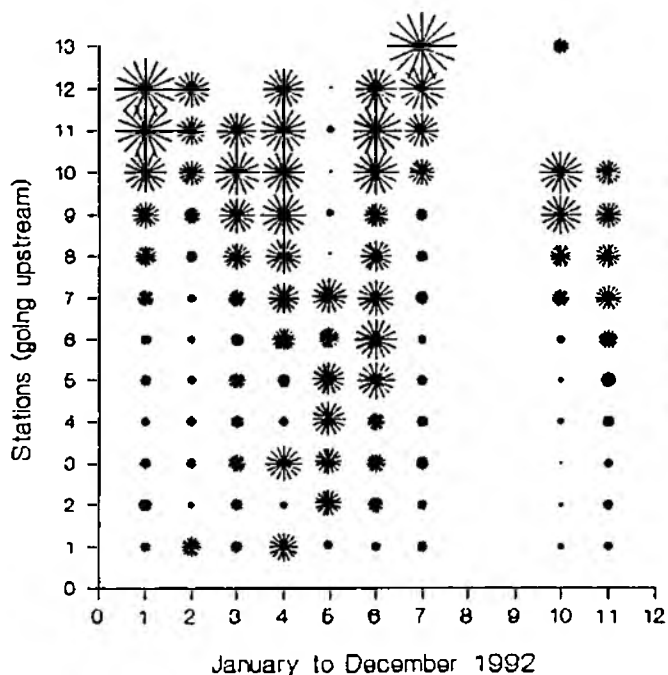
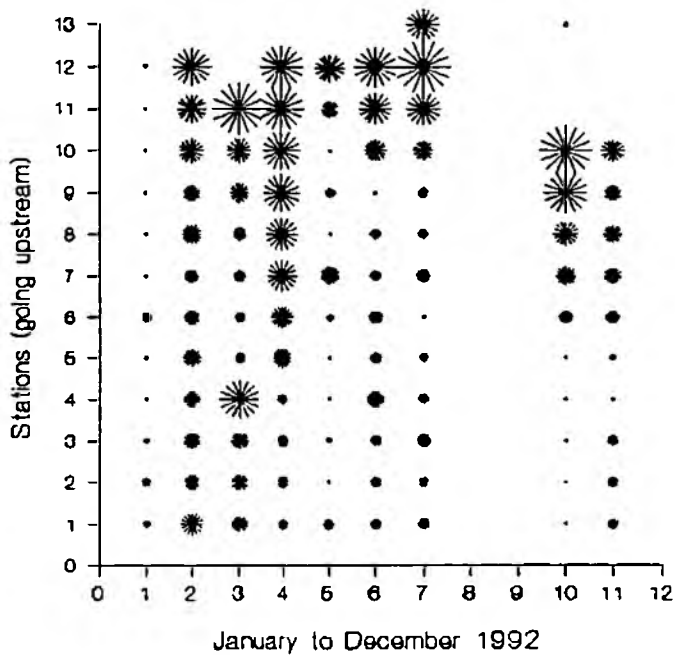


FIGURE 4 Nutrient Concentration in the Ribble.

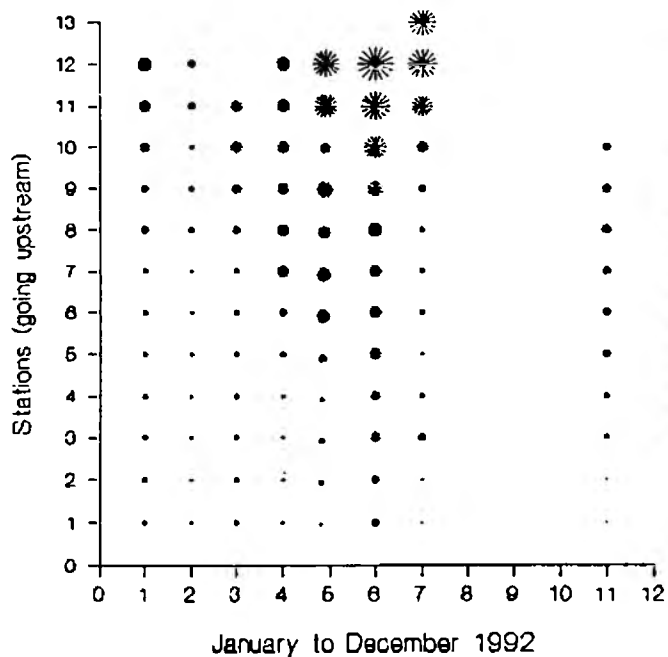
Ammonia 0.03 - 1.26 mg/l



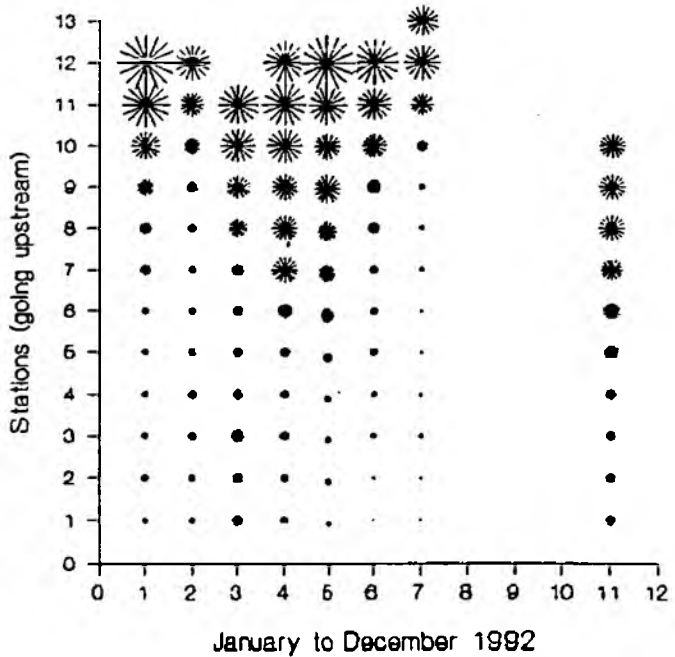
Phosphate 0.03 - 0.7 mg/l



Nitrite 0.01 - 0.320 mg/l



Nitrate 0.06 - 5.1 mg/l

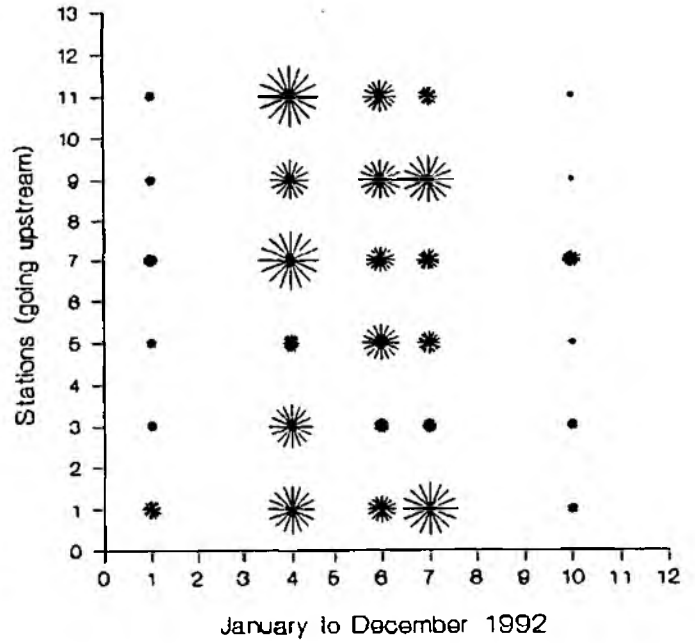
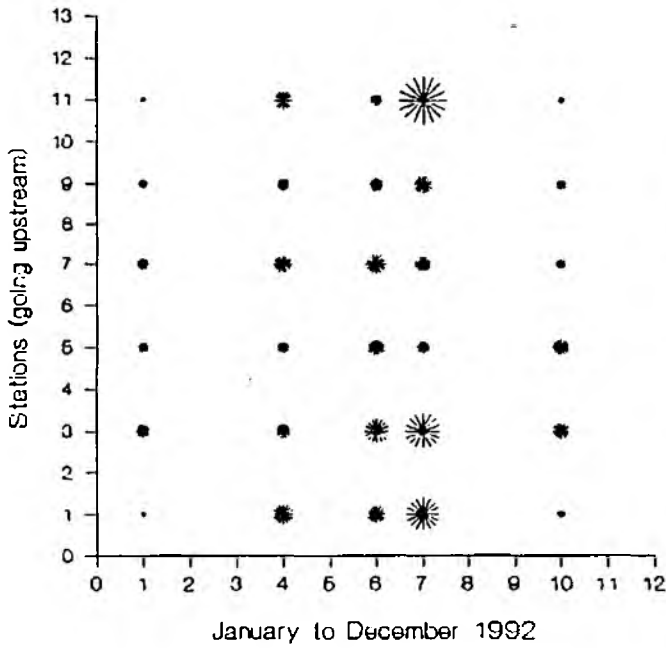


**FIGURE 5a Metal Concentration in the Ribble.**

Total Mercury 0.03 - 0.43 ug/l

Dissolved Mercury 0.01 - 0.14 ug/l

EQS 0.3 µg/l



Dissolved Nickel 0.65 - 3.55 ug/l

Dissolved Zinc 3.70 - 27.50 ug/l

EQS 30 µg/l

EQS 40 µg/l

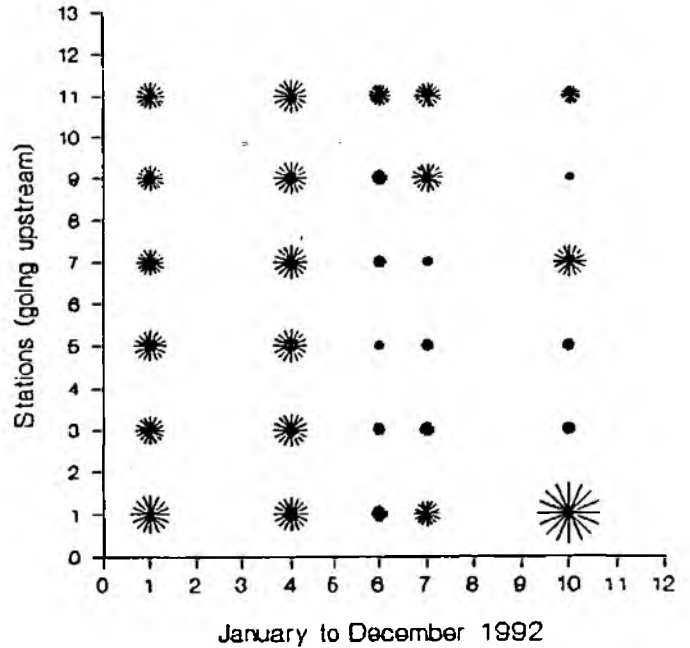
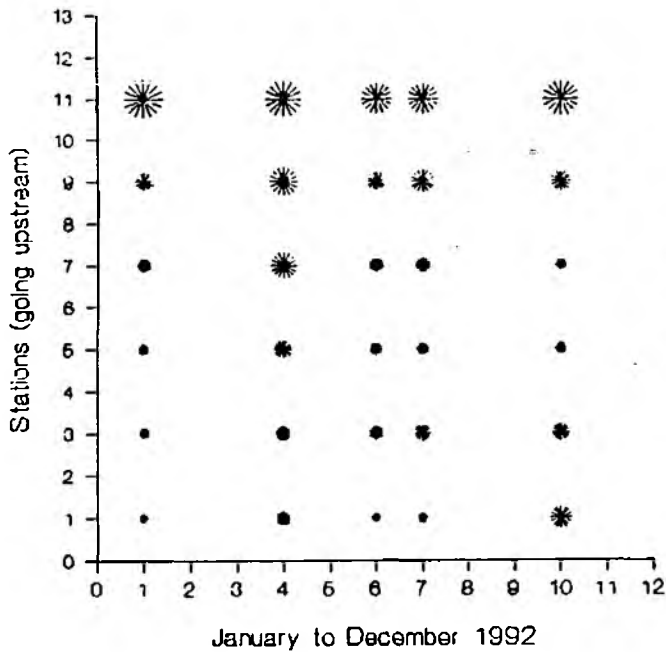
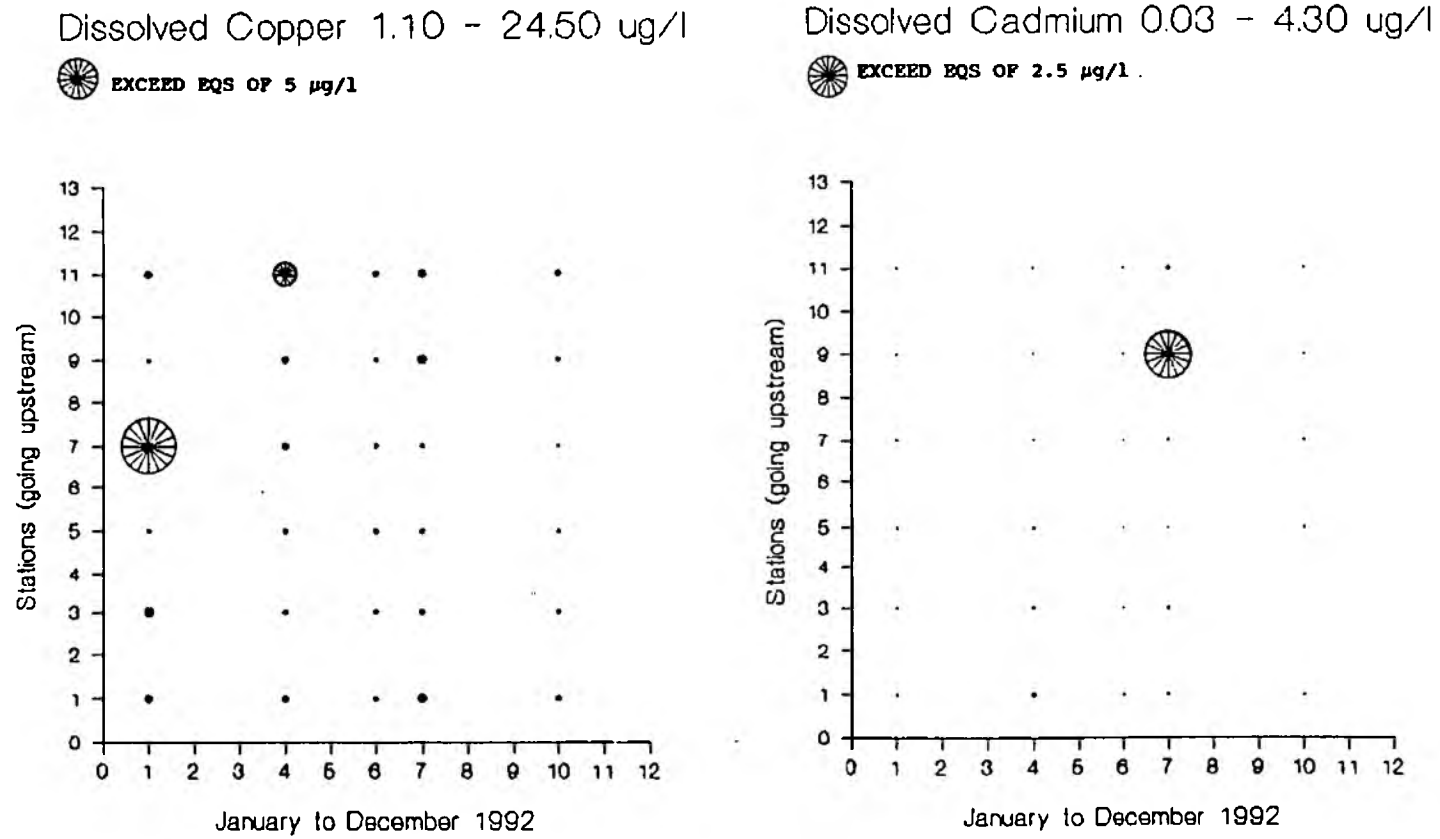




FIGURE 6 Metals occasionally exceeding EQS levels in the Ribble.





Appendix 1. Sanitary Parameters

Date	Time	Station	Temp	D.O. mg/l	D.O. %	Conduc- tivity us/cm	Chloride mg/l	pH	Ammonia mg/l	Nitrite mg/l	Nitrate mg/l	Phosphate mg/l	BOD mg/l	Suspended Solids mg/l
21/1/92	1224	1	5.8	9.97	98.5	47000	17740	7.7	0.16	0.04	0.38	0.08	1	29
21/1/92	1234	2	5.5	10.44	101	44800	16760	7.8	0.22	0.04	0.62	0.1	1.2	28
21/1/92	1239	3	5.5	9.69	94.5	46000	17260	7.8	0.18	0.04	0.46	0.06	1	40
21/1/92	1245	4	5.5	10.04	98	45800	17180	7.8	0.14	0.04	0.44	0.03	0.67	30
21/1/92	1250	5	5.5	9.8	96	46500	17480	7.8	0.18	0.04	0.44	0.03	1	42
21/1/92	1257	6	5.4	9.82	95.5	46100	17300	7.8	0.16	0.04	0.5	0.12	0.67	34
21/1/92	1302	7	5.3	9.95	94.5	42500	15780	7.8	0.28	0.04	0.9	0.03	1	25
21/1/92	1308	8	5.3	9.52	90.5	41800	15480	7.7	0.36	0.06	1	0.03	1.4	32
21/1/92	1312	9	5	9.9	91.5	38100	13940	7.6	0.46	0.06	1.46	0.03	5.6	24
21/1/92	1319	10	5	9.07	80	29500	10460	7.6	0.74	0.08	2.5	0.03	1.6	20
21/1/92	1323	11	4.7	9.35	77.5	16900	5660	7.5	1.04	0.1	4.18	0.03	2.8	22
21/1/92	1332	12	4.7	9.47	76	9620	2787	7.5	1.1	0.12	5.1	0.05	3.6	22
20/2/92	1130	1	5	9.99	96.5	46300	17400	7.8	0.36	0.02	0.4	0.28	1.6	120
20/2/92	1135	2	5	9.53	91.5	45500	17060	7.8	0.1	0.02	0.54	0.18	1.4	89
20/2/92	1140	3	5	9.16	87	43900	16360	7.8	0.16	0.02	0.7	0.2	2.2	112
20/2/92	1145	4	5	10.15	96.5	43800	16320	7.8	0.16	0.02	0.68	0.2	1.2	138
20/2/92	1155	5	5	9.54	91.5	45000	16840	7.8	0.14	0.02	0.58	0.22	2.8	79
20/2/92	1200	6	4.9	7.43	71.5	45500	17060	7.8	0.12	0.02	0.58	0.18	1.2	104
20/2/92	1205	7	5	9.58	91.5	44600	16660	7.7	0.14	0.02	0.56	0.16	2.8	106
20/2/92	1210	8	4.9	10.28	97	42900	15940	7.8	0.18	0.04	0.74	0.24	1.2	75
20/2/92	1220	9	4.9	9.81	91.5	40600	14980	7.8	0.28	0.04	0.96	0.2	3.2	160
20/2/92	1226	10	4.8	9.64	87	34800	12580	7.8	0.44	0.04	1.4	0.3	1.6	63
20/2/92	1232	11	4.8	9.82	85	26800	9400	7.7	0.52	0.06	2.08	0.36	2.8	39
20/2/92	1240	12	4.8	9.58	78	12111	3940	7.7	0.64	0.06	3.16	0.48	3.2	46
20/3/92	1153	1	8.03	10.39	106	43900	16360	8.2	0.2	0.04	0.76	0.18	1.4	128
20/3/92	1200	2	8.05	9.5	96.5	42200	15640	8.2	0.2	0.04	0.78	0.18	2.7	275
20/3/92	1204	3	9	9.05	91.5	37800	13820	8.2	0.3	0.04	1.06	0.2	2.7	215
20/3/92	1207	4	8.05	9.19	92.5	41100	15180	8.1	0.22	0.04	0.82	0.5	2.7	186
20/3/92	1211	5	8.05	9.36	95	41900	15520	8.2	0.28	0.04	0.76	0.12	2.7	162
20/3/92	1214	6	8.05	9.49	95	40000	14720	8.2	0.22	0.04	0.88	0.12	2.7	86
20/3/92	1216	7	8.06	9.55	95	38600	14140	8.2	0.3	0.04	1	0.14	2.7	65
20/3/92	1220	8	9	9.25	90	29400	10420	8.1	0.46	0.06	1.52	0.16	1.4	36
20/3/92	1223	9	9	8.92	84	22200	7620	8	0.62	0.08	2.02	0.24	1.4	45
20/3/92	1227	10	9.02	9.12	80.5	7900	2125	7.8	0.8	0.1	2.96	0.32	1.4	46
20/3/92	1225	11	8.5	8.73	74.5	1650	382	7.5	0.68	0.1	3.54	0.68	2.7	60
7/4/92	1455	1	8.69	10.07	105.5	45700	17140	7.9	0.52	0.02	0.52	0.12	0.67	28
7/4/92	1457	2	8.6	9.46	99	45800	17180	7.9	0.12	0.02	0.52	0.14	0.67	15
7/4/92	1500	3	9.1	9	94.5	44000	16420	7.9	0.62	0.02	0.66	0.14	0.67	64
7/4/92	1505	4	9	9.62	101	44600	16660	8	0.16	0.02	0.62	0.12	0.67	28
7/4/92	1510	5	8.9	9.22	95.5	42200	15640	7.9	0.22	0.04	0.82	0.24	1	41
7/4/92	1515	6	9.3	9.03	92.5	38500	14100	7.9	0.4	0.06	1.2	0.28	0.67	16
7/4/92	1517	7	10.1	8.36	82.5	26800	9400	7.7	0.54	0.1	2.28	0.4	1.2	13
7/4/92	1520	8	9.9	8.62	85	28500	10060	7.8	0.62	0.1	2.18	0.42	1.2	25
7/4/92	1525	9	9.5	8.33	80.5	25300	8820	7.6	0.8	0.1	2.38	0.48	4.2	27
7/4/92	1530	10	9.6	8.25	77	17100	5720	7.7	0.76	0.1	3.16	0.5	2	26
7/4/92	1533	11	10.1	8.58	77	4100	382	7.6	0.82	0.12	4	0.58	4.8	26
7/4/92	1540	12	10.1	8.78	78	1810	380	7.6	0.72	0.12	3.76	0.56	3.8	23
6/5/92	1320	1	11.5	8.63	98	45300	18451	8.1	0.14	0.02	0.36	0.12	2.2	124
6/5/92	1324	2	11.5	9.23	101	45500	15588	8.1	0.46	0.04	0.5	0.03	2.6	93
6/5/92	1328	3	11.5	9.2	103.5	45500	17955	8.1	0.46	0.04	0.48	0.06	2.6	102
6/5/92	1331	4	11.5	9.25	104.5	44600	18230	8.1	0.62	0.04	0.58	0.03	4.2	142

## Appendix 1 cont.

Date	Time	Station	Temp	D.O. mg/l	D.O. %	Conduc- tivity us/cm	Chloride mg/l	pH	Ammonia mg/l	Nitrite mg/l	Nitrate mg/l	Phosphate mg/l	BOD mg/l	Suspended Solids mg/l
6/5/92	1334	5	11.5	8.95	99	43000	16579	8.1	0.58	0.06	0.78	0.03	2.6	156
6/5/92	1337	6	11.8	9.23	101	40000	14720	7.9	0.36	0.12	1.22	0.08	1.4	51
6/5/92	1339	7	11.8	9.15	99	37500	13680	7.9	0.6	0.12	1.48	0.22	2.8	79
6/5/92	1342	8	11.8	8.29	87	33900	11689	8	0.03	0.1	1.7	0.03	3.4	186
6/5/92	1345	9	12	9.06	94	29100	10300	7.8	0.12	0.14	2.44	0.12	2.7	180
6/5/92	1347	10	12	8.91	0	25000	8305	7.9	0.03	0.08	2.34	0.03	2.6	98
6/5/92	1351	11	12.1	7.39	74	20700	7060	7.7	0.12	0.2	3.44	0.2	3.2	72
6/5/92	1354	12	12.6	8.38	81	8660	2362	7.7	0.03	0.24	4.88	0.36	4	42
2/6/92	1205	1	15.8	8.84	108.5	47400	17840	8.3	0.16	0.06	0.06	0.12	1.2	154
2/6/92	1215	2	16	8.54	105	46800	17600	8.3	0.26	0.06	0.14	0.12	1.4	72
2/6/92	1220	3	16.5	8.54	105	44700	16700	8.2	0.32	0.08	0.4	0.12	1.4	40
2/6/92	1230	4	16.2	8.34	102	45300	16960	8.3	0.3	0.08	0.36	0.2	1.4	69
2/6/92	1235	5	16.1	8.48	103	44500	16620	8.3	0.66	0.1	0.56	0.12	1.4	18
2/6/92	1240	6	16.1	8.41	102	44000	16420	8.2	0.74	0.1	0.58	0.16	2.2	2
2/6/92	1245	7	16	7.8	94	43300	16120	8.2	0.64	0.1	0.64	0.12	1.4	59
2/6/92	1250	8	16.1	8.61	103.5	42000	15560	8.2	0.56	0.12	0.9	0.12	1.4	41
2/6/92	1255	9	16.3	8.02	95	38200	13980	8	0.42	0.14	1.2	0.03	5.8	14
2/6/92	1300	10	16.7	7.03	82	33000	11860	8	0.8	0.2	2.04	0.26	1.4	58
2/6/92	1310	11	16.7	5.62	64	27000	9480	7.7	0.92	0.26	2.9	0.4	2.2	54
2/6/92	1315	12	16.9	5.02	55	17700	5940	7.7	0.74	0.32	4.1	0.52	3	69
1/7/92	1236	1	17	8.73	111	49700	18860	8.2	0.18	0.01	0.06	0.14	2	15
1/7/92	1243	2	16.7	7.68	97	49500	18780	8.3	0.16	0.02	0.12	0.12	1.6	12
1/7/92	1249	3	16.6	4.71	59	48300	18260	8.2	0.22	0.06	0.28	0.16	2.8	63
1/7/92	1256	4	16.8	7.43	94	49200	18640	8.3	0.2	0.04	0.18	0.12	2	34
1/7/92	1300	5	16.5	7.9	99.5	49700	18860	8.3	0.18	0.02	0.1	0.1	1.8	21
1/7/92	1305	6	16.6	7.96	100.5	49700	18860	8.3	0.14	0.04	0.12	0.03	1.8	26
1/7/92	1310	7	16.5	6.38	79.5	48200	18220	8.2	0.22	0.04	0.3	0.16	2	33
1/7/92	1317	8	16.2	7.49	93	48300	18260	8.2	0.2	0.04	0.32	0.12	1.8	24
1/7/92	1324	9	16.6	6.96	86.5	46700	17560	8.2	0.2	0.06	0.48	0.12	3	30
1/7/92	1335	10	16.5	6.38	78	43800	16320	8.1	0.46	0.1	0.94	0.24	2.8	37
1/7/92	1344	11	17	5.81	69.5	37400	13640	8.1	0.62	0.18	1.9	0.42	3.6	43
1/7/92	1355	12	17	6.46	74.5	29600	10500	8.1	0.82	0.26	3.12	0.7	4.8	41
15/10/92	1430	1	10	7	0	38500	14100	7.8	0.26	0	0	0.06	2	97
15/10/92	1310	2	11.5	7.02	80	50200	19080	8.1	0.1	0	0	0.03	1.4	174
15/10/92	1315	3	11.2	0	0	50200	19080	8.2	0.06	0	0	0.03	1.4	148
15/10/92	1322	4	11.2	9.01	102	50100	19040	8.2	0.03	0	0	0.03	1.4	148
15/10/92	1330	5	10.5	9.18	103	48800	18480	8.2	0.1	0	0	0.03	1.6	148
15/10/92	1335	6	10.5	8.86	0	45300	16960	8	0.08	0	0	0.03	0.67	94
15/10/92	1340	7	10.2	9.04	98	45500	17060	8.1	0.12	0	0	0.16	1.6	95
15/10/92	1345	8	10	6.45	68.5	42200	15640	8	0.3	0	0	0.24	3.8	57
15/10/92	1350	9	10	8.2	84.5	36700	13360	8	0.38	0	0	0.3	3.2	22
15/10/92	1355	10	9.8	4.75	45.5	23100	7980	7.8	0.7	0	0	0.54	4	25
15/10/92	1400	13	9.3	8.53	74.5	7530	2154	7.8	0.76	0	0	0.66	4.8	24
26/11/92	1140	1	7.2	9.78	97	41500	15360	7.8	0.14	0.01	0.78	0.12	1.4	270
26/11/92	1145	2	7.2	8.97	89	41400	15320	7.9	0.16	0.01	0.76	0.12	2	194
26/11/92	1149	3	7.1	8.92	88	40900	15100	7.9	0.14	0.04	0.76	0.12	1.4	300
26/11/92	1154	4	7.1	10.03	98.5	39900	14680	7.9	0.2	0.04	0.82	0.03	1.4	192
26/11/92	1157	5	7.1	8.93	84.5	32800	11780	7.7	0.26	0.06	1.18	0.06	1.8	80
26/11/92	1202	6	7	9.59	89	29100	10300	7.8	0.32	0.06	1.38	0.16	2.6	73
26/11/92	1205	7	7	9.55	84.5	19500	6620	7.7	0.44	0.06	1.84	0.2	2.4	80
26/11/92	1210	8	7	9.15	79	12480	4060	7.7	0.42	0.08	2.32	0.22	2.8	57
26/11/92	1215	9	7	9.58	81	7220	2255	7.6	0.44	0.08	2.32	0.2	2.4	51
26/11/92	1218	10	7	9.58	79.5	2000	418	7.8	0.42	0.06	2.2	0.28	3.2	48

Appendix 2. Metals.

Date	Station	Fine	Chloride	Mercury diss. µg/l	Mercury µg/l	Cadmium diss. µg/l	Lead diss. µg/l	Copper diss. µg/l	Zinc diss. µg/l	Nickel diss. µg/l	Arsenic diss. µg/l	Chromium diss. µg/l	Boron mg/l
21/1/92	1	1224	17740	0.04	0.04	0.14	2.5	3.2	17	0.65	2.05	1.35	0
21/1/92	3	1239	17260	0.02	0.11	0.11	2.5	4.1	12.5	0.8	2.15	0.5	0
21/1/92	5	1250	17480	0.02	0.08	0.15	2.5	1.5	14	0.85	2.1	0.5	0
21/1/92	7	1302	15780	0.03	0.1	0.08	2.5	24.5	11.5	1.15	2.25	0.5	0
21/1/92	9	1312	13940	0.02	0.07	0.1	2.5	1.7	11.5	1.55	2.35	1.15	0
21/1/92	11	1323	5660	0.02	0.03	0.12	2.5	3.35	12	3.55	2.6	0.5	0
7/4/92	1	1455	17140	0.11	0.17	0.37	2.5	2.7	15	1.15	2.05	0.5	3.48
7/4/92	3	1500	16420	0.1	0.12	0.17	2.5	1.95	15	1.25	2.3	0.5	3.45
7/4/92	5	1510	15640	0.04	0.09	0.15	2.5	1.8	15	1.5	1.45	0.55	3.29
7/4/92	7	1517	9400	0.14	0.15	0.05	2.5	2.5	15	2.3	2.6	0.39	2.39
7/4/92	9	1525	8820	0.09	0.1	0.05	2.5	2.95	15	2.55	2.55	0.5	2.05
7/4/92	11	1533	382	0.14	0.16	0.08	2.5	11	15	3.3	1.9	0.41	0.31
2/6/92	1	1205	17840	0.06	0.15	0.13	2.5	1.9	6.8	0.7	1.9	2	3.76
2/6/92	3	1220	16700	0.03	0.21	0.07	2.5	1.95	5.2	1.15	2.9	1.6	3.6
2/6/92	5	1235	16520	0.08	0.14	0.03	2.5	1.9	4.1	1.05	2.8	1	3.57
2/6/92	7	1245	16120	0.06	0.18	0.03	2.5	1.75	5.1	1.15	3.25	0.5	3.45
2/6/92	9	1255	13980	0.09	0.11	0.05	2.5	1.8	6.7	1.55	3.5	0.5	3.09
2/6/92	11	1310	9480	0.07	0.09	0.07	2.5	2.35	9.1	2.75	4.1	0.5	2.18
1/7/92	1	1236	18860	0.12	0.29	0.19	2.5	3.65	11	0.77	2.1	3.6	4.65
1/7/92	3	1249	18260	0.03	0.31	0.2	2.5	2.25	6	1.4	3.35	2.8	4.52
1/7/92	5	1300	18860	0.05	0.1	0.06	2.5	1.65	5	0.98	2.4	3.05	4.69
1/7/92	7	1310	18220	0.05	0.13	0.07	2.5	1.7	3.8	1.2	2.6	2.2	4.64
1/7/92	9	1324	17560	0.11	0.15	4.3	2.5	4	13	2.05	3.15	1.3	4.57
1/7/92	11	1344	13640	0.04	0.43	0.28	2.5	3.45	11	2.7	4.15	1.25	4.01
15/10/92	1	1430	14100	0.02	0.055	0.12	2.5	2.45	27.5	1.88	2.75	0.51	3.12
15/10/92	3	1310	19080	0.02	0.136	0	2.5	1.78	5.2	1.42	1.92	0.58	3.9
15/10/92	5	1322	19040	0.013	0.139	0.19	2.5	1.34	5	0.91	2.05	0.31	3.84
15/10/92	7	1335	16960	0.038	0.076	0.05	2.5	1.1	14.4	0.91	2.1	0.5	3.7
15/10/92	9	1345	15640	0.01	0.081	0.04	2.5	1.8	3.7	1.74	2.65	0.3	3.3
15/10/92	11	1355	7980	0.012	0.046	0.12	2.5	2.5	7.9	3.2	3.15	0.83	1.82