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Institute of Freshwater Ecology

Assessment of the potential for phosphorus reduction in river waters

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F.H. Denison, HNC
S.M. Smith

Report To: Department of the Environment
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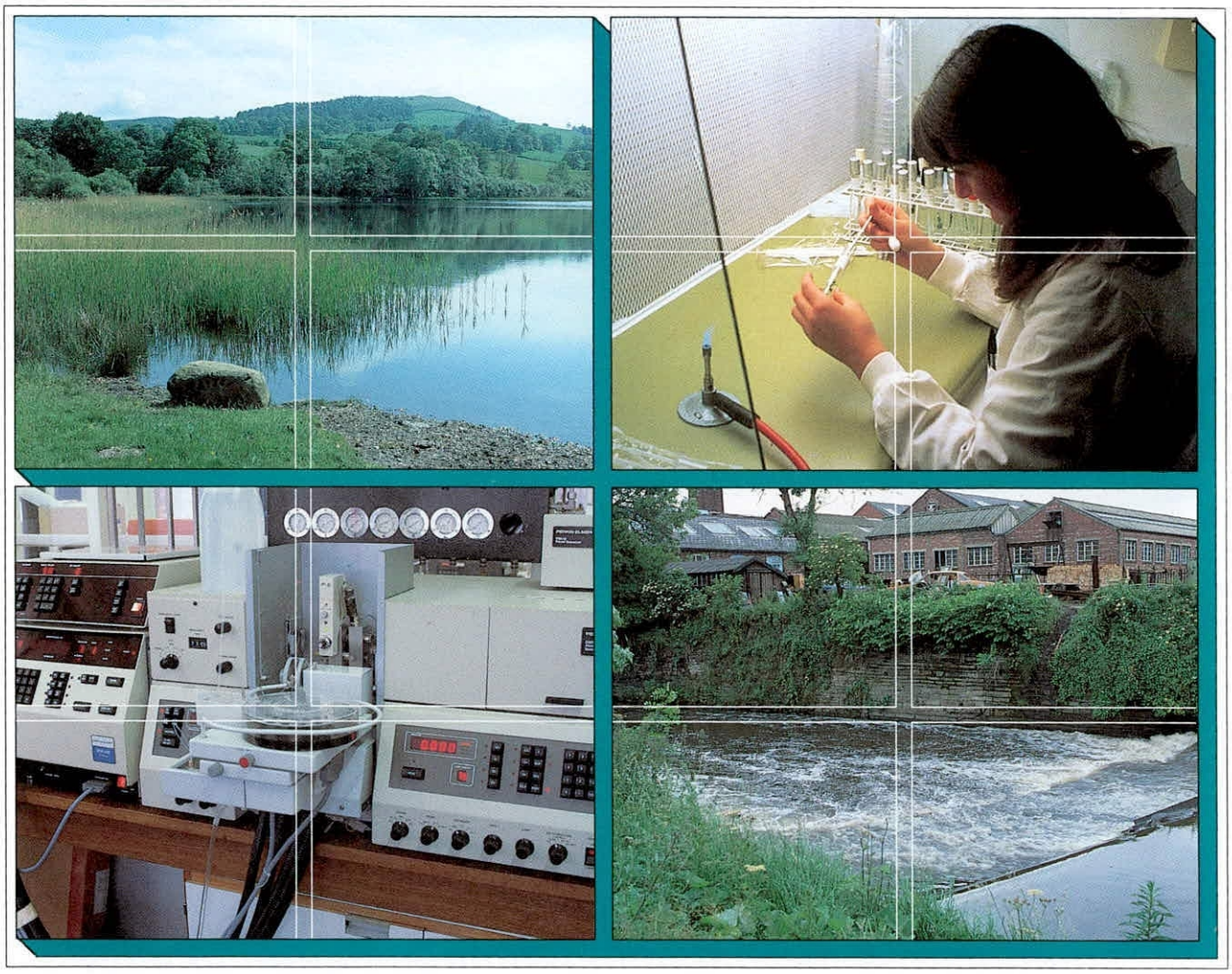

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GLOSSARY OF SYMBOLS

BAP	Bioavailable phosphorus measured here using iron oxide stripping. The concentration of phosphorus which is readily released over 24 h from unfiltered water, suspended sediment or sediment.
C_e	Equivalent to EPC. Normally this is the equilibrium concentration of SRP but because of the slow kinetics involved in the release and uptake of SRP, this is defined here as the concentration after 24 h of contact with suspended solids in well-mixed conditions.
DO	Dissolved oxygen expressed as a % percentage of the aqueous saturation at the field temperature and atmospheric pressure.
EPC	Equilibrium phosphorus concentration. The concentration of SRP in contact with a suspended sediment after 24 h contact in well-mixed conditions. The EPC_0 is the EPC of a sediment containing only native phosphorus ie. when the sediment is in contact with a solution with SRP=EPC_0, there is no net flux of SRP.
K_d	Distribution coefficient in units of $dm^3\ kg^{-1}$. The ratio of the concentration of adsorbed SRP to the concentration in the solution after 24 h contact.
Native P	Native phosphorus. That phosphorus in sediments prior to leaching or supplementation in laboratory experiments.
n_i	Initial adsorption amount. The initial concentration of SRP associated with the sediment prior to sorption. n_i is normally < BAP for sediments.
Non-M&R	Non Murphy and Riley phosphorus. Difference between TDP and SRP, ie that phosphorus in organic or polymeric form which is converted to SRP during digestion.
OM	Organic matter content expressed as a percentage of the dry weight measured by combustion at 550°C
PP	Particulate phosphorus. Difference between TP and TDP, ie that phosphorus associated with the particulate phase of size > 0.45 µm.
SRP	Soluble reactive phosphorus. Soluble phosphorus measured after filtration through a 0.45 µm membrane filter without acid digestion.
STW	Sewage treatment works.
TDP	Total dissolved phosphorus. Filtered through 0.45 µm membrane filter but subject to acid digestion prior to analysis.
TP	Total phosphorus. Unfiltered and subject to acid digestion prior to analysis.
f_i	Flux in the ith river section; mmol s^{-1}
q_i	Discharge in the ith river section; $m^3\ s^{-1}$
c_i	Concentration of SRP in the ith river section; µmol dm^{-3} or mmol m^{-3}
pc_i, pq_i	Concentration and discharge of point-source in ith section

SUMMARY

All the effort over the last six months has been directed to the intensive field work, including the macrophyte surveys, and the ancillary fluvarium and laboratory work. This report covers the winter and spring sampling programme on the rivers Gt. Ouse, Blackwater and Wey, including the results from the field measurements, laboratory analysis, determination of the sorption isotherms of phosphorus on samples of the bed-sediments and calculation of the equilibrium phosphate concentrations, EPC_0, and other relevant parameters. The results from the fluvarium channel experiments for sediments taken at the impacted sites downstream of the major STW inputs are also discussed. So far these results indicate some similarities between the three rivers in terms of the sediment composition and size distribution. The parameters describing the uptake and release kinetics of phosphorus from the river bed-sediments are also generally similar in magnitude with important differences between the response of the sediments collected during the winter and spring site visits. It is noted that the results so far show a greater release of phosphorus from the sediments in the winter than in the spring. The uptake kinetics for the rivers Blackwater and Wey appear less seasonally dependent. Some general correlations between the release and uptake kinetics and clay content have been noted as well as relationships between the sorption affinities of the sediment, K_d, organic matter, silt and clay content and biologically available phosphorus by iron oxide stripping (BAP). The data will be reviewed again with a more detailed analysis when the intensive field sampling programme is completed in autumn of this year.

1. INTRODUCTION

Under the Urban Waste Water Treatment Directive (91/271/EEC), water bodies will be designated as sensitive areas if they fulfil certain criteria. Phosphorus removal will be required at sewage treatment works discharging into these phosphorus limited sensitive areas, the aim being to reduce phosphorus loading to the water body and therefore to reduce the biological symptoms of eutrophication. Member states also have to review and monitor eutrophication in their sensitive areas over the coming years.

There are uncertainties about how water bodies will respond to reductions in phosphorus loading and the time scale for the biological symptoms of eutrophication to be reduced. This project seeks to develop an understanding about how water bodies respond to reductions in phosphorus loading, and in particular how these reductions could be counteracted by phosphorus release from sediments.

The assessment of the effects of phosphorus removal from effluents must involve the development of criteria to establish the release of phosphorus from sediments after reducing phosphorus loading to a river. Sediments vary in their capacity for uptake and release of phosphorus depending on the nature of the binding and occurrence in the sediment. If the sediment has a high loading of exchangeable phosphorus caused by exposure to a diluted sewage effluent, a high release of phosphorus may be expected; this will largely negate the effects of tertiary treatment even in the longer-term. In other sediments, the phosphorus is likely to be fixed by heterogeneous reactions in the sediment. This phosphorus will not be easily released and will contribute a minor component of the phosphorus load in the river subsequent to tertiary treatment.

The objectives of the project are: (a) to develop criteria for predicting whether a sediment will remove/release a substantial flux of phosphorus following a reduction in the river water concentrations of phosphorus and (b) to validate a proposed procedure by prediction using criteria developed above and measured at selected sites.

2. LABORATORY METHODS

The following IFE (River Laboratory) Standard Operating Procedures (SOPs) were used in this work. When other methods are used they are explained or referenced in the text. The SOPs are available to the DoE on request.

SOP: 26/20.7.94 Update none.	Particle size analysis of sediment samples.
SOP: 23/18.4.94 Update none.	The determination of the organic matter content of a sediment.
SOP: 22/14.3.94 Update none.	An ignition method for the determination of the total phosphorus in sediments.
SOP: 21/4.3.94 Update none.	Total phosphorus determination by persulphate digestion.
SOP: 20/7.3.94 Update none.	The determination of bioavailable phosphorus by iron oxide stripping.
SOP: 19/8.3.94 Update none.	The determination of the soluble reactive phosphorus in water by flow-injection analysis.

SOP: 15/12.8.93 Update 5.11.93	Conductivity measurement using Ciba-Corning M90 field meter.
SOP: 14/12.8.93 Update 5.11.93	Oxygen measurement using Ciba-Corning M90 meter
SOP: 13/12.8.93 Update 5.11.93	pH measurement using Ciba-Corning field meter.
SOP: 36/16.5.95 Update none	Determination of total suspended solids in water.

3. QUARTERLY SITE VISITS

The planned research included site visits to at least two of the rivers chosen from the information obtained in the pilot studies. It was decided after the last stage of the project to attempt intensive studies of three rivers: the Gt. Ouse, R. Wey and R. Blackwater with site visits organised on a seasonal basis. This report covers the work for the winter 94/95, i.e. December 1994 to February 1995, and spring 1995, i.e. March 1995 to May 1995. The work includes measurements of flow related transfer fluxes (FRTF) in the fluvarium channel.

3.1 Fluvarium Channel

The current version of the channel now incorporates the following features:

1. Control of the water velocity over the bed-sediment.

2. The channel is completely enclosed enabling the gas atmosphere to be controlled.

3. The concentration of oxygen in the water can now be controlled by air and nitrogen lines.

4. Measurements of pH, temperature and dissolved oxygen are logged using a Hunter portable computer. Because of electrical interference between conductivity and pH it is necessary to measure conductivity manually at suitable intervals.

5. The flow rate is continually measured using the flow transducer placed downstream of the recirculating pump. The flow rate may be altered by inserting appropriate restrictors in the downstream tank or adjusting the butterfly valve.

6. The filtration and sampling of the water is now fully automated. Samples can be taken at pre-defined intervals, filtered through a 0.45 μm membrane filter and placed in a collection bottle. The system of tubes, filter and syringe are fully flushed prior to each sampling. In addition, the tube connected to the sample collector is flushed with air after each collection. This permits continuous operation over several days or however long is necessary. Normally the system is run for 24 or 48 h periods with sampling at 1 hour intervals.

7. The temperature of the channel is maintained close to the river Frome temperature by flowing water from the fluvarium.

The fluvarium channel is now in operation and will be used to complete Task 3 over the next year. Any further developments of the fluvarium channel will await the results of this stage of the project.

Control experiments without sediment have been done and indicate no contamination of SRP from the equipment. Preliminary experiments have shown satisfactory performance including the ability to reach low oxygen (<2%) in the overlying water. The flow transducer has been calibrated by measuring the time of discharge at various heads of water. The calibration of the transducer was found to be linear with mA loop signal directly proportional to the discharge.

3.2 Field Work

On-site work involved the following:

(a) Sampling the water and on-site filtration for measurements of SRP, TDP, Si, NO_3 and Ca. Sampling the water for suspended solids measurements.

(b) Measurements of pH, T, conductivity and oxygen concentrations.

(c) Assessment of the riverine environment using macrophytes (NRA, 1994).

(d) Sampling the bed-sediment at selected sites for wet chemical analysis, sorption studies and particle size determinations.

(e) Sampling the surface (< 5 cm) bed-sediment at the site downstream of the main STW using stainless steel trays designed for direct insertion into the fluvarium channel.

(f) Measurement of the water velocity across a section of the river to enable the discharge at all the sites to be estimated.

(g) Sampling the water for major-ion and nutrient analysis at additional downstream sites to enable the calculation of discharge from NRA gauging stations. This was necessary for the Gt. Ouse and Blackwater rivers where the gauging station is situated downstream of the confluence with a major tributary.

Samples were filtered using a 0.45 µm cellulose nitrate membrane filter. Samples for total phosphorus measurement were taken on-site and placed in 60 ml HDPE Azlon bottles for direct measurement; this method avoids the loss of suspended solids caused by sub-sampling. All samples were stored in a cold box during transportation. The analyses were done as soon as possible after returning to the main laboratory with SRP, Si and NO_3 all analysed within 1 day of returning.

3.3 Laboratory Measurements

These include:

(a) Nutrient fractions including SRP, total dissolved phosphorus (TDP), total phosphorus (TP), nitrate, silicon as well as major ions such as calcium, magnesium, sodium, potassium and alkalinity.

(b) Measurements on the 2 mm sieved bed-sediment such as the organic matter content (OM), total phosphorus, calcium and iron concentrations after acid digestion.

(c) Measurements of the "biologically available phosphorus", BAP, by the method of iron-oxide stripping.

(d) Measurement of the sorption characteristics of the surface bed-sediment at 10^0C and calculation of the equilibrium phosphate concentration, EPC_0, initial native phosphorus amount and adsorption affinity, K_d.

The fluvarium channel experiments were conducted as follows:

(a) River bed-sediments were collected from the sites downstream of the major STW input. Surface sediments (<5 cm depth) were collected using the four stainless steel sections. If possible these were forced into the sediment and a horizontal section taken by moving the tray through the sediment. Where this was difficult because of the depth of water, the sediment was taken in shorter sections and placed directly in the tray. No attempt was made to sieve the sediment; the prime purpose was to try and get a representative sediment from the site with a minimum disturbance to the sediment. At sites where the sediment surface was coarse and uneven, this structure was retained as much as possible.

(b) The sections were end-capped and placed in a tray containing about 2-3 cm depth of river water from the site. The tray was then covered with aluminium foil and transported immediately to the fluvarium. The transport time varies between sites from 1.5 to 3 h.

(c) On arrival at the fluvarium, the small amount of fines leached from the sediments were returned to the sections. The sections were then placed in the fluvarium channel in readiness for the phosphorus release experiment. Before adding the background electrolyte (2 mM $CaCl_2$), the pH and dissolved oxygen (DO) sensors were calibrated. The solution was then added and first phosphorus release experiment started. Manual sampling was done at time 0, 15 and 30 mins; thereafter the automatic sampler operated at 1 hour intervals for 24 h.

(d) SRP uptake was investigated by the augmentation of SRP above the expected EPC_0 of the sediment. The kinetics of uptake of SRP was measured over 24 or 48 h.

(e) The release of SRP under anaerobic conditions was evaluated by lowering the DO concentration in the fluvarium channel by the addition of Na_2SO_3 in sufficient amount to just remove all the DO. Subsequently, the solution was purged with high purity nitrogen gas to maintain a DO concentration in the water close to zero percent. The kinetics of the release of SRP was measured over 24 to 48 h.

3.4 Results

A summary of the site visits covered in this report is shown in Table 1. The results will be discussed fully at the completion of the intensive sampling programme (autumn 1995). This will involve an examination of correlations between various water and sediment parameters for each river and a search for general relationships between the parameters controlling the release and uptake of P and the sediment composition.

3.4.1 Gt. Ouse

Of the three rivers studied this has the greatest water hardness, with calcium concentrations greater than 3.5 mM; the sediments also contain the highest amounts of calcium (ca 5-13 % by mass). It also has the lowest concentrations of dissolved phosphorus, with all values for the different P fractions below 20 µM. However, the Ouse has the highest concentrations of nitrate of the order of 0.80 mM or greater compared with the other rivers which are generally less than 0.5 mM. In the winter survey the silicon concentrations varied little along the study section in contrast to the spring survey when the concentration decreased from about 80 µM to 15 µM at the lower site, G, indicating uptake by diatoms. Changes in the silicon concentration can be used to estimate P-uptake by diatoms (Marker and Casey, 1982); this will be investigated when all the seasonal data are available.

The fluvarium channel results produced similar values of K_p and the Elovich 'b' parameters for the sediments collected in the winter and spring surveys. However, the release experiments on the winter and spring sediments were very different with a substantial release of P in the winter but no net release in the spring.

Table 1. Field site visits for the winter and spring of 1995

Name of river	Date of visit	Major STW
Gt. Ouse	9/10 January 1995	Brackley
Blackwater	30 January 1995	Aldershot (town and military)
Wey	13 February 1995	Alton
Gt. Ouse	27/28 March 1995	Brackley
Blackwater	10 April 1995	Aldershot (town and military)
Wey	8 May 1995	Alton

3.4.2 R. Wey

This is the only river for which an autumn survey has been completed (report RL/T11059J1/2; September 1994-March 1995). This is also a hardwater river with calcium concentrations in the range of 2.3 - 3.5 mM with a marked difference between the winter and spring

concentrations. The silicon concentrations measured during the spring visit also showed a decrease in the downstream direction. It is interesting to note that the Ca, P and Fe concentrations in the sediment are in a similar range to the results from the Gt. Ouse.

The fluvarium channel results gave similar values for the parabolic constant, K_p, and Elovich 'b' parameter for the autumn and winter results for P release but lower values for each of the parameters derived from the spring data (Table 20). The uptake parameter, K_p, decreases from the winter to spring. Further interpretation awaits the results from the summer survey.

3.4.3 R. Blackwater

This river has lower concentrations of calcium in the water and sediments compared with the other two rivers. The total P concentration of the sediments are slightly higher at the downstream sites of the STW's compared with the other rivers but still < 0.1 % by dry mass of the sediment.

The results from the fluvarium channel experiments for the release of P produced almost linear release rates with little indication of a decrease in the rate as the EPC_0 is approached. In this situation, both the EPC_0 and the K_p parameters were optimised to give best agreement with the experimental kinetic data. For both the winter and spring results, the optimised EPC_0 were greater than the value measured with the suspended sediment. The reason for this difference is as yet uncertain and will be examined in more detail later. The derived kinetic parameters, e.g. K_p, indicate a substantial decrease in the release rates for the spring sample compared with the winter sample but little change in the phosphorus uptake parameters.

3.4.4 General comments

The results show that the sediments contain similar quantities of organic matter, total phosphorus and total iron with some variations in the calcium concentration. The preliminary results from the fluvarium channel experiments indicate a decrease in the release rates in the spring compared with the winter (and autumn for the R. Wey sample). Apart from the R.Wey, the uptake parameters (K_p and b) do not show this trend with similar values measured for the sediments collected in the winter and spring. Any trends of this nature may be detected when a full years data are available.

Multiregression analysis of the winter and spring data: OM, TP, BAP,EPC_0, K_d, n_i, K_p, Elovich parameters, total iron and calcium in the bed-sediment and the sand/silt/clay fractionation, for all the rivers at the site immediately downstream of the major STW inputs produced some interesting correlations. The most notable at this stage is the relationship between the kinetic parameter, K_p, and the clay fraction of the sediment with a negative correlation for the release kinetics and positive correlation with the uptake kinetics. Other correlations between K_d and OM or BAP or silt or clay were also shown but further analysis at the other sites is needed to confirm these results. When all the seasonal data are available they will be examined on both a single river catchment, individual site and seasonal basis.

Table 2. Comparison of the results from the flow-related transfer flux (FRTF) measurements from the fluvarium channel. The parabolic parameter, K_p, is in units of $m^4\ h^{-1}\ \mu mol^{-1}$ and the Elovich parameters, a and b, are in units of $\mu mol\ m^{-2}\ h^{-1}$ and $m^2\ \mu mol^{-1}$, respectively.

river	season	parameter	net release of P	net uptake of P
Wey	autumn	$K_p/10^{-7}$	0.844(0.009)	0.613(0.016)
		a	68.94(2.85)	146(7.7)
		$b/10^{-3}$	2.15(0.12)	0.44(0.05)
Wey	winter	$K_p/10^{-7}$	0.811(0.008)	0.218(0.017)
		a	29.44(1.20)	568.9(157.7)
		$b/10^{-3}$	2.70(0.02)	1.80(0.22)
Wey	spring	$K_p/10^{-7}$	0.311(0.071)	0.098(0.014)
		a	66.65(3.58)	57.93(22.42)
		$b/10^{-3}$	1.25(0.11)	1.04(0.87)
Ouse	winter	$K_p/10^{-7}$	16.46(0.44)	0.407(0.189)
		a	17.51(2.97)	542.1(100.2)
		$b/10^{-3}$	11.20(2.10)	0.934(0.095)
Ouse	spring	$K_p/10^{-7}$	no release	0.626(0.026)
		a	no release	415(107)
		$b/10^{-3}$	no release	0.80(0.13)
Blackwater	winter	$K_p/10^{-7}$	5.91(0.35)	0.219(0.012)
		a	23.89(0.60)	266.4(45.1)
		$b/10^{-3}$	0.922(0.008)	0.753(0.103)
Blackwater	spring	$K_p/10^{-7}$	0.231(0.198)	0.211(0.005)
		a	27.09(2.31)	276(24)
		$b/10^{-3}$	1.57(0.29)	0.771(0.005)

4. FUTURE RESEARCH

The intensive field sampling programme will be continued with site visits to the rivers Blackwater and Gt. Ouse in the autumn. This will complete the seasonal work and provide enough detailed information for further laboratory and modelling exercises. The data from the programme will then be examined in more detail. Bed-sediments samples from all the rivers have been retained for further analysis if this is needed.

The data from the macrophyte surveys in the spring and summer of 1995 will also be tabulated and used to estimate the effects of weed growth on P uptake in the rivers. Similarly, the data on silicon concentrations will be used to estimate spring diatom growth. These results will then be interpreted using the PNFILE program, discussed in the last report, by modelling changes in the load of SRP along each river section taking account of STW inputs and tributaries.

The NRA data together with STW discharge data from the water companies, will be used to estimate net efflux/influx sediment parameters for the kinetic models for SRP along the selected river sections. The results will then be compared with the parameters measured using the fluvarium channel and other data from the intensive field programme.

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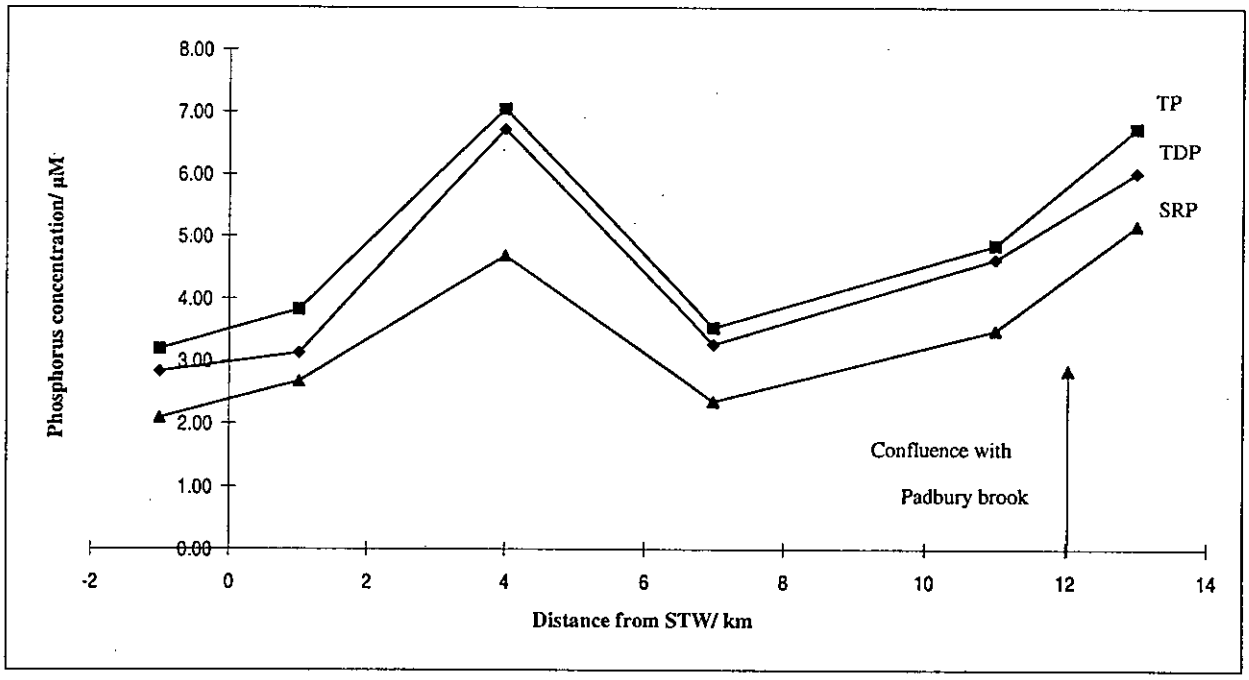
APPENDICES

PILOT STUDY TO GT. OUSE
9-10/01/95

SITE	A	B	C	D	G	E (Padbury brook)	F
NGR of site	SP595 368	SP 602 358	SP 627 346	SP 652 341	SP 717 344	SP 713 315	SP 738 355
Distance from STW/ km	-1	1	4	7	11		13
pH	7.24	7.46	7.71	7.79	8.21	8.08	8.17
Conductivity (µS/cm)	756	1345	620	773	789	873	809.00
Dissolved Oxygen (%)	99	98	93	88	84	83	89.00
Temperature	6.8	7.1	6.4	7.0	6.7	7.1	6.20
Flow (m^3/s)	0.62	0.99	1.13	1.44			
Filtered water (0.45 um)							
Ca++ (mM)	3.66	3.59	3.54	3.58	3.62	3.69	3.74
Mg++ (mM)	0.20	0.19	0.18	0.18	0.20	0.31	0.27
Na+ (mM)	0.90	1.05	1.08	0.93	0.95	1.02	1.02
K+ (mM)	0.055	0.090	0.080	0.080	0.061	0.183	0.103
Alkalinity (mM)	4.68	4.77	4.85	4.32	4.85	4.32	4.47
NO3- (mM)	0.79	0.81	0.79	0.82	0.75	1.06	0.86
Silica (µM)	139	128	125	120	135.00	132	130.00
Soluble Reactive Phosphorus (µM)	2.08	2.67	4.68	2.35	3.49	8.33	5.17
Total Dissolved Phosphorus (µM)	2.82	3.12	6.72	3.27	4.63	9.63	6.02
Non - MR Reactive fraction (µM)	0.74	0.45	2.04	0.92	1.14	1.30	0.85
Unfiltered water							
Total Phosphorus (µM)	3.18	3.82	7.05	3.53	4.86	9.97	6.74
Particulate Phosphorus (µM)	0.36	0.70	0.33	0.26	0.23	0.34	0.72
Suspended Solids (mg/l)	4.6	5.6	4.0	6.4	5.4	5.8	3.2
Sediment sieved 2mm							
% water	22.24	25.92	21.67	19.17			
Organic Matter (% of dry wt)	3.62	3.73	4.08	2.55			
Total Phosphorus (µmol/g)	13.95	17.57	13.94	9.12			
Total Calcium (µmol/g)	2163	2361	3152	2299			
Total Iron (µmol/g)	469.3	481.0	423.8	649.0			
Bioavailable Phosphorus (µmol/g)	0.92	1.83	1.51	1.11			
Equilibrium Phosphorus Concentration (µM)	1.10	2.46	4.51	2.60			
Kd (dm^3/kg)		151.05	79.51	182.01			
ni (µmol/g)		0.371	0.359	0.474			



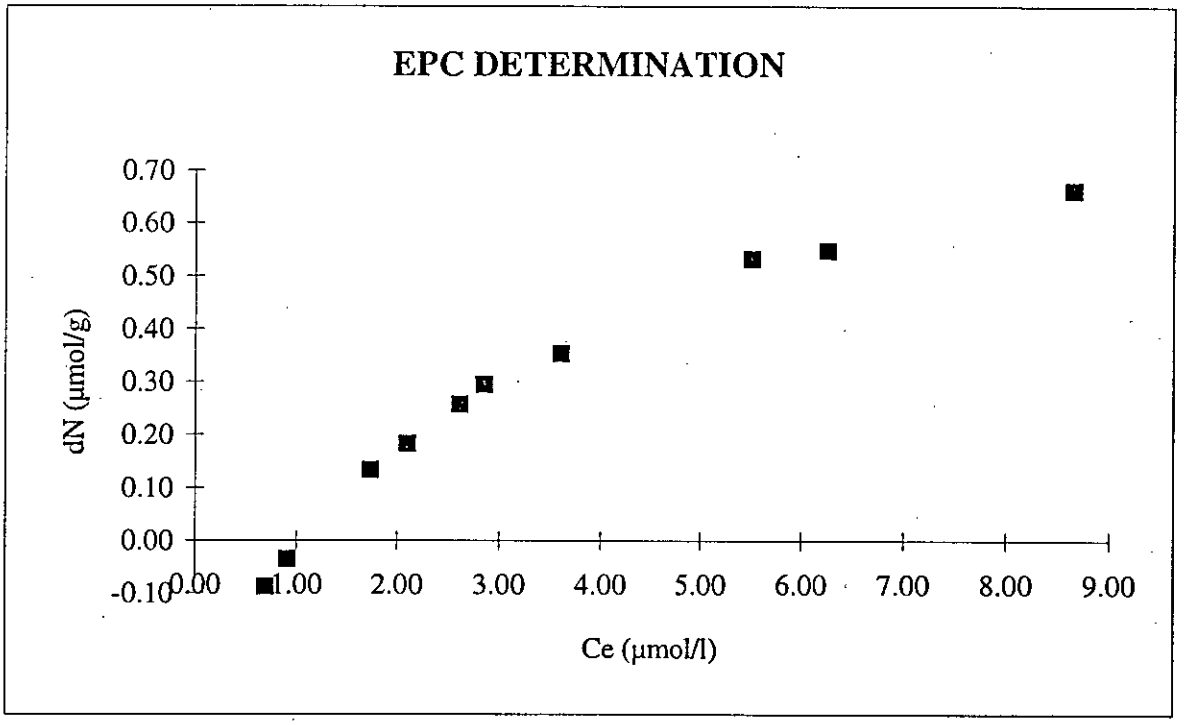
SITE A GREAT OUSE: SEDIMENT & WATER COLLECTED 9/01/95

EPC DETERMINATION: ANALYSIS 17/01/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.06	1.60	0	0.70	-0.09
2.38	1.85	5	2.62	0.26
2.17	1.68	10	5.51	0.53
4.08	3.17	5	2.10	0.18
4.66	3.62	10	3.60	0.35
4.41	3.43	20	8.66	0.66
6.59	5.13	0	0.92	-0.04
6.32	4.91	5	1.73	0.13
6.22	4.84	10	2.85	0.30
6.45	5.01	20	6.26	0.55

% WATER OF SEDIMENT = 22.24
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 3.62%
TOTAL PHOSPHORUS OF SEDIMENT = 13.95 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 0.92 µmol/g dry weight

SRP OF WATER = 2.08 µmol/l
TDP OF WATER = 2.82 µmol/l
TP OF WATER = 3.18 µmol/l

EPCo = 1.10 µM



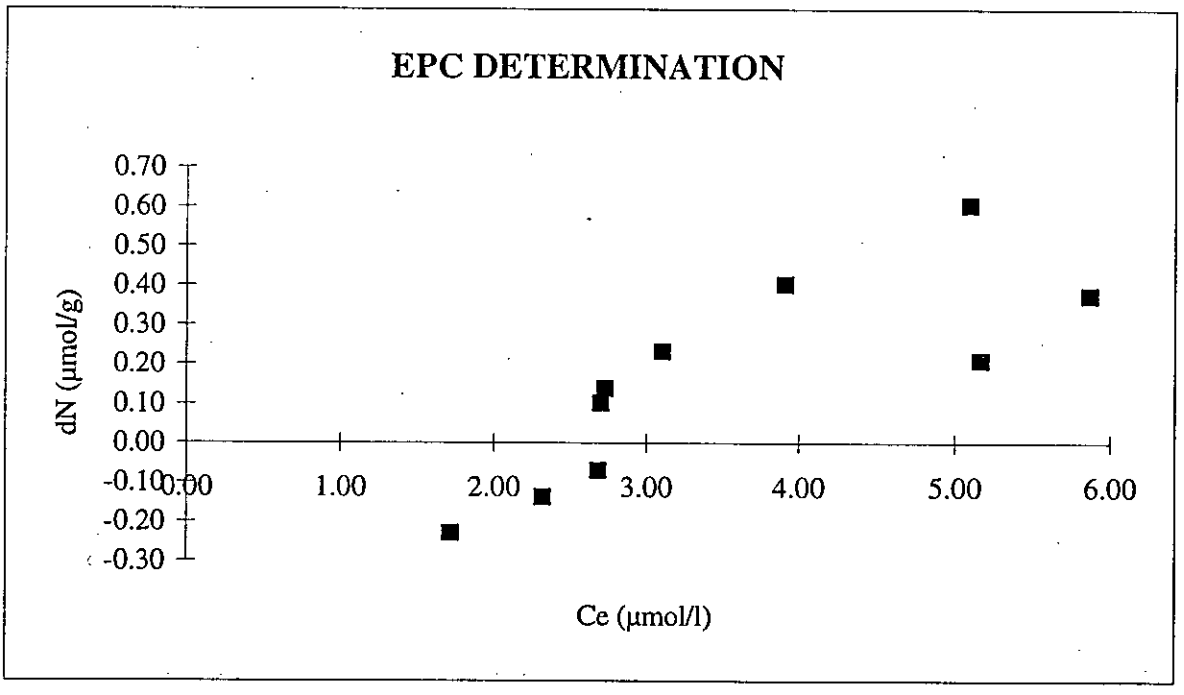
SITE B GREAT OUSE: SEDIMENT & WATER COLLECTED 9/01/95

EPC DETERMINATION: ANALYSIS 17/01/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.02	1.50	0	1.72	-0.23
2.18	1.62	5	3.11	0.23
2.19	1.62	10	5.09	0.60
4.55	3.37	0	2.32	-0.14
4.42	3.28	5	2.73	0.14
4.08	3.02	10	3.91	0.40
6.16	4.56	5	2.70	0.10
6.19	4.58	10	5.17	0.21
10.28	7.61	0	2.68	-0.07
10.13	7.51	20	5.87	0.38

% WATER OF SEDIMENT = 25.92
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 3.73%
TOTAL PHOSPHORUS OF SEDIMENT = 17.57 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 1.831 µmol/g dry weight

SRP OF WATER = 2.67 µmol/l
TDP OF WATER = 3.12 µmol/l
TP OF WATER = 3.82 µmol/l

EPCo = 2.46 µM
Kd = 151.05 dm^3/kg
ni = 0.371 µmol/g



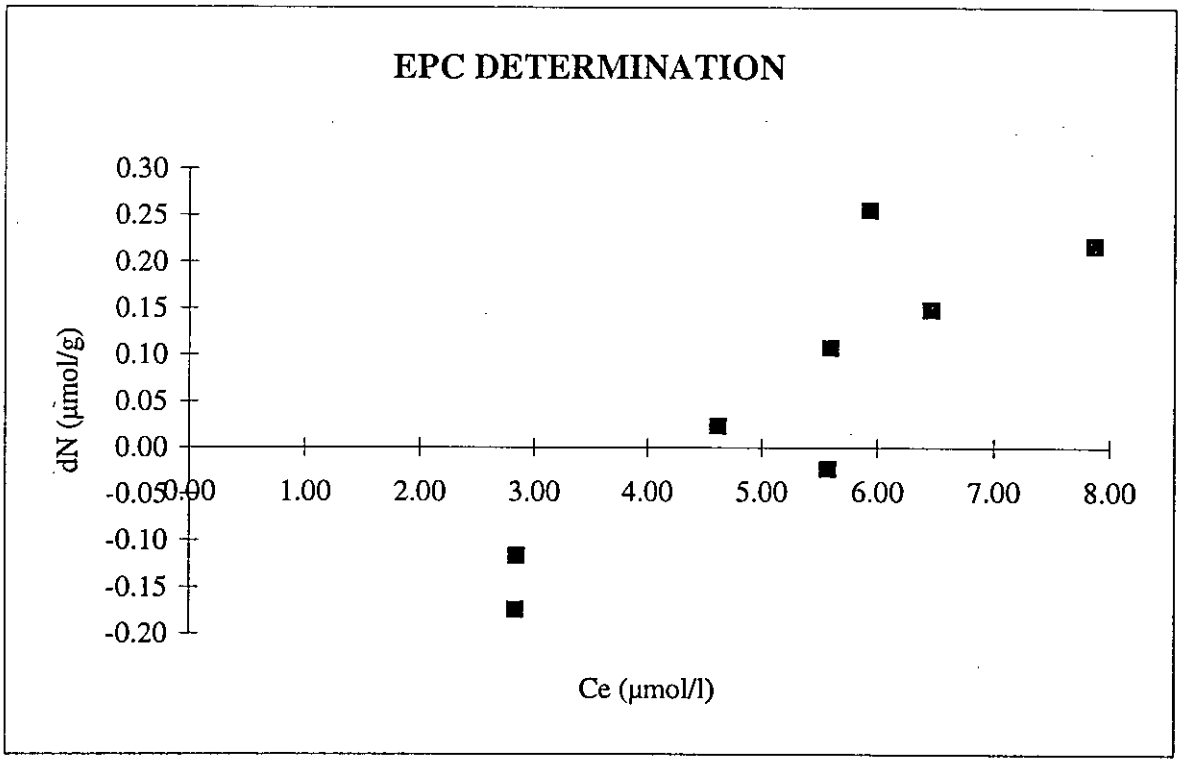
SITE C GREAT OUSE: SEDIMENT & WATER COLLECTED 9/01/95

EPC DETERMINATION: ANALYSIS 17/01/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.50	1.96	10	7.87	0.22
4.16	3.26	0	2.84	-0.17
4.16	3.26	5	4.62	0.02
4.06	3.18	10	5.94	0.26
6.24	4.89	0	2.85	-0.12
6.29	4.92	5	5.57	-0.02
6.08	4.76	10	6.46	0.15
10.41	8.15	10	5.60	0.11

% WATER OF SEDIMENT = 21.67
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 4.08%
TOTAL PHOSPHORUS OF SEDIMENT = 13.94 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 1.509 µmol/g dry weight

SRP OF WATER = 4.68 µmol/l
TDP OF WATER = 6.72 µmol/l
TP OF WATER = 7.05 µmol/l

EPCo = 4.51 µM
Kd = 79.51 dm^3/kg
ni = 0.359 µmol/g



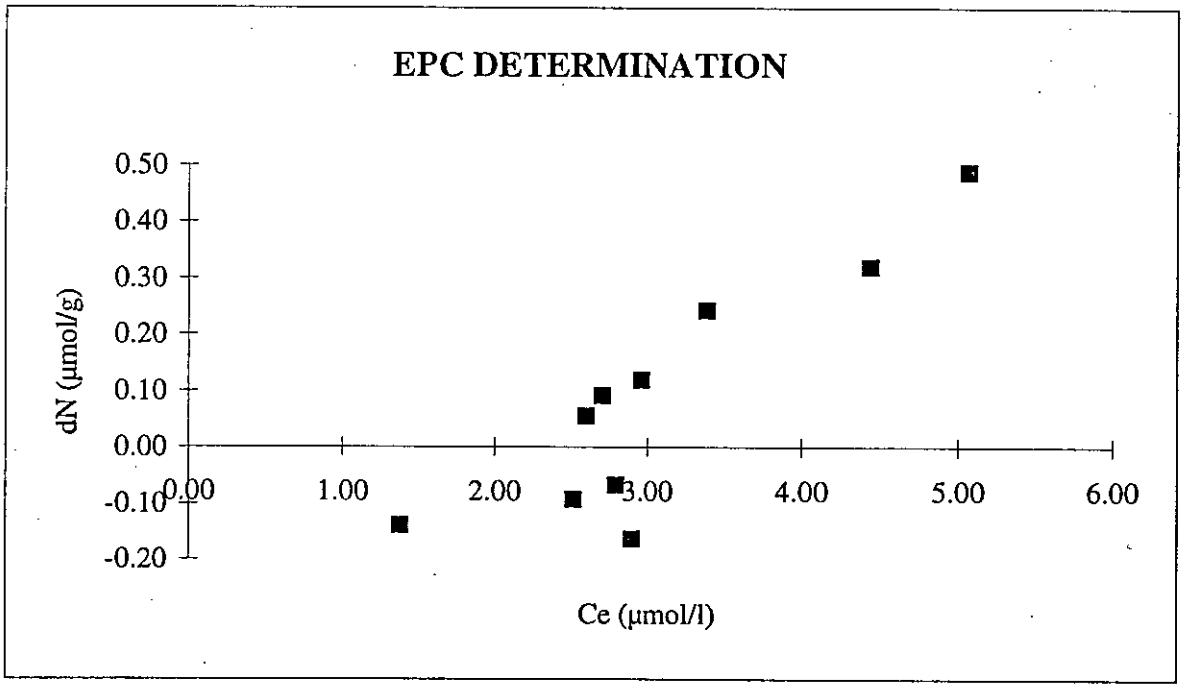
SITE D GREAT OUSE: SEDIMENT & WATER COLLECTED 9/01/95

EPC DETERMINATION: ANALYSIS 17/01/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (μM)	[P] at 24 h (μM)	dN (μmol/g. dry wt)
2.46	1.99	0	1.38	-0.14
2.50	2.02	10	5.07	0.49
4.38	3.54	0	2.90	-0.16
4.25	3.44	5	2.96	0.12
4.29	3.47	10	4.44	0.32
6.70	5.41	0	2.52	-0.09
6.22	5.03	5	2.71	0.09
6.73	5.44	10	3.39	0.24
10.21	8.26	0	2.80	-0.07
10.68	8.63	5	2.60	0.06

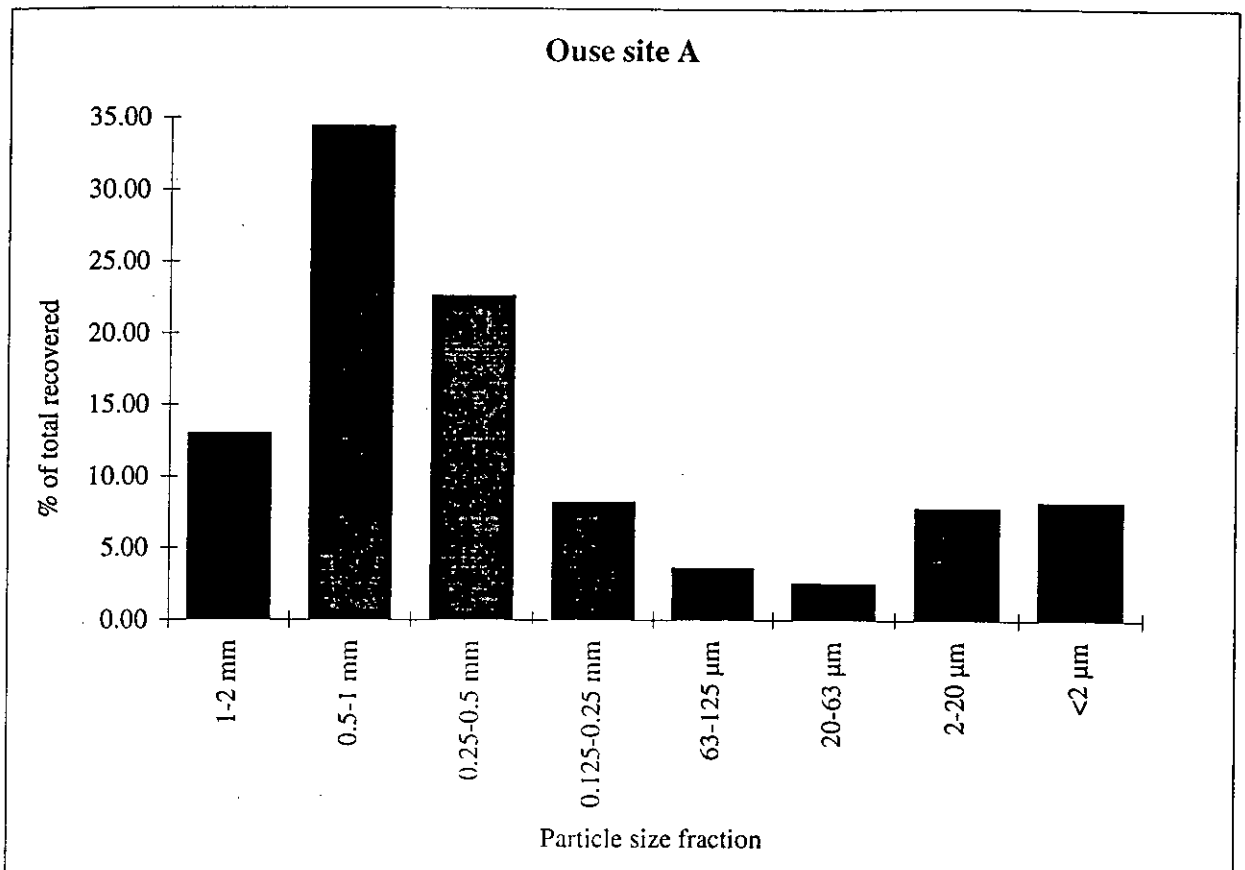
% WATER OF SEDIMENT = 19.17
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.55%
TOTAL PHOSPHORUS OF SEDIMENT = 9.12 μmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 1.11 μmol/g dry weight

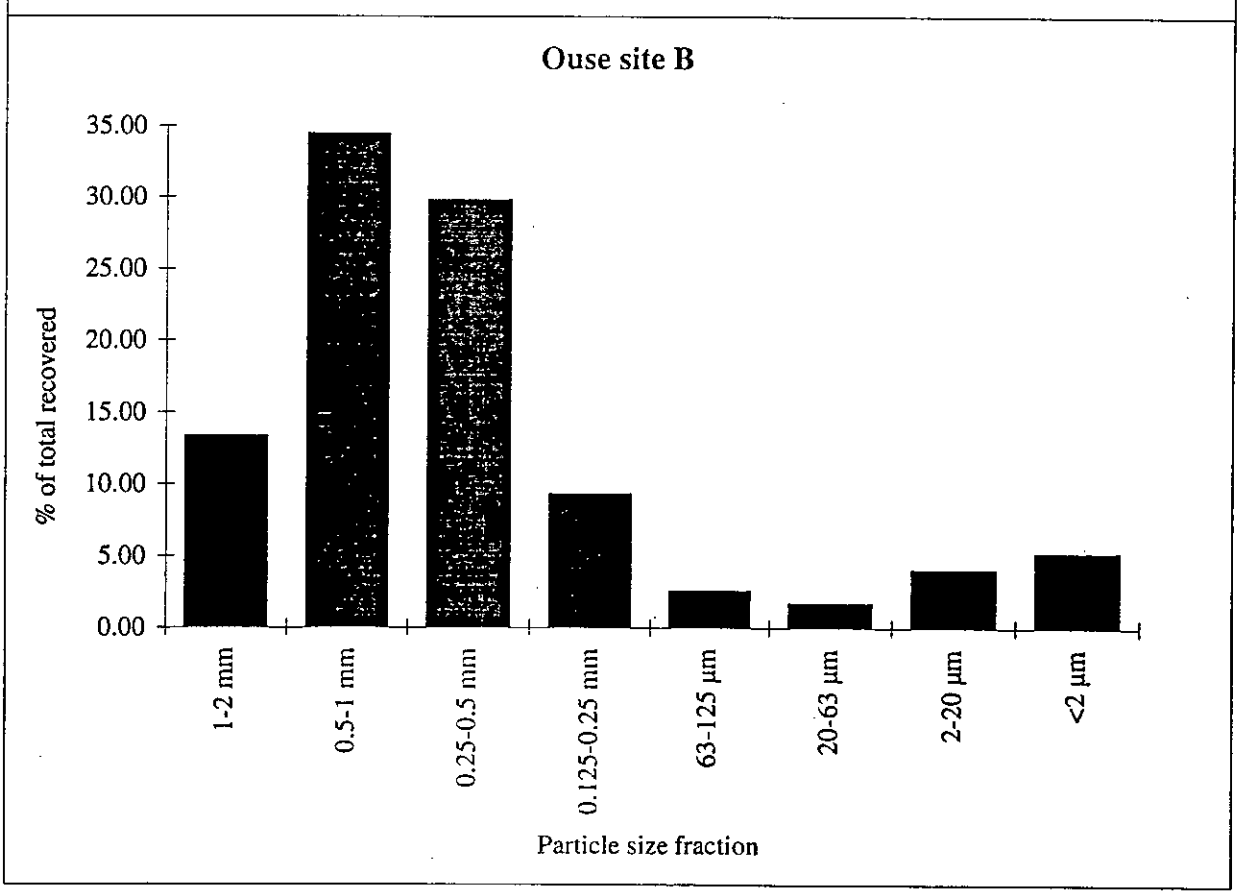
SRP OF WATER = 2.35 μmol/l
TDP OF WATER = 3.27 μmol/l
TP OF WATER = 3.53 μmol/l

EPCo = 2.60 μM
Kd = 182.01 dm^3/kg
ni = 0.474 μmol/g

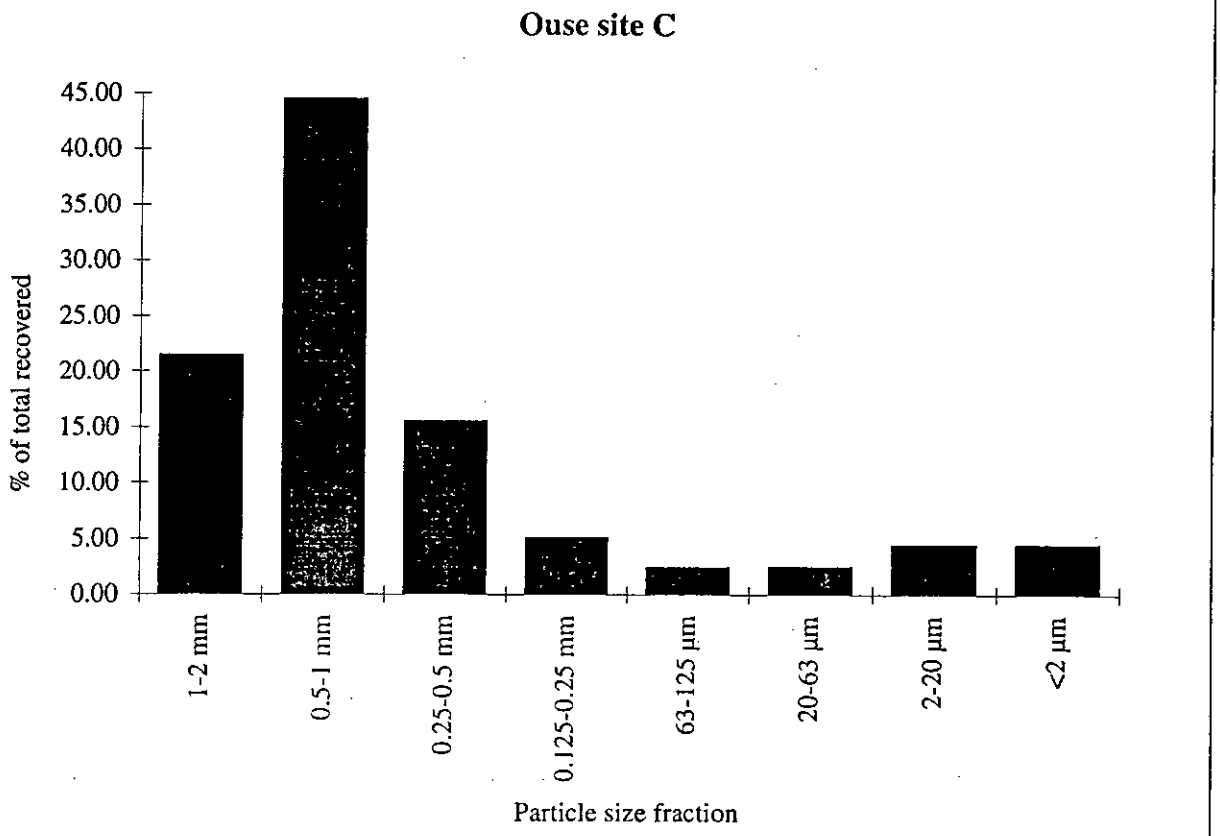


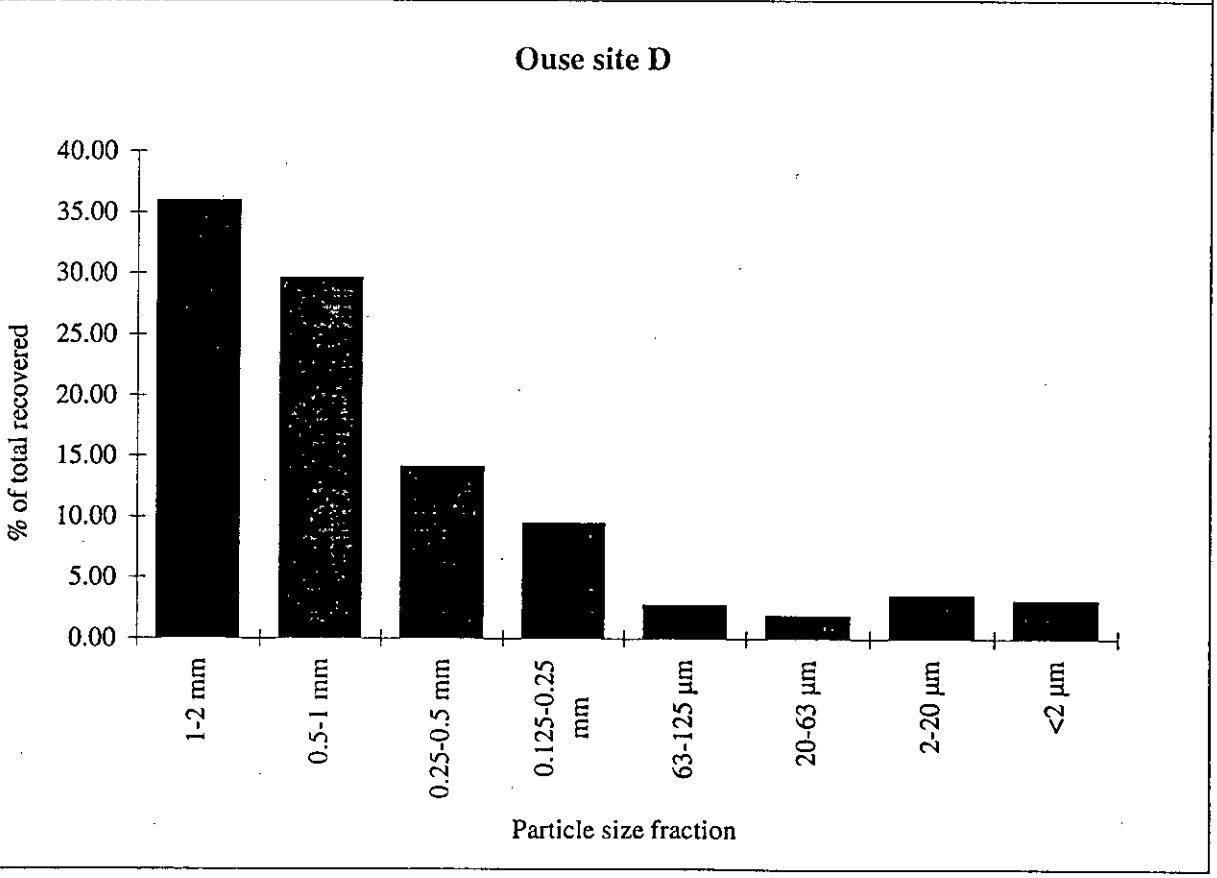
PARTICLE SIZE DISTRIBUTION OF Gt. OUSE SEDIMENTS
SAMPLE DATE 9-10/1/95





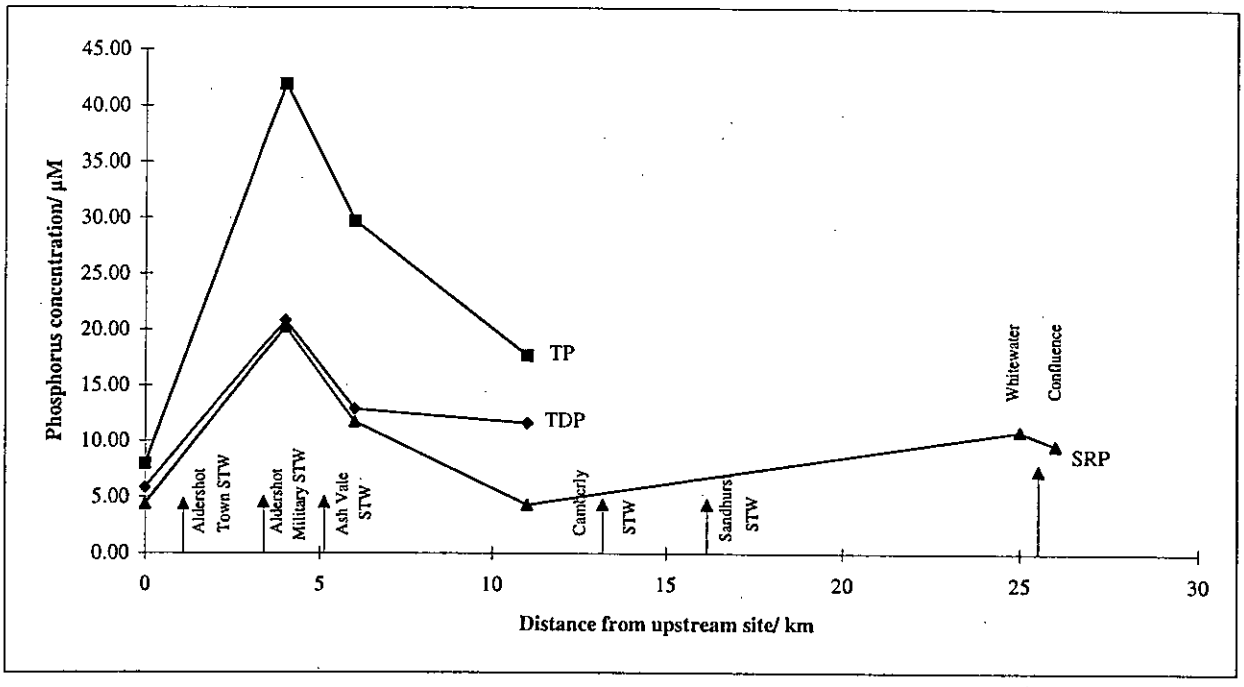
PARTICLE SIZE DISTRIBUTION OF Gt. OUSE SEDIMENTS
SAMPLE DATE 9-10/1/95





PILOT STUDY TO RIVER BLACKWATER
30/01/95

SITE	A	B	C	D	E	G (Whitewater)	F
NGR of site	SU 882 499	SU 885 538	SU 880 559	SU 859 594	SU 742 634	SU 742 635	SU 740 638
Distance from upstream site/ km	0	4	6	11	25		26
pH	7.34	6.91	7.09	6.91			
Conductivity (µS/cm)	466	502	505	441	416	407	420
Dissolved Oxygen (%)	82	79	73	70			
Temperature	7.6	8.8	8.8	8.6	7.1	7.7	7.0
Flow (m^3/s)	0.22	1.08	1.58	2.80			
Filtered water (0.45 µm)							
Ca++ (mM)	1.78	1.91	1.75	1.48	1.43	1.50	1.42
Mg++ (mM)	0.23	0.25	0.25	0.21	0.20	0.19	0.20
Na+ (mM)	1.60	1.15	1.21	1.15	1.06	0.81	1.06
K+ (mM)	0.079	0.121	0.122	0.105	0.101	0.088	0.100
Alkalinity (mM)	2.78	2.62	2.48	2.01	1.82	2.04	1.83
NO3- (mM)	0.23	0.24	0.22	0.16	0.20	0.22	0.20
Silica (µM)	194	219	225	224	215	195	214
Soluble Reactive Phosphorus (µM)	4.36	20.24	11.75	4.29	10.94	5.84	9.65
Total Dissolved Phosphorus (µM)	5.82	20.83	12.85	11.60			
Non - MR Reactive fraction (µM)	1.46	0.59	1.10	7.31			
Unfiltered water							
Total Phosphorus (µM)	7.91	41.90	29.71	17.70			
Particulate Phosphorus (µM)	2.09	21.07	16.86	6.10			
Bioavailable Phosphorus (µM)	4.85	20.79	18.77	10.82			
Suspended Solids (mg/l)	30.3	87.6	71.5	42.5	31.6	28.4	33.2
Sediment sieved 2mm							
% water	18.77	21.11	23.44	19.09			
Organic Matter (% of dry wt)	1.93	1.56	1.46	0.63			
Total Phosphorus (µmol/g)	8.97	13.58	22.43	16.46			
Total Calcium (µmol/g)	252.20	89.50	527.60	73.40			
Total Iron (µmol/g)	522.47	99.34	319.85	231.73			
Bioavailable Phosphorus (µmol/g)	0.87	6.46	7.91	4.13			
Equilibrium Phosphorus Concentration (µM)	0.99	6.38	4.73	3.06			
Kd (dm^3/kg)	170.30	117.20	258.60	109.80			
ni (µmol/g)	0.169	0.748	1.223	0.336			



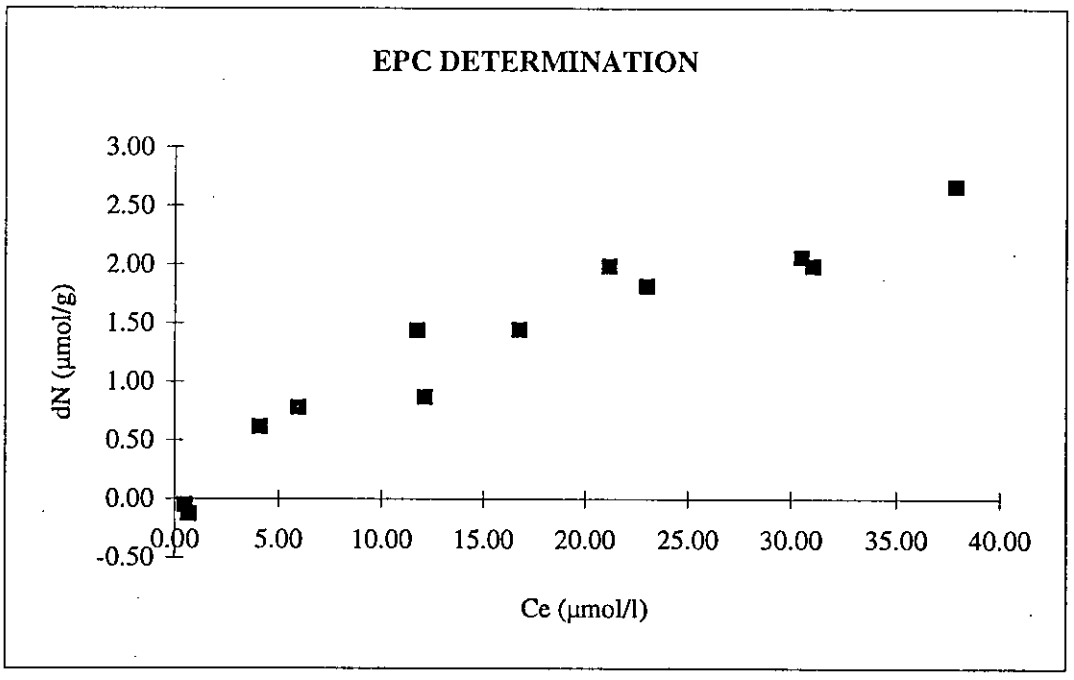
SITE A RIVER BLACKWATER: SEDIMENT & WATER COLLECTED 30/01/95

EPC DETERMINATION: ANALYSIS 15/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (μM)	[P] at 24 h (μM)	dN (μmol/g. dry wt)
1.29	1.05	0	0.67	-0.13
1.29	1.05	10	5.92	0.78
1.41	1.15	20	11.75	1.44
1.09	0.89	30	21.17	1.99
1.11	0.90	40	31.04	1.99
1.12	0.91	50	37.86	2.67
2.18	1.77	0	0.46	-0.05
2.37	1.92	10	4.08	0.62
2.23	1.81	20	12.13	0.87
2.25	1.83	30	16.78	1.44
2.30	1.87	40	23.02	1.82
2.33	1.89	50	30.50	2.06

% WATER OF SEDIMENT = 18.77
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.93%
TOTAL PHOSPHORUS OF SEDIMENT = 8.97 μmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 0.87 μmol/g dry weight

SRP OF WATER = 4.36 μmol/l
TDP OF WATER = 5.82 μmol/l
TP OF WATER = 7.91 μmol/l

EPCo = 0.992 μM
Kd = 170.3 dm^3/kg
ni = 0.169 μmol/g



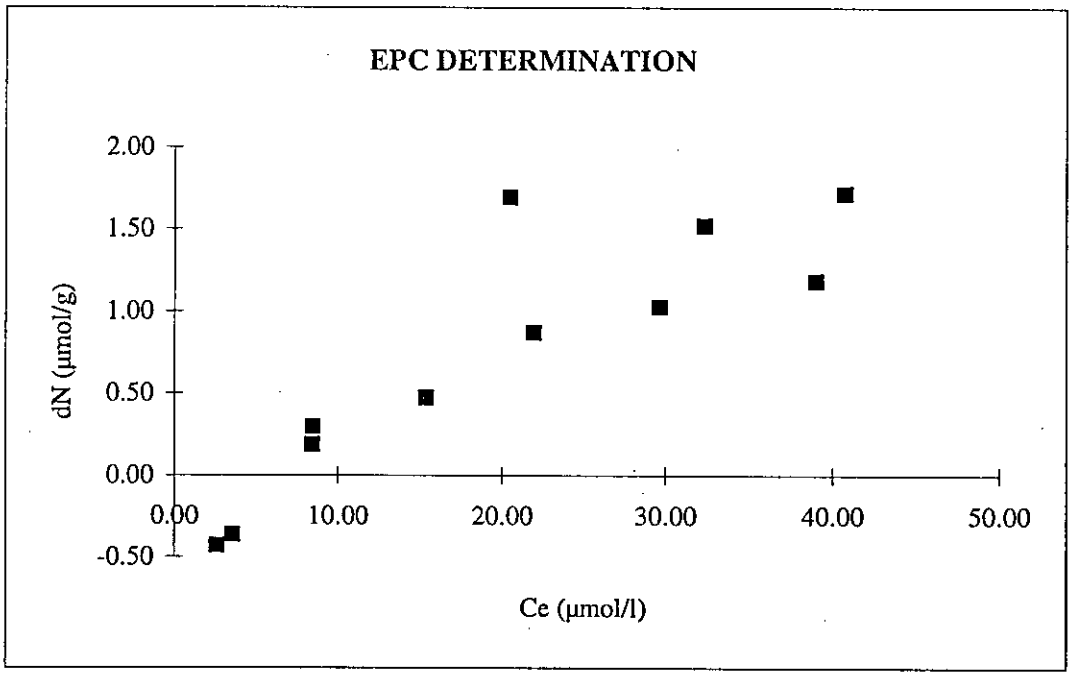
SITE B RIVER BLACKWATER: SEDIMENT & WATER COLLECTED 30/01/95

EPC DETERMINATION: ANALYSIS 15/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
1.51	1.19	0	2.55	-0.43
1.33	1.05	10	8.46	0.30
1.43	1.12	30	20.48	1.69
1.27	1.01	40	32.35	1.52
1.36	1.07	50	40.78	1.72
2.44	1.92	0	3.50	-0.36
2.17	1.71	10	8.40	0.19
2.46	1.94	20	15.41	0.47
2.35	1.85	30	21.95	0.87
2.56	2.02	40	29.63	1.03
2.35	1.85	50	39.01	1.19

% WATER OF SEDIMENT = 21.11
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.56%
TOTAL PHOSPHORUS OF SEDIMENT = 13.58 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 6.46 µmol/g dry weight

SRP OF WATER = 20.24 µmol/l
TDP OF WATER = 20.83 µmol/l
TP OF WATER = 41.9 µmol/l

EPCo = 6.38 µM
Kd = 117.2 dm^3/kg
ni = 0.748 µmol/g



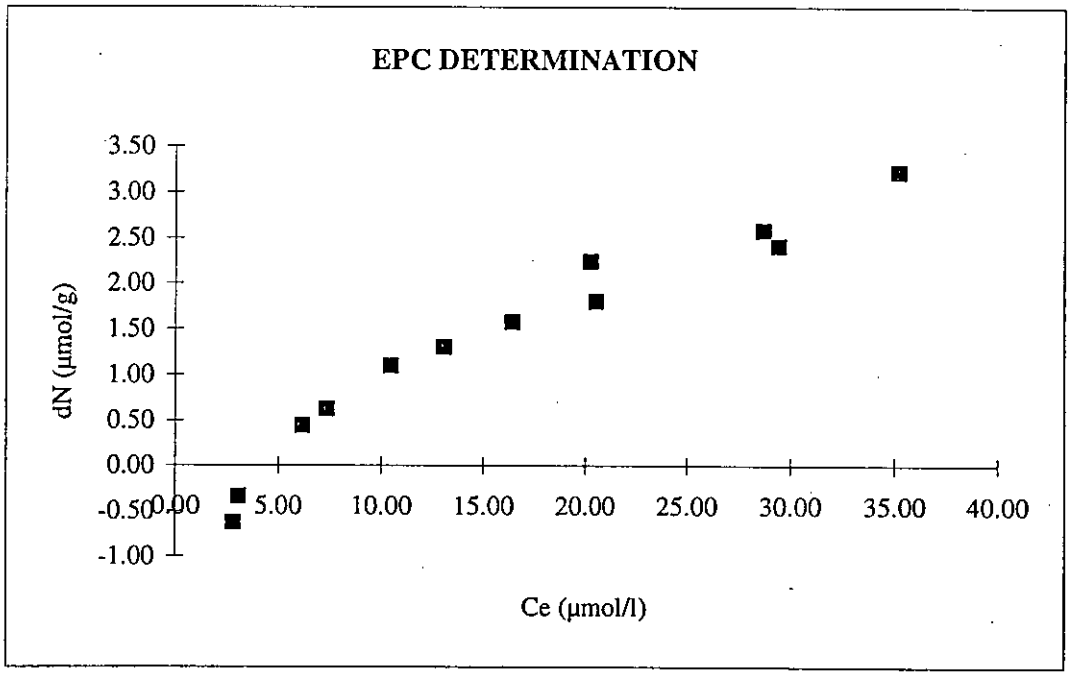
SITE C RIVER BLACKWATER: SEDIMENT & WATER COLLECTED 30/01/95

EPC DETERMINATION: ANALYSIS 15/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
1.16	0.89	0	2.77	-0.62
1.10	0.84	10	7.37	0.63
1.39	1.06	20	13.06	1.31
1.13	0.87	30	20.28	2.24
1.14	0.87	40	28.71	2.58
1.20	0.92	50	35.22	3.22
2.33	1.78	0	3.02	-0.34
2.26	1.73	10	6.17	0.44
2.26	1.73	20	10.47	1.10
2.25	1.72	30	16.41	1.58
2.81	2.15	40	20.55	1.81
2.23	1.71	50	29.42	2.41

% WATER OF SEDIMENT = 23.44
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.46%
TOTAL PHOSPHORUS OF SEDIMENT = 22.43 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 7.91 µmol/g dry weight

SRP OF WATER = 11.75 µmol/l
TDP OF WATER = 12.85 µmol/l
TP OF WATER = 29.71 µmol/l

EPCo = 4.729 µM
Kd = 258.6 dm^3/kg
ni = 1.223 µmol/g



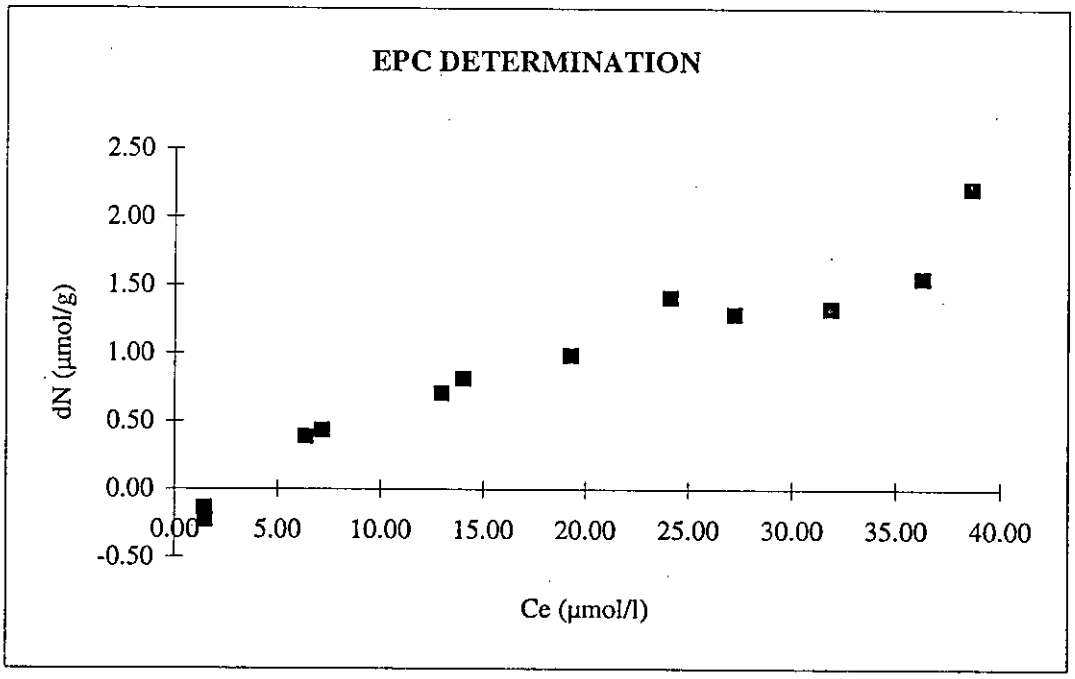
SITE D RIVER BLACKWATER: SEDIMENT & WATER COLLECTED 30/01/95

EPC DETERMINATION: ANALYSIS 15/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
1.56	1.26	0	1.43	-0.23
1.62	1.31	10	7.16	0.43
1.81	1.46	20	14.03	0.82
1.03	0.84	30	24.10	1.41
1.51	1.22	40	31.88	1.33
1.27	1.03	50	38.61	2.21
2.47	2.00	0	1.39	-0.14
2.31	1.87	10	6.40	0.39
2.45	1.99	20	12.97	0.71
2.69	2.18	30	19.28	0.98
2.46	1.99	40	27.23	1.29
2.19	1.77	50	36.28	1.55

% WATER OF SEDIMENT = 19.09
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 0.63%
TOTAL PHOSPHORUS OF SEDIMENT = 16.46 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 4.13 µmol/g dry weight

SRP OF WATER = 4.29 µmol/l
TDP OF WATER = 11.60 µmol/l
TP OF WATER = 17.70 µmol/l

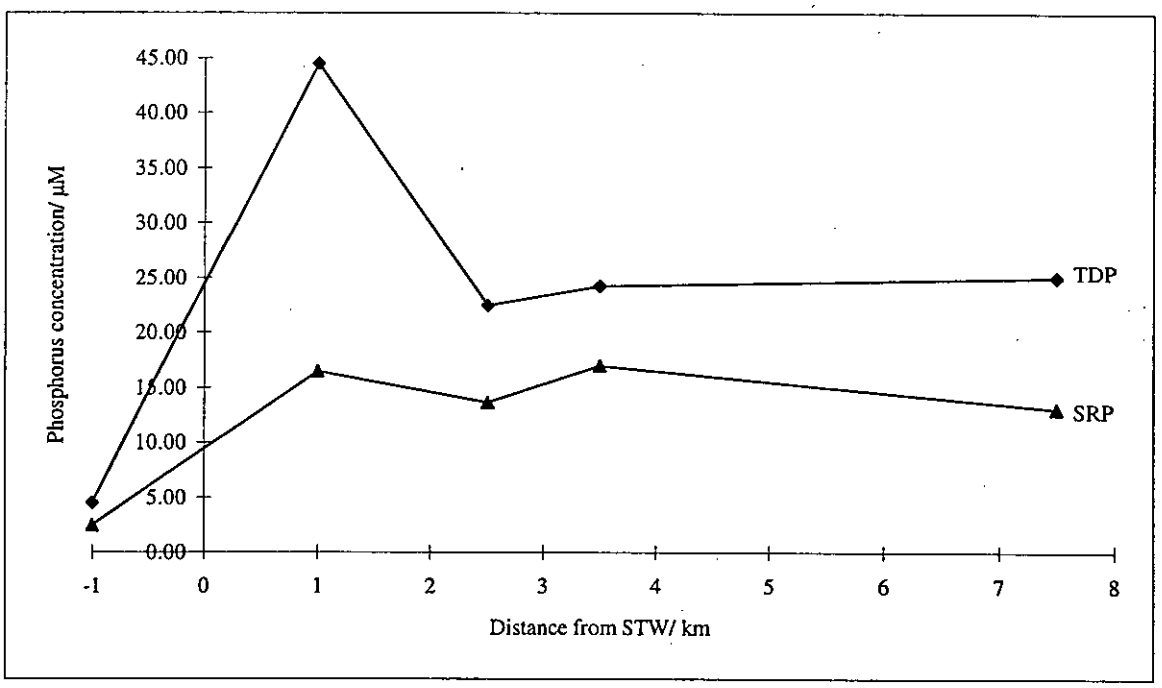
EPCo = 3.06 µM
Kd = 109.8 dm^3/kg
ni = 0.336 µmol/g



APPENDIX C

PILOT STUDY TO RIVER WEY
ALTON 13/02/95

SITE	A	B	C	D	E	F
NGR of site	SU 724 396	SU 730 387	SU 733 403	SU 745 412	SU 756 417	SU 786 432
Distance from STW/ km	-1	Tributary	1	2.5	3.5	7.5
pH	7.18	7.50	7.25	7.10	7.21	7.00
Conductivity (µS/cm)	527	588	558	520	572	588
Dissolved Oxygen (%)	96	98	99	ND	90	96
Temperature	9.4	9.1	9.5	9.4	9.3	9.2
Flow (m^3/s)	0.55		1.76	1.85	2.34	2.55
Filtered water (0.45 um)						
Ca++ (mM)	2.38	2.59	2.59	2.34	2.62	2.77
Mg++ (mM)	0.07	0.08	0.09	0.08	0.08	0.09
Na+ (mM)	0.51	0.58	0.80	0.79	0.83	0.70
K+ (mM)	0.03	0.04	0.05	0.04	0.07	0.05
Alkalinity (mM)	4.05	3.91	4.25	3.81	4.22	4.40
NO3- (mM)	0.33	0.57	0.46	0.47	0.50	0.53
Silicon (µM)	150	216	202	181	219	216
Soluble Reactive Phosphorus (µM)	2.46	9.10	16.43	13.62	16.95	13.04
Total Dissolved Phosphorus (µM)	4.52	8.17	44.48	22.48	24.22	25.07
Non - MR Reactive fraction (µM)	2.06	-0.93	28.05	8.86	7.27	12.03
Unfiltered water						
Total Phosphorus (µM)	5.31	8.19	>200	42.19	>200	>200
Particulate Phosphorus (µM)	0.79	0.02	>155	19.71	>175	>175
Bioavailable Phosphorus (µM)	15.03	11.46	16.32	13.38	21.05	48.40
Sediment sieved 2mm						
% water	18.89		20.56	27.91	21.78	22.91
Organic Matter (% of dry wt)	1.47		1.61	3.06	1.89	1.68
Total Phosphorus (µmol/g)	4.29		19.12	28.01	14.01	10.13
Total Calcium (µmol/g)	1245.10		1177.10	1083.70	1021.00	898.20
Total Iron (µmol/g)	270.47		415.79	595.63	226.90	248.62
Bioavailable Phosphorus (µmol/g)	0.82		1.73	4.32	1.58	9.25
Equilibrium Phosphorus Concentration (µM)	1.72		9.27	3.80	5.90	5.28
Kd (dm^3/kg)	77.07		94.15	140.44	95.33	64.26
ni (µmol/g)	0.1325		0.8724	0.533	0.562	0.339



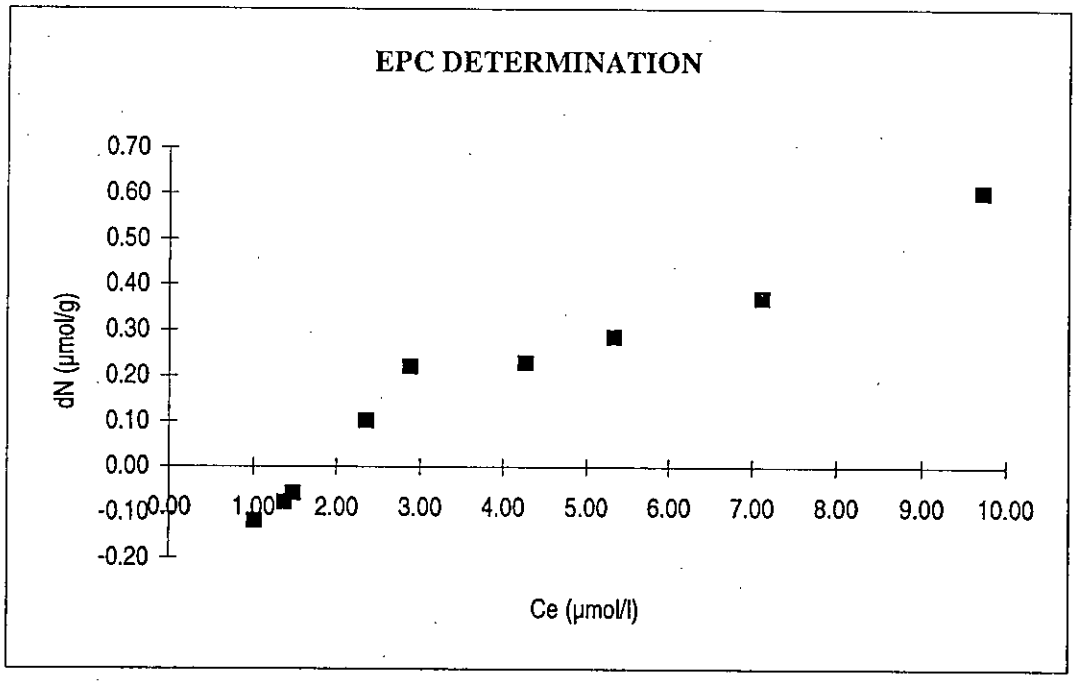
SITE A RIVER WEY: SEDIMENT & WATER COLLECTED 13/02/95

EPC DETERMINATION: ANALYSIS 22/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.13	1.73	0	1.02	-0.12
2.36	1.91	5	2.89	0.22
1.92	1.56	10	7.12	0.37
4.44	3.60	0	1.38	-0.08
4.01	3.25	10	5.34	0.29
4.20	3.40	20	9.72	0.60
6.37	5.16	0	1.48	-0.06
6.38	5.18	5	2.36	0.10
6.16	5.00	10	4.27	0.23

% WATER OF SEDIMENT = 18.89
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.47%
TOTAL PHOSPHORUS OF SEDIMENT = 4.286 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 0.82 µmol/g dry weight

SRP OF WATER = 2.46 µmol/l
TDP OF WATER = 4.52 µmol/l
TP OF WATER = 5.31 µmol/l

EPCo = 1.719 µM
Kd = 77.07 dm^3/kg
ni = 0.1325 µmol/g



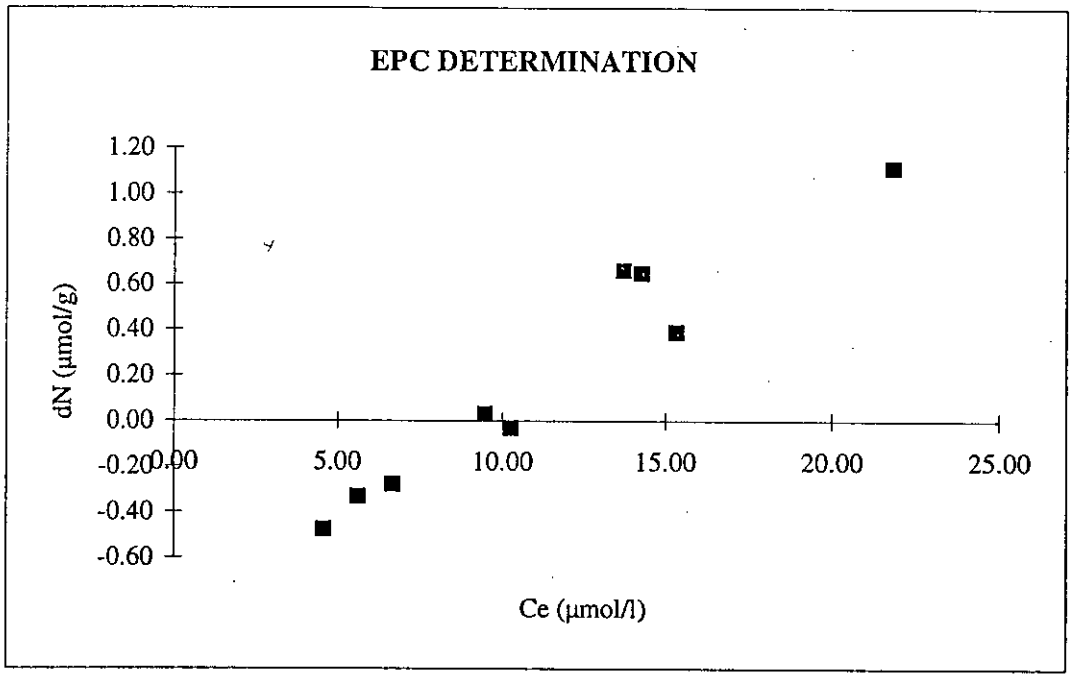
SITE C RIVER WEY: SEDIMENT & WATER COLLECTED 13/02/95

EPC DETERMINATION: ANALYSIS 22/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.42	1.93	0	4.57	-0.47
2.16	1.71	10	10.27	-0.03
2.39	1.90	20	13.73	0.66
4.27	3.39	0	5.62	-0.33
4.41	3.50	10	9.48	0.03
4.16	3.31	25	14.26	0.65
6.03	4.79	0	6.67	-0.28
6.25	4.97	25	15.34	0.39
6.38	5.07	50	21.83	1.11

% WATER OF SEDIMENT = 20.56
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.61%
TOTAL PHOSPHORUS OF SEDIMENT = 19.115 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 1.73 µmol/g dry weight

SRP OF WATER = 16.43 µmol/l
TDP OF WATER = 44.48 µmol/l
TP OF WATER = >200 µmol/l

EPCo = 9.266 µM
Kd = 94.15 dm^3/kg
ni = 0.8724 µmol/g



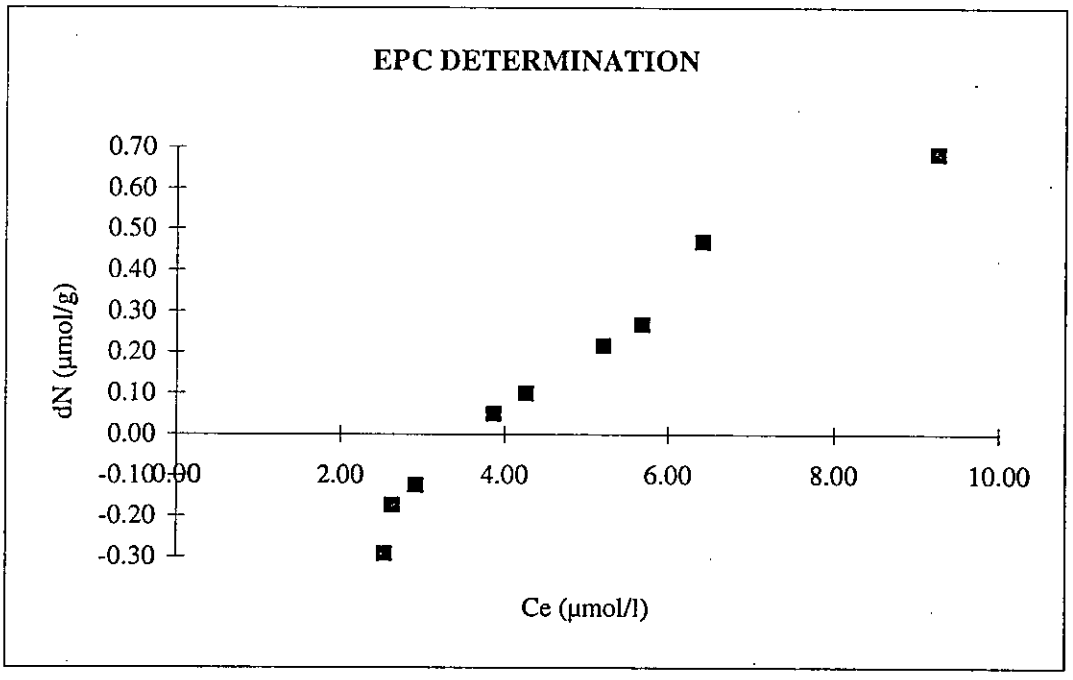
SITE D RIVER WEY: SEDIMENT & WATER COLLECTED 13/02/95

EPC DETERMINATION: ANALYSIS 22/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.42	1.74	0	2.54	-0.29
2.05	1.48	5	4.26	0.10
2.12	1.53	10	6.42	0.47
4.24	3.06	0	2.64	-0.17
4.46	3.22	10	5.68	0.27
4.35	3.14	20	9.26	0.68
6.51	4.70	0	2.92	-0.12
6.35	4.58	5	3.87	0.05
6.12	4.42	10	5.21	0.22

% WATER OF SEDIMENT = 27.91
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 3.06%
TOTAL PHOSPHORUS OF SEDIMENT = 28.009 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 4.32 µmol/g dry weight

SRP OF WATER = 13.62 µmol/l
TDP OF WATER = 22.48 µmol/l
TP OF WATER = 42.19 µmol/l

EPCo = 3.798 µM
Kd = 140.44 dm^3/kg
ni = 0.533 µmol/g



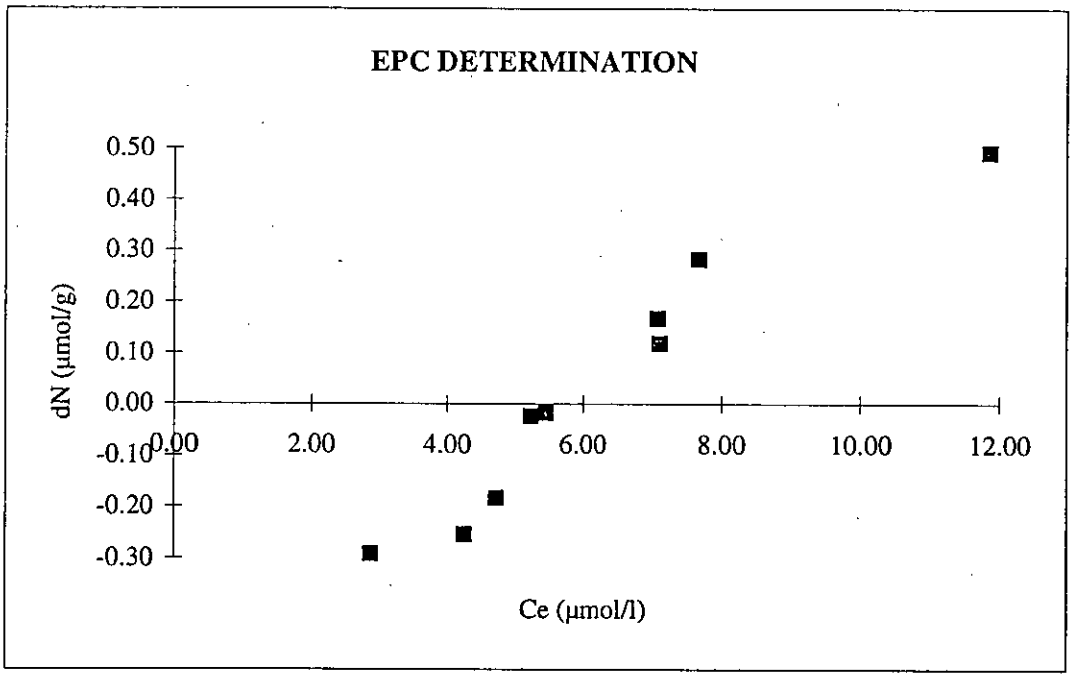
SITE E RIVER WEY: SEDIMENT & WATER COLLECTED 13/02/95

EPC DETERMINATION: ANALYSIS 22/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (μM)	[P] at 24 h (μM)	dN (μmol/g. dry wt)
2.52	1.97	0	2.87	-0.29
2.42	1.90	5	5.23	-0.02
2.11	1.65	10	7.67	0.28
4.28	3.35	0	4.24	-0.25
4.45	3.48	10	7.08	0.17
4.23	3.31	20	11.86	0.49
6.58	5.15	0	4.72	-0.18
6.64	5.20	5	5.45	-0.02
6.28	4.92	10	7.11	0.12

% WATER OF SEDIMENT = 21.78
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.89%
TOTAL PHOSPHORUS OF SEDIMENT = 14.006 μmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 1.58 μmol/g dry weight

SRP OF WATER = 16.95 μmol/l
TDP OF WATER = 24.22 μmol/l
TP OF WATER = >200 μmol/l

EPCo = 5.898 μM
Kd = 95.33 dm^3/kg
ni = 0.562 μmol/g



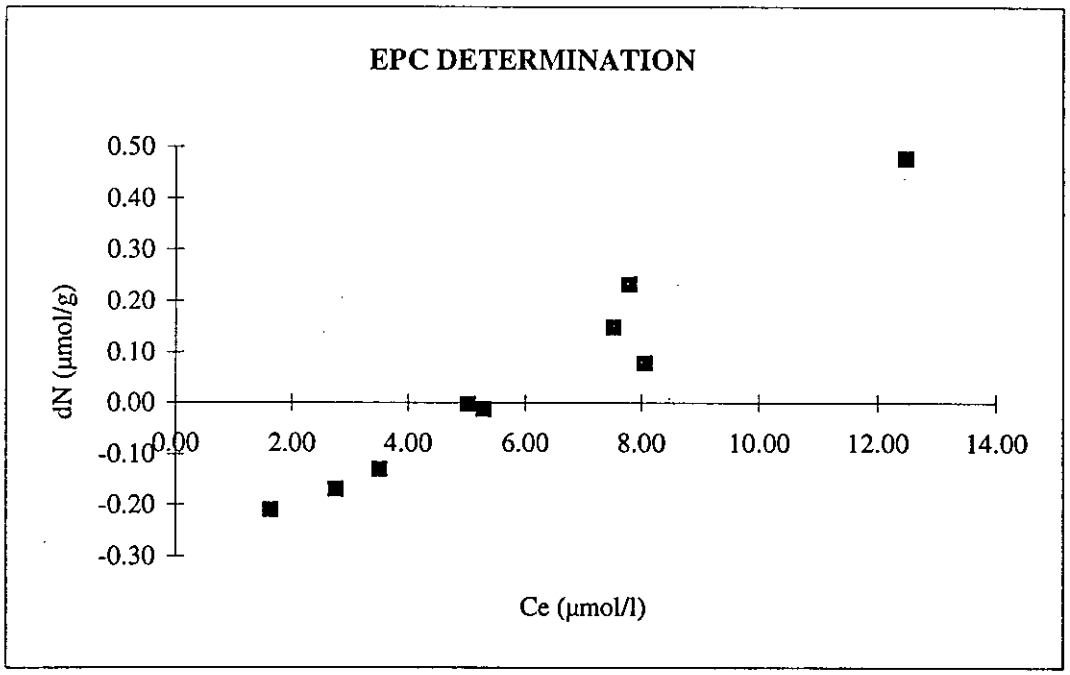
SITE F RIVER WEY: SEDIMENT & WATER COLLECTED 13/02/95

EPC DETERMINATION: ANALYSIS 22/02/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/g. dry wt)
2.03	1.56	0	1.64	-0.21
2.11	1.63	5	5.02	0.00
2.47	1.90	10	7.79	0.23
4.24	3.27	0	2.76	-0.17
4.30	3.32	10	7.53	0.15
4.09	3.15	20	12.47	0.48
6.97	5.37	0	3.51	-0.13
6.13	4.72	5	5.28	-0.01
6.48	4.99	10	8.05	0.08

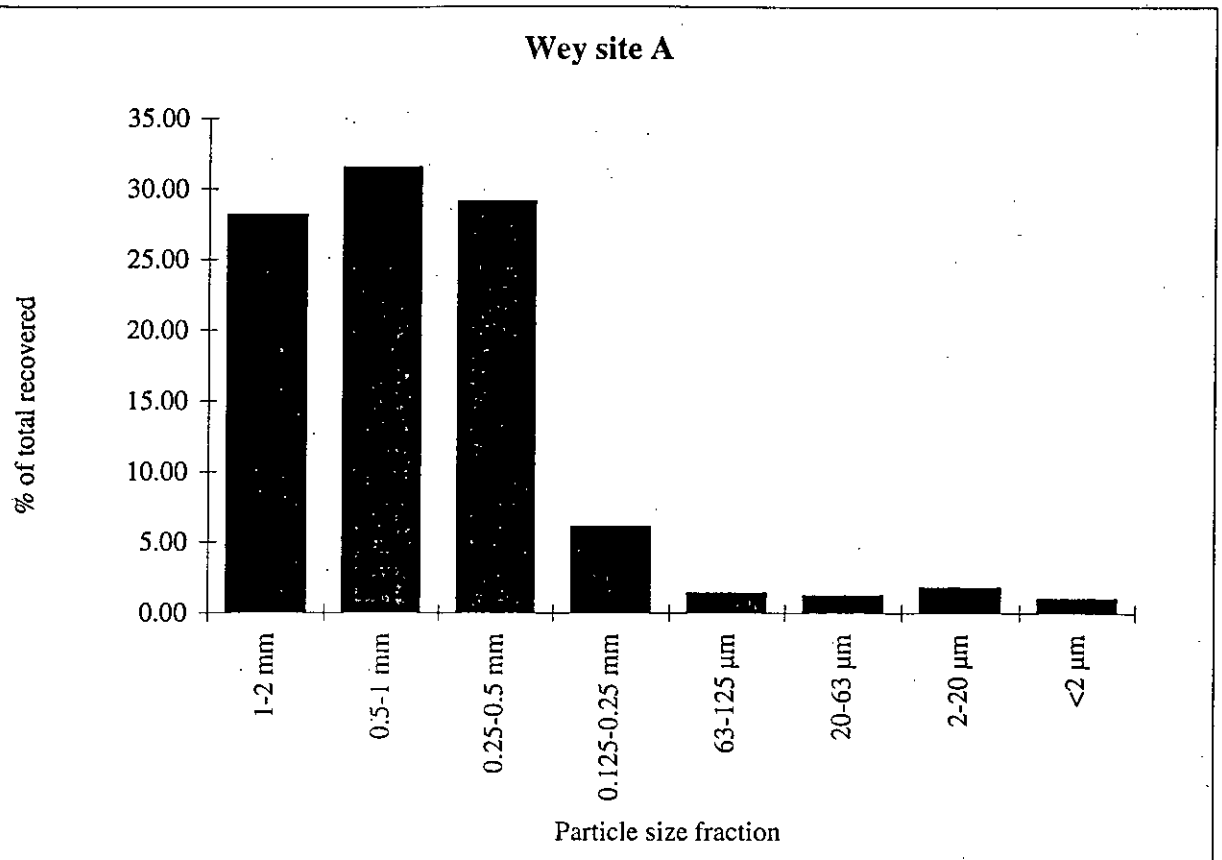
% WATER OF SEDIMENT = 22.91
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.68%
TOTAL PHOSPHORUS OF SEDIMENT = 10.134 µmol/g dry weight
BIOAVAILABLE PHOSPHORUS OF SEDIMENT = 9.25 µmol/g dry weight

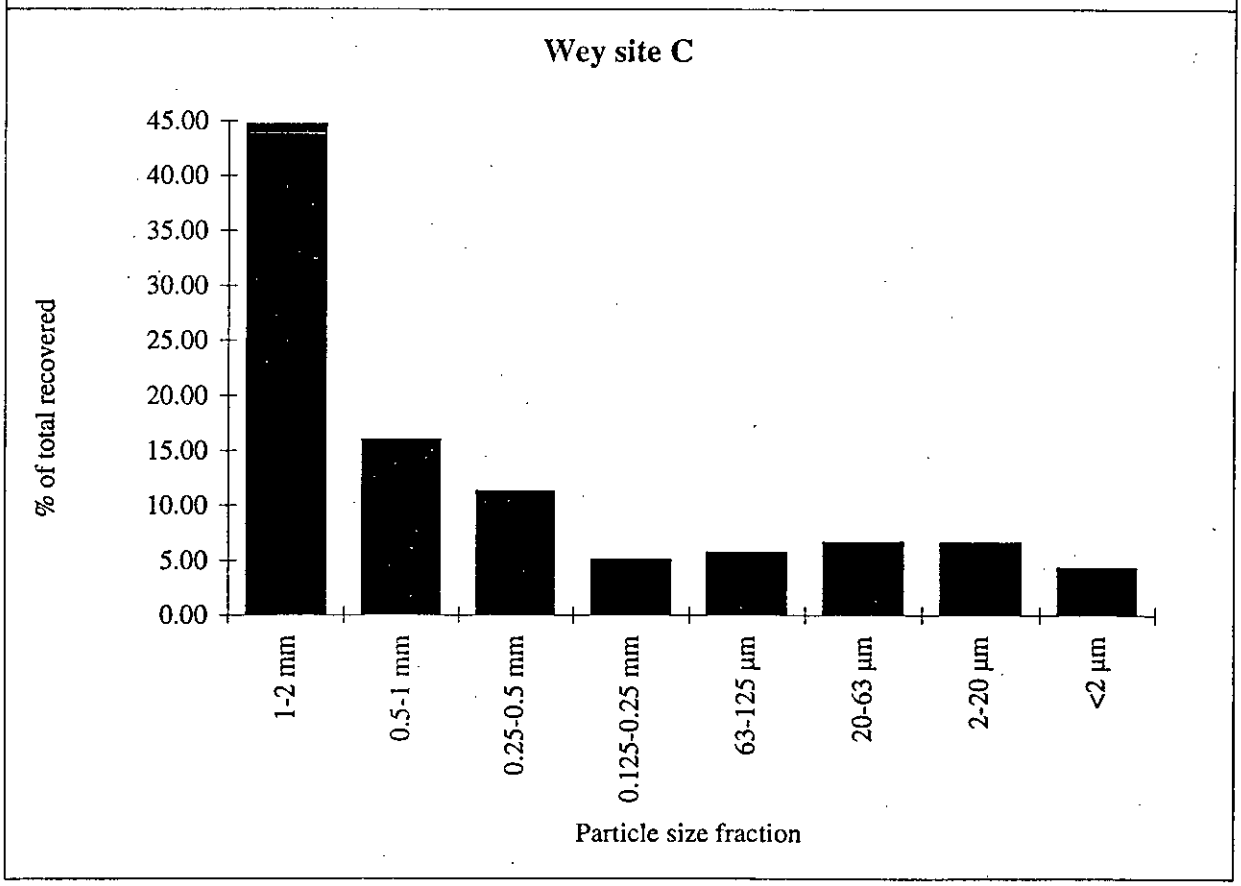
SRP OF WATER = 13.04 µmol/l
TDP OF WATER = 25.07 µmol/l
TP OF WATER = >200 µmol/l

EPCo = 5.279 µM
Kd = 64.26 dm^3/kg
ni = 0.339 µmol/g

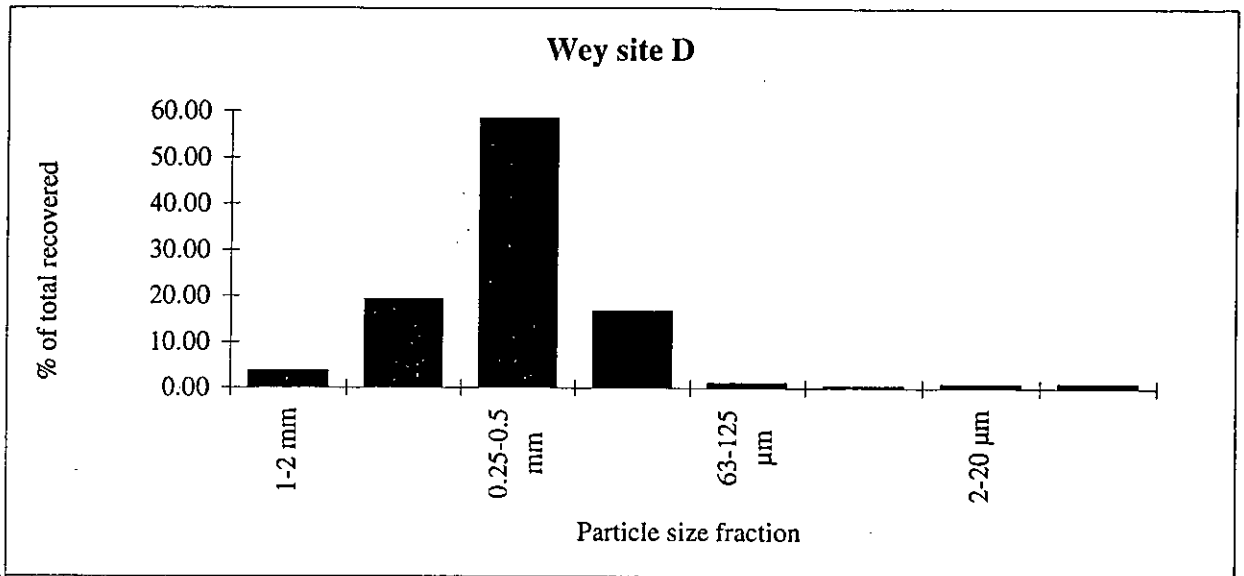


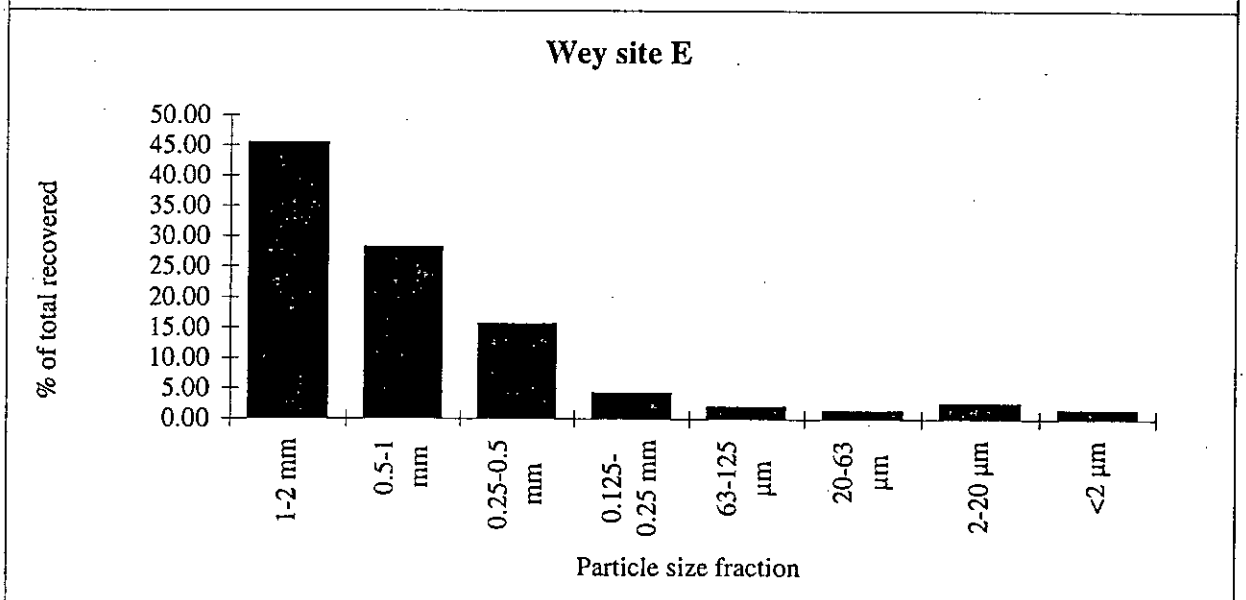
PARTICLE SIZE DISTRIBUTION OF RIVER WEY SEDIMENTS
SAMPLE DATE 13/2/95

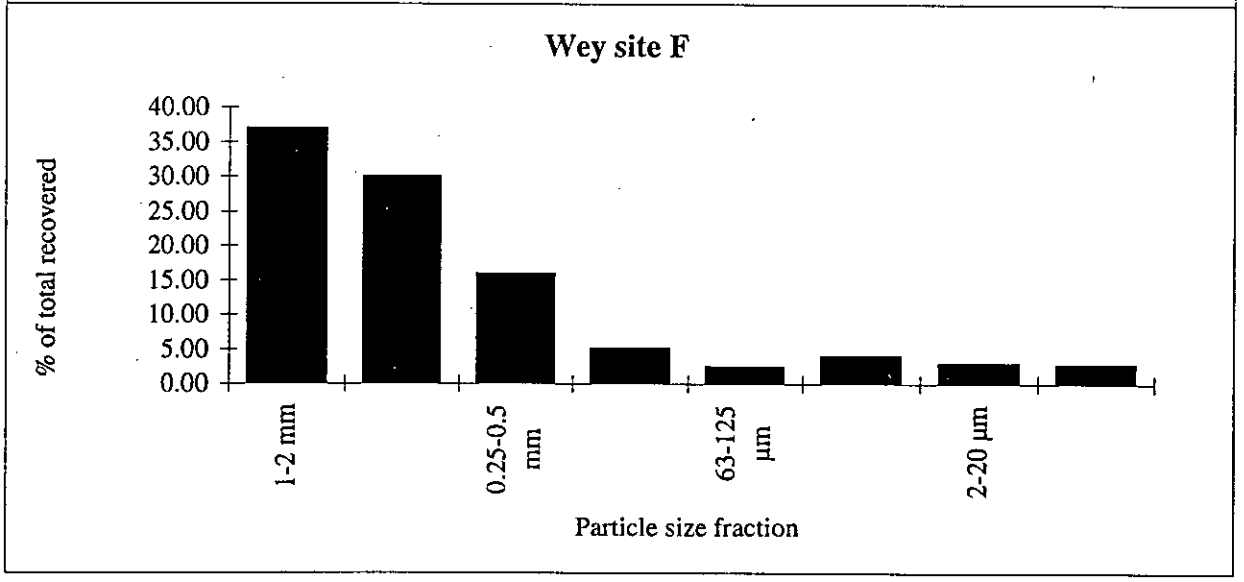




PARTICLE SIZE DISTRIBUTION OF RIVER WEY SEDIMENTS
SAMPLE DATE 13/2/95

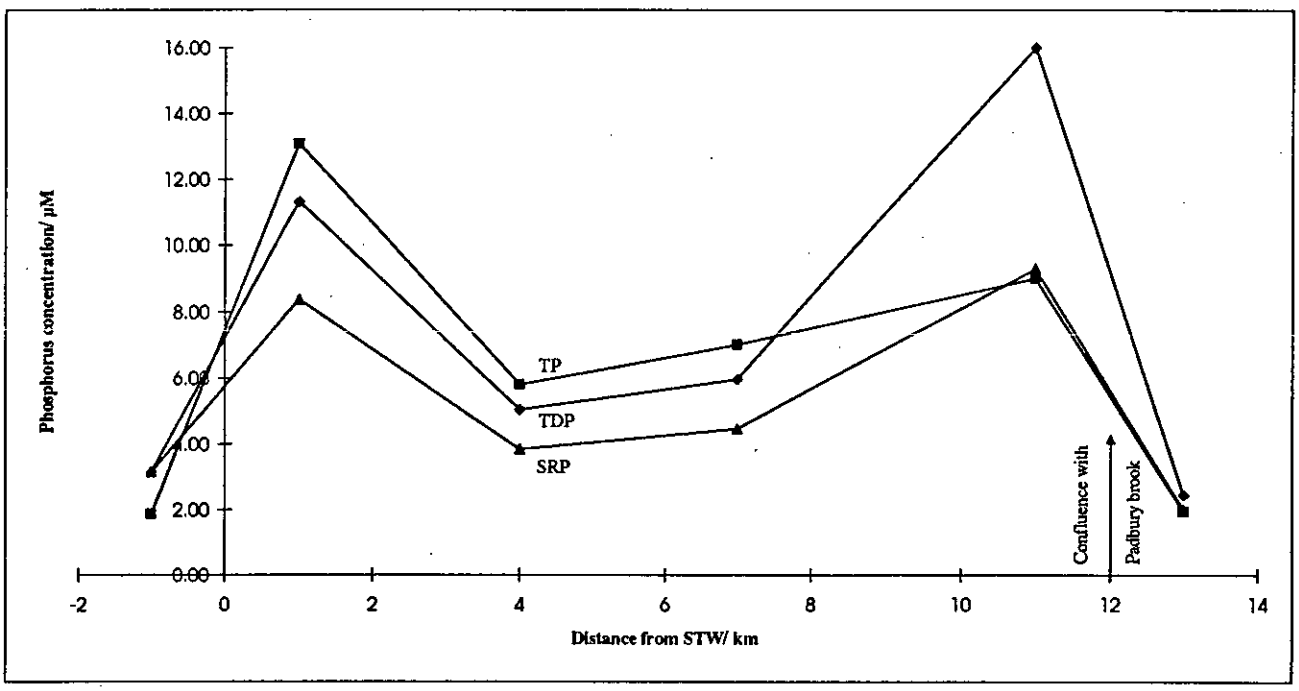






PILOT STUDY TO GT. OUSE
27-28/3/95

SITE	A	B	C	D	G	E (Padbury brook)	F
NGR of site	SP595 368	SP 602 358	SP 627 346	SP 652 341	SP 717 344	SP 713 315	SP 738 355
Distance from STW/ km	-1	1	4	7	11		13
pH	8.49	8.23	8.26	8.61	8.25	8.36	8.22
Conductivity (µS/cm)	835	893	845	820	805	800	783.00
Dissolved Oxygen (%)	113	94	93	116			
Temperature	7.5	4.4	4.4	7.6			
Flow (m^3/s)	0.17	0.82	0.80	1.14			
Filtered water (0.45 um)							
Ca++ (mM)	3.82	3.77	3.79	3.62	3.54	3.57	3.62
Mg++ (mM)	0.20	0.18	0.16	0.17	0.29	0.23	0.20
Na+ (mM)	0.68	0.88	0.70	0.69	1.02	1.01	0.83
K+ (mM)	0.074	0.115	0.084	0.087	0.136	0.118	0.169
Alkalinity (mM)	5.30	5.04	5.24	4.90	4.37	4.75	4.95
NO3- (mM)	0.84	0.99	0.93	0.94	0.89	0.82	0.78
Silica (µM)	92.9	82.6	62.0	61.6	15.3	27.1	37.4
Soluble Reactive Phosphorus (µM)	3.14	8.36	3.84	4.46	9.30	8.72	1.99
Total Dissolved Phosphorus (µM)	3.15	11.30	5.05	5.95	16.00	7.40	2.45
Non - MR Reactive fraction (µM)	0.01	2.94	1.21	1.49	6.70	-1.32	0.46
Unfiltered water							
Total Phosphorus (µM)	1.87	13.07	5.80	7.00	9.00	7.91	1.93
Particulate Phosphorus (µM)	-1.28	1.77	0.75	1.05	-7.00	0.51	-0.52
Suspended Solids (mg/l)	6.3	5.7	4.0	7.2			
Sediment sieved 2mm							
% water	25.20	23.41	19.68	22.83			
Organic Matter (% of dry wt)	2.56	2.97	1.96	2.37			
Total Phosphorus (µmol/g)	2.84	4.31	4.98	3.87			
Total Calcium (µmol/g)	1320	2407	2756	1336			
Total Iron (µmol/g)	480.5	485.8	785.5	212.6			
Bioavailable Phosphorus (µmol/g)	1.49	2.51	1.65	2.23			
Equilibrium Phosphorus Concentration (µM)	0.85	2.29	3.70	2.78			
Kd (dm^3/kg)	193.5	240.5	55.5	96.3			
ni (µmol/g)	0.165	0.552	0.206	0.268			

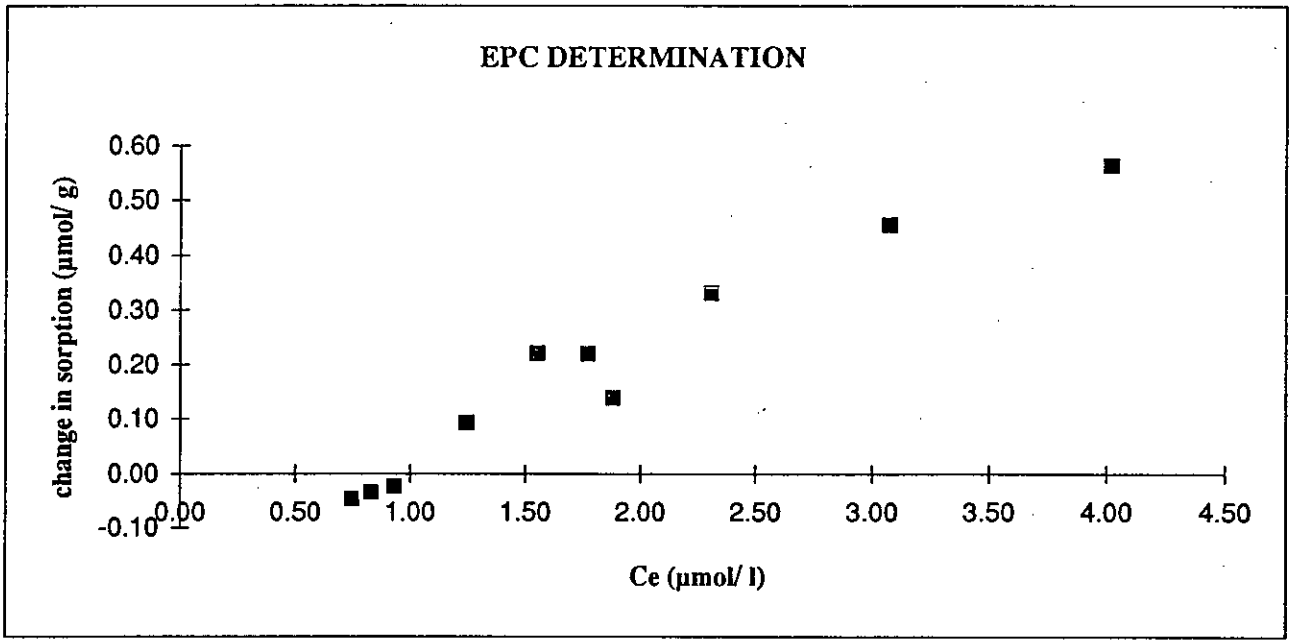


SITE A GREAT OUSE. SEDIMENT & WATER COLLECTED 27-8/3/95

EPCo DETERMINATION: ANALYSIS 30/3/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.58	1.93	0	2.19	-0.23
2.15	1.61	5	7.63	-0.33
2.84	2.13	10	4.02	0.56
4.29	3.21	0	0.75	-0.05
4.19	3.13	5	1.55	0.22
4.07	3.05	10	3.08	0.45
6.18	4.62	0	0.83	-0.04
6.03	4.51	5	1.88	0.14
6.23	4.66	10	2.31	0.33
10.35	7.74	0	0.93	-0.02
10.87	8.13	5	1.25	0.09
10.04	7.51	10	1.77	0.22

% WATER OF SEDIMENT = 25.20
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.56 %
TOTAL PHOSPHORUS OF SEDIMENT = 2.84 µmol/ g

SRP OF WATER = 3.14 µmol/ l
TDP OF WATER = 3.15 µmol/ l
TP OF WATER = 1.87 µmol/ l
EPCo = 0.85 µM
Kd = 193.5 l/kg
ni = 0.16 µmol/g

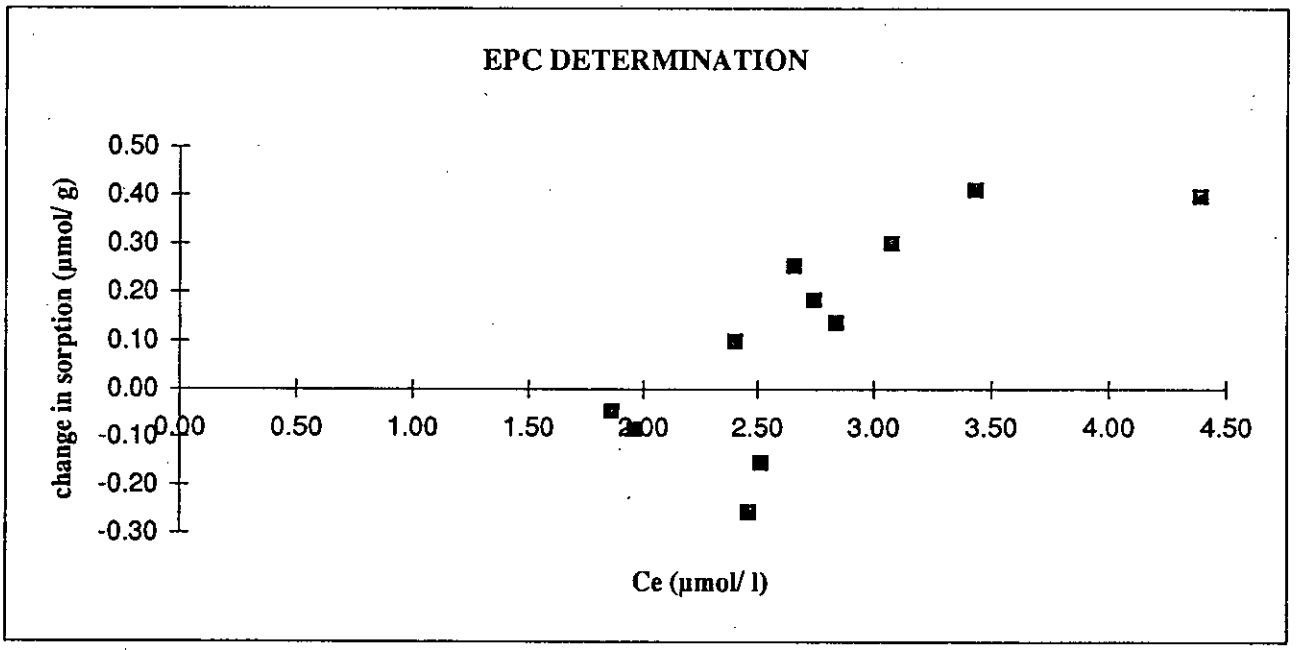


SITE B GREAT OUSE. SEDIMENT & WATER COLLECTED 27-8/3/95

EPCo DETERMINATION: ANALYSIS 30/3/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.49	1.91	0	2.46	-0.26
2.41	1.85	5	2.66	0.25
4.23	3.24	0	2.52	-0.16
4.14	3.17	5	2.84	0.14
4.18	3.20	10	3.43	0.41
6.06	4.64	0	1.96	-0.08
6.87	5.26	5	2.40	0.10
6.04	4.62	10	3.07	0.30
10.31	7.90	0	1.86	-0.05
10.39	7.96	10	2.75	0.18
10.29	7.88	20	4.39	0.40

% WATER OF SEDIMENT = 23.41
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.97 %
TOTAL PHOSPHORUS OF SEDIMENT = 4.31 µmol/ g

SRP OF WATER = 8.36 µmol/ l
TDP OF WATER = 11.30 µmol/ l
TP OF WATER = 13.07 µmol/ l
EPCo = 2.29 µM
Kd = 240.5 l/kg
ni = 0.552 µmol/g

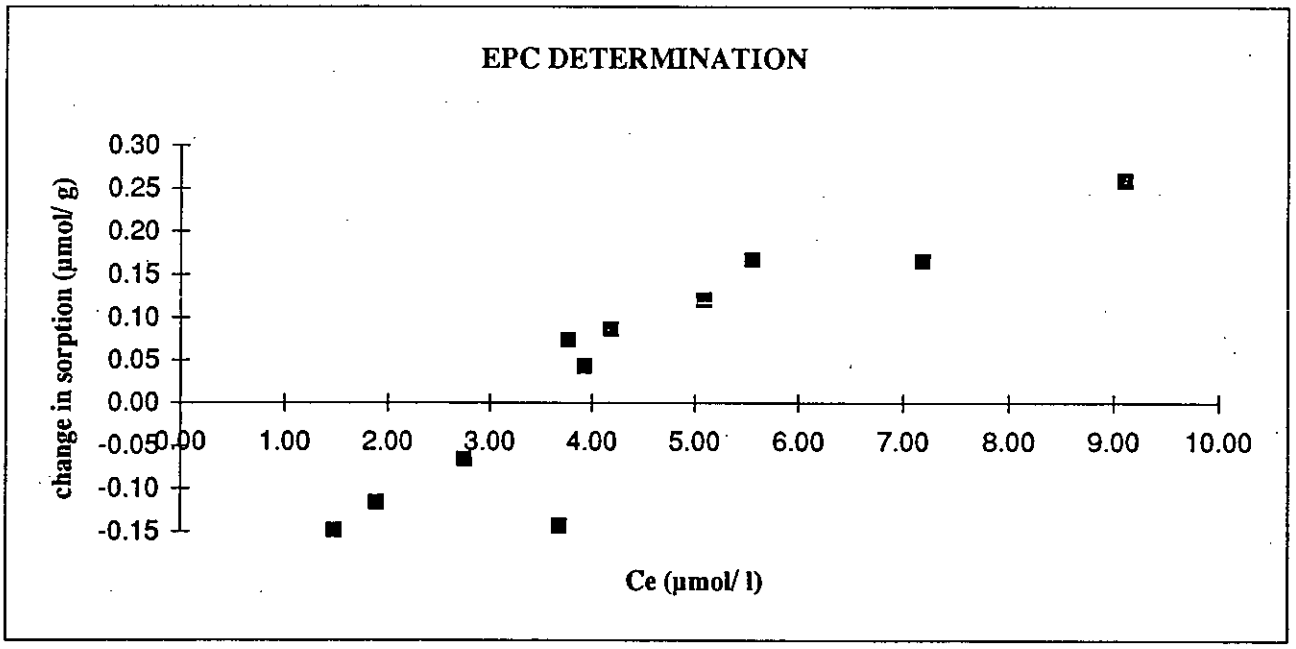


SITE C GREAT OUSE. SEDIMENT & WATER COLLECTED 27-8/3/95

EPCo DETERMINATION: ANALYSIS 30/3/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.47	1.98	0	1.48	-0.15
2.37	1.90	5	4.18	0.09
4.03	3.24	0	1.89	-0.12
4.19	3.37	5	3.76	0.07
4.23	3.39	10	7.18	0.17
6.40	5.14	0	3.68	-0.14
6.23	5.00	5	3.93	0.04
6.61	5.31	10	5.56	0.17
10.36	8.32	0	2.76	-0.07
10.19	8.18	10	5.09	0.12
10.48	8.41	20	9.11	0.26

% WATER OF SEDIMENT = 19.68
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.96 %
TOTAL PHOSPHORUS OF SEDIMENT = 4.98 µmol/ g

SRP OF WATER = 3.84 µmol/ l
TDP OF WATER = 5.05 µmol/ l
TP OF WATER = 5.80 µmol/ l
EPCo = 3.70 µM
Kd = 55.5 l/kg
ni = 0.206 µmol/g

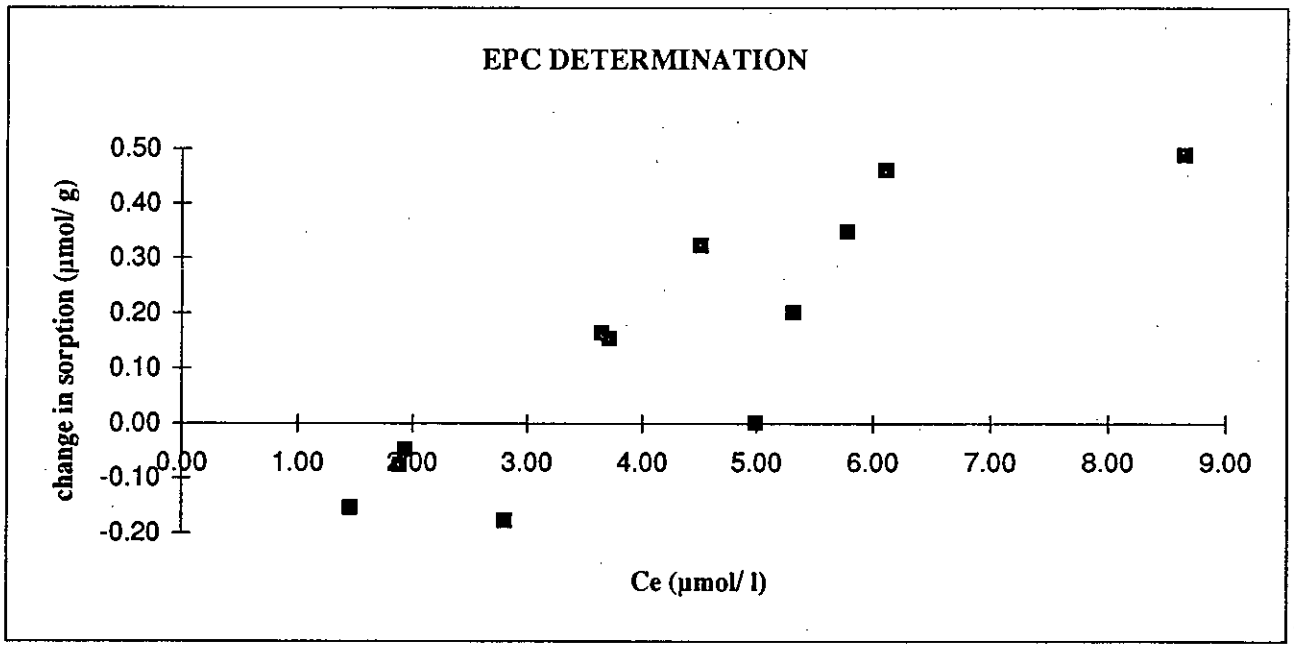


SITE D GREAT OUSE. SEDIMENT & WATER COLLECTED 27-8/3/95

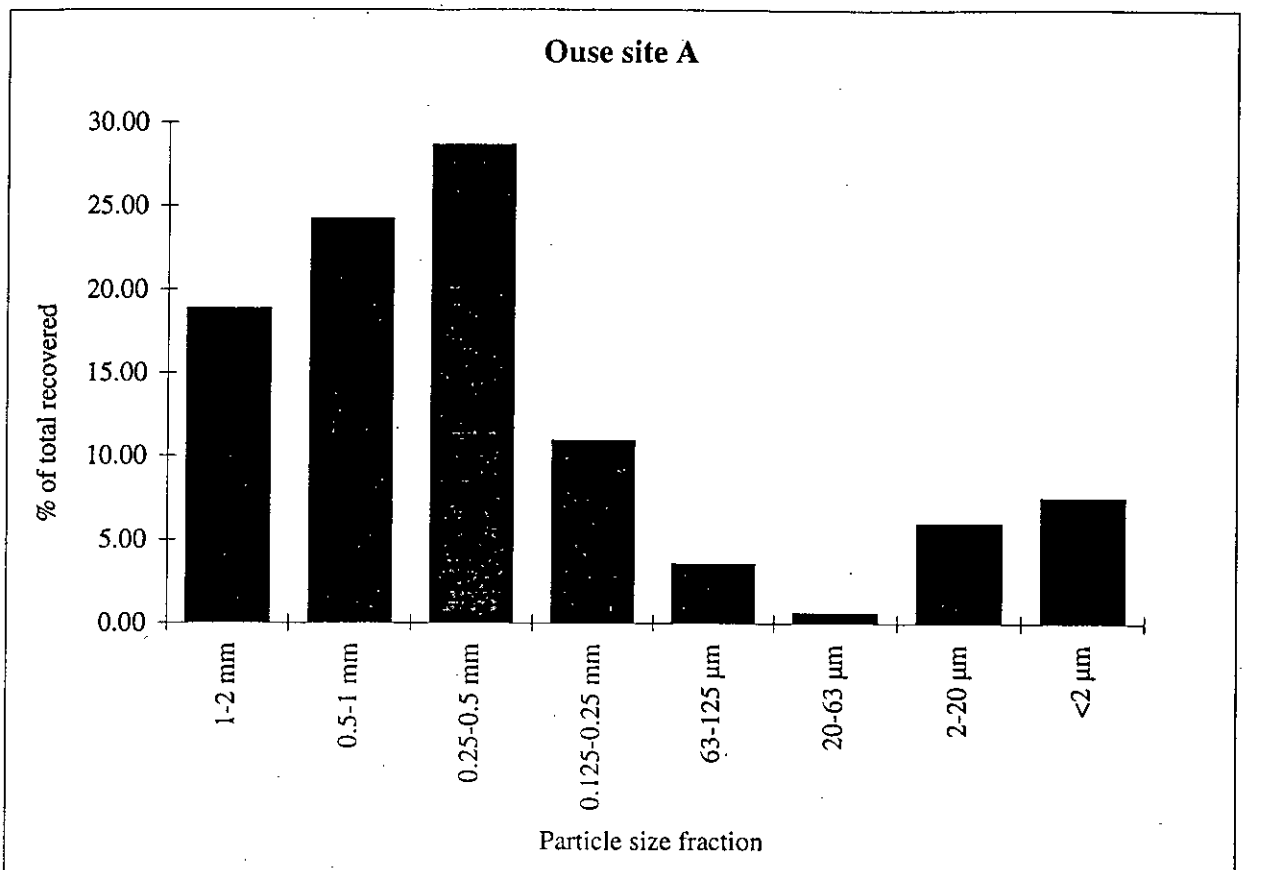
EPCo DETERMINATION: ANALYSIS 30/3/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.45	1.89	0	1.46	-0.15
2.13	1.64	5	3.65	0.16
2.19	1.69	10	6.11	0.46
4.10	3.16	0	2.81	-0.18
4.60	3.55	5	5.00	0.00
4.42	3.41	10	4.51	0.32
6.43	4.96	0	1.89	-0.08
6.03	4.65	10	5.32	0.20
6.03	4.65	20	8.65	0.49
10.37	8.01	0	1.94	-0.05
10.60	8.18	10	3.72	0.15
10.58	8.17	20	5.78	0.35

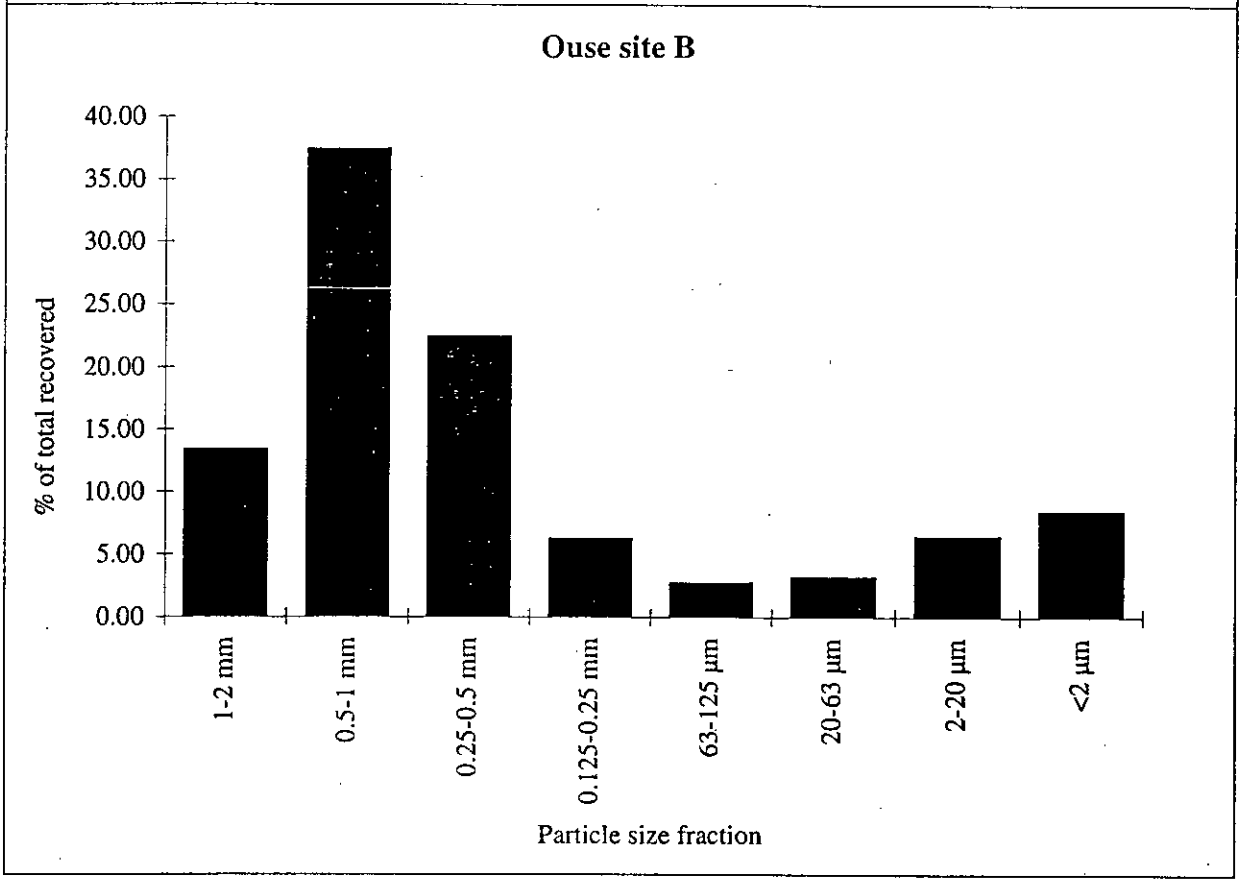
% WATER OF SEDIMENT = 22.83
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.37 %
TOTAL PHOSPHORUS OF SEDIMENT = 3.87 µmol/ g

SRP OF WATER = 4.46 µmol/ l
TDP OF WATER = 5.95 µmol/ l
TP OF WATER = 7.00 µmol/ l
EPCo = 2.78 µM
Kd = 96.3 l/kg
ni = 0.268 µmol/g

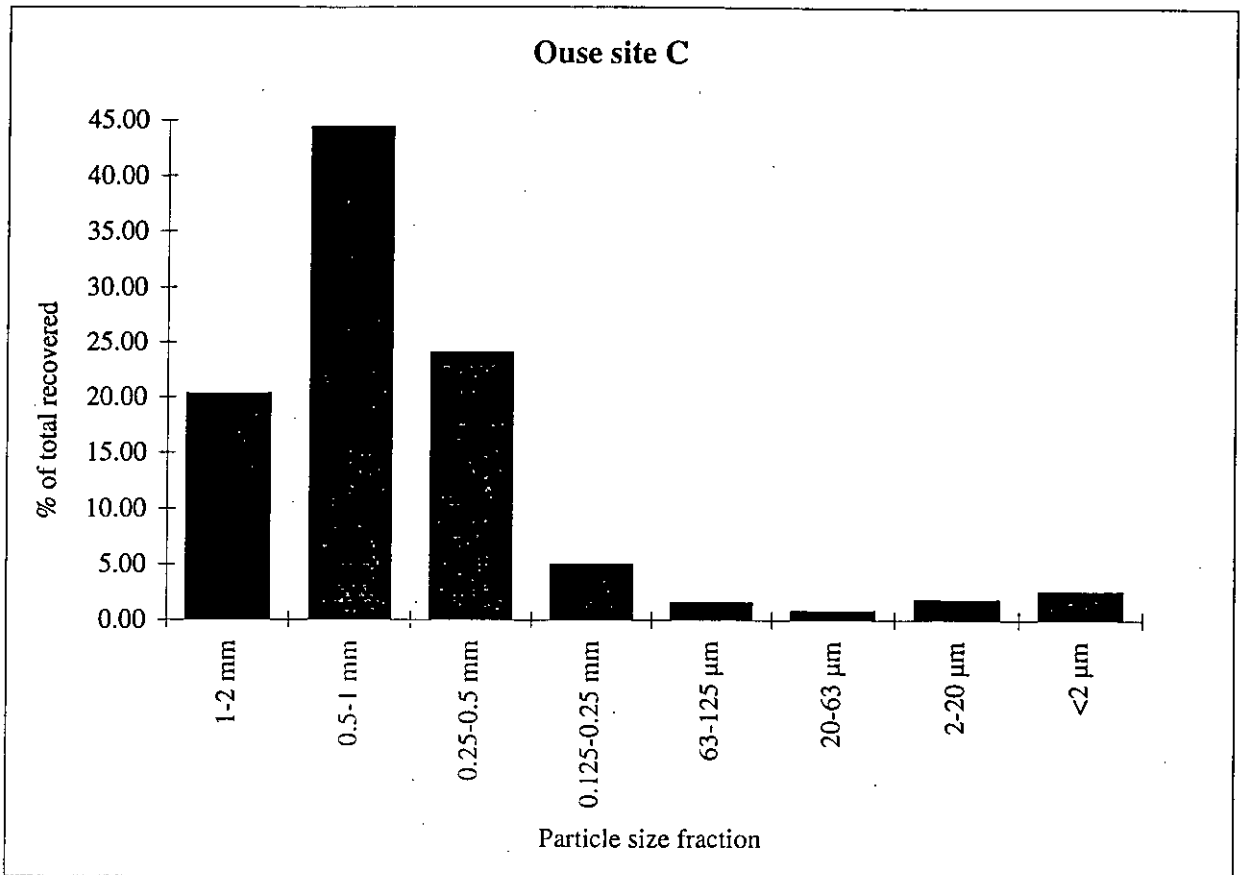


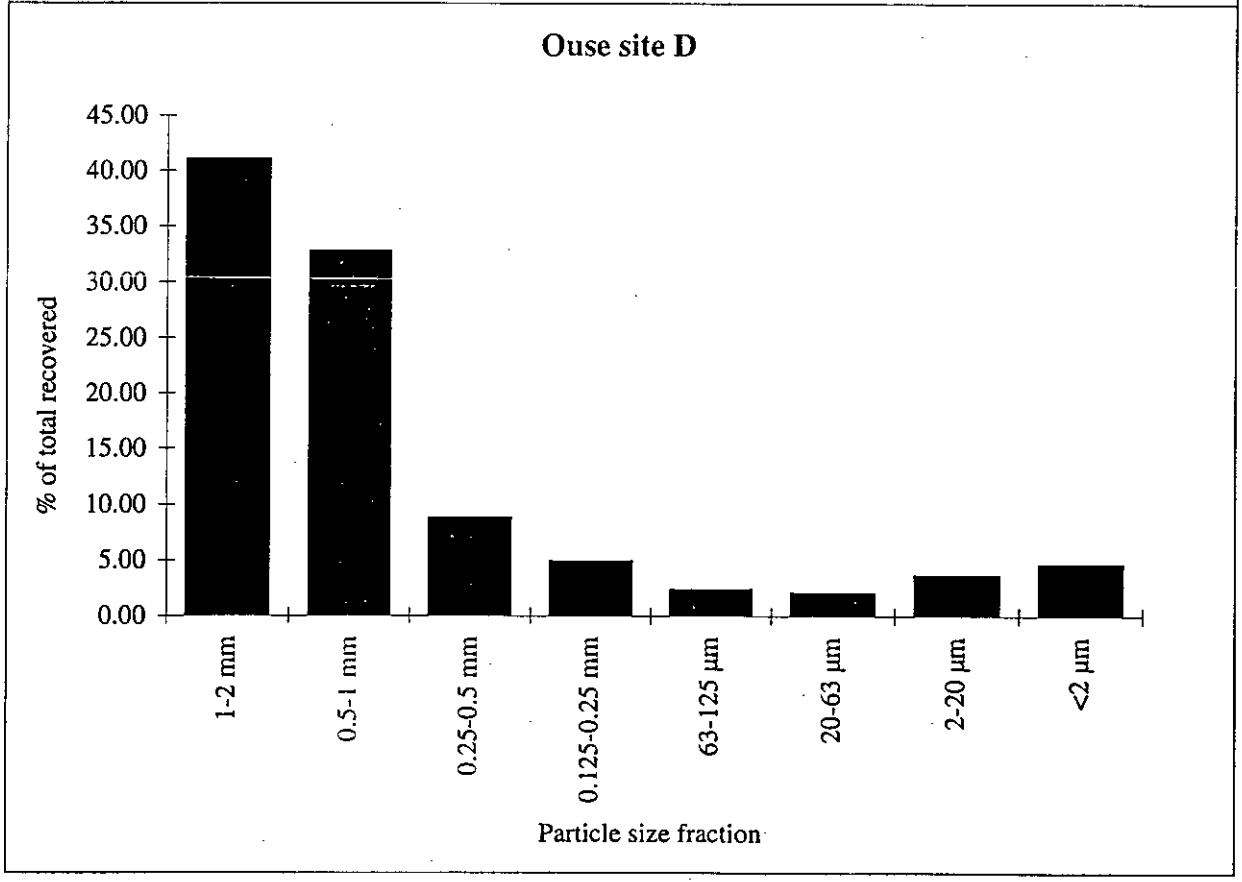
PARTICLE SIZE DISTRIBUTION OF Gt. OUSE SEDIMENTS
SAMPLE DATE 27-8/3/95





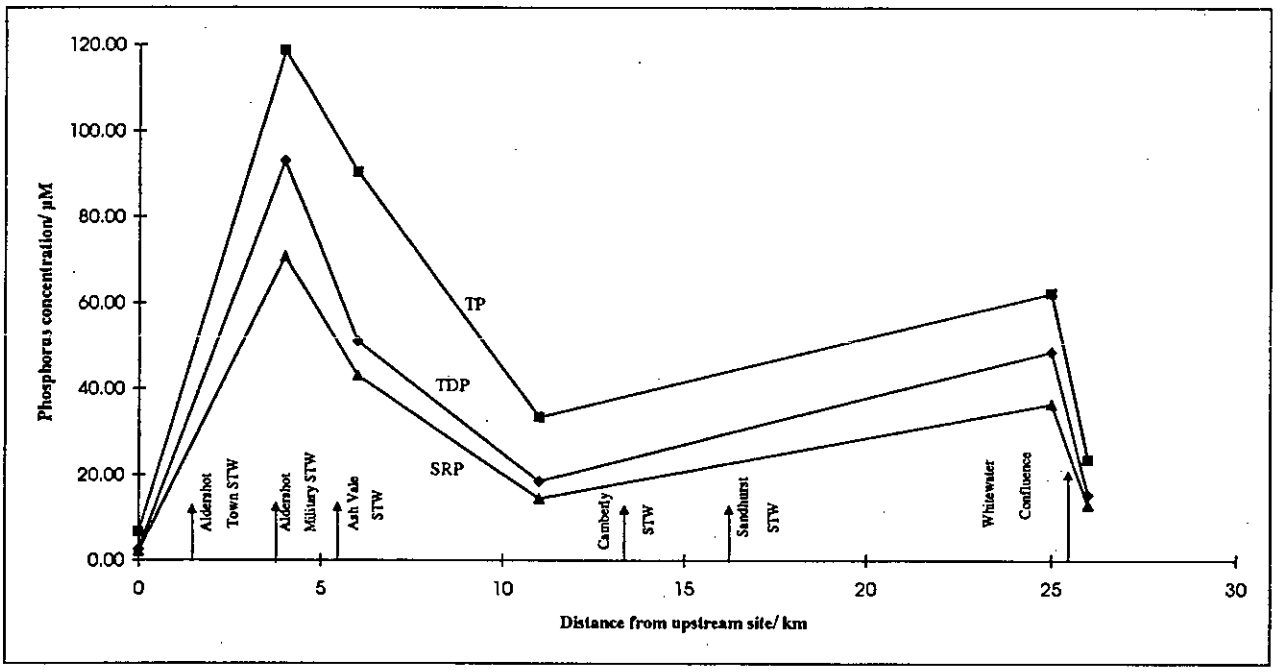
PARTICLE SIZE DISTRIBUTION OF Gt. OUSE SEDIMENTS
SAMPLE DATE 27-8/3/95





PILOT STUDY TO RIVER BLACKWATER
04/10/95

SITE	A	B	C	D	E	G (Whitewater)	F
NGR of site	SU 882 499	SU 885 538	SU 880 559	SU 859 594	SU 742 634	SU 742 635	SU 740 638
Distance from upstream site/ km	0	4	6	11	25		26
pH	7.68	7.68	7.92	8.58			
Conductivity (µS/cm)	559	830	808	649			
Dissolved Oxygen (%)	61	153	152	173			
Temperature	10.8	14.2	16.4	15.2			
Flow (m^3/s)	0.01	0.24	0.35	0.60			
Filtered water (0.45 µm)							
Ca++ (mM)	1.91	2.21	1.93	1.83	1.98	2.09	2.40
Mg++ (mM)	0.30	0.35	0.32	0.27	0.31	0.28	0.16
Na+ (mM)	1.08	2.56	2.78	1.69	1.92	1.68	0.75
K+ (mM)	0.102	0.284	0.273	0.211	0.251	0.234	0.079
Alkalinity (mM)	3.22	3.57	3.42	2.30	2.53	2.64	3.70
NO3- (mM)	0.13	0.51	0.38	0.31	0.45	0.46	0.49
Silica (µM)	55	231	217	176	184	181	133
Soluble Reactive Phosphorus (µM)	2.13	70.70	42.94	14.37	36.48	34.22	12.98
Total Dissolved Phosphorus (µM)	2.60	93.00	51.00	18.40	48.60	51.00	15.30
Non - MR Reactive fraction (µM)	0.47	22.30	8.06	4.03	12.12	16.78	2.32
Unfiltered water							
Total Phosphorus (µM)	6.55	118.5	90.25	33.3	62.2	58.8	23.5
Particulate Phosphorus (µM)	3.95	25.50	39.25	14.90	13.60	7.80	8.20
Suspended Solids (mg/l)	6.4	13.8	15.4	10.7			
Sediment sieved 2mm							
% water	19.60	45.31	20.09	22.57			
Organic Matter (% of dry wt)	2.08	5.44	1.04	0.97			
Total Phosphorus (µmol/g)	7.54	16.95	27.73	19.60			
Total Calcium (µmol/g)	287.1	167.8	79.0	51.3			
Total Iron (µmol/g)	699.6	439.3	321.0	300.6			
Bioavailable Phosphorus (µmol/g)	1.20	9.35	13.98	15.56			
Equilibrium Phosphorus Concentration (µM)	0.77	3.14	4.78	7.73			
Kd (dm^3/kg)	502.8	928.8	135.7	88.1			
ni (µmol/g)	0.386	2.921	0.649	0.681			

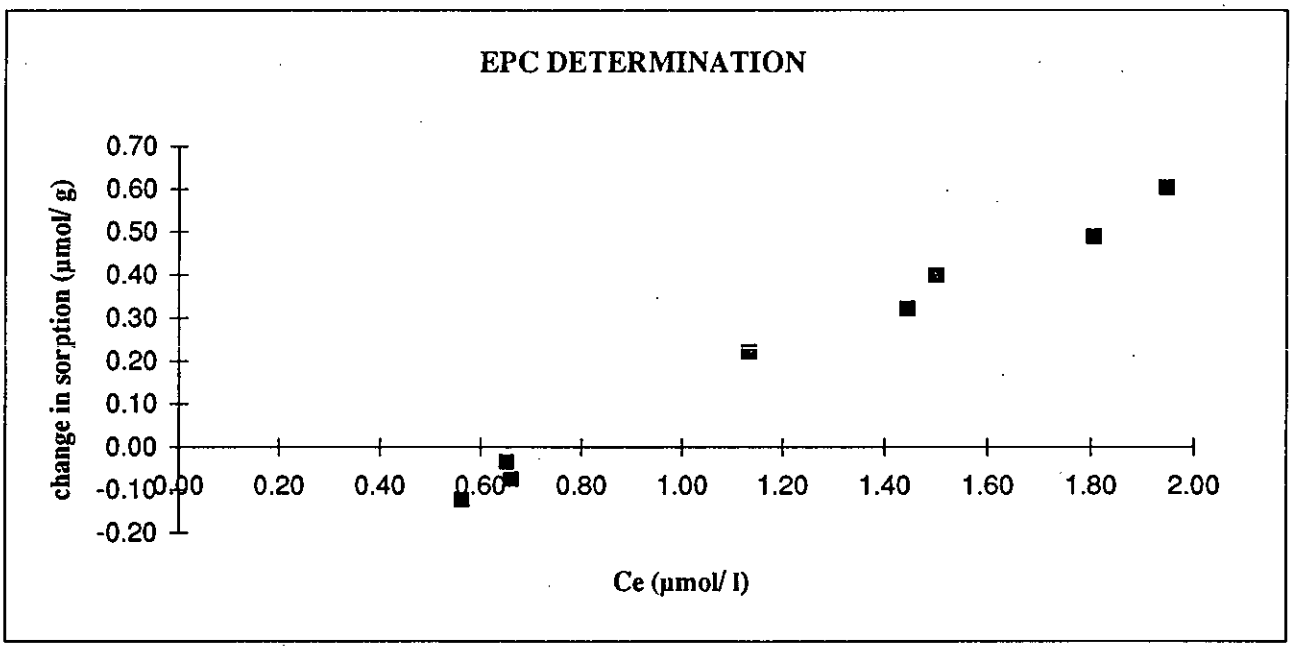


SITE A BLACKWATER. SEDIMENT & WATER COLLECTED 10/4/95

EPCo DETERMINATION: ANALYSIS 27/4/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
1.13	0.91	0	0.56	-0.12
1.26	1.01	5	1.95	0.60
1.47	1.18	10	4.63	0.91
2.14	1.72	0	0.66	-0.08
2.19	1.76	5	1.50	0.40
2.29	1.84	10	2.97	0.76
4.51	3.62	0	0.65	-0.04
4.34	3.49	5	1.14	0.22
4.19	3.37	10	1.81	0.49
6.63	5.33	10	1.45	0.32

% WATER OF SEDIMENT = 19.60
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.08 %
TOTAL PHOSPHORUS OF SEDIMENT = 7.54 µmol/ g

SRP OF WATER = 2.13 µmol/ l
TDP OF WATER = 2.60 µmol/ l
TP OF WATER = 6.55 µmol/ l
EPCo = 0.77 µM
Kd = 502.8 l/kg
ni = 0.386 µmol/g

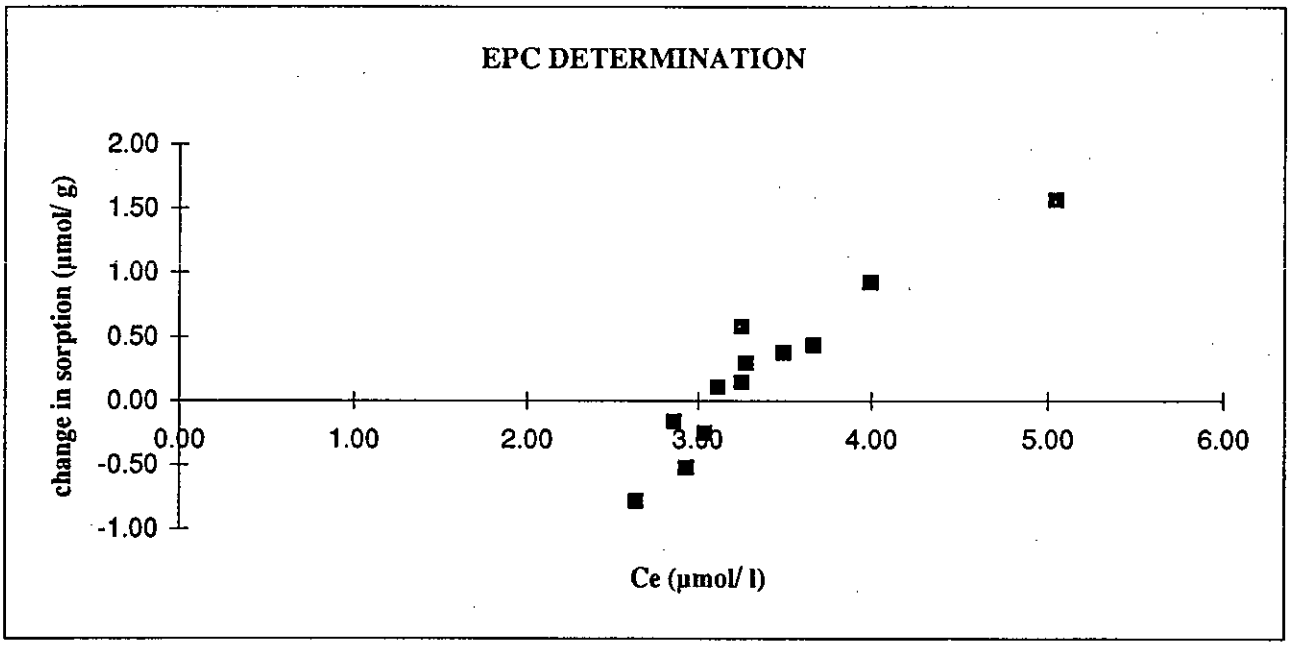


SITE B BLACKWATER. SEDIMENT & WATER COLLECTED 10/4/95

EPCo DETERMINATION: ANALYSIS 27/4/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
1.23	0.67	0	2.64	-0.78
1.12	0.61	5	3.67	0.43
1.16	0.63	10	5.05	1.56
2.03	1.11	0	2.93	-0.53
2.13	1.16	5	3.28	0.30
2.39	1.30	10	4.00	0.92
4.32	2.36	0	3.04	-0.26
4.41	2.41	5	3.26	0.14
4.29	2.34	10	3.26	0.58
6.33	3.46	0	2.86	-0.17
6.59	3.61	5	3.12	0.10
6.42	3.51	10	3.50	0.37

% WATER OF SEDIMENT = 45.31
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 5.44 %
TOTAL PHOSPHORUS OF SEDIMENT = 16.95 µmol/ g

SRP OF WATER = 70.70 µmol/ l
TDP OF WATER = 93.00 µmol/ l
TP OF WATER = 118.5 µmol/ l
EPCo = 3.14 µM
Kd = 928.8 l/kg
ni = 2.921 µmol/g

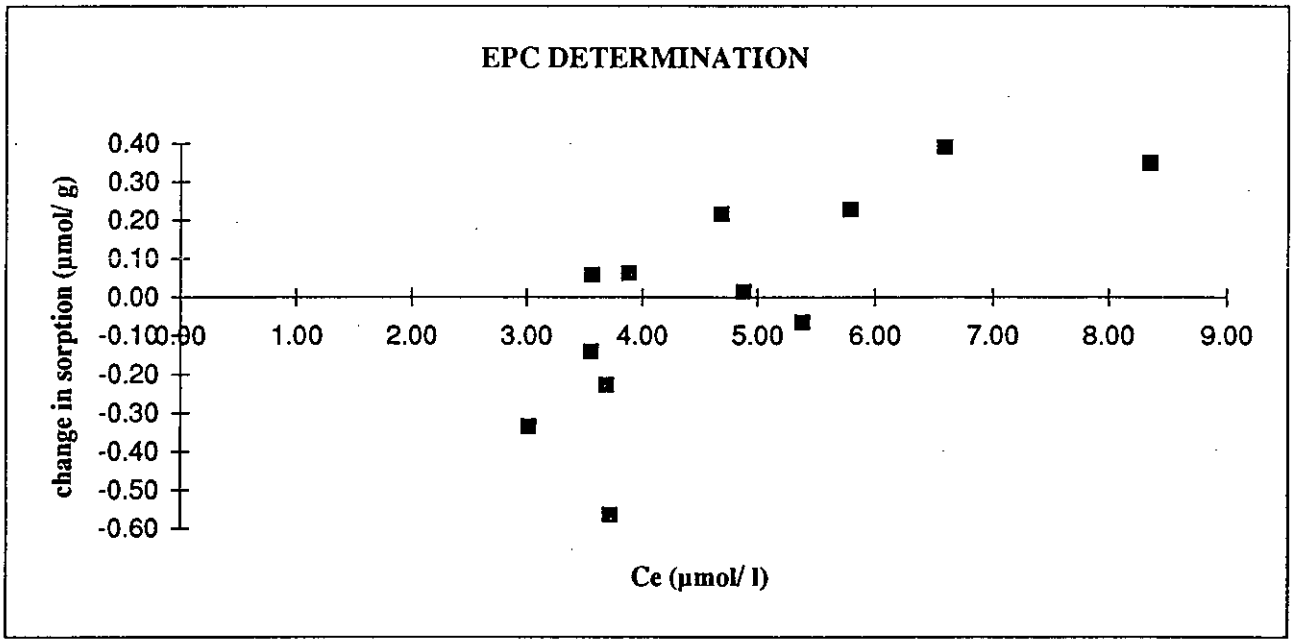


SITE C BLACKWATER. SEDIMENT & WATER COLLECTED 10/4/95

EPCo DETERMINATION: ANALYSIS 27/4/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
1.65	1.32	0	3.73	-0.57
1.45	1.16	5	5.39	-0.07
1.19	0.95	10	8.35	0.35
2.25	1.80	0	3.02	-0.34
2.08	1.66	5	4.88	0.01
2.19	1.75	10	6.59	0.39
4.04	3.23	0	3.70	-0.23
4.50	3.60	5	3.89	0.06
4.64	3.70	10	5.79	0.23
6.25	4.99	0	3.56	-0.14
6.34	5.07	5	3.57	0.06
6.16	4.92	10	4.69	0.22

% WATER OF SEDIMENT = 20.09
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.04 %
TOTAL PHOSPHORUS OF SEDIMENT = 27.73 µmol/ g

SRP OF WATER = 42.94 µmol/ l
TDP OF WATER = 51.00 µmol/ l
TP OF WATER = 90.25 µmol/ l
EPCo = 4.78 µM
Kd = 135.7 l/kg
ni = 0.649 µmol/g

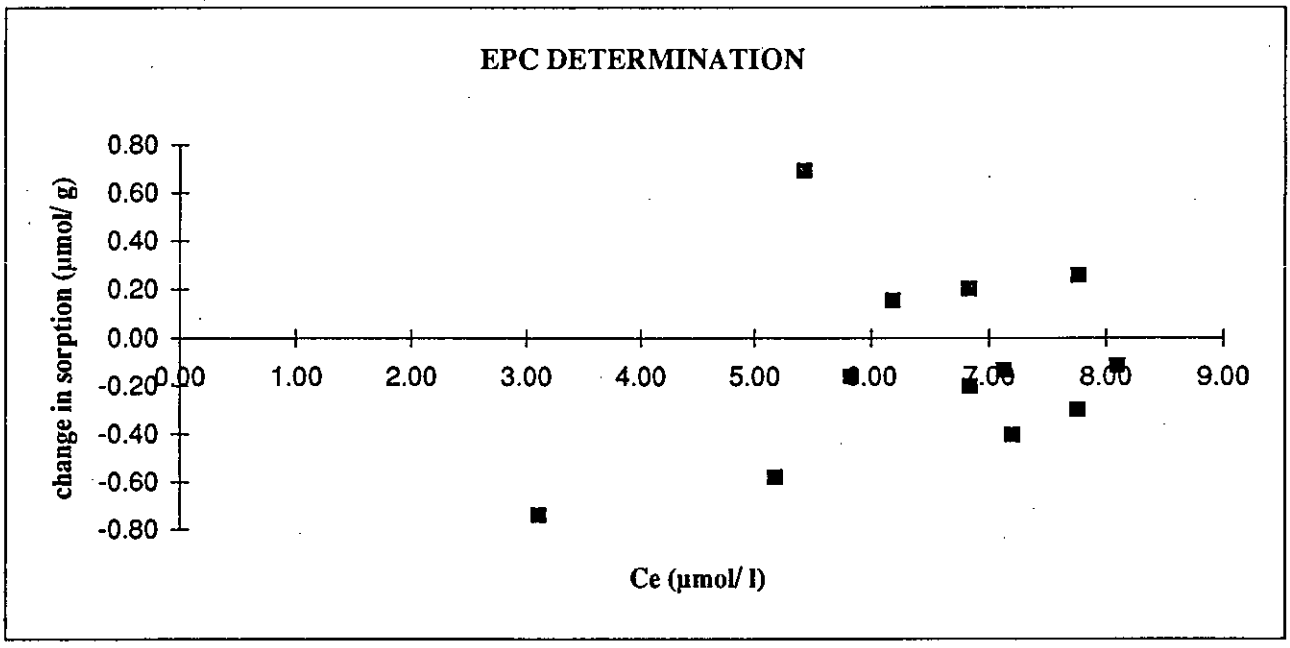


SITE D BLACKWATER. SEDIMENT & WATER COLLECTED 10/4/95

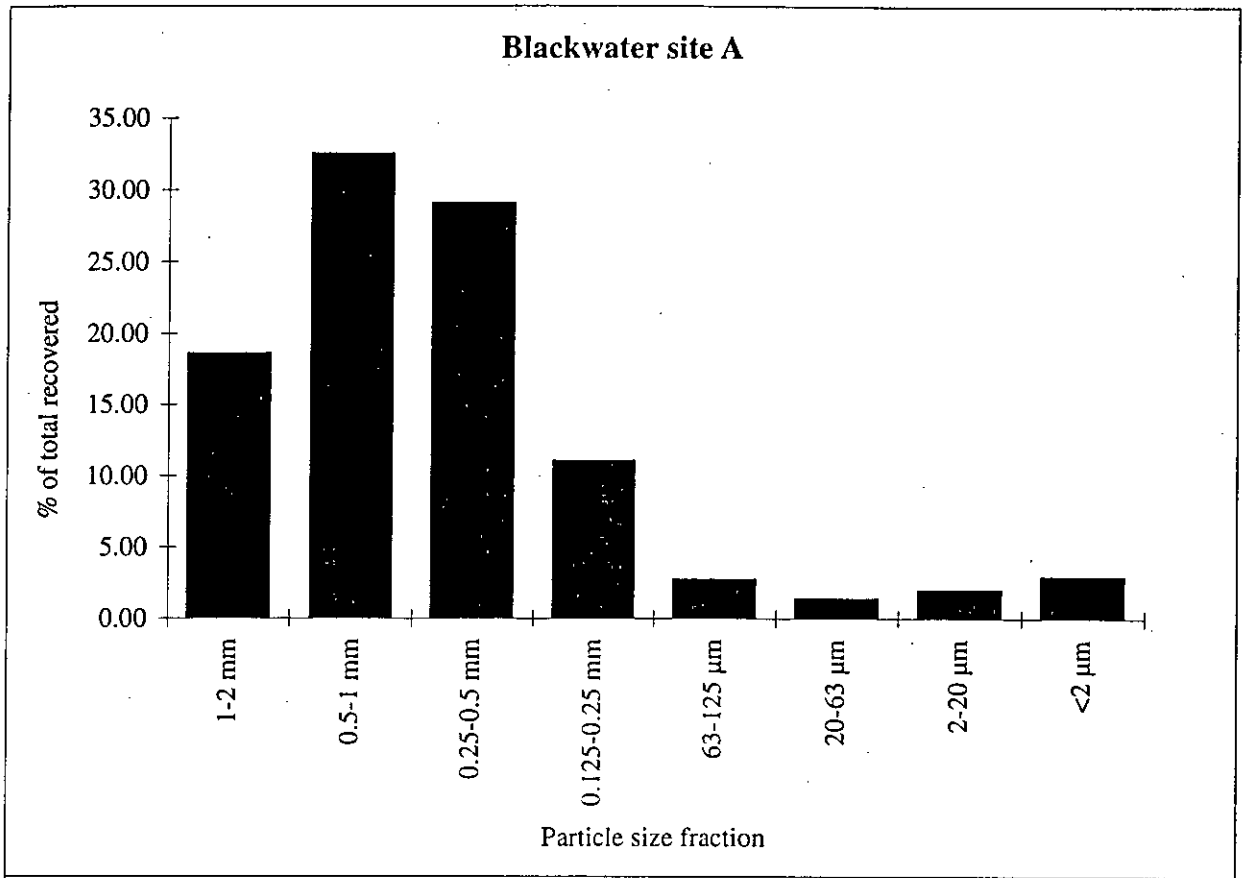
EPCo DETERMINATION: ANALYSIS 27/4/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
1.08	0.84	0	3.11	-0.74
1.31	1.02	5	5.83	-0.16
1.71	1.32	10	5.43	0.69
2.31	1.79	0	5.19	-0.58
2.35	1.82	5	6.85	-0.20
2.25	1.74	10	7.77	0.26
4.60	3.56	0	7.20	-0.40
4.01	3.11	5	7.13	-0.14
4.04	3.13	10	6.84	0.20
6.64	5.14	0	7.76	-0.30
6.73	5.21	5	8.10	-0.12
6.38	4.94	10	6.19	0.15

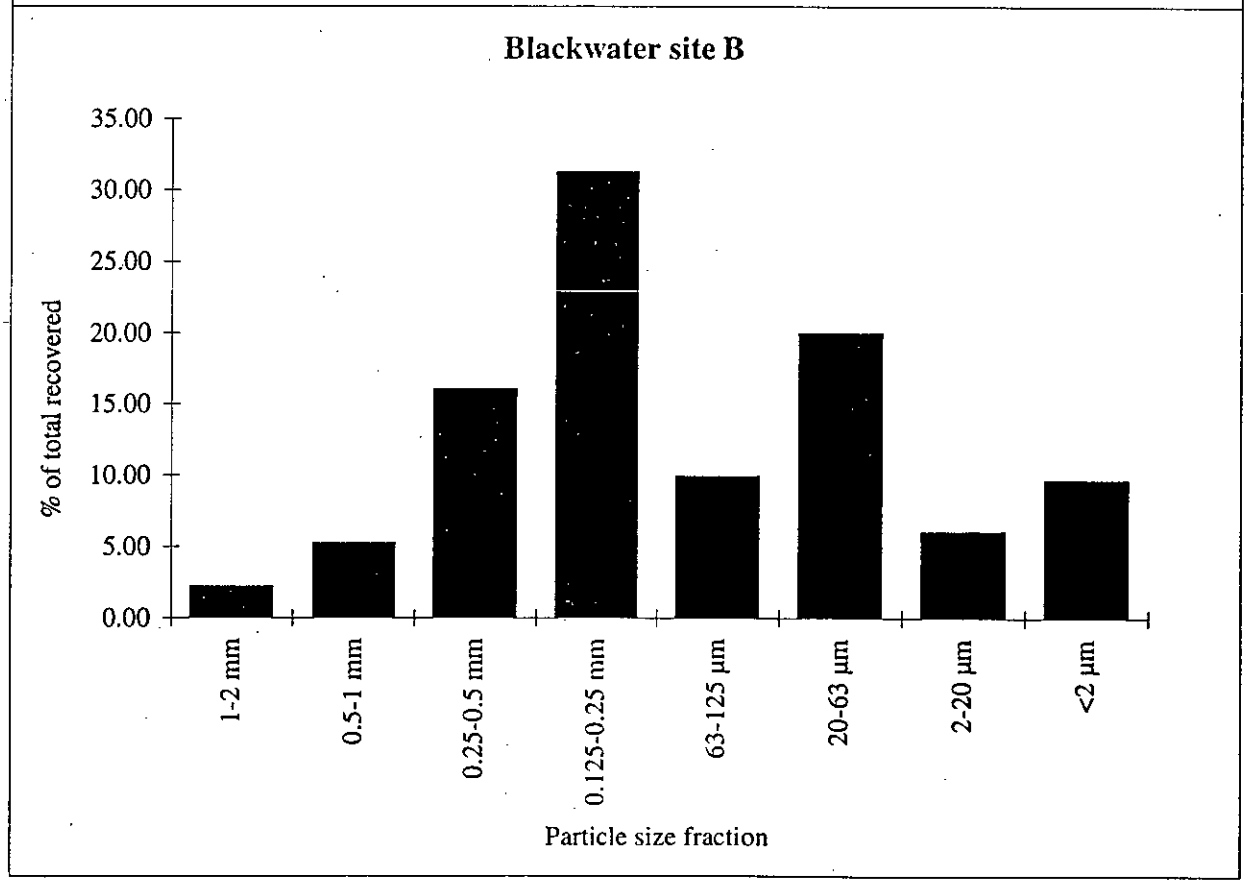
% WATER OF SEDIMENT = 22.57
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 0.97 %
TOTAL PHOSPHORUS OF SEDIMENT = 19.60 µmol/ g

SRP OF WATER = 14.37 µmol/ l
TDP OF WATER = 18.40 µmol/ l
TP OF WATER = 33.30 µmol/ l
EPCo = 7.73 µM
Kd = 88.1 l/kg
ni = 0.681 µmol/g

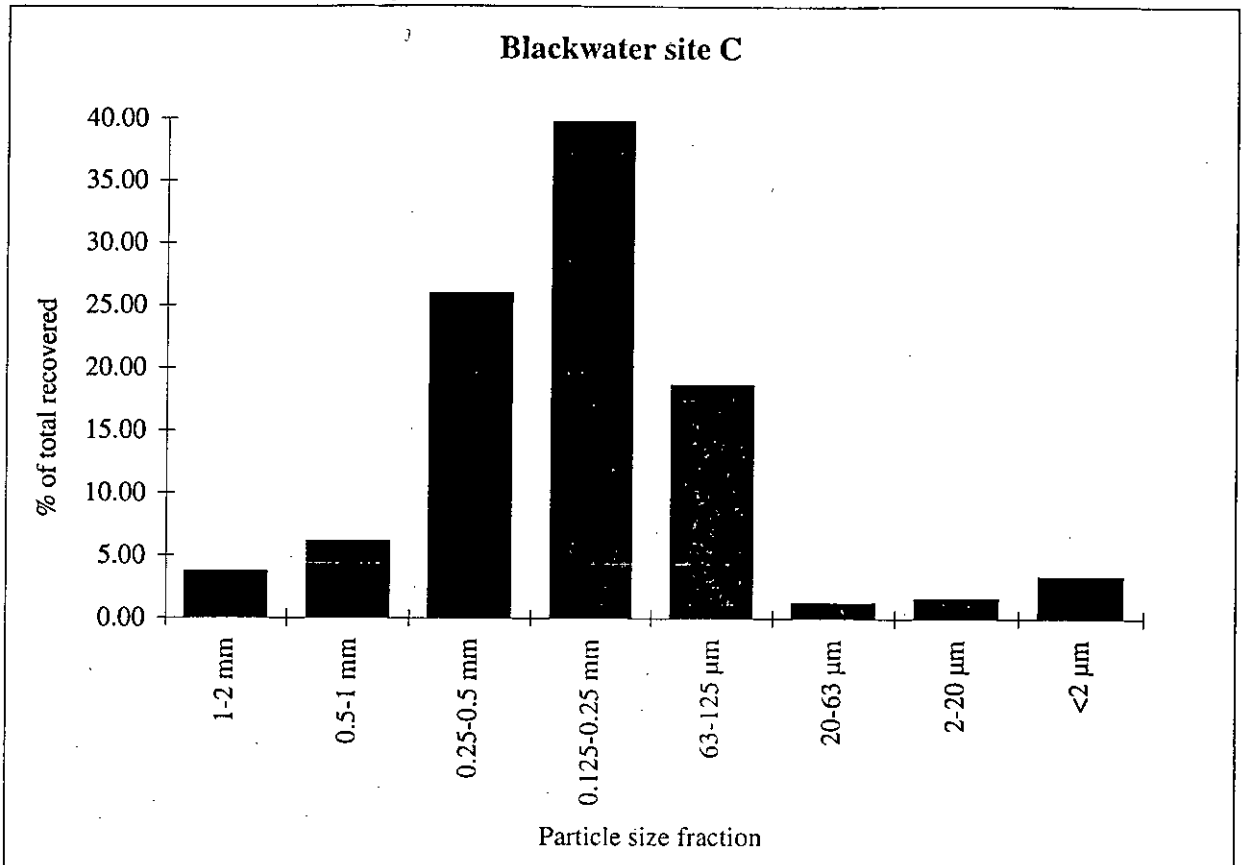


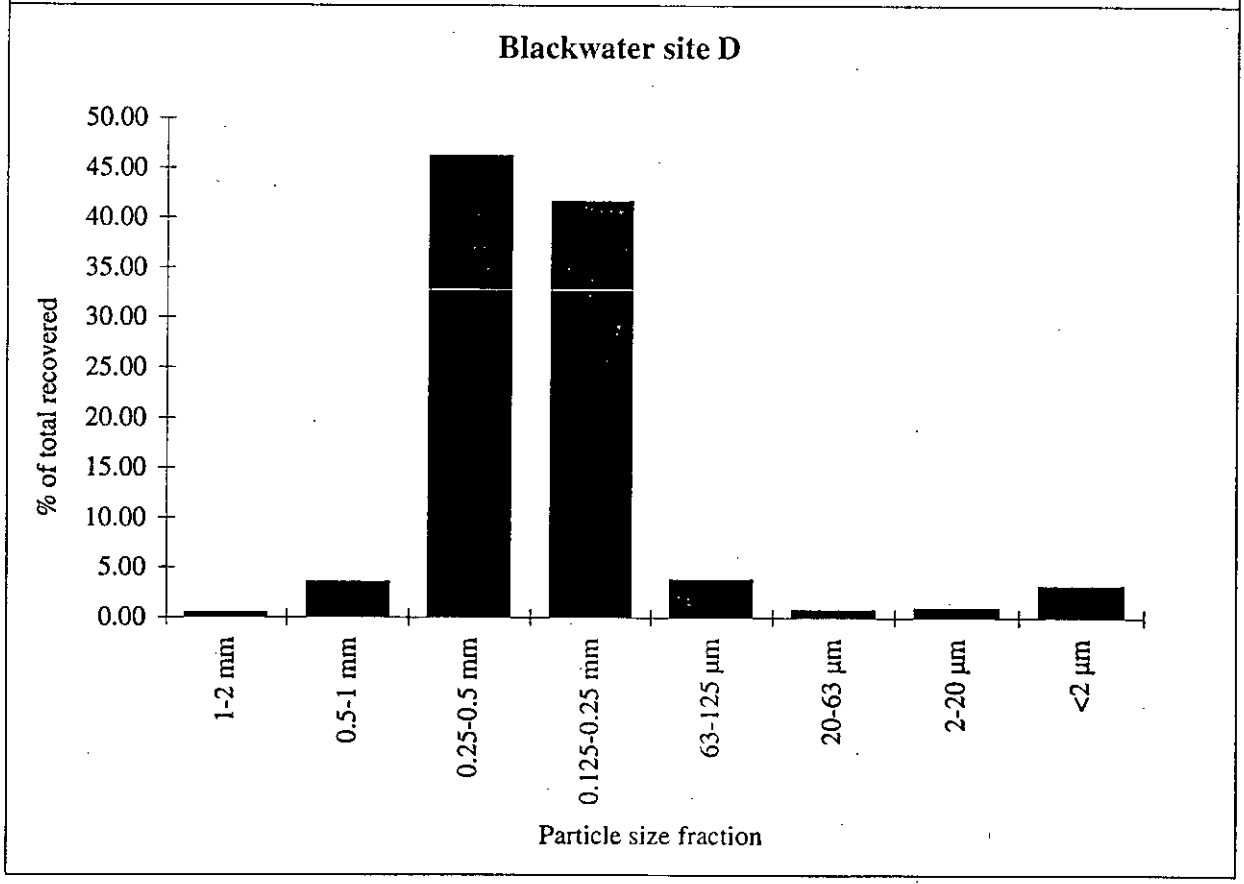
PARTICLE SIZE DISTRIBUTION OF RIVER BLACKWATER SEDIMENTS SAMPLE DATE 10/4/95





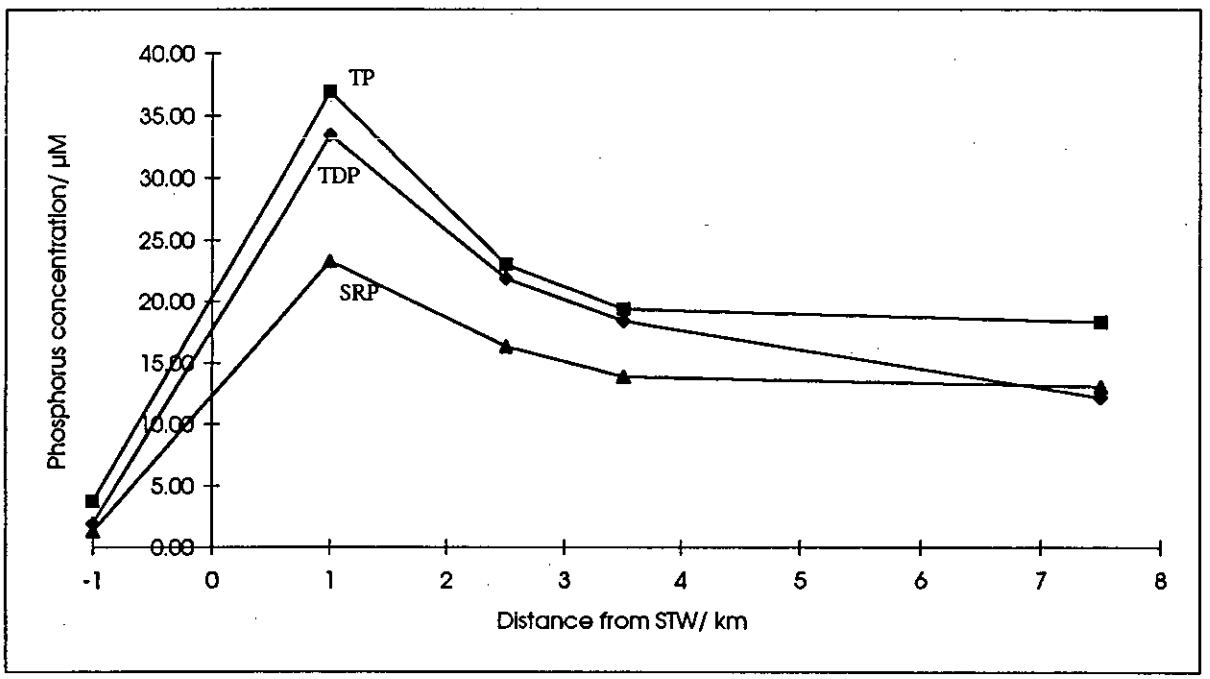
PARTICLE SIZE DISTRIBUTION OF RIVER BLACKWATER SEDIMENTS SAMPLE DATE 10/4/95





PILOT STUDY TO RIVER WEY
ALTON 8/5/95

SITE	A	B	C	D	E	F
NGR of site	SU 724 396	SU 730 387	SU 733 403	SU 745 412	SU 756 417	SU 786 432
Distance from STW/ km	-1	Tributary	1	2.5	3.5	7.5
pH	7.36	8.14	7.65	7.97	8.20	8.76
Conductivity (µS/cm)	605	787	701	687	654	642
Dissolved Oxygen (%)	92	132	75	102	118	142
Temperature	13.7	15.7	15	15.2	15.8	16.2
Flow (m^3/s)	0.21		0.38	0.40	0.54	0.61
Filtered water (0.45 um)						
Ca++ (mM)	2.94	3.47	3.10	3.06	3.15	3.05
Mg++ (mM)	0.08	0.09	0.09	0.09	0.09	0.09
Na+ (mM)	0.27	0.42	1.02	0.90	0.76	0.73
K+ (mM)	0.034	0.036	0.091	0.080	0.069	0.072
Alkalinity (mM)	5.14	5.52	5.39	5.25	5.17	5.16
NO3- (mM)	0.36	0.54	0.43	0.42	0.42	0.41
Silicon (µM)	171	128	204	157	161	124
Soluble Reactive Phosphorus (µM)	1.30	2.24	23.25	16.30	13.88	13.04
Total Dissolved Phosphorus (µM)	1.90	2.20	33.40	21.89	18.40	12.20
Non - MR Reactive fraction (µM)	0.60	-0.05	10.15	5.59	4.52	-0.84
Unfiltered water						
Total Phosphorus (µM)	3.75	2.50	36.90	23.00	19.40	18.30
Particulate Phosphorus (µM)	1.85	0.30	3.50	1.11	1.00	6.10
Suspended Solids (mg/l)	12.6	8.0	16.0	5.0	12.4	7.0
Sediment sieved 2mm						
% water	19.64		24.41	22.23	30.26	24.77
Organic Matter (% of dry wt)	1.54		1.72	2.43	3.03	1.68
Total Phosphorus (µmol/g)	4.72		22.36	24.46	17.91	
Total Calcium (µmol/g)	894		1439	1270	1566	
Total Iron (µmol/g)	168.6		240.3	670.5	230.4	
Bioavailable Phosphorus (µmol/g)	1.45		3.91	6.84	3.30	2.89
Equilibrium Phosphorus Concentration (µM)	2.55		10.19	13.34	11.76	13.23
Kd (dm^3/kg)	55.4		54.0	56.6	65.0	35.4
ni (µmol/g)	0.141		0.550	0.755	0.764	0.469

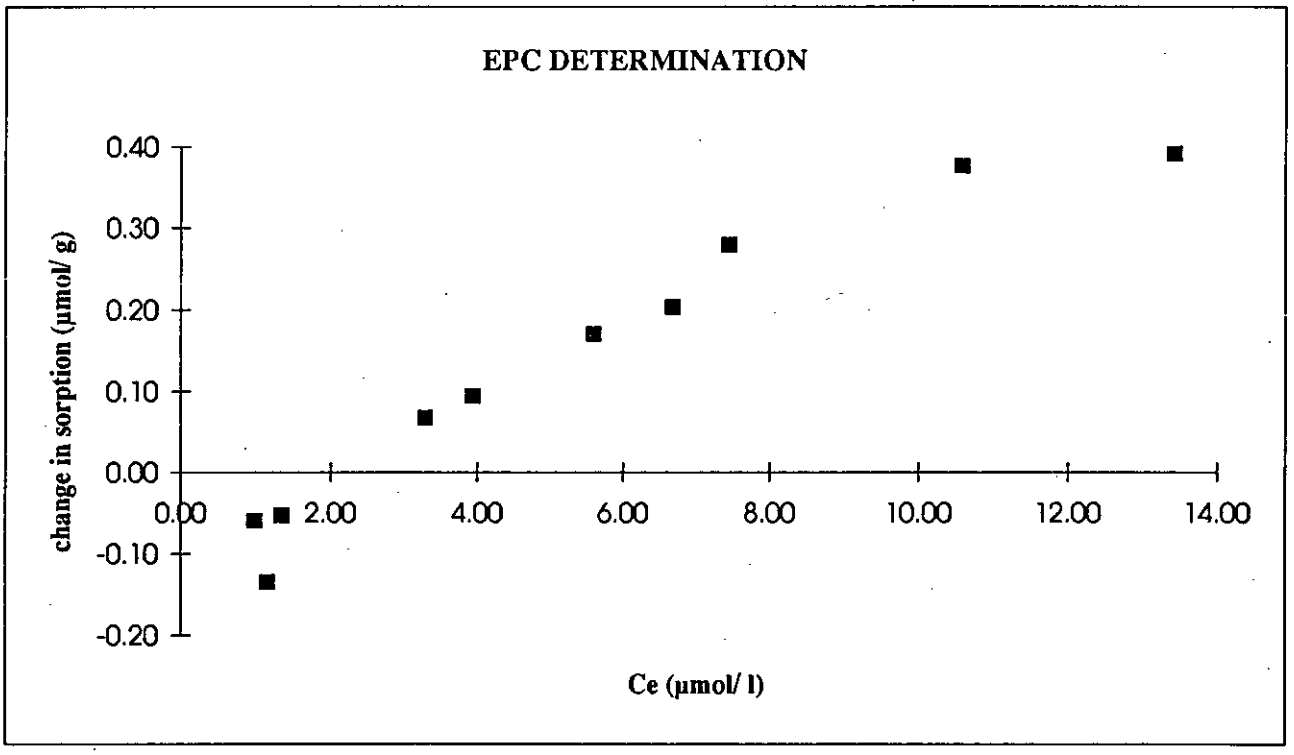


SITE A RIVER WEY. SEDIMENT & WATER COLLECTED 8/5/95

EPCo DETERMINATION: ANALYSIS 10/5/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.14	1.72	0	1.17	-0.14
2.80	2.25	5	3.94	0.09
2.27	1.83	10	7.45	0.28
4.14	3.33	0	1.00	-0.06
4.06	3.26	10	6.69	0.20
4.18	3.36	20	13.43	0.39
6.26	5.03	0	1.36	-0.05
6.30	5.07	5	3.30	0.07
6.47	5.20	10	5.59	0.17
6.24	5.01	20	10.59	0.38

% WATER OF SEDIMENT = 19.64
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.54 %
TOTAL PHOSPHORUS OF SEDIMENT = 4.72 µmol/ g

SRP OF WATER = 1.30 µmol/ l
TDP OF WATER = 1.90 µmol/ l
TP OF WATER =3.75 µmol/ l
EPCo = 2.55 µM
Kd = 55.4 l/kg
ni = 0.141 µmol/g

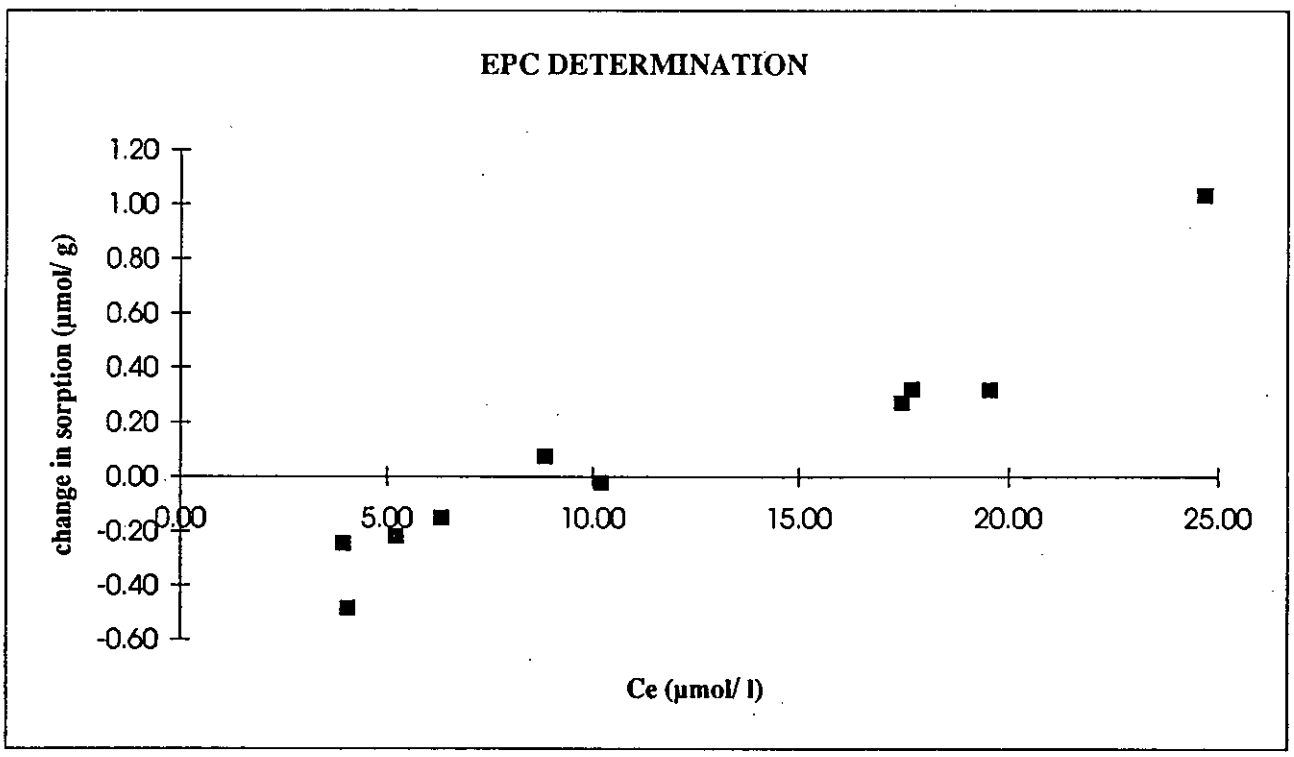


SITE C RIVER WEY. SEDIMENT & WATER COLLECTED 8/5/95

EPCo DETERMINATION: ANALYSIS 10/5/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.20	1.66	0	4.05	-0.49
2.30	1.74	5	6.34	-0.15
2.28	1.72	10	10.21	-0.02
2.49	1.88	20	17.47	0.27
4.24	3.20	0	3.95	-0.25
4.23	3.20	10	8.86	0.07
4.55	3.44	25	19.56	0.32
6.28	4.74	0	5.23	-0.22
6.06	4.58	25	17.70	0.32
6.50	4.91	50	24.69	1.03

% WATER OF SEDIMENT = 24.41
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.72 %
TOTAL PHOSPHORUS OF SEDIMENT = 22.36 µmol/ g

SRP OF WATER = 23.25 µmol/ l
TDP OF WATER = 33.40 µmol/ l
TP OF WATER = 36.90 µmol/ l
EPCo = 10.19 µM
Kd = 54.0 l/kg
ni = 0.550 µmol/g

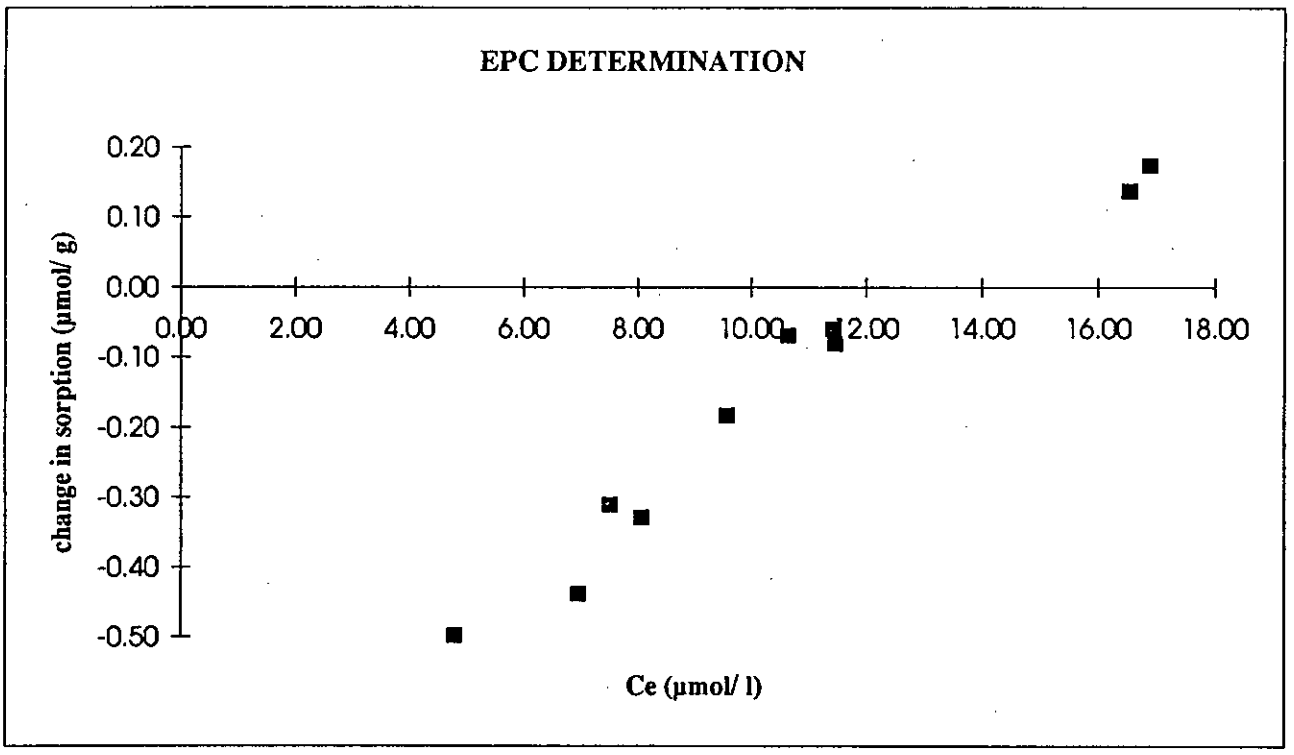


SITE D RIVER WEY. SEDIMENT & WATER COLLECTED 8/5/95

EPCo DETERMINATION: ANALYSIS 10/5/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.47	1.92	0	4.80	-0.50
2.09	1.63	5	7.53	-0.31
2.42	1.88	10	10.65	-0.07
4.07	3.17	0	6.97	-0.44
4.66	3.62	10	11.47	-0.08
4.63	3.60	20	16.90	0.17
6.30	4.90	0	8.08	-0.33
6.42	4.99	5	9.59	-0.18
6.08	4.73	10	11.44	-0.06
6.51	5.06	20	16.55	0.14

% WATER OF SEDIMENT = 22.23
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 2.43 %
TOTAL PHOSPHORUS OF SEDIMENT = 24.46 µmol/ g

SRP OF WATER = 16.30 µmol/ l
TDP OF WATER = 21.89 µmol/ l
TP OF WATER = 23.00 µmol/ l
EPCo = 13.34 µM
Kd = 56.6 l/kg
ni = 0.755 µmol/g

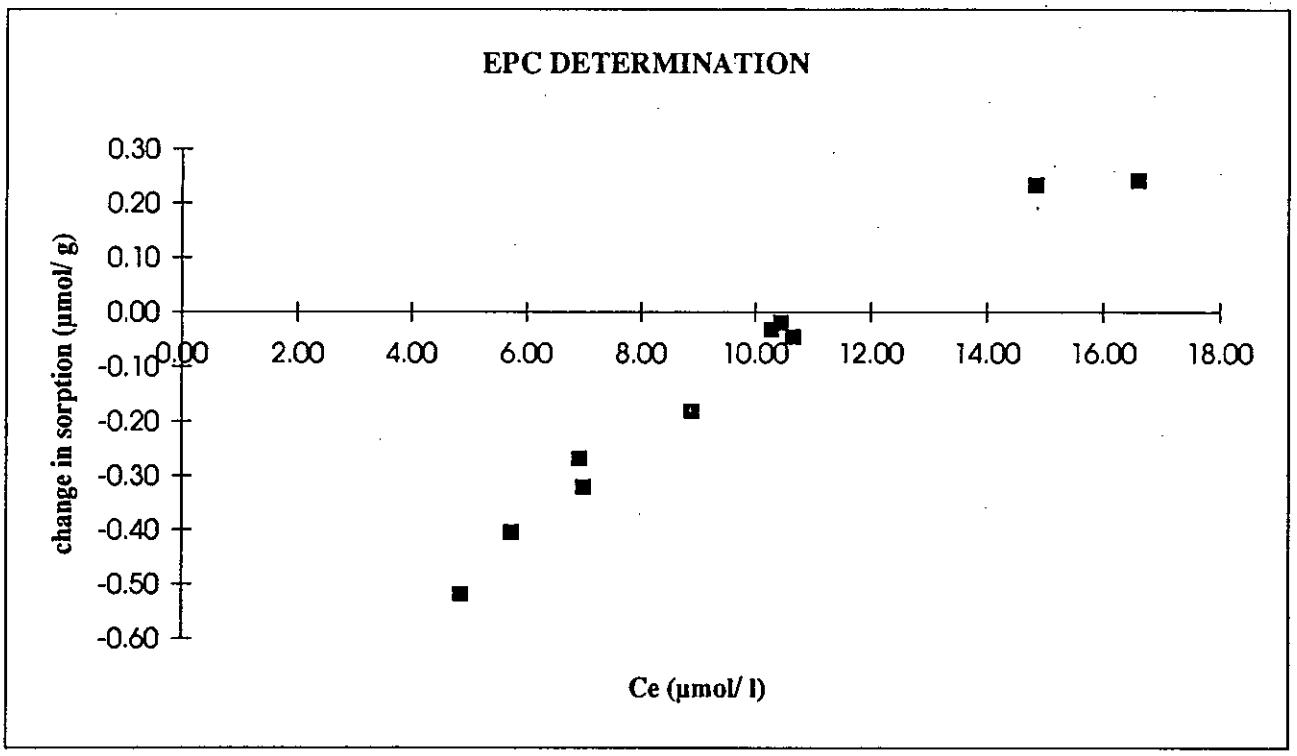


SITE E RIVER WEY. SEDIMENT & WATER COLLECTED 8/5/95

EPCo DETERMINATION: ANALYSIS 10/5/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.69	1.88	0	4.87	-0.52
2.06	1.44	5	6.95	-0.27
2.57	1.79	10	10.29	-0.03
4.06	2.83	0	5.76	-0.41
4.25	2.97	10	10.67	-0.04
4.05	2.82	20	16.62	0.24
6.23	4.35	0	7.00	-0.32
6.10	4.25	5	8.89	-0.18
6.41	4.47	10	10.45	-0.02
6.37	4.44	20	14.85	0.23

% WATER OF SEDIMENT = 30.26
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 3.03 %
TOTAL PHOSPHORUS OF SEDIMENT = 17.91 µmol/ g

SRP OF WATER = 13.88 µmol/ l
TDP OF WATER = 18.40 µmol/ l
TP OF WATER = 19.40 µmol/ l
EPCo = 11.76 µM
Kd = 65.0 l/kg
ni = 0.764 µmol/g

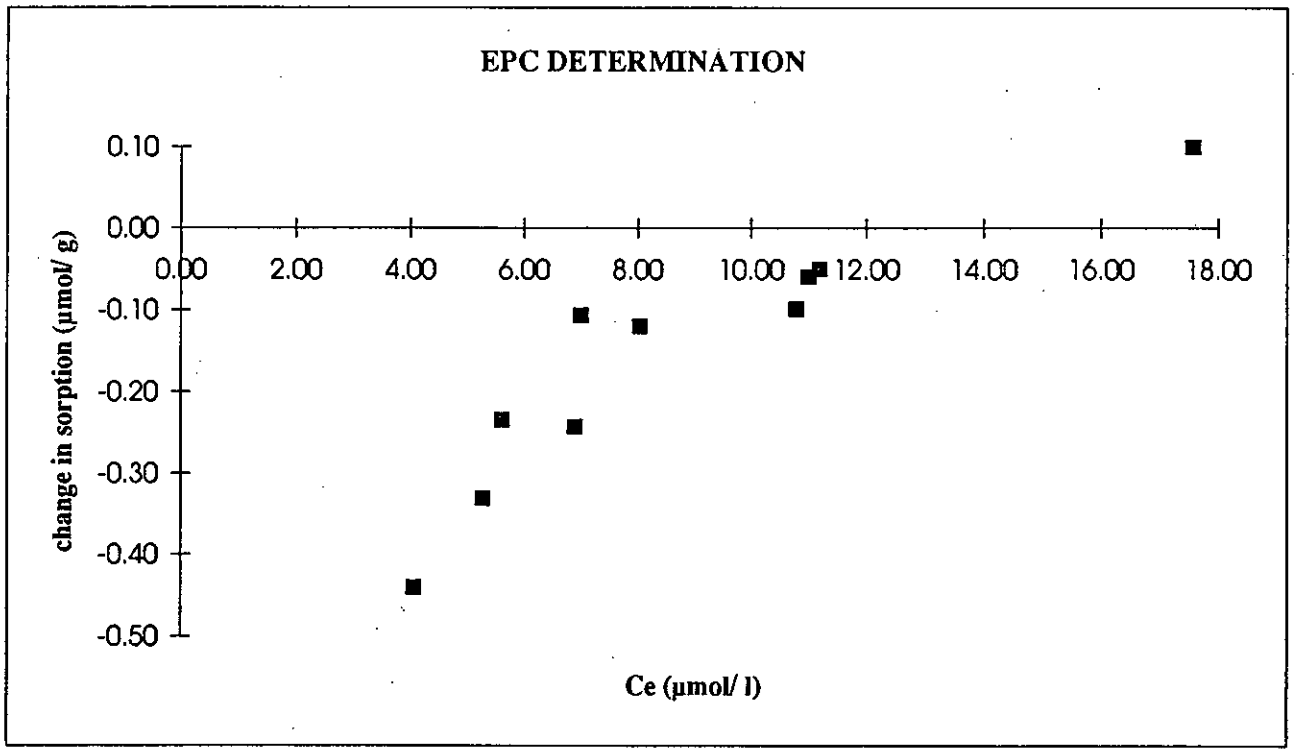


SITE F RIVER WEY. SEDIMENT & WATER COLLECTED 8/5/95

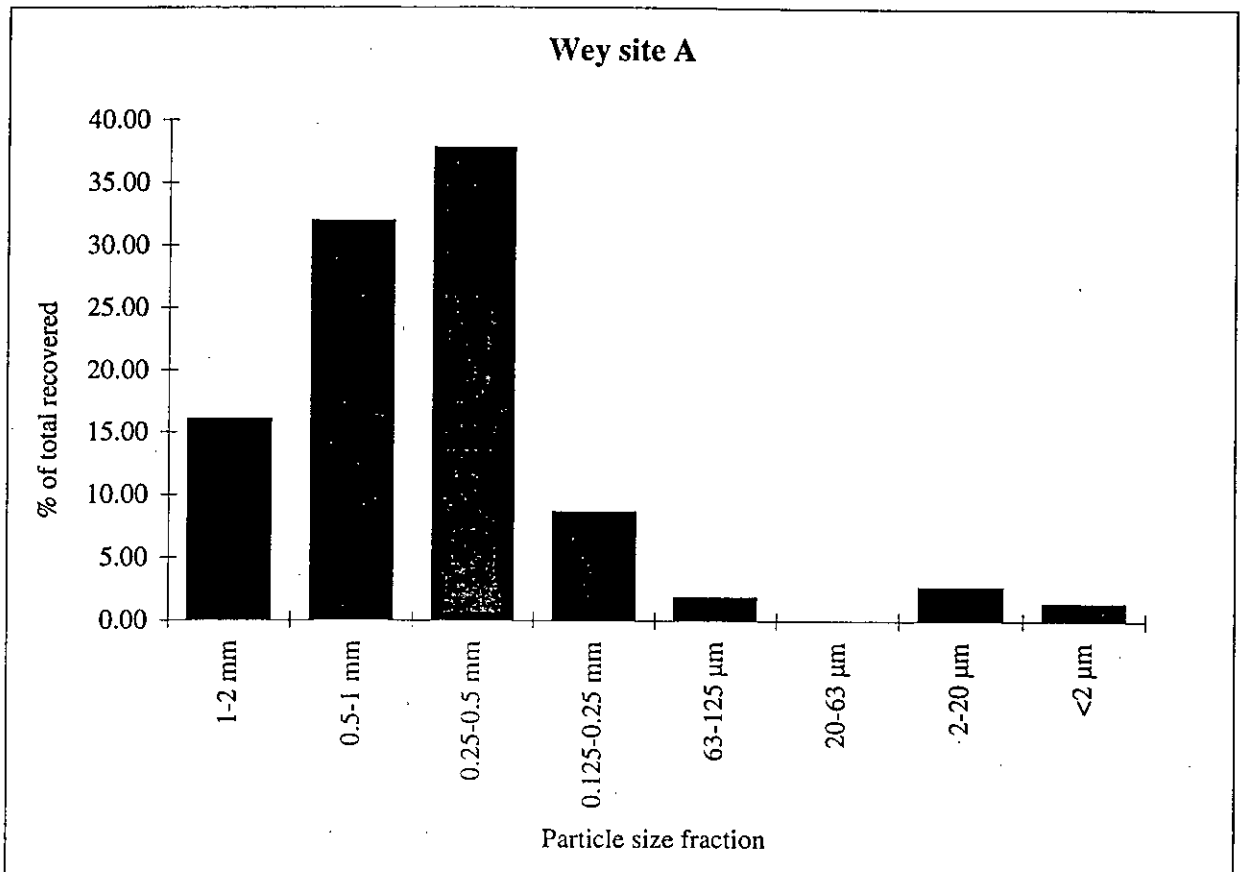
EPCo DETERMINATION: ANALYSIS 10/5/95				
weight of wet sediment/ g	weight of dry sediment/ g	initial [P] (µM)	[P] at 24 h (µM)	dN (µmol/ g dry wt)
2.46	1.85	0	4.07	-0.44
2.07	1.56	5	6.90	-0.24
2.14	1.61	10	10.79	-0.10
4.24	3.19	0	5.30	-0.33
5.00	3.76	5	7.01	-0.11
4.45	3.35	10	11.01	-0.06
6.37	4.79	0	5.63	-0.24
6.72	5.06	5	8.04	-0.12
6.30	4.74	10	11.19	-0.05
6.58	4.95	20	17.57	0.10

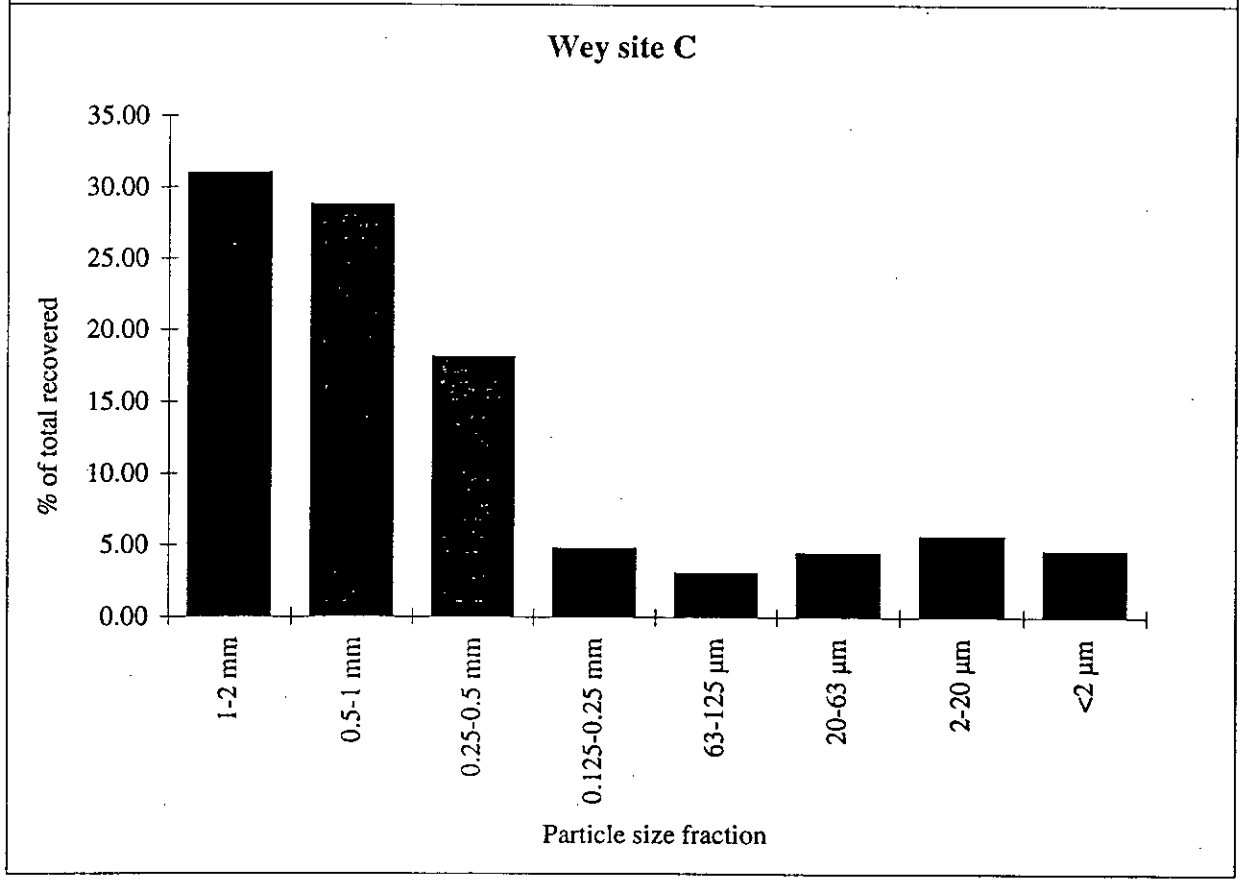
% WATER OF SEDIMENT = 24.77
ORGANIC MATTER OF SEDIMENT AS % OF DRY MASS = 1.68 %

SRP OF WATER = 13.04 µmol/ l
TDP OF WATER = 12.20 µmol/ l
TP OF WATER = 18.30 µmol/ l
EPCo = 13.23 µM
Kd = 35.4 l/kg
ni = 0.469 µmol/g

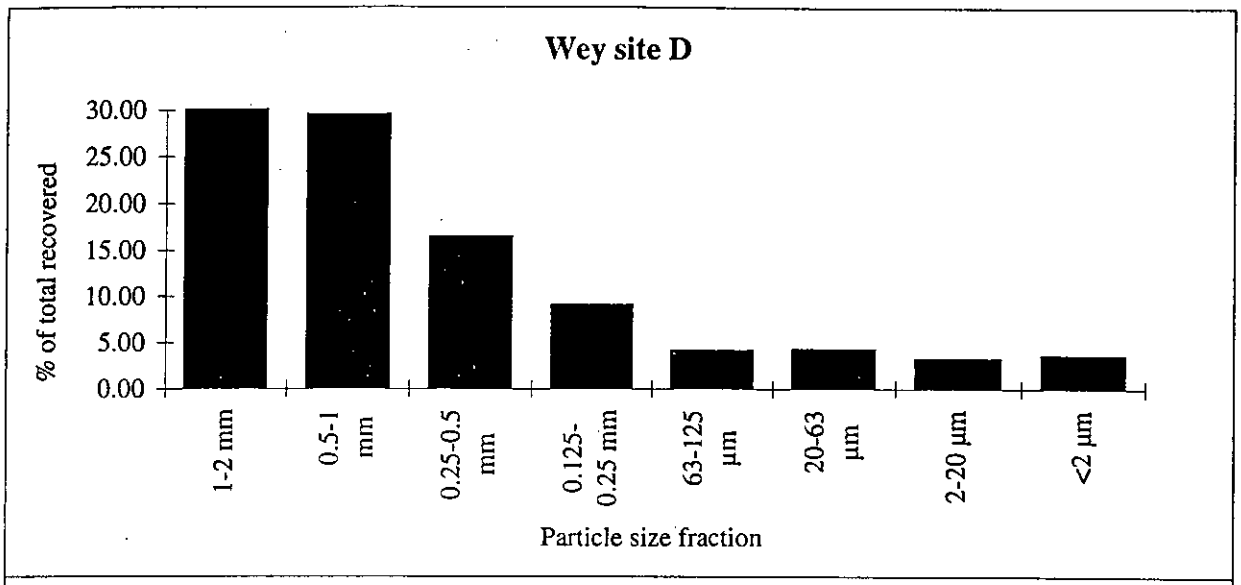


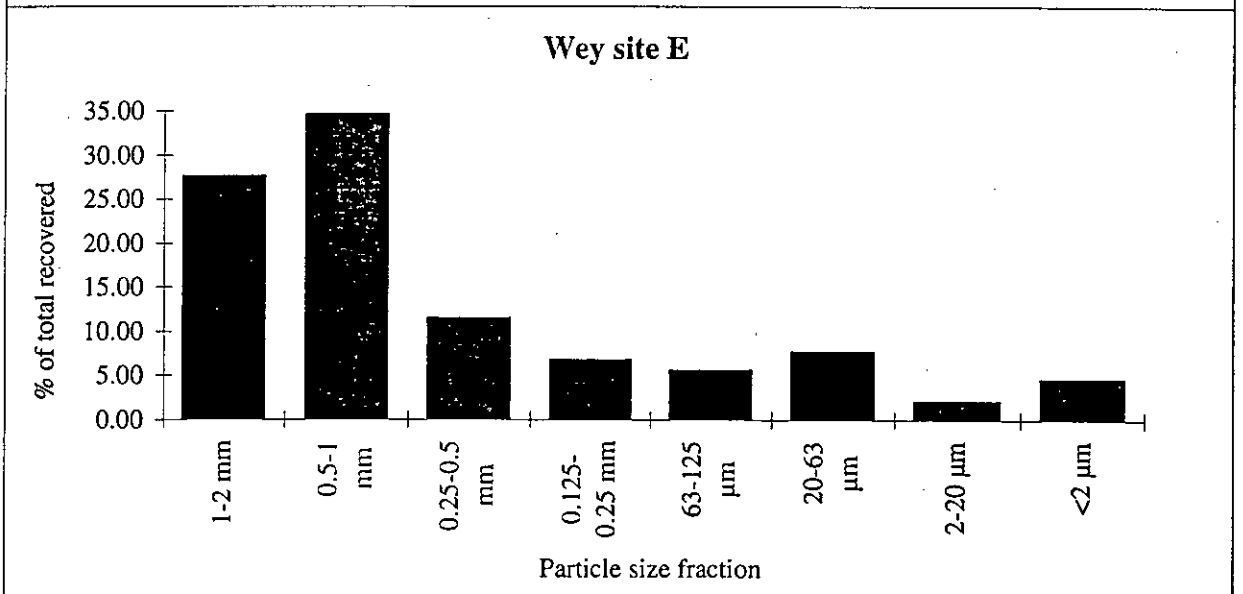
PARTICLE SIZE DISTRIBUTION OF RIVER WEY SEDIMENTS
SAMPLE DATE 8/5/95

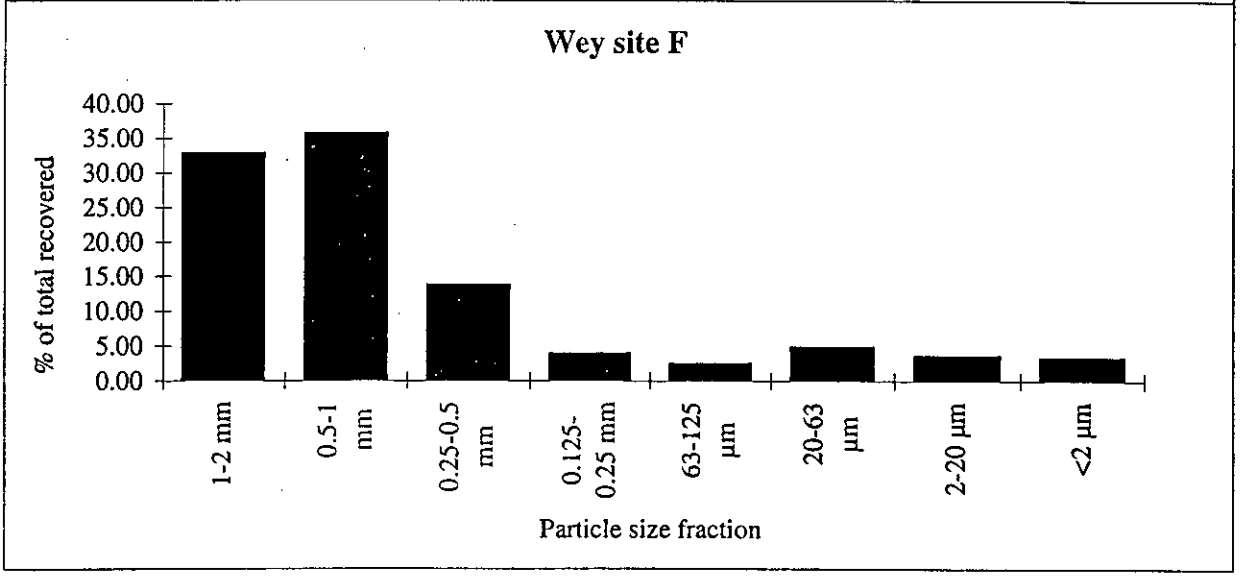




PARTICLE SIZE DISTRIBUTION OF RIVER WEY SEDIMENTS
SAMPLE DATE 8/5/95







APPENDIX G

Fluvarium experiments with Gt. Ouse sediment Winter 1994

Sediment collected 10/01/94

River water chemistry at time of sampling:

Ca++ = 3.59 mM	NO3- = 0.81 mM
Mg++ = 0.19 mM	Silicon = 128 µM
Na+ = 1.05 mM	SRP = 2.67 µM
K+ = 0.09 mM	TDP = 3.12 µM
Alkalinity = 4.77 mM	TP = 3.82 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 28 litres/min
Velocity over sediment = 14.8 cm/s

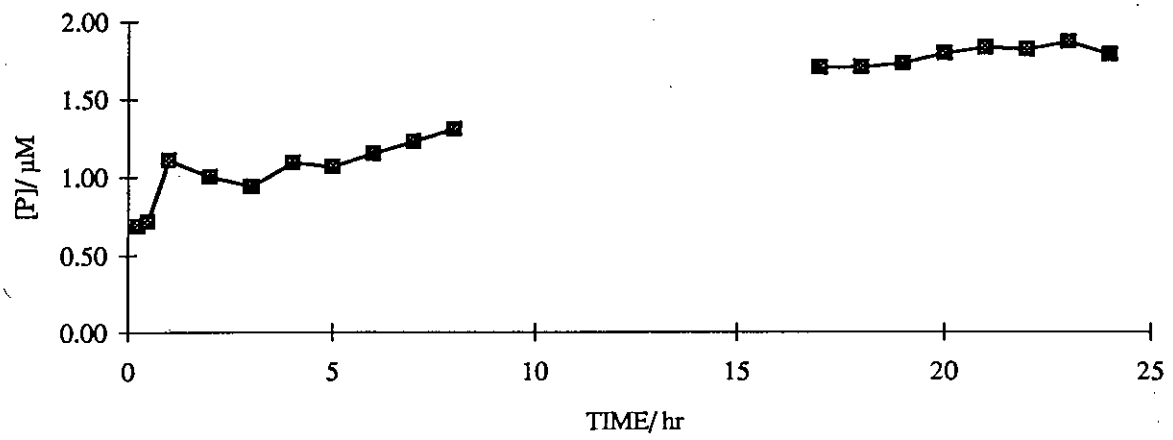
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 10 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 10 minutes.

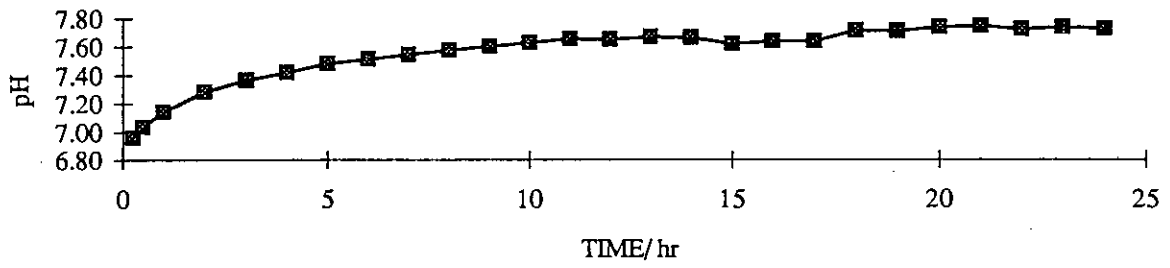
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 2.46 µM; Kd = 151.05 dm^3/kg; ni = 0.371 µmol/g

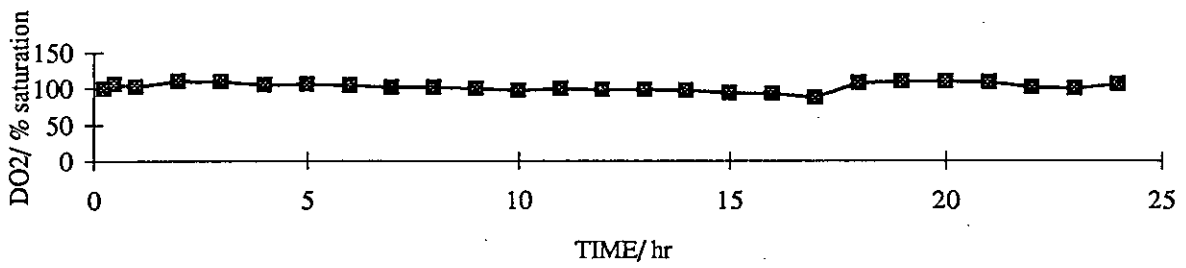
RELEASE OF SRP FROM Gt. OUSE SEDIMENT



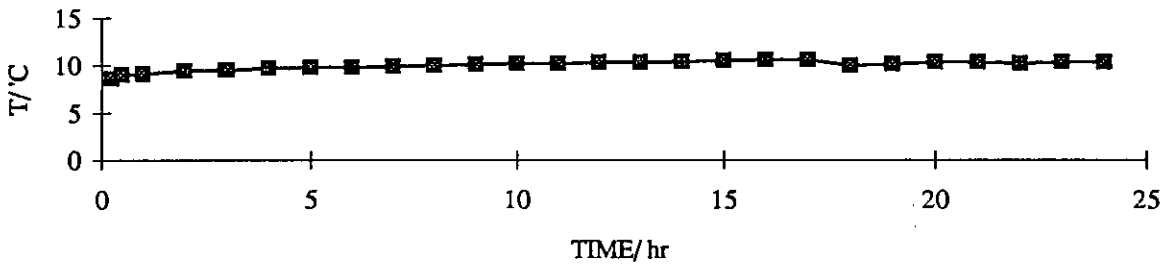
pH DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



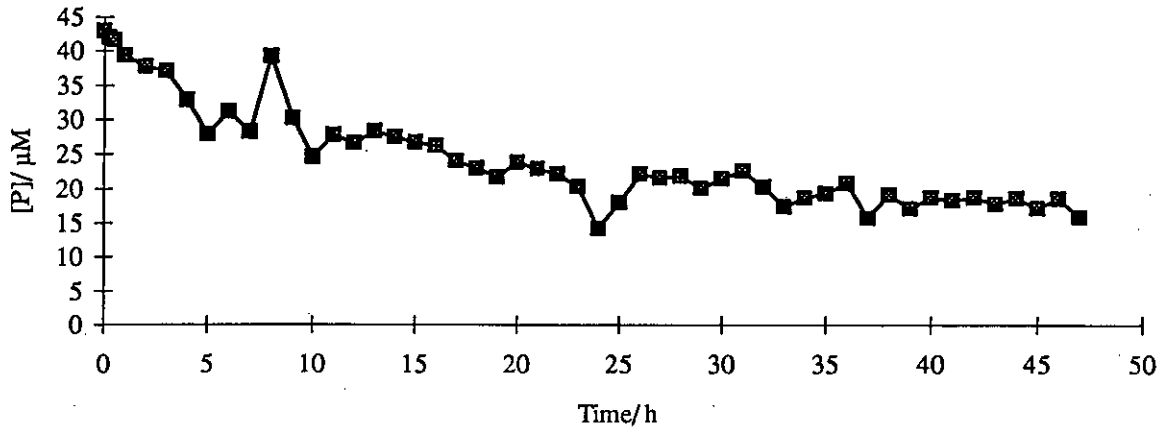
DISSOLVED OXYGEN CONCENTRATION DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



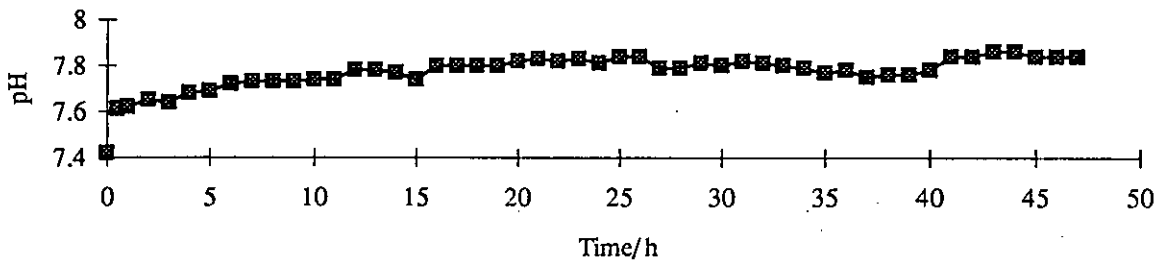
TEMPERATURE DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



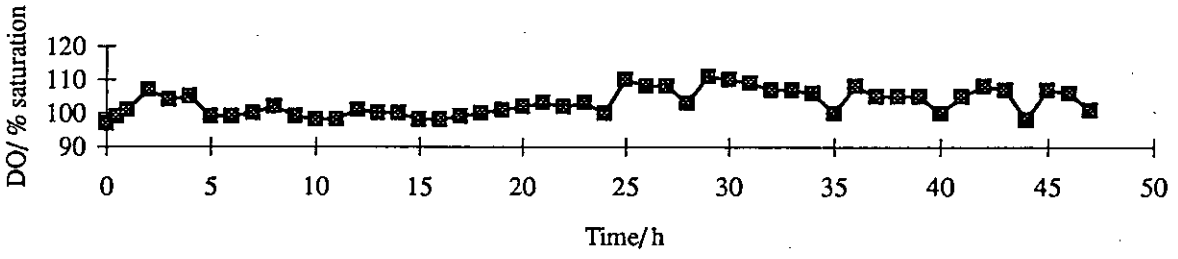
Uptake of SRP by Gt. Ouse sediment



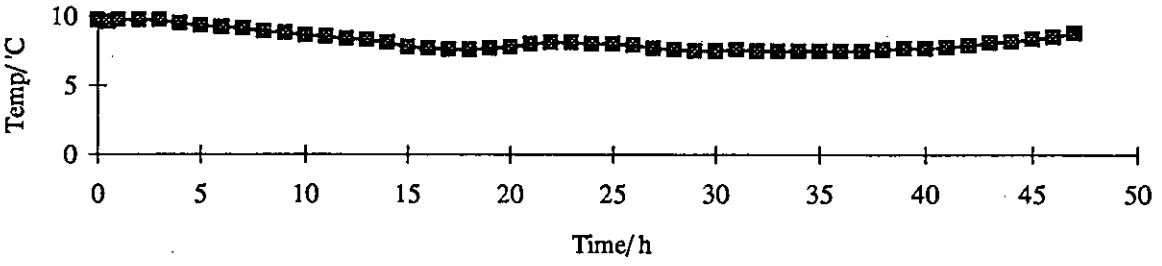
pH during uptake experiment with Gt. Ouse sediment



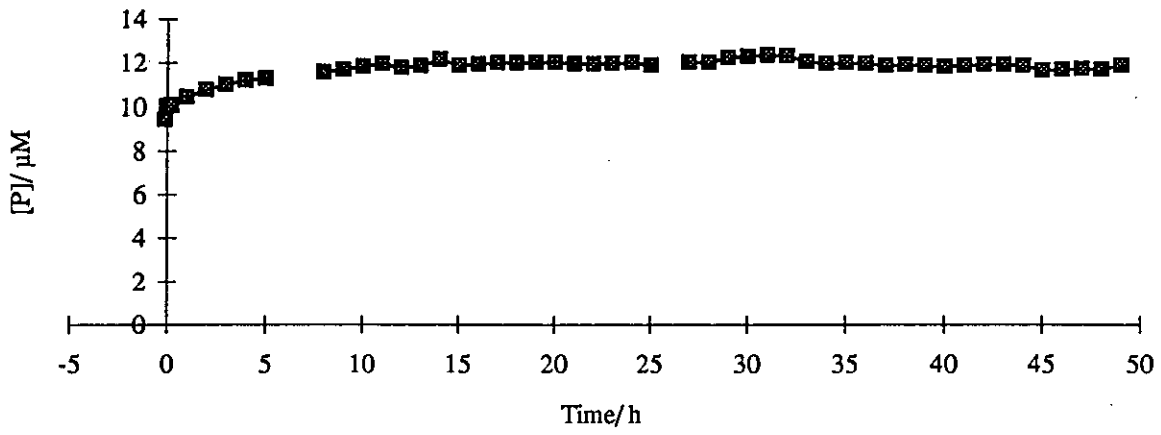
Dissolved oxygen concentration during uptake experiment with Gt. Ouse sediment



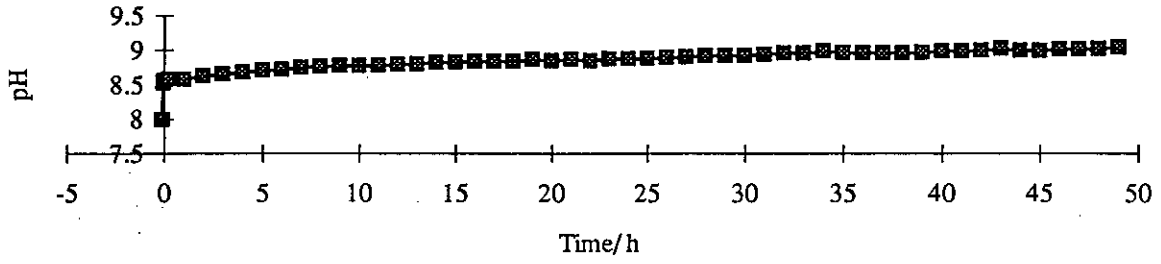
Temperature during uptake experiment with Gt. Ouse sediment



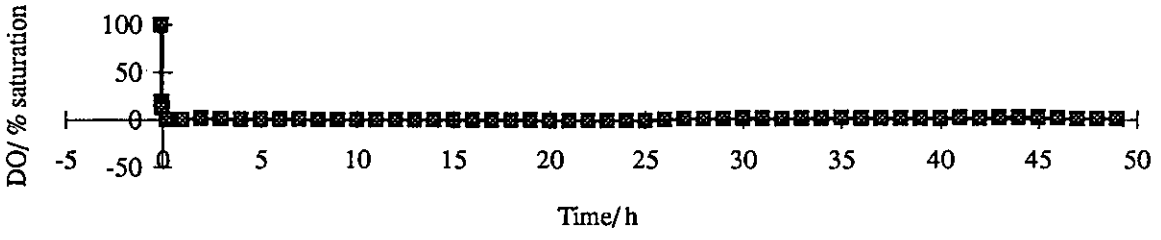
SRP Concentration during Anaerobic experiment with Gt. Ouse sediment



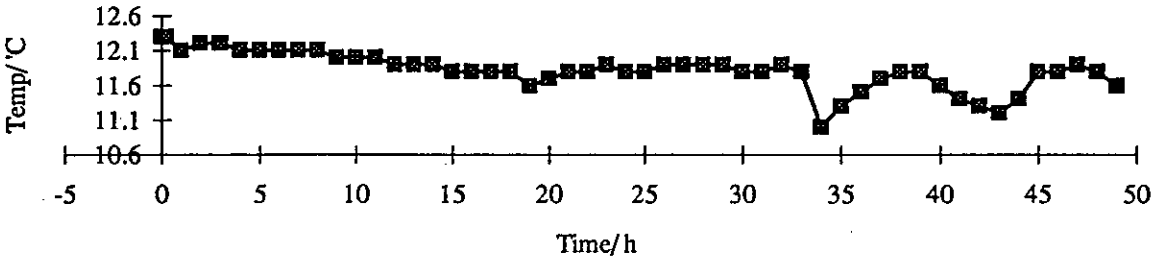
pH during Anaerobic experiment with Gt. Ouse sediment



Dissolved oxygen concentration during Anaerobic experiment with Gt. Ouse sediment



Temperature during Anaerobic experiment with Gt. Ouse sediment



APPENDIX H

Fluvarium experiments with River Blackwater sediment Winter 1994

Sediment collected 30/01/95

River water chemistry at time of sampling:

Ca++ = 1.91 mM	NO3- = 0.24 mM
Mg++ = 0.25 mM	Silicon = 219 µM
Na+ = 1.15 mM	SRP = 20.24 µM
K+ = 0.121 mM	TDP = 20.83 µM
Alkalinity = 2.62 mM	TP = 41.90 µM

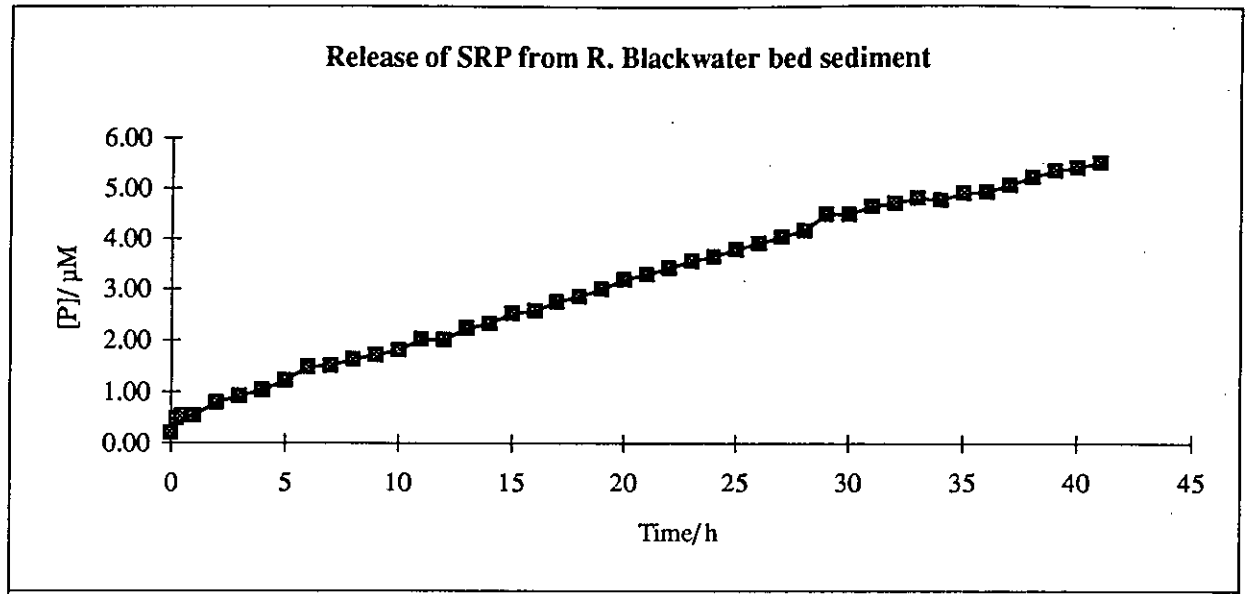
Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 12 litres/min
Velocity over sediment = 7.21 cm/s

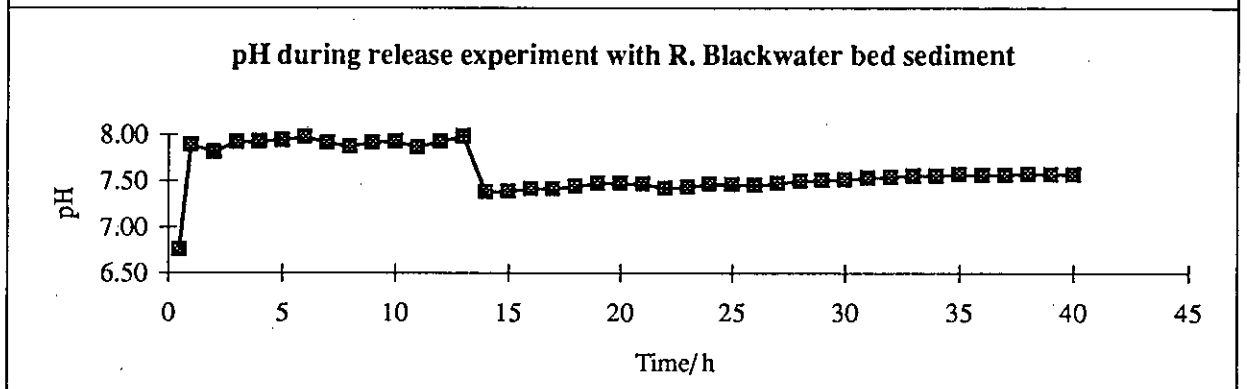
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 5 minutes after circulation started.

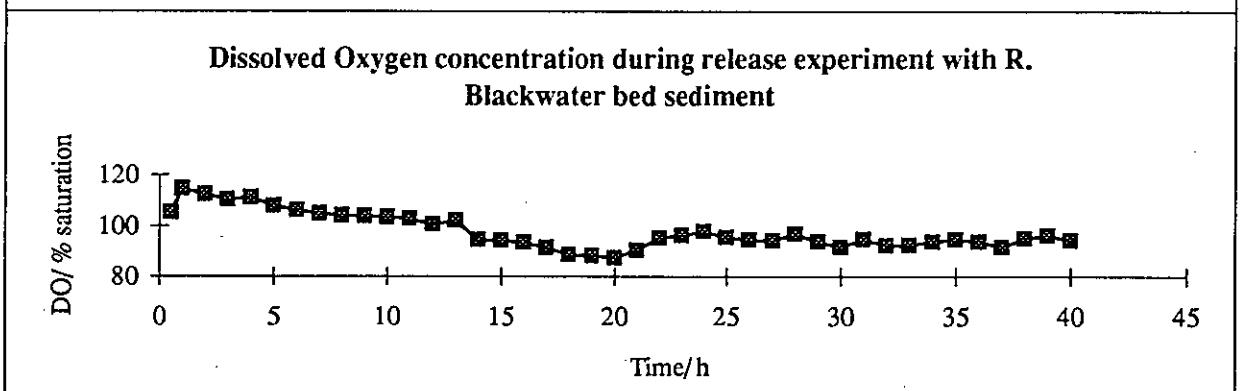
Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 5 minutes.

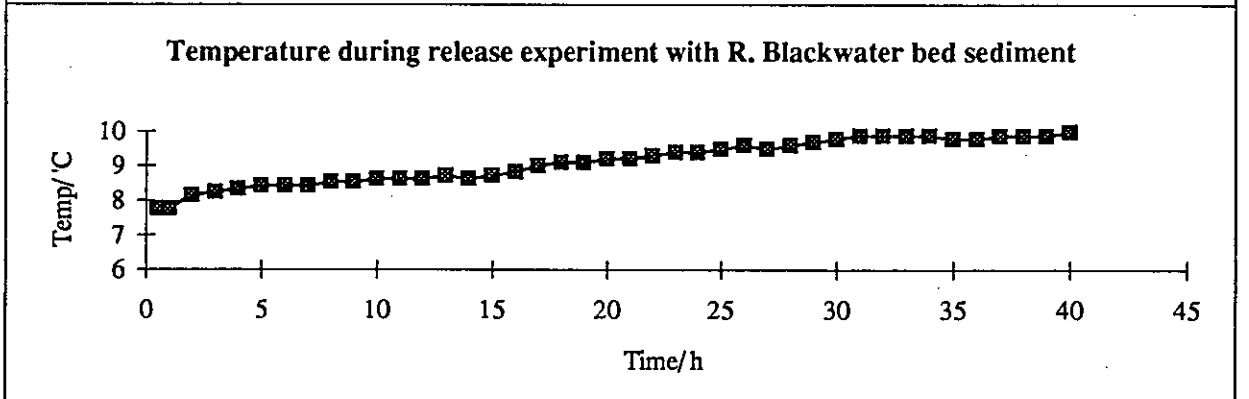
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 6.38 µM; Kd = 117.2 dm^3/kg; ni = 0.748 µmol/g

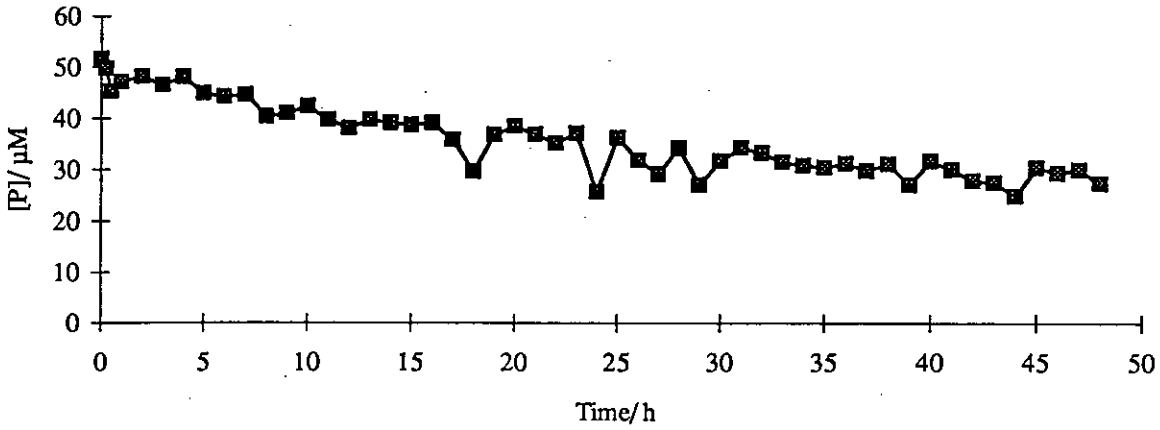

Release of SRP from R. Blackwater bed sediment
[P]/ µM
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
5
10
15
20
25
30
35
40
45
Time/ h


pH during release experiment with R. Blackwater bed sediment
pH
8.00
7.50
7.00
6.50
0
5
10
15
20
25
30
35
40
45
Time/ h

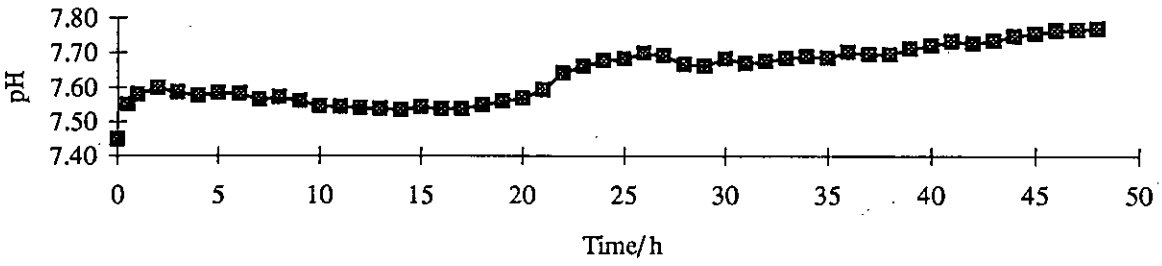

Dissolved Oxygen concentration during release experiment with R. Blackwater bed sediment
DO/ % saturation
120
100
80
0
5
10
15
20
25
30
35
40
45
Time/ h


Temperature during release experiment with R. Blackwater bed sediment
Temp/ 'C
10
9
8
7
6
0
5
10
15
20
25
30
35
40
45
Time/ h

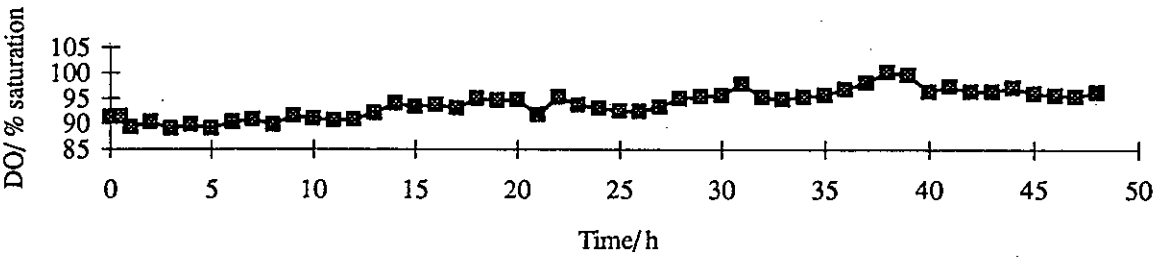
Uptake of SRP by R. Blackwater bed sediment



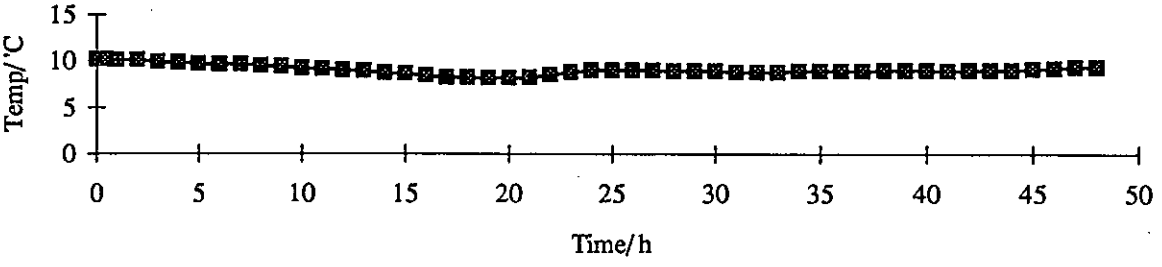
pH during uptake experiment with R. Blackwater bed sediment



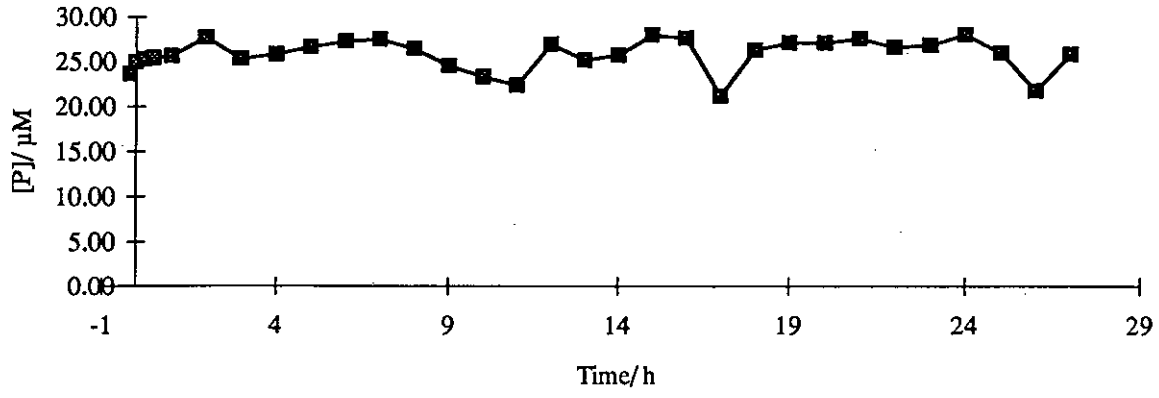
Dissolved Oxygen concentration during uptake experiment with R. Blackwater bed sediment



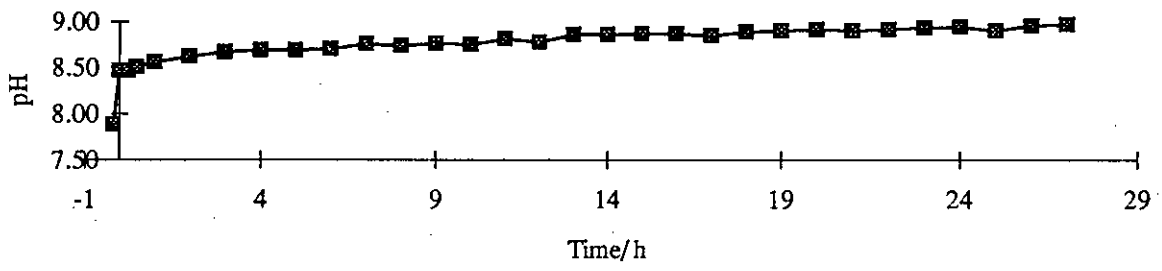
Temperature during uptake experiment with R. Blackwater bed sediment



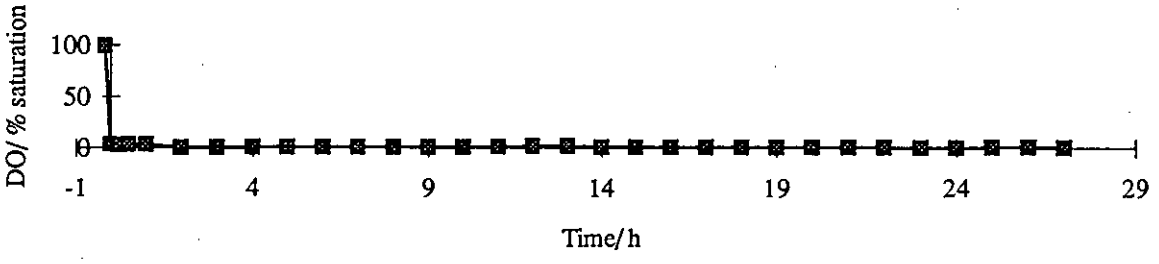
SRP Concentration during Anaerobic experiment with R. Blackwater sediment



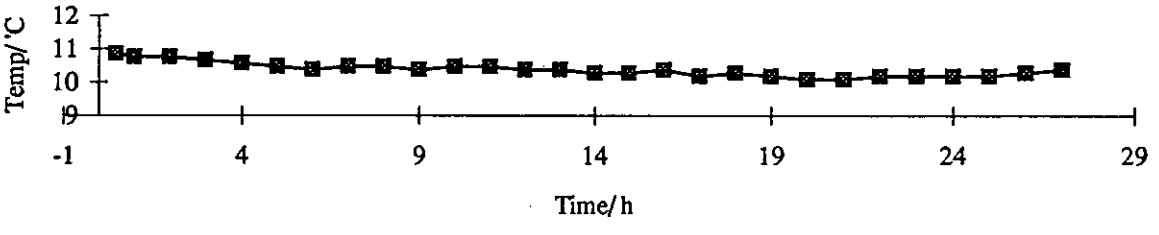
pH during Anaerobic experiment with R. Blackwater sediment



Dissolved Oxygen concentration during Anaerobic experiment with R. Blackwater sediment



Temperature during Anaerobic experiment with R. Blackwater sediment



APPENDIX I

Fluvarium experiments with River Wey sediment Winter 1994

Sediment collected 13/02/95

River water chemistry at time of sampling:

Ca++ = 2.59 mM	NO3- = 0.46 mM
Mg++ = 0.09 mM	Silicon = 202 µM
Na+ = 0.80 mM	SRP = 16.43 µM
K+ = 0.05 mM	TDP = 44.48 µM
Alkalinity = 4.25 mM	TP = >200 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 28 litres/min
Velocity over sediment = 14.82 cm/s

Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 5 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 5 minutes.

Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 9.266 µM; Kd = 94.15 dm^3/kg; ni = 0.8724 µmol/g

Fluvarium experiments with River Wey sediment Winter 1994

Sediment collected 13/02/95

River water chemistry at time of sampling:

Ca++ = 2.59 mM	NO3- = 0.46 mM
Mg++ = 0.09 mM	Silicon = 202 µM
Na+ = 0.80 mM	SRP = 16.43 µM
K+ = 0.05 mM	TDP = 44.48 µM
Alkalinity = 4.25 mM	TP = >200 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 28 litres/min
Velocity over sediment = 14.82 cm/s

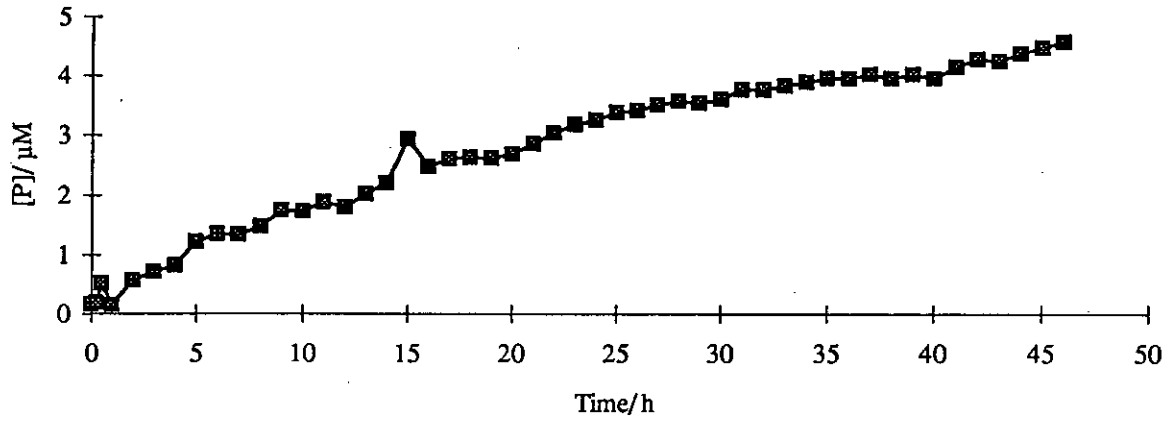
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 5 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 5 minutes.

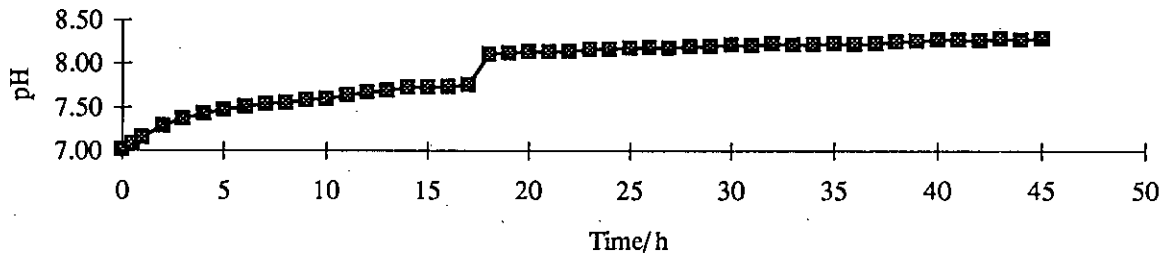
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 9.266 µM; Kd = 94.15 dm^3/kg; ni = 0.8724 µmol/g

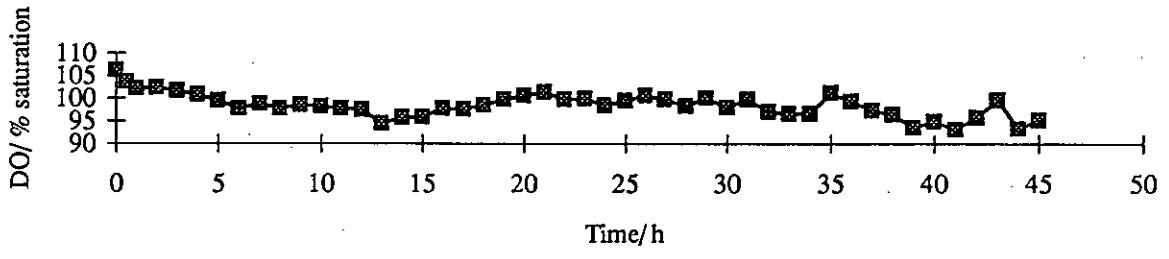
Release of SRP from River Wey bed sediment



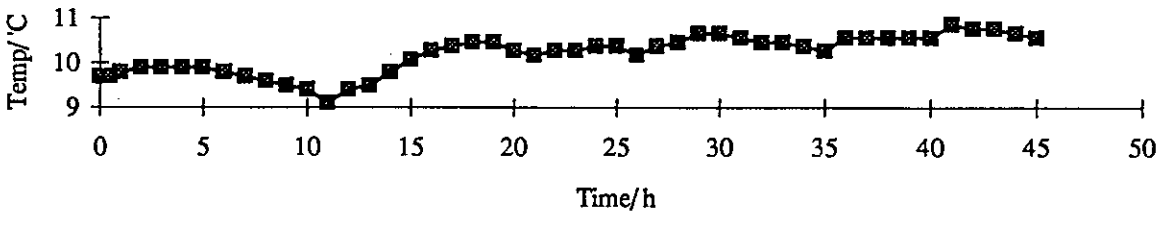
pH during release experiment with River Wey bed sediment



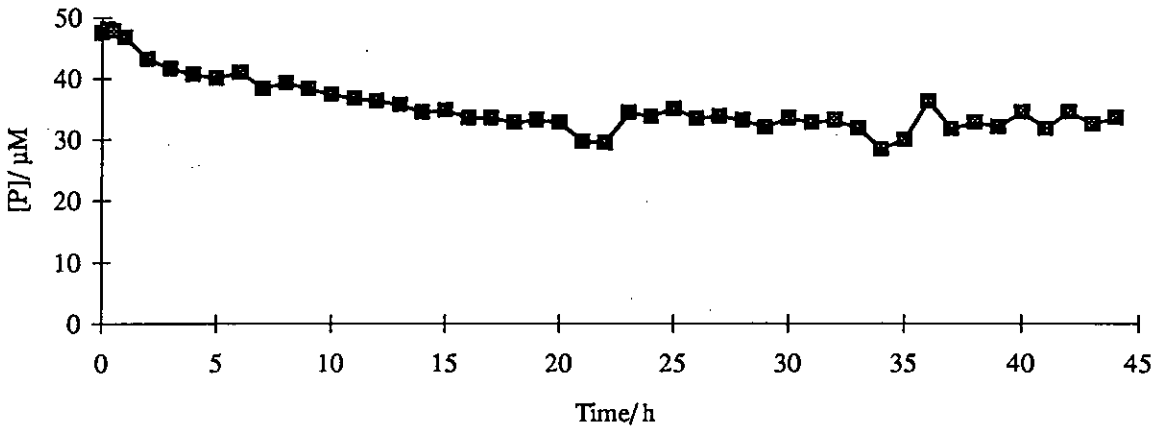
Dissolved Oxygen concentration during release experiment with River Wey bed sediment



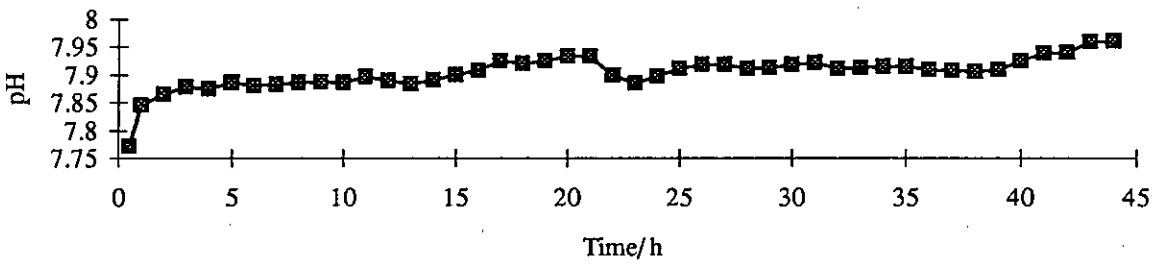
Temperature during release experiment with River Wey bed sediment



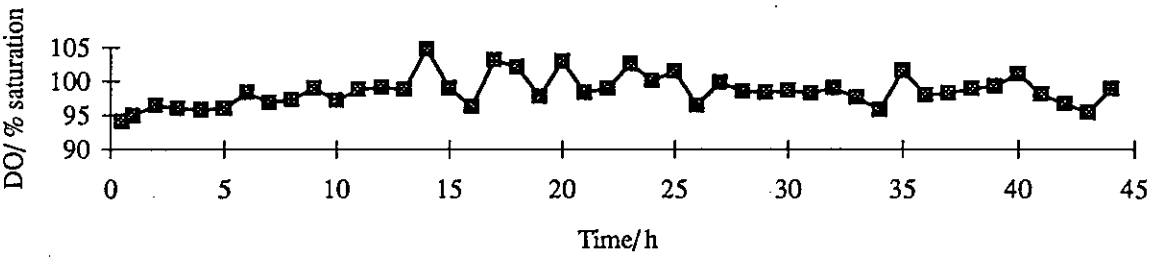
Uptake of SRP by R. Wey bed sediment



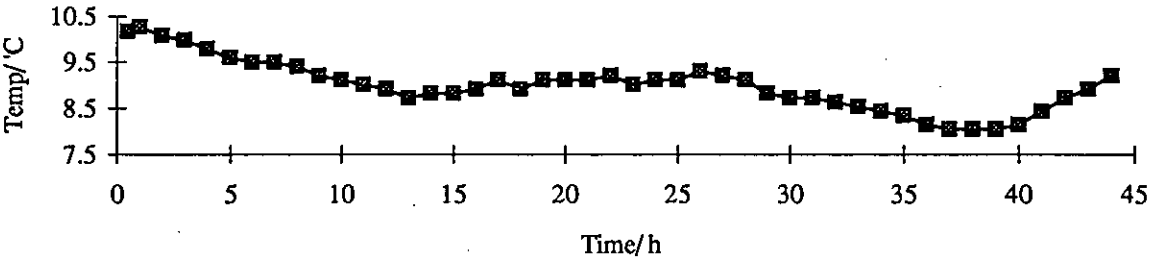
pH during uptake experiment with R. Wey bed sediment



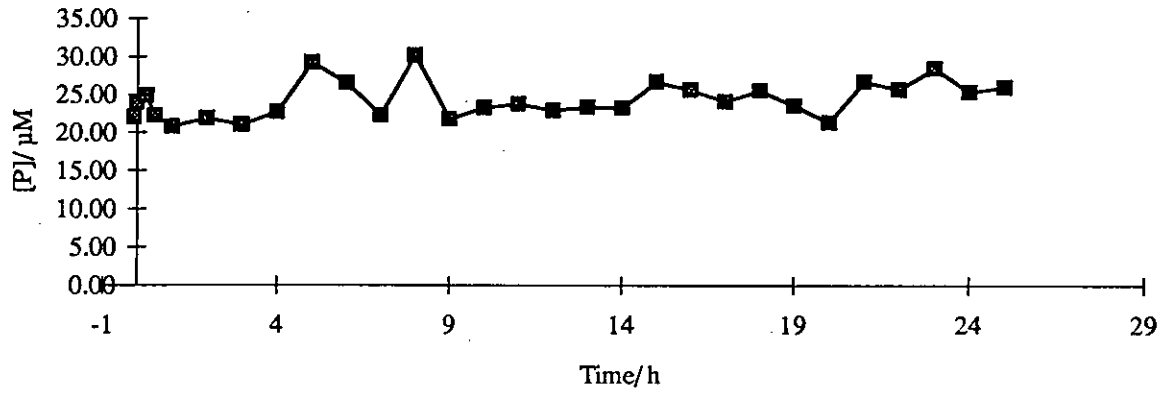
Dissolved Oxygen concentration during uptake experiment with R. Wey bed sediment



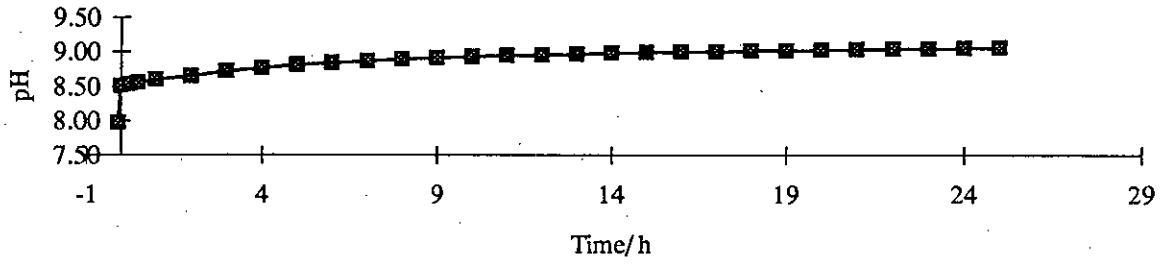
Temperature during uptake experiment with R. Wey bed sediment



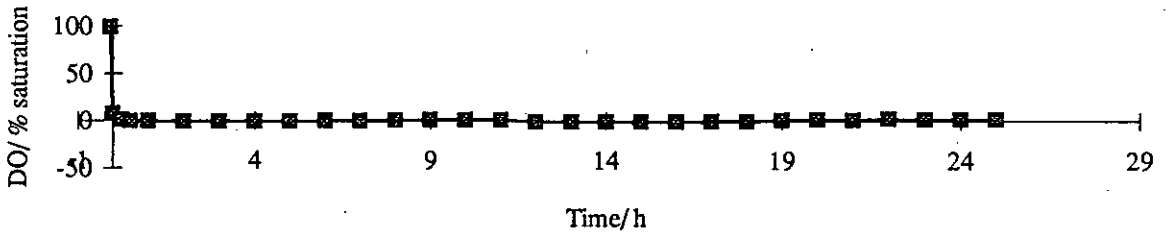
SRP Concentration during Anaerobic experiment with R. Wey sediment



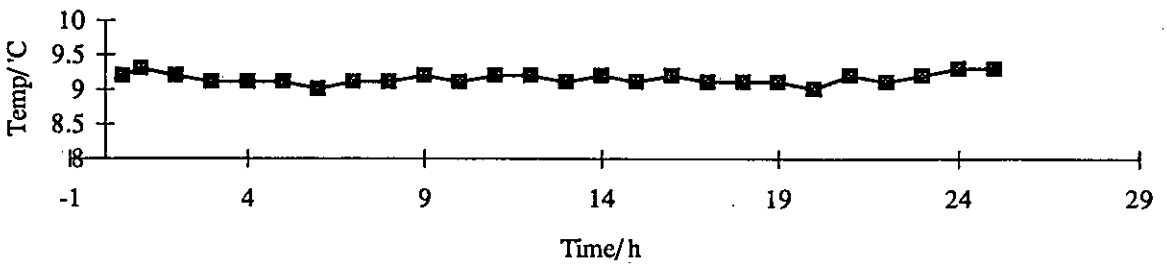
pH during Anaerobic experiment with R. Wey sediment



Dissolved Oxygen concentration during Anaerobic experiment with R. Wey sediment



Temperature during Anaerobic experiment with R. Wey sediment



APPENDIX J

Fluvarium experiments with Gt. Ouse sediment Spring 1995

Sediment collected 28/3/95

River water chemistry at time of sampling:

Ca++ = 3.77 mM	NO3- = 0.99 mM
Mg++ = 0.18 mM	Silicon = 82.6 µM
Na+ = 0.88 mM	SRP = 8.36 µM
K+ = 0.115 mM	TDP = 11.3 µM
Alkalinity = 5.04 mM	TP = 13.07 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 28 litres/min
Velocity over sediment = 14.5 cm/s

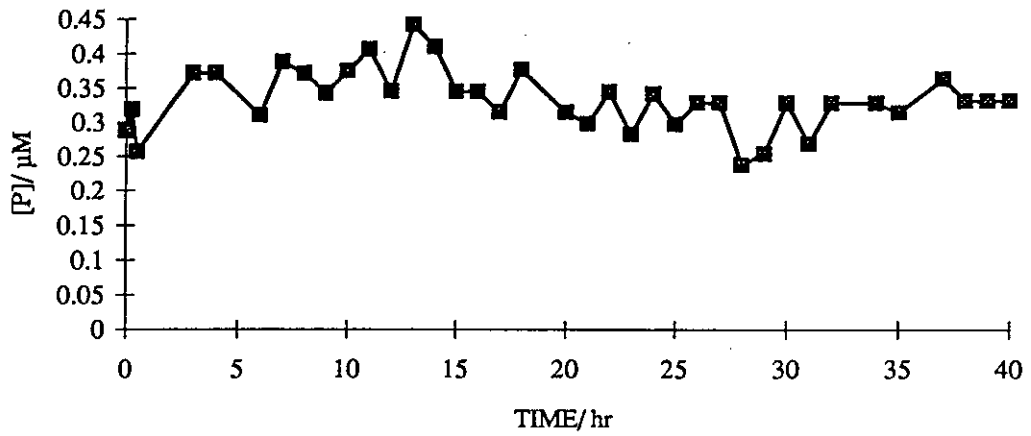
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 10 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 10 minutes.

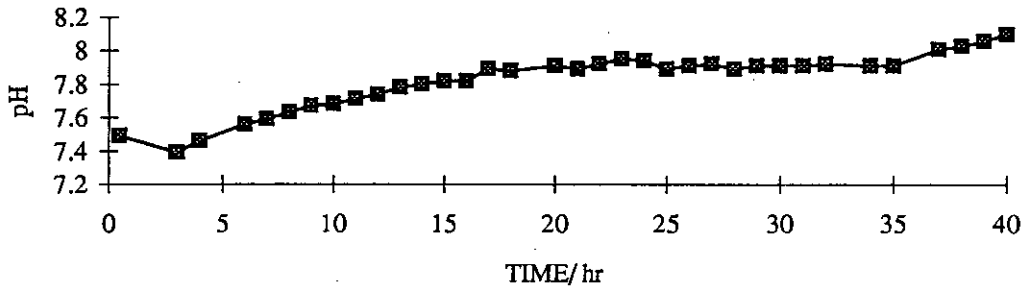
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 2.29 µM; Kd = 240.5 dm^3/kg; ni = 0.552 µmol/g

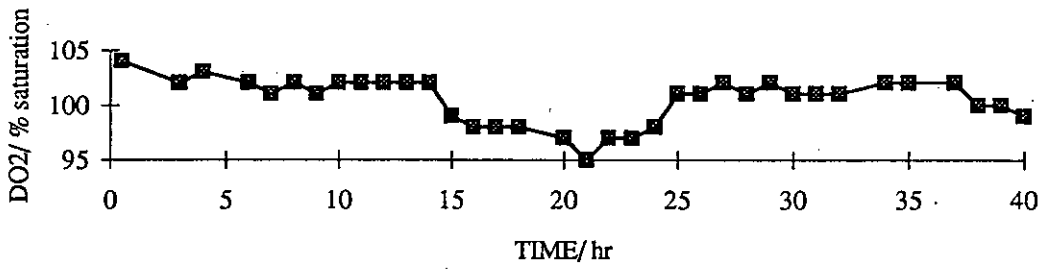
RELEASE OF SRP FROM Gt. OUSE SEDIMENT



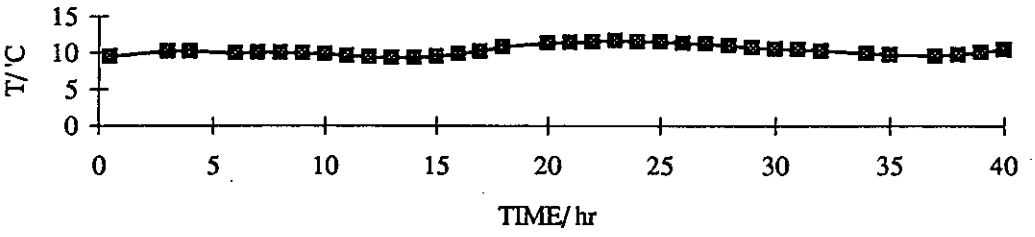
pH DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



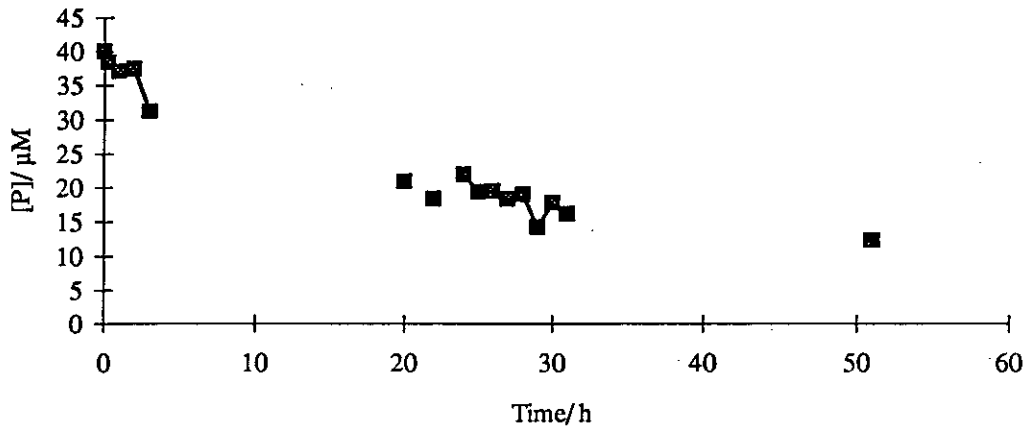
DISSOLVED OXYGEN CONCENTRATION DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



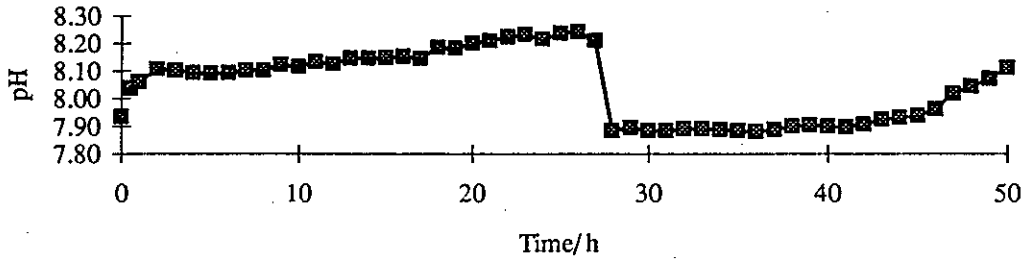
TEMPERATURE DURING RELEASE EXPERIMENT WITH Gt. OUSE SEDIMENT



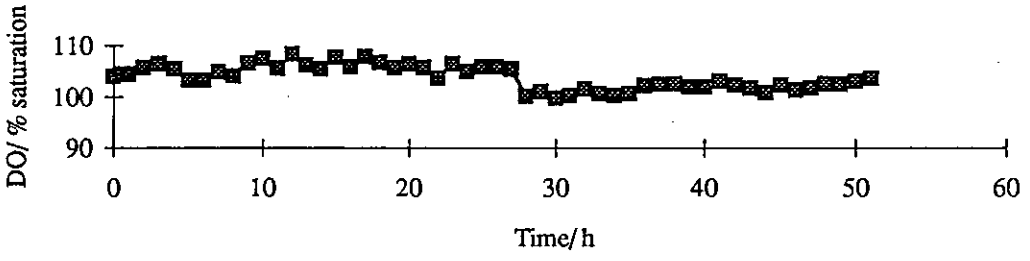
Uptake of SRP by Gt. Ouse sediment



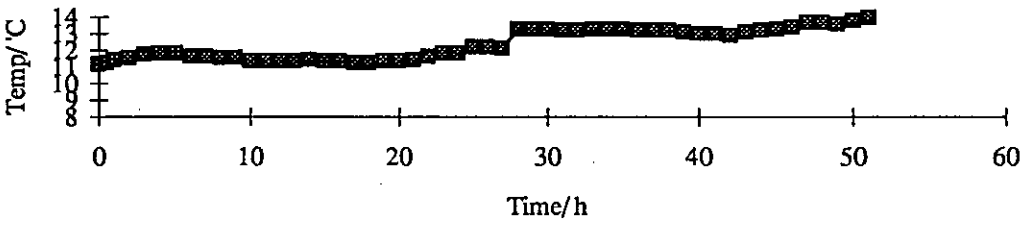
pH during uptake experiment with Gt. Ouse sediment



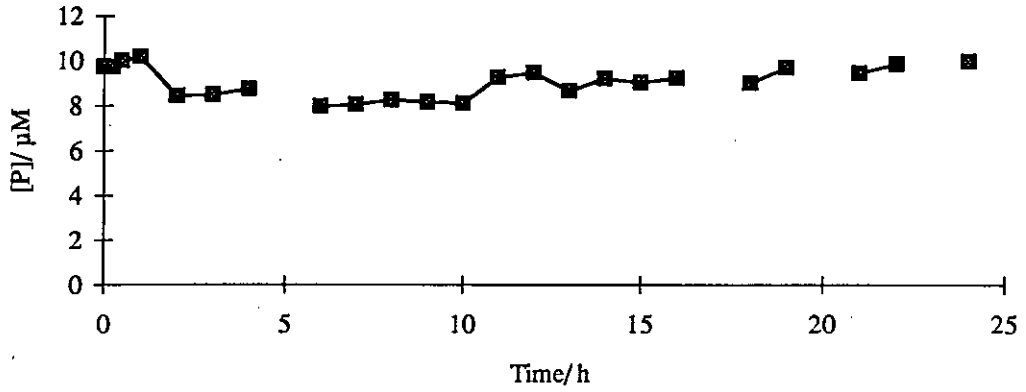
Dissolved oxygen concentration during uptake experiment with Gt. Ouse sediment



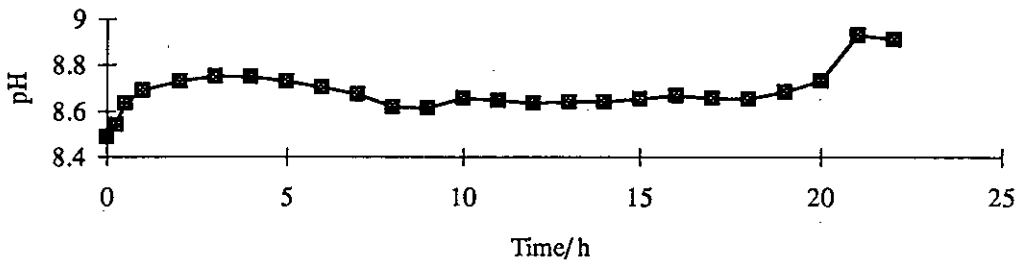
Temperature during uptake experiment with Gt. Ouse sediment



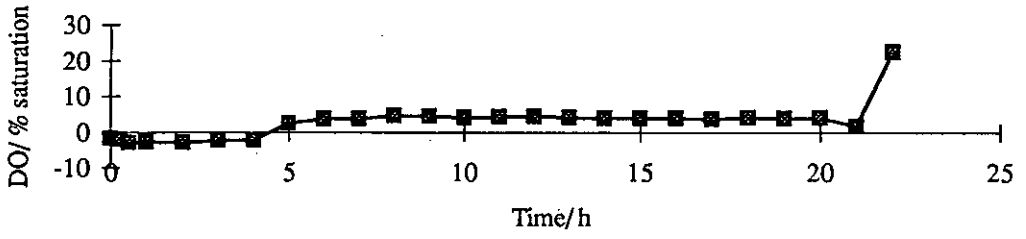
SRP Concentration during Anaerobic experiment with Gt. Ouse sediment



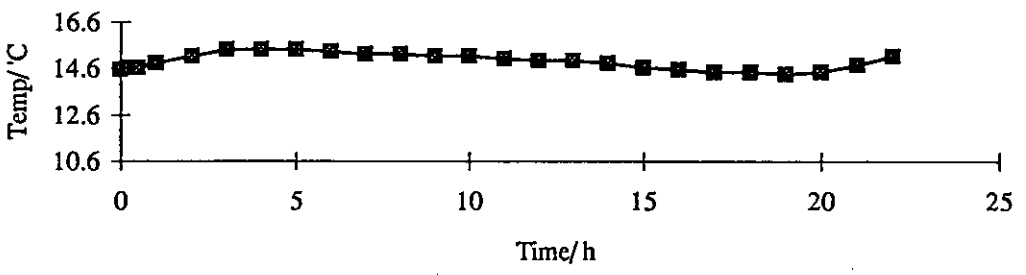
pH during Anaerobic experiment with Gt. Ouse sediment



Dissolved oxygen concentration during Anaerobic experiment with Gt. Ouse sediment



Temperature during Anaerobic experiment with Gt. Ouse sediment



APPENDIX K

Fluvarium experiments with River Blackwater sediment Spring 1995

Sediment collected 10/4/95

River water chemistry at time of sampling:

Ca++ = 2.21 mM	NO3- = 0.51 mM
Mg++ = 0.35 mM	Silicon = 231 µM
Na+ = 2.56 mM	SRP = 70.70 µM
K+ = 0.284 mM	TDP = 93.00 µM
Alkalinity = 3.57 mM	TP = 118.50 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate - experiment 16 = average 24.4 litres/min (decreased during experiment)
Flow rate - experiment 17 = average 18.6 litres/min (decreased during experiment)
Flow rate - experiment 18 = average 13.5 litres/min (decreased during experiment)

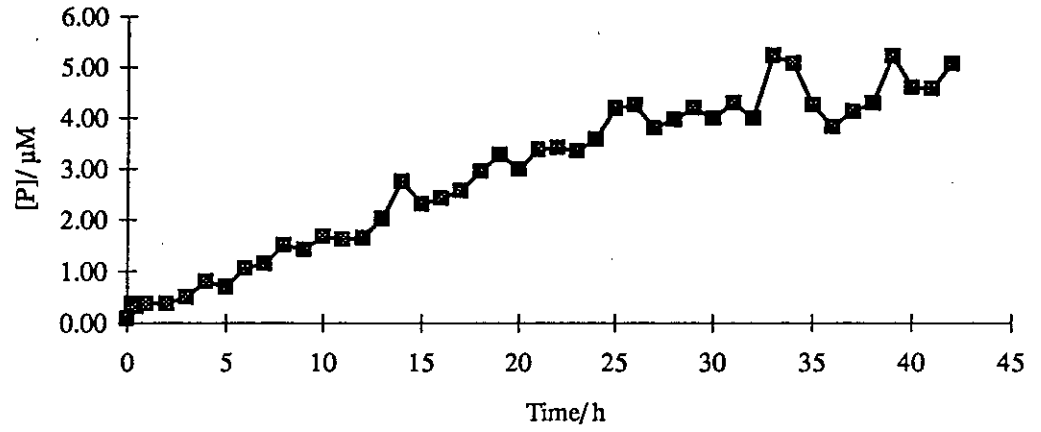
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 5 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 5 minutes.

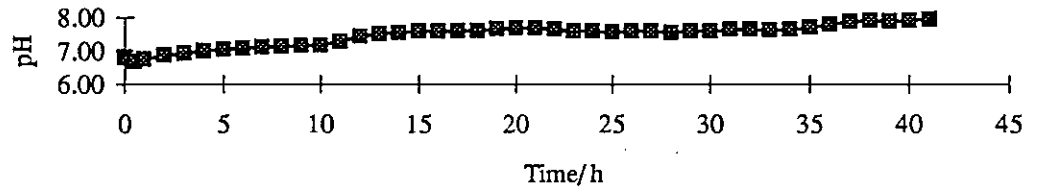
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 3.14 µM; Kd = 928.8 dm^3/kg; ni = 2.9206 µmol/g

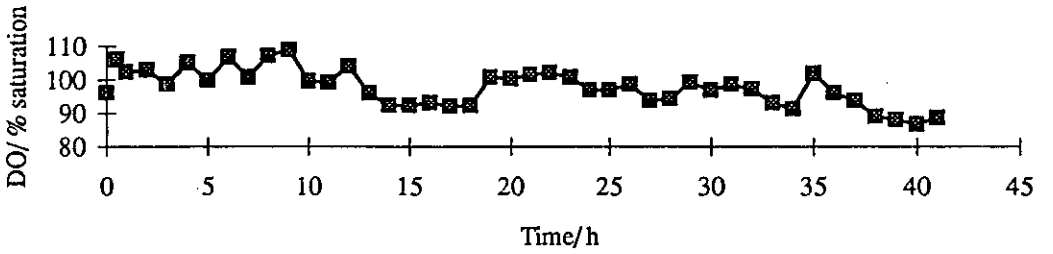
Release of SRP from R. Blackwater bed sediment



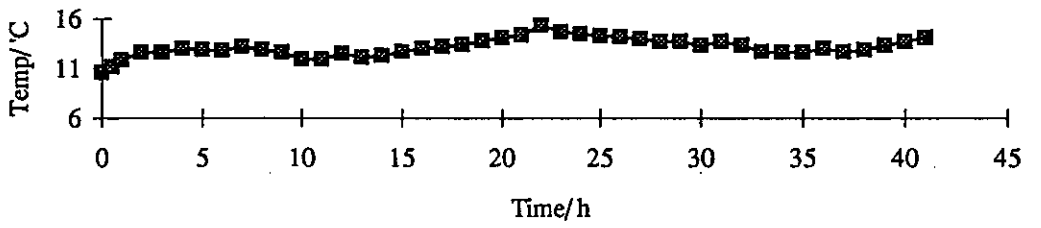
pH during release experiment with R. Blackwater bed sediment



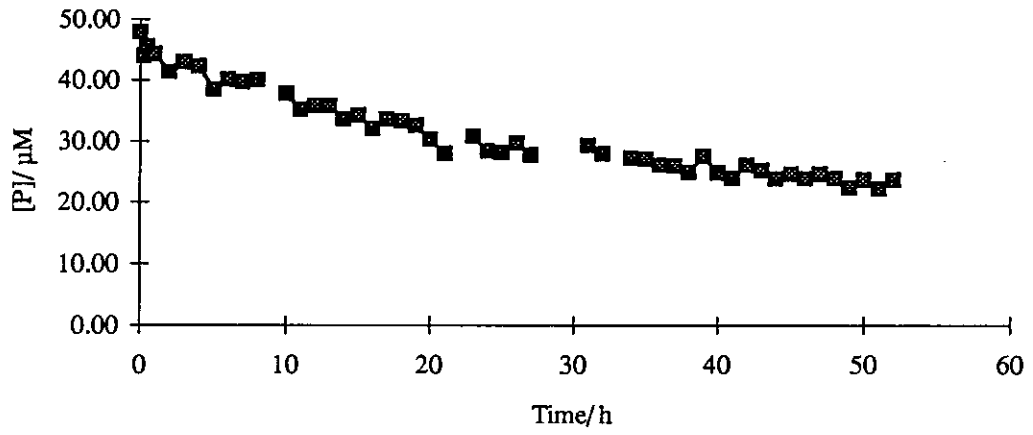
Dissolved Oxygen concentration during release experiment with R. Blackwater bed sediment



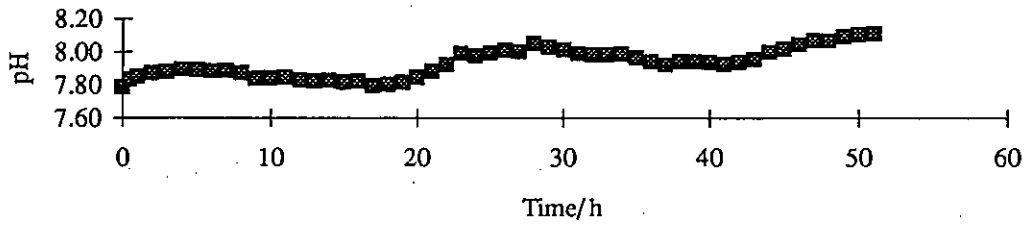
Temperature during release experiment with R. Blackwater bed sediment



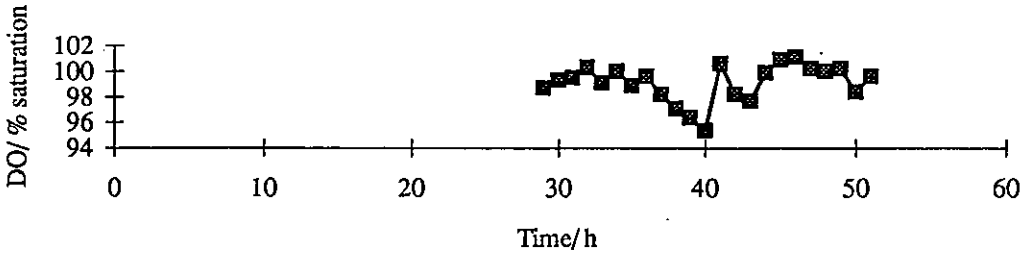
Uptake of SRP by R. Blackwater bed sediment



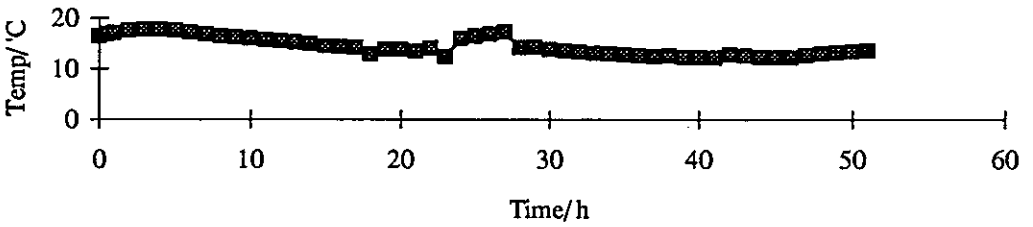
pH during uptake experiment with R. Blackwater bed sediment



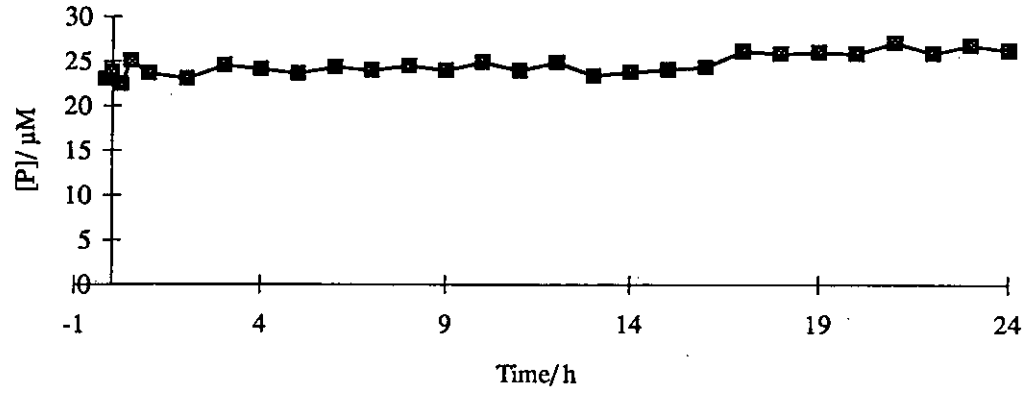
Dissolved Oxygen concentration during uptake experiment with R. Blackwater bed sediment



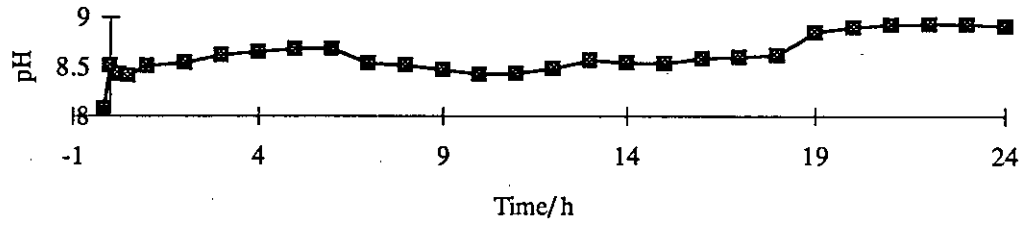
Temperature during uptake experiment with R. Blackwater bed sediment



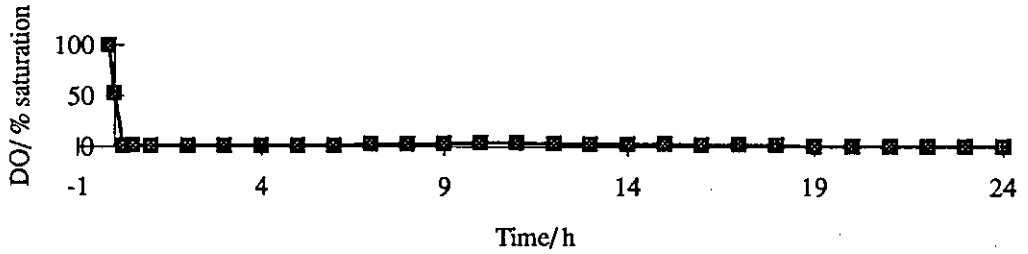
SRP Concentration during Anaerobic experiment with R. Blackwater sediment



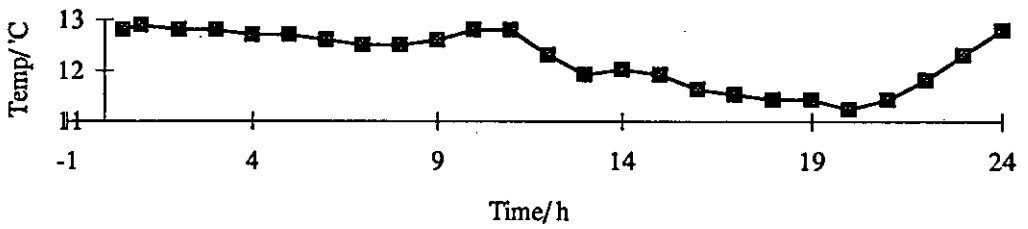
pH during Anaerobic experiment with R. Blackwater sediment



Dissolved Oxygen concentration during Anaerobic experiment with R. Blackwater sediment



Temperature during Anaerobic experiment with R. Blackwater sediment



APPENDIX L

Fluvarium experiments with River Wey sediment Spring 1995

Sediment collected 8/5/95

River water chemistry at time of sampling:

Ca++ = 3.10 mM	NO3- = 0.43 mM
Mg++ = 0.09 mM	Silicon = 204 µM
Na+ = 1.02 mM	SRP = 23.25 µM
K+ = 0.091 mM	TDP = 33.40 µM
Alkalinity = 5.39 mM	TP = 36.90 µM

Channel experiment conditions:
Volume of solution = 21 litres
Flow rate = 28.4 litres/min
Velocity over sediment = 16.7 cm/s

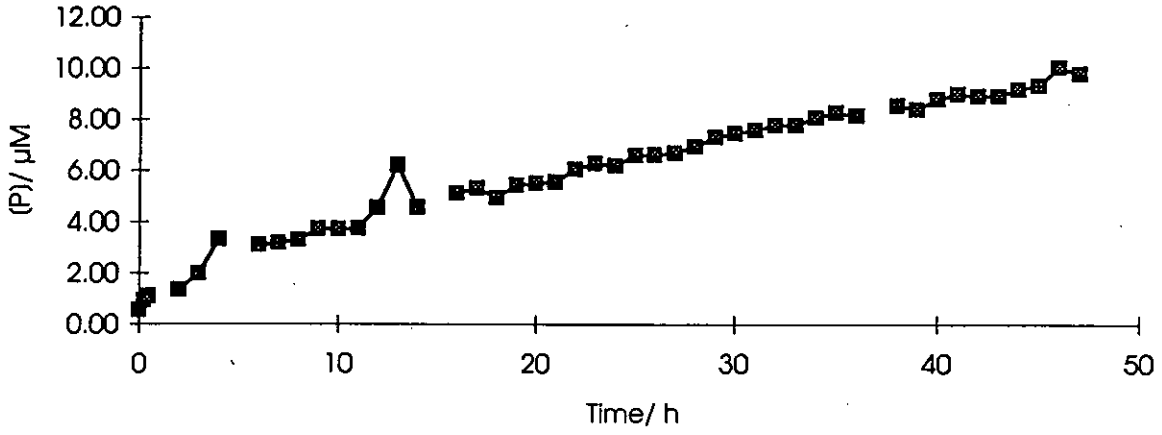
Experiment 1 - release experiment. 2 mM CaCl2 solution put into channel and sampling started 5 minutes after circulation started.

Experiment 2 - uptake experiment. 23.3 ml of 36 mM KH2PO4 added and sampling started after 5 minutes.

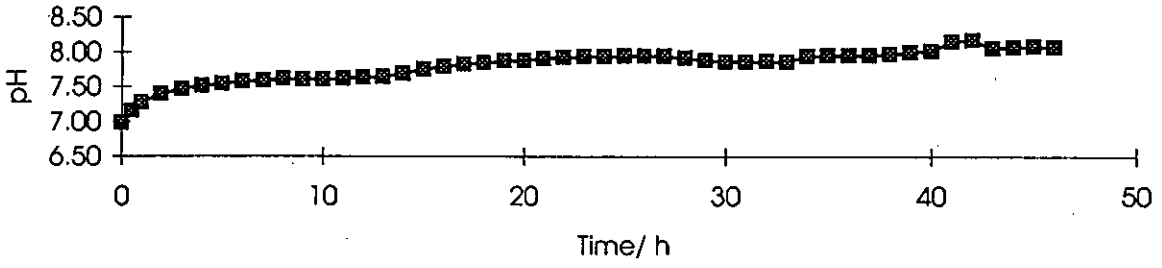
Experiment 3 - Anaerobic experiment. System allowed to equilibriate over weekend, then 6.7 g sodium sulphite added, and Nitrogen supply switched on. 1st sample after 5 minutes.

Sediment: EPCo = 10.19 µM; Kd = 54.0 dm^3/kg; ni = 0.55 µmol/g

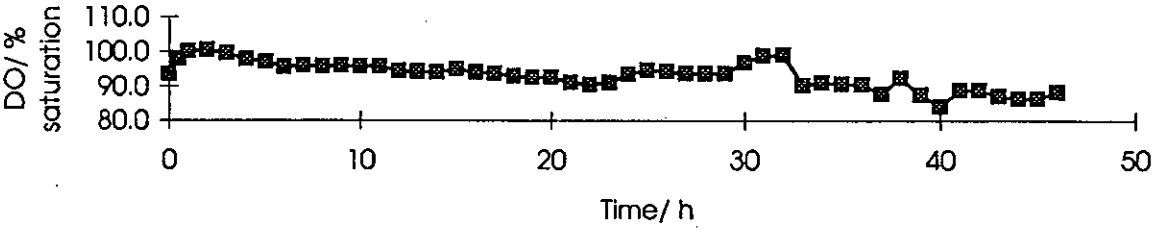
Release of SRP from R. Wey bed sediment



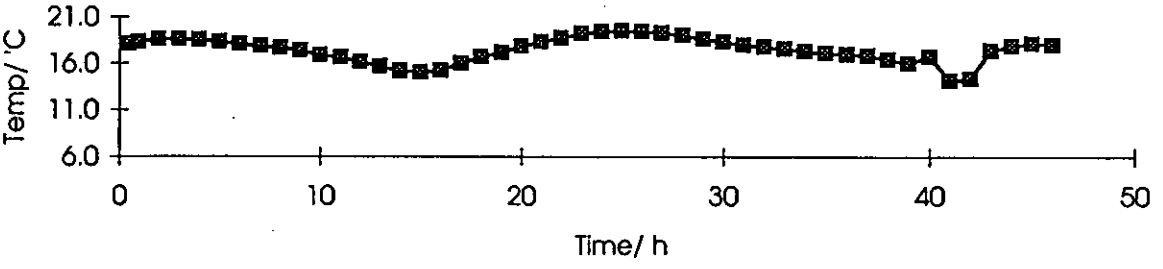
pH during release experiment with R. Wey bed sediment



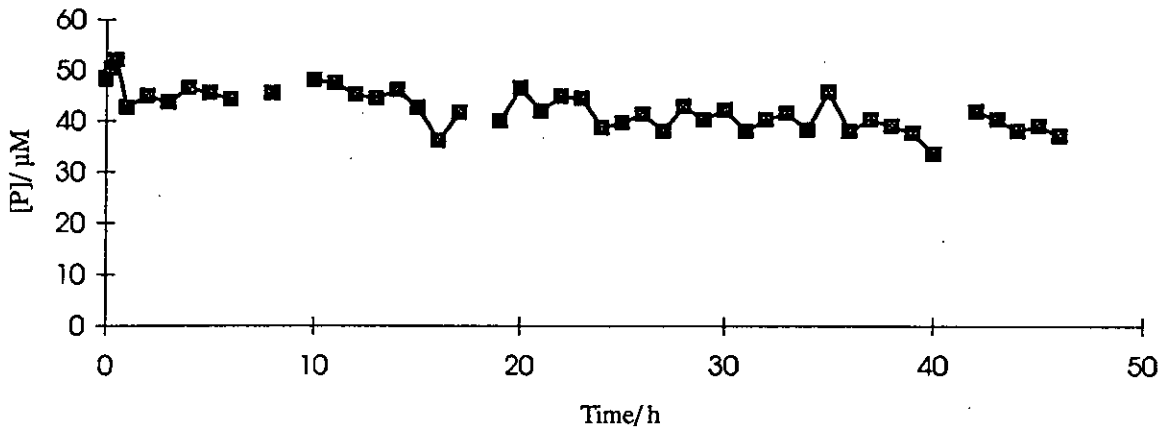
Dissolved Oxygen concentration during release experiment with R. Wey bed sediment



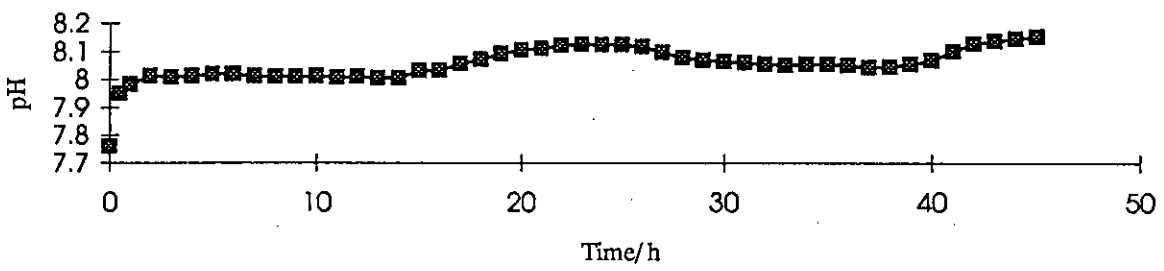
Temperature during release experiment with R. Wey bed sediment



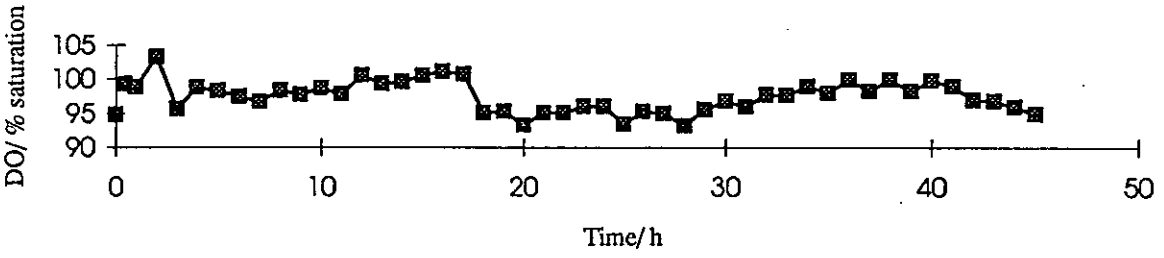
Uptake of SRP by R. Wey bed sediment



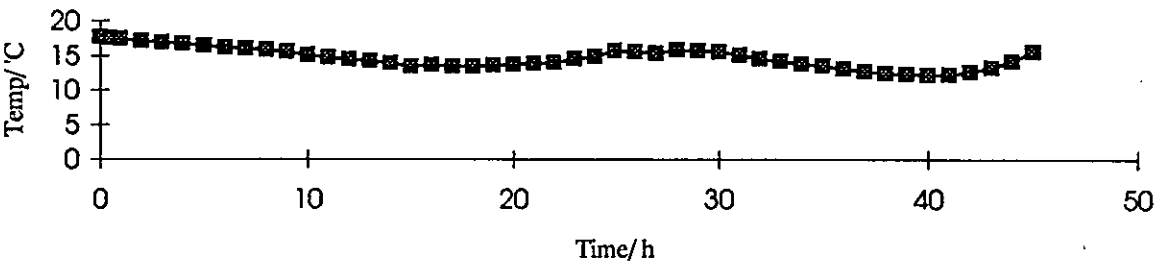
pH during uptake experiment with R. Wey bed sediment



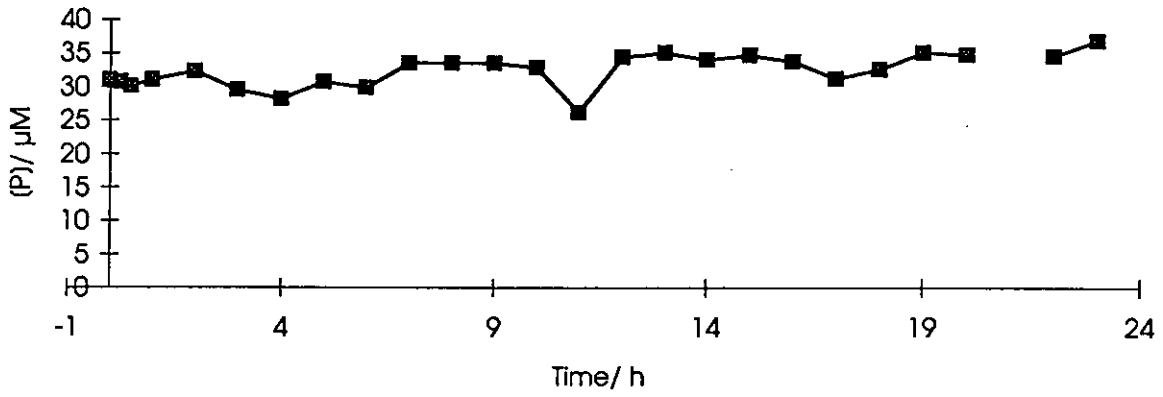
Dissolved Oxygen concentration during uptake experiment with R. Wey bed sediment



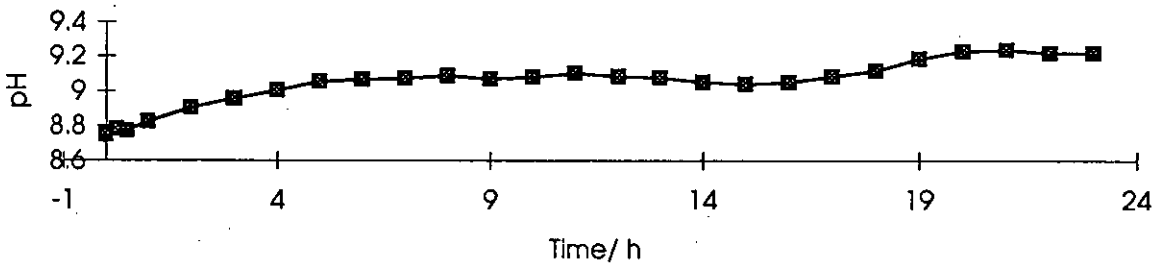
Temperature during uptake experiment with R. Wey bed sediment



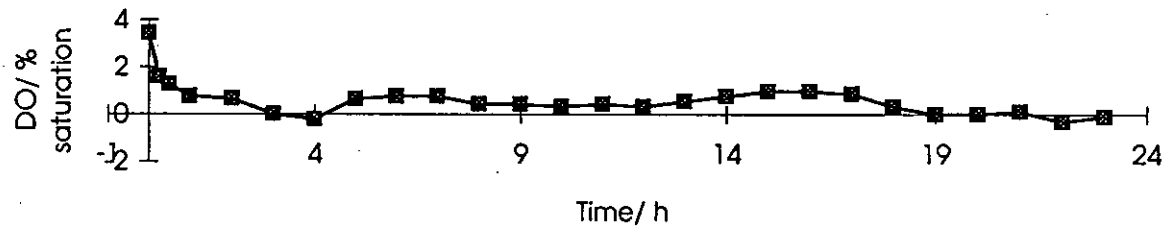
SRP Concentration during Anaerobic experiment with R. Wey sediment



pH during Anaerobic experiment with R. Wey sediment



Dissolved Oxygen concentration during Anaerobic experiment with R. Wey sediment



Temperature during Anaerobic experiment with R. Wey sediment