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Report: MSP-CME-99-03
Marine and Special Projects
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CHESHIRE STILLWATERS
Summary Results of 1999
Oak Mere, Betley Mere, Petty Pool, Tabley Mere, Norbury Mere and Combermere

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1. INTRODUCTION

During 1999, stillwaters monitored for the third year of the Stillwaters Monitoring Programme were Tabley Mere, Comber Mere and Norbury Mere. Surveys of Petty Pool and Betley Mere continued for a second and third year respectively after water quality concerns were highlighted in previous end-of-year reports. Oak Mere was also surveyed for the third year running due to its unusual ecology.

Specific reasons highlighted by the Stillwaters Group for monitoring each stillwater were:

OAK MERE:

- Conservation Status
- Drought issue - water level falling
- Appearance of algal blooms in recent years
- Possible impact of mineral extraction
- An oligotrophic still water

BETLEY MERE:

- Representative of marginal group of meres
- Monitoring recommended for nitrate directive. Felt to be threatened state
- Problems of point source pollution
- Heavily eutrophicated
- High phytoplankton crops threatening submerged plant population
- Intense fish predation (fishery – angling club)

PETTY POOL:

- Conservation status
- Pollution problems in past
- Crayfish reported

TABLEY MERE:

- Knutsford Group of Meres
- Monitoring recommended for Nitrate Directive
- Assess status of mere following installment of M6 interceptor

COMBER MERE:

- Largest mere in Environment Agency North West Region
- Artificially eutrophicated
- Records of native crayfish

NORBURY MERE:

- Pollution problems in west drain
- Monitoring of nutrients recommended
- Fisheries issue – carp and bream

This year, the variety of parameters monitored were limited to algal, zooplankton and water chemical samples. Fisheries and marginal invertebrate surveys were not completed due to lack of resources.

SURVEY DATES

Norbury Mere	07/04/99		
Combermere	07/04/99	16/07/99	04/10/99
Betley Mere	07/04/99	16/07/99	06/10/99
Tabley Mere	09/04/99	15/07/99	06/10/99
Petty Pool	09/04/99	15/07/99	04/10/99
Oakmere	09/04/99	15/07/99	06/10/99

2. PHYSICO-CHEMICAL CHARACTERISTICS AND WATER CHEMISTRY

This report documents the water chemical samples taken by Marine and Special Projects, on the dates shown above. Sample points were chosen to cover the deepest parts of the stillwater whilst at the same time giving good spatial coverage. At the sampling sites bottom and surface water samples were taken to determine nutrient concentrations. A multi-parameter probe measured temperature, pH, specific conductivity and dissolved oxygen (% saturation) through the water column at each site. The sampling methodology employed was largely identical to all previous stillwater surveys and is detailed in report MSP-CME-95-01.

As part of the overall growing interest in Oak Mere, a multi -parameter probe has been deployed in Oak Mere since summer 1997. During visits to Oak Mere to service the water quality instrument, nutrient and chlorophyll samples were taken. These data, along with the continuous physico-chemical data provided by the data sonde and the three comprehensive surveys, have provided a more detailed insight into the limnological characteristics of Oak Mere. Water level measurements have also continued through 1999.

The aim of this report is to provide the yearly statistical results and broad outline of each stillwater. However, since the normal summary reports presented after each survey were not completed for 1999, the report also contains some detail to individual surveys.

Table 1 and 2 list the mean data for physico-chemical parameters and surface and bottom water nutrient concentrations for all stillwaters and Table 3 lists mean data for Oak Mere from the continuous monitoring data. The Appendix includes location maps; graphed individual survey profiles with yearly comparisons for Betley mere, Oak Mere and Petty Pool; graphed continuous physico-chemical data and nutrient spot samples for Oak Mere and water level data; and finally the raw data.

The text description of each stillwater (section 2.1) is supported by the graphs and tables as detailed.

2.1. Survey Details

The beginning of April was relatively wet and cool. However, Comber Mere, Tabley Mere and, to a lesser extent, Oak Mere and Petty Pool showed evidence that the water was beginning to stratify. Tabley Mere showed spatial variation through the mere, attributed to its shape.

Table 1. Average profile readings in surface and bottom waters - April, July & October 1999

Norbury Mere

	07/04/99					
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	12.2					
pH units	8					
Spec.Cond. µS/cm	633.3					
DO % sat.	112.8					

Comber Mere

	07/04/99		16/07/99		04/10/99	
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	10.7	10	19.9	15.65	14.05	13.59
pH units	8.6	8.4	9.02	8.04	7.39	7.27
Spec.Cond. µS/cm	553.7	556.5	467.36	543.18	474.75	488.58
DO % sat.	130.7	114.7	97.6	8.52	61.22	51.9

Betley Mere

	07/04/99		16/07/99		04/10/99	
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	13.2	13.2	18.15	18.14	12.16	12.14
pH units	7.9	7.9	7.63	7.63	7.27	7.35
Spec.Cond. µS/cm	584.3	584.7	651	653.33	530.17	530.17
DO % sat.	99.7	97.6	50.65	49.72	73.1	67.91

Oak Mere

	09/04/99		17/07/99		06/10/99	
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	12	11.9	19.83	18.43	11.29	11.18
pH units	4.6	4.5	4.7	4.74	4.7	4.72
Spec.Cond. µS/cm	100	100.1	97.09	96.94	91.55	91.61
DO % sat.	90.9	87.9	96.92	71.76	96.5	92.81

Petty Pool

	09/04/99		15/07/99			
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	12.9	12.3	19.33	18.48		
pH units	7.5	7.3	8.47	8.03		
Spec.Cond. µS/cm	485.2	486.3	446.98	460.45		
DO % sat.	87.4	64.3	86.97	52.47		

Tabley Mere

	09/04/99		17/07/99		06/10/99	
Paramater	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temperatur °C	13.4	12	19.44	19.09	11.61	10.55
pH units	9.1	8.7	9.04	8.6	7.97	7.15
Spec.Cond. µS/cm	678.8	694.3	567.18	589.9	516.33	567.61
DO % sat.	163.2	123.7	120.63	85.56		

Table 2. Average nutrient readings in surface and bottom waters - April, July & October 1999

Name	Date	Depth	Secchi m	Susp. Solids mg/l	Chlorophyll mg/l	Phaeophytin mg/l	Total P µg/l	ortho - P µg/l	Total N µg/l	Nitrate µg/l	Nitrite µg/l	Ammonia µg/l	silicate µg/l
Norbury Mere	07-APR-1999	surface		11.33	91.00	57.85	94.00	34.17	2636.67	2583.33	54.80	260.43	1643.00
Oak Mere	09-APR-1999	surface	1.20	3.00	8.98	8.12	35.67	20.00	164.00	160.00	4.00	19.00	668.33
		bottom					37.50	20.00	157.67	153.00	4.67	22.67	655.33
Oak Mere	15-JUL-1999	surface	2.30	3.00	6.13		25.33	20.70	3.00	3.00	0.70	10.43	741.17
		bottom					75.00	41.40	10.00	9.37	1.12	68.43	248.73
Oak Mere	06-OCT-1999	surface	2.2	7.00	6.81	5.15	146.33	17.10		3.00	1.00	9.63	517.67
		bottom					56.50	17.45		3.00	1.00	9.50	543.00
Petty Pool	09-APR-1999	surface	1.47	3.33	21.87	15.05	33.00	20.55	3026.67	2996.67	30.43	161.50	8575.00
		bottom					36.67	13.90	3080.00	3046.67	34.27	127.53	8603.33
Petty Pool	15-JUL-1999	surface	0.73	12.33	56.05	37.80	207.33	151.00	114.57	105.50	9.07	71.10	3702.33
		bottom					245.67	169.33	175.27	167.10	8.17	98.67	3817.67
Petty Pool	04-OCT-1999	surface		22.00	121.00	47.30	256.00	176.00		408.20	9.80	130.00	1494.00
Betley Mere	07-APR-1999	surface	0.77	9.67	37.27	22.83	164.00	142.33	2630.00	2593.33	36.43	29.37	4730.00
		bottom					209.67	149.33	2536.67	2510.00	25.53	13.90	4700.00
Betley Mere	16-JUL-1999	surface	0.77	6.33	13.79	10.69	1011.00	986.67	122.53	112.80	9.73	223.67	8120.33
		bottom					1081.67	986.67	117.63	108.27	9.33	204.67	8217.33
Betley Mere	06-OCT-1999	surface	0.7	15.67	46.50	29.87	403.33	320.67		2671.67	47.67	166.23	9236.00
		bottom					433.67	309.00		2639.33	83.67	8.73	9398.00
Comber Mere	07-APR-1999	surface	1.20	6.00	49.13	35.27	187.67	151.33	2420.00	2393.33	26.77	141.33	412.33
		bottom					186.00	164.67	2453.33	2423.33	27.83	309.63	1130.67
Comber Mere	16-JUL-1999	surface	0.93	9.33	62.00	38.03	71.67	75.80	3.00	59.90	0.90	118.17	879.33
		bottom					356.00	294.53	98.30	72.93	26.17	527.67	4614.00
Comber Mere	04-OCT-1999	surface	1.73	6.33	26.27	18.23	364.00	1614.33		1413.77	25.07	392.33	3601.33
		bottom					540.33	506.00		525.30	615.67	69.07	5264.33
Tabley Mere	09-APR-1999	surface	0.35	19.67	197.67	130.60	82.33	9.73	3213.33	3156.67	55.63	396.00	24.27
		bottom					81.00	15.50	2345.00	2305.00	38.30	283.00	720.30
Tabley Mere	15-JUL-1999	surface	1.20	6.00	20.30		268.67	218.67	651.07	597.17	21.03	67.50	2412.33
		bottom					369.00	223.00	689.70	630.43	25.90	152.43	2052.67
Tabley Mere	06-OCT-1999	surface	0.85	20.33	146.80	86.67	316.33	315.00		6062.00	155.33	279.00	5202.33
		bottom					301.33	200.33		6746.00	321.33	186.87	6063.00

Mid July was warm with occasional rain. Water temperatures increased to an average of 18 °C from April's average of 12°C. Both Oak Mere and Comber Mere showed signs of increased stratification, whereas Betley Mere and Petty Pool had similar profiles to April. Tabley Mere did not show the same extremely high dissolved oxygen levels.

At the beginning of October ambient temperatures were beginning to cool and it was dry. Prior to the October surveys there had been periods of heavy rainfall and water levels were up in many of the Stillwaters, particularly Norbury Mere where the immediate bankside was flooded.

Access and Instrumentation Problems
In April Norbury Mere was sampled for nutrients and physico-chemical parameters from three bank-side sites but in July and October access was not possible and no samples were taken. In October Petty Pool was not accessible and only nutrient and chlorophyll samples were taken from one bank site. The only instrumentation problem occurred during the October surveys. At Betley Mere the instrument malfunctioned just after Site 1 had been profiled and at Tabley Mere the dissolved oxygen readings fluctuated enough to warrant omission from the results.

NORBURY MERE – April only

- Dissolved oxygen was supersaturated in the southern mere, averaging 125 %.
- Water clarity was quite low and brown in colour.
- Consistent with the high chlorophyll a concentration (91 mg/l), over half of the soluble phosphate present had been consumed by phytoplankton (34 µg/l ortho–phosphate compared to 94 µg/l total phosphorus).
- Nitrogen was predominately present as nitrate (2583 µg/l NO_3), although ammonia levels were also significant (260 µg/l) suggesting higher rates of animal excretions and bacterial oxidation than plant uptake.

COMBER MERE

- Dissolved oxygen levels and differences between surface and bottom waters reflected the degree of stratification. During July stratification was most intense, the thermocline being 5 m from the bottom with bottom waters averaging 8 % sat.
- Surface water values of phosphorus decreased to 70 µg/l in July due to consumption and bottom values had risen to 355 µg/l since stratification physically limits input from the hypolimnion. Once stratification began to break down in October, values were up in both surface and bottom waters. The slightly lower values of ortho – Phosphate showed uptake was relatively low.
- Again, due to uptake by algae, nitrate levels in July had fallen to 60 µg/l in surface waters and stratification meant values differed through the water column. This variation was significant with ammonia (120 µg/l surface, 525 µg/l bottom) because the anoxic bottom waters caused nitrate to convert to ammonia. Along with the high pH present, high ammonia levels could be harmful to plants and animals with toxic ammonium hydroxide forming.
- Silicate increased through the year, rising from 400 µg/l to 3600 µg/l in surface waters. One indication of an enriched water body is a low concentration of silica as high loading of nitrogen and phosphorus favours algae that do not require silica. Comber Mere had low silicate readings compared to the other known enriched stillwaters.

BETLEY MERE

- There was a significant decrease in dissolved oxygen in surface waters during summer months, from near super-saturation levels in April to an average of 50 % sat. in July. By October levels had risen again to 70 % sat..
- Through the year the normal seasonal pattern of Phosphorus is confused with an apparent increase in values in summer, from an average of 190 µg/l in April to 1000 µg/l in July and decreasing to 415 µg/l in October.
- This correlates with the unexpected decrease in chlorophyll a concentration during the summer months, from 37 mg/l in April to 14 mg/l in July and increasing again to 47 mg/l in October. Generally, these chlorophyll concentrations are low considering the concentrations of the principle nutrients.
- Nitrogen is predominately present as nitrate and levels follow the expected pattern with a decrease in summer months. Ammonia rose significantly from 20 µg/l in April to over 200 µg/l in July.
- Although Betley Mere is shallow (< 1 m in places) the secchi disc did not touch the bottom, reflecting the low water clarity throughout the year (0.7 m).

Comparison with 1997 and 1998 data

Over the last three years there has been no significant change to the seasonal pattern in physico-chemical parameters and nutrient levels. The only slight change to note may be a decrease in phosphorus concentration, with a corresponding decrease in summer chlorophyll abundance. Nitrate levels appear to remain stable although the percentage present as ammonia may be reducing. However, continuous monitoring would need to confirm this.

PETTY POOL

- Although dissolved oxygen levels did not fall below 50 % sat. in bottom waters, pH had increased from an average of 7.4 in April to an average of 8.2 in July, which could begin to cause problems to some fish species.
- Both phosphorus and nitrogen were predominately present as total phosphorus and nitrate in April and July although some ortho-phosphate had been consumed. However, phosphorus levels showed an apparent increase from April to July (35 to 250 µg/l).
- This has produced an unusual seasonal pattern since chlorophyll concentration also increased (from 3 to 22 mg/l).
- Water clarity decreased from April to July from 1.5 m to 0.7 m depth, reflecting the increase in both chlorophyll and suspended solids (3 to 12 mg/l) concentration.
- Silicate decreased through the year indicating less input from the catchment than sedimentation to the lake bottom.

Comparison with 1998 data

Physico-chemical parameters remained relatively stable between April '98 and July '99, only dissolved oxygen showing a downward trend. Nutrient data fluctuates and it is difficult to determine any long-term trends to due to the limited data. However, it appears that spring / summer phosphorus levels rose between '98 and '99 and nitrogen levels slightly decreased, although ammonia levels had risen.

TABLEY MERE

- In April, dissolved oxygen in the small, shallow basin (site 1) read in excess of the instrumentation limits (over 200 %) and Site 3 (very shallow at <1 m) read 150 – 160 % sat.. Site 2 is situated in a narrow channel and is the deepest point (4 m).

- pH was high in April and July, averaging 8.9. In October pH varied from a minimum of 6.7 to a maximum of 9. Such variation should be treated with caution and may reflect an instrumentation problem rather than a true reading.
- As with other stillwaters, phosphorus (total and ortho) showed an increase through the year, from 80 μg/l in April to 300 μg/l in October.
- Ammonia showed high levels, in both supersaturated surface and anoxic bottom waters (maximum 396 μg/l in April). The increase in October during de-stratification was expected but July values may not be representative since summer values of ammonia in the epilimnion can fluctuate considerably over a few days.
- The low values of ammonia in summer are not from algal consumption since chlorophyll a readings were significantly low at 20 mg/l.
- Chlorophyll concentrations were very high in April at almost 200 mg/l. Release of photo-synthetically produced oxygen would contribute to the excessive super-saturation of surface waters seen in April.
- Secchi disc transparency was exceptionally low in April and July at 0.3 and 0.7 m depth respective which, for April can be attributed to both chlorophyll levels and suspended solids concentration (20 mg/l).
- The increase of silicate through the year (700 to 5500 μS/cm) illustrates either an increase of silica in run-off from the catchment and / or release from some decaying algal species before sedimentation.

OAK MERE, including continuous monitoring

- Throughout the year dissolved oxygen in surface waters remained high and in July reached a low of 20 % sat. in bottom waters.
- Super-saturation levels of 115 % sat. in September is not atypical but a late winter high does distort the expected seasonal pattern (115 % sat. recorded in February / March). However chlorophyll a levels were uncharacteristically high in February (35 mg/l) which would provide photo-synthetically produced oxygen.
- There was little change in pH during 1999, with pH ranging from 4.3 to 5.1.
- Nitrogen and phosphorus levels remained relatively low all year. However phosphorus does appear to remain relatively steady through the year (around 50 μg/l) where nitrogen decreases (200 μg/l down to the Limit of Detection)
- Chlorophyll levels reflect the levels of nutrients available. The high chlorophyll levels in February may be a factor of the abundance of nitrogen present, (nitrate max. of 200 μg/l) and the low concentrations during the summer months (< 3 mg/l) a reflection of the low nutrient levels available. The increase in chlorophyll concentration in autumn can be expected as de-stratification occurs and more nutrients are available to the photic zone, however the December high of 50 mg/l is atypical so late in the year.
- Neither the suspended solids (maximum 6 mg/l) nor chlorophyll concentration can explain the low water clarity (0.6 to 1.8 m depth).

Water level data

Oak Mere is a surface manifestation of groundwater. The Mere has experienced considerable variation in water level in the past with levels lowering in recent times. This drop is due to ground water flowing to an area of heavy abstraction. However, more recent visual observations

TABLE 3.

Surface water physico-chemical parameters in Oakmere

Parameter	1997 Min	1997 Max	1997 Average	1997 Coverage %	1998 Min	1998 Max	1998 Average	1998 Coverage %	1999 Min	1999 Max	1999 Average	1999 Coverage %
Temperature °C	2.82	25.3	13.0	44	2.8	23.2	15	58.9	1.9	24.1	12.4	65.5
Specific conductivity µS/cm	96.3	169.9	114.5	43.9	79	122.4	98.9	58.9	78	118	96.2	60.6
Dissolved Oxygen %	39.2	118.2	87.9	28.8	72.1	112.6	91.5	58.9	57.9	116.5	93.5	54.9
pH	4.33	4.9	4.6	43.9	4.2	5.0	4.5	58.9	4.3	5.1	4.6	62.7
Depth metres	0.5	1.42	1.16	36.3	0.4	1.2	0.8	58.9	0.4	1.1	0.8	56.0

Surface water nutrient levels in Oakmere

Parameter	1997 Min	1997 Max	1997 Average	1998 Min	1998 Max	1998 Average	1999 Min	1999 Max	1999 Average
Chlorophyll a µg/l	2.77	17.54	9.67	4.25	15.43	8.14	3.12	48.5	14.9
Total P µg/l	44.67	85.67	61.46	37.0	54.0	46.78	23.0	69.0	48.18
Ortho - P µg/l	27.17	71.71	44.78	28.1	47.83	37.32	1.0	37.2	15.73
Nitrate µg/l	3.0	241.33	121.50	3.70	429.0	117.54	3.0	201.0	61.2
Ammonia µg/l	18.75	63.70	45.87	13.8	119.67	66.41	5.2	119.0	30.83
Silicate µg/l	72.33	376.0	178.08	71.22	558.0	287.41	41.8	730.0	393.25

No. of samples taken 4 7 11

Bottom water nutrient levels in Oakmere

Parameter	1997 Min	1997 Max	1997 Average	1998 Min	1998 Max	1998 Average	1999 Min	1999 Max	1999 Average
Total P µg/l	57.33	81.67	71.67	30.00	48.33	39.0	35.20	127.0	65.64
Ortho-P µg/l	36.77	65.70	54.27	31.43	49.73	39.12	1.0	82.0	26.57
Nitrate µg/l	3.8	136.3	87.04	10.70	411.33	205.46	3.0	157.0	39.38
Ammonia µg/l	30.67	112.40	62.91	17.77	135.67	68.31	12.8	167.0	51.07
Silcate µg/l	72.67	149.0	110.98	149.67	326.67	229.11	352.0	671.0	480.62

No. of samples taken 3 3 6

have seen a rise in water level and this is confirmed by water level data, see Appendix, showing a rise of 0.7 m from Ordance Datum from spring 1998 until present. During the late summer / early autumn months water level shows a decrease but this is only slight and has not effected the overall net increase.

Apart from nutrient levels determining productivity, availability of carbon dioxide is a limiting factor. If there is an increase in the amount of decaying organic debris, the amount of carbon dioxide in the water will increase. The increase in water level at Oak Mere has meant more of the grass verge is being covered, leading to an increase in abundance of decaying matter. This could account for the high chlorophyll readings in December since water levels have continued to rise.

Comparison with 1997 and 1998

pH has remained stable over the last two years, at around 4.6. Specific conductivity is narrower than the previous two years with less extreme events and dissolved oxygen showed a greater variation between surface and bottom waters during summer '99. Over the three years phosphate levels appear to have decreased and silicate levels to have increased. Nitrogen does not show any long - term trend except to say ammonia levels appear to have decreased. Water samples for nutrients and chlorophyll concentration will continue through year 2000.

3. ALGAL AND ZOOPLANKTON SURVEYS

PHYTOPLANKTON RESULTS

The Algae were sampled in 1999 during April, July and October. Triplicate preserved samples were collected at all sites with the exception of Petty Pool due to access problems. Live samples were taken at all the Meres with the exception of the October survey on Combermere and Petty pool.

All comparisons below refer to preserved algae.

OAKMERE

- On all occasions the algal community was composed of the green alga, *Chlorella vulgaris* with increased abundance in July. *Scenedesmus quadricauda* was present at one site in the April sample. *Rhodomonas minuta* was dominant in all three samples with the additional occurrence of *Cryptomonas sp* in April. The diatom, *Stephanodiscus spp*, which is common in most water bodies, was also present in the July and October samples.
- The April sample was dominated by *Rhodomonas minuta* which is an important food source for zooplankton.
- There was no evidence within 1999 samples of any blue-green algae.

PETTY POOL

- A number of blue-green algal species were recorded in July and October at Petty Pool. These included *Anabaena sp*, *Aphanizomenon sp*, *Gomphosphaeria sp*, *Microcystis sp* and *Oscillatoria sp*. Warning level thresholds were exceeded by the majority of species present and indicated the possible production of toxins. Planktonic blue-green algae at times produce very large floating masses at the surface of lakes in calm weather, particularly in autumn. Petty pool was a prime example of this phenomenon, especially in October, where the surface water had a green paint appearance.

- In July, a bloom of *Gomphosphaeria sp* was found at all three sample locations with the additional presence of *Chlorella vulgaris*.
- In October, the bloom of colonial *Gomphosphaeria sp* had subsided and been replaced by *Microcyctis sp* and *Anabaena sp.*
- Abundance of Crytophyceae were relatively high in the April sample but markedly decreased in the following samples taken.

TABLEY MERE

- A bloom of *Gomphosphaeria spp* at all three locations was recorded in July at Tabley Mere.
- Significant numbers and increased diversity of flagellates, diatoms and planktonic green algae was noted in the April sample, with the highest densities being recorded at site 1.
- In October, the diatom *Stephanodiscus spp*, dominated at all three sample sites.

COMBERMERE

- The highest diversity of algal species was recorded in samples taken in July at Combermere, with seven different species of blue green alga recorded. Blue-greens were also recorded in April and October but to a significantly lesser extent.
- Overall, the flora present included a diverse range of planktonic greens, flagellates and diatoms.
- Ten different species of diatoms were recorded across the three sample periods. *Cyclotella sp* dominated in the October sample, *Stephanodiscus sp* dominated in July and *Asterionella formosa* was the most dominant diatom in the April sample. This increased diversity of diatoms, when compared to other mere sites with the exception of Betley, may be due to the higher levels of silicates present.

BETLEY MERE

- On all three occasions, the algal community was composed of planktonic green algae such as *Staurastrum spp*, diatoms and flagellates. Blue-green algae were present in small numbers in the preserved October samples and were more abundant in the live samples from July.
- In July, the flora was dominated by flagellates (Rhodomonas minuta) as it was in July 1998. High numbers of *Cryptomonas sp* were also recorded.
- *Chlorella vulgaris* was the most dominant green alga in all three sample periods, closely followed by *Crucigenia tetrapedia* in the July and October samples.

ZOOPLANKTON ANALYSIS

BETLEY MERE

- The zooplankton community indicates a healthy structure with a range of species and abundance typical of clear water, where sufficient zooplankton exist to graze the algae. *Diaptomus sp* dominated in October whereas *Cyclops spp* dominated in July. Low abundances were recorded of all species present in the April sample, which may correspond to the low densities of algae available to be grazed.
- In general, abundance was higher in July than the other two months and this may also correspond to the higher densities and diversity of algae present.

OAKMERE

- High numbers of *Bosmina sp* were recorded in April at this site but were significantly less abundant than samples taken in April last year. *Ceriodaphnia sp* became dominant in the July samples and *Diaptomus spp* were dominant in October.
- A total of six zooplankton species were found in Oakmere in 1999, which indicates a healthy community for a mere of this water chemistry.

PETTY POOL

- No samples were received for October at this site due to restricted access. A more diverse rotifera community was noted in the April samples, which may be linked to the high numbers of the Cryptophyceae family of algae present at that time.
- Generally lower abundance was recorded, possibly due to the high levels of toxin producing blue-green algae, present in July and October.

COMBERMERE

- Reduced species diversity was recorded in April but significantly increased in July and October.
- High abundance of Daphniidae were recorded in the center of the Lake in July with reduced abundance in October. This is probably due to the high abundance of the alga, *Rhodomonas minuta*, which is a valuable food source for the zooplankton community.

TABLEY MERE

- Six zooplankton species were recorded with generally low abundance across the sampling periods. Species diversity was highest during the July sampling periods.
- It is possible that insufficient habitats are available to provide refuge for the zooplankton.

4. DISCUSSION

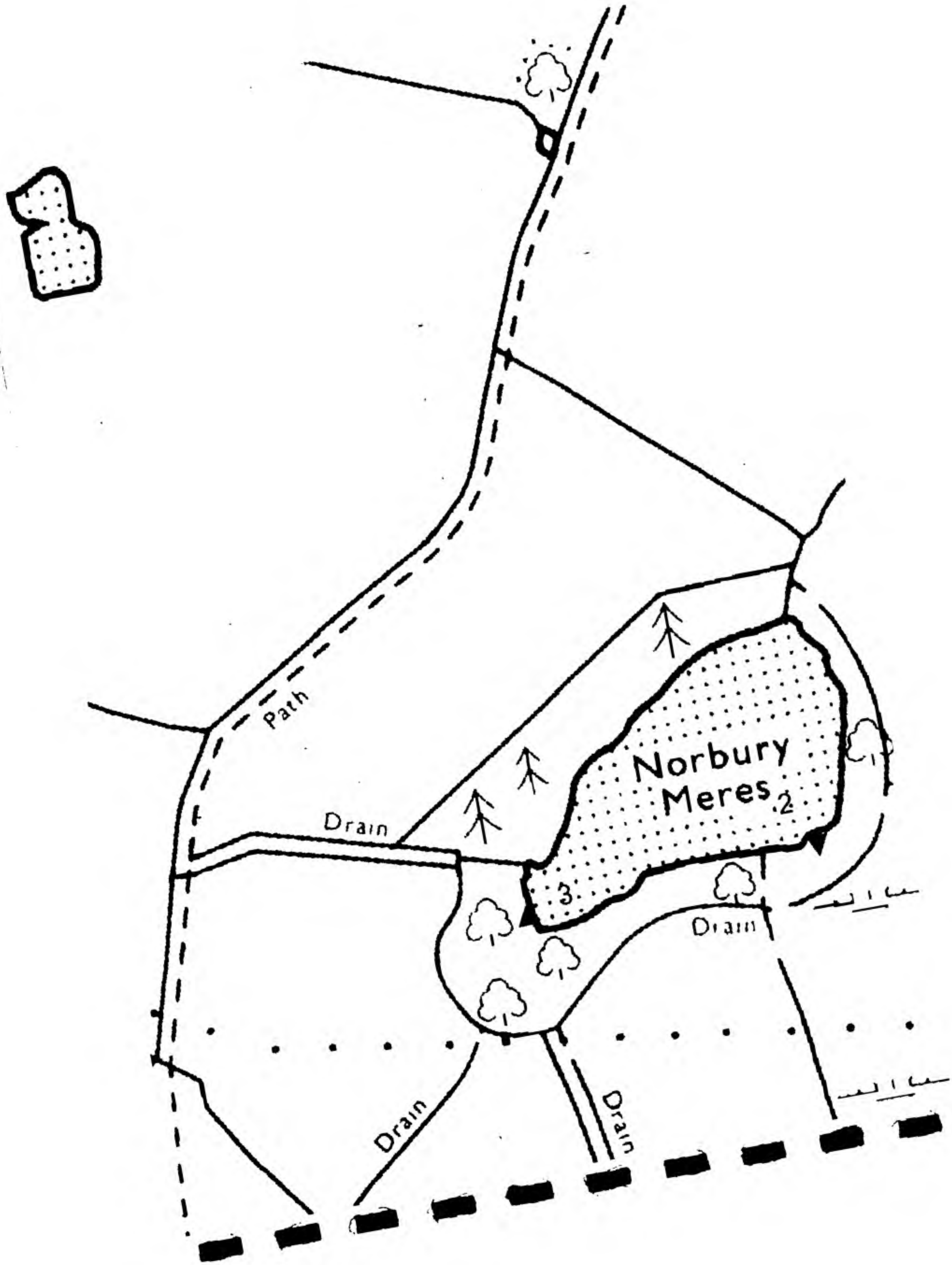
- 1999 data from Petty Pool, Betley Mere, Combermere and Tabley Mere classified the trophic status of each stillwater as hyper-eutrophic / eutrophic.
- These stillwaters showed a similar seasonal pattern in that phosphorus **increased** throughout the year (except for Comber Mere) and nitrogen decreased in summer months with a slight increase again in autumn.
- The nutrient requirements of plankton are approximately in the ratio of 15:1 phosphorus to nitrogen (Redfield ratio). If the ratio is less than 15:1 there is more nitrogen present and phosphorus becomes the growth-limiting factor. Greater than 15:1 and nitrogen is deficient and becomes the growth-limiting factor. In freshwaters, phosphorus is the growth-limiting factor.
- Based on the Redfield ratio for the four stillwaters, the decrease in levels of nitrogen below the summer phosphorus levels and only a nominal rise in autumn meant nitrogen became the growth - limiting factor for phytoplankton during summer and autumn.
- For Petty Pool and Tabley Mere in April, the N:P ratio meant phosphorus became the growth –limiting factor.
- Oak Mere has been classified as mesotrophic / eutrophic and the N:P ratio shows that nitrogen was the limiting factor throughout the year.
- Blue green algae was present in three meres: Petty Pool, Comber Mere and Betley Mere.

Zooplankton species numbers were highest in Oak Mere and Tabley Mere with the lowest in Petty Pool.

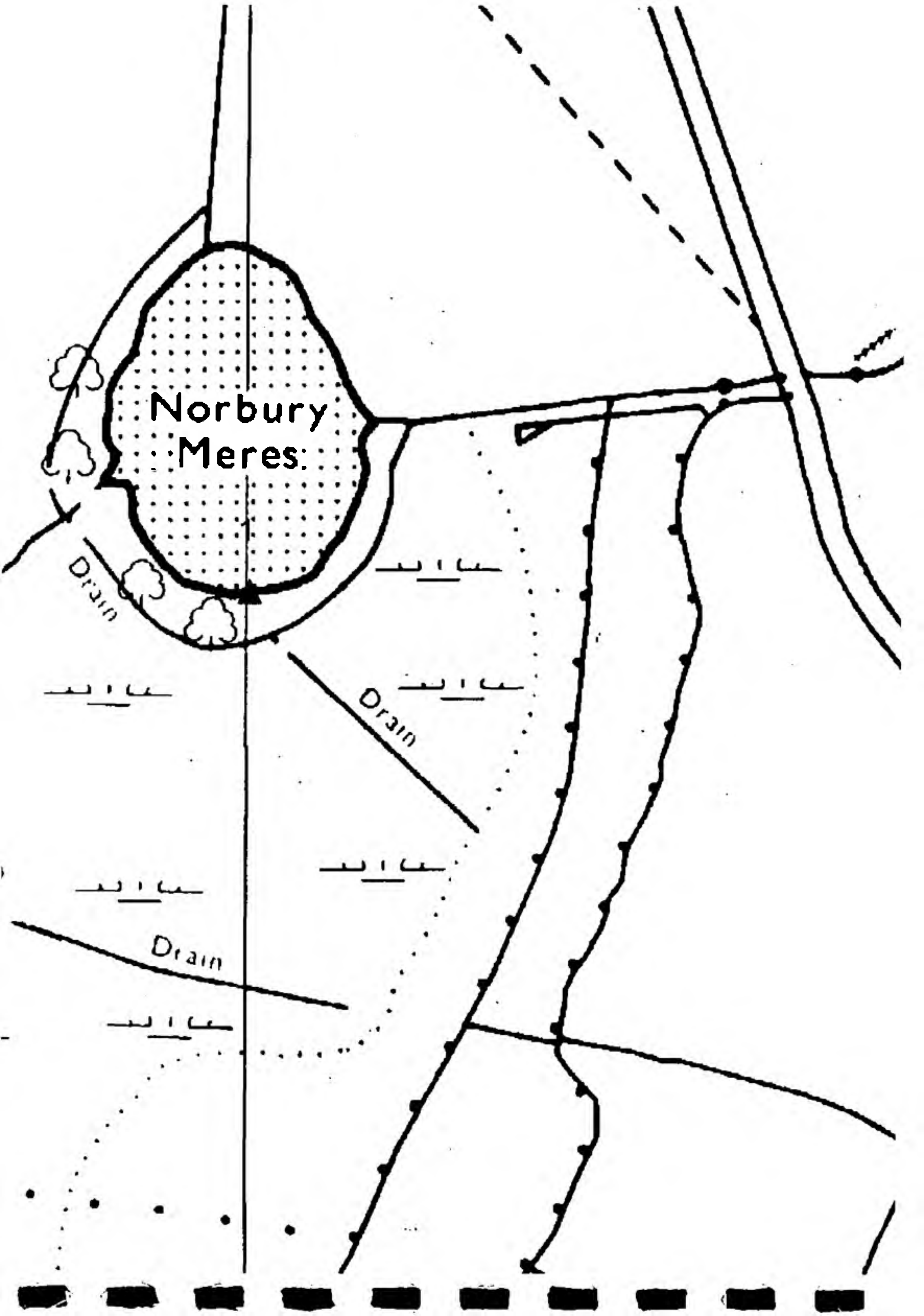
5. PLANNED SURVEYS 2000

The 2000 programme is to be decided at the next Stillwaters Meeting, due to be held 29th February 2000.

Based on the principle that the monitoring programme cycles every three years, surveys in 2000 should include Oak Mere, Betley Mere and Marbury Big Mere. However, it is likely that interpretation of the 1999 results will mean other stillwaters are included. (Contact Sarah Jones 01925 653999 ext 2743 for listings).



Path
Norbury
Meres
2
3
Drain
Drain
Drain
Drain


Norbury
Meres
Drain
Drain
Drain

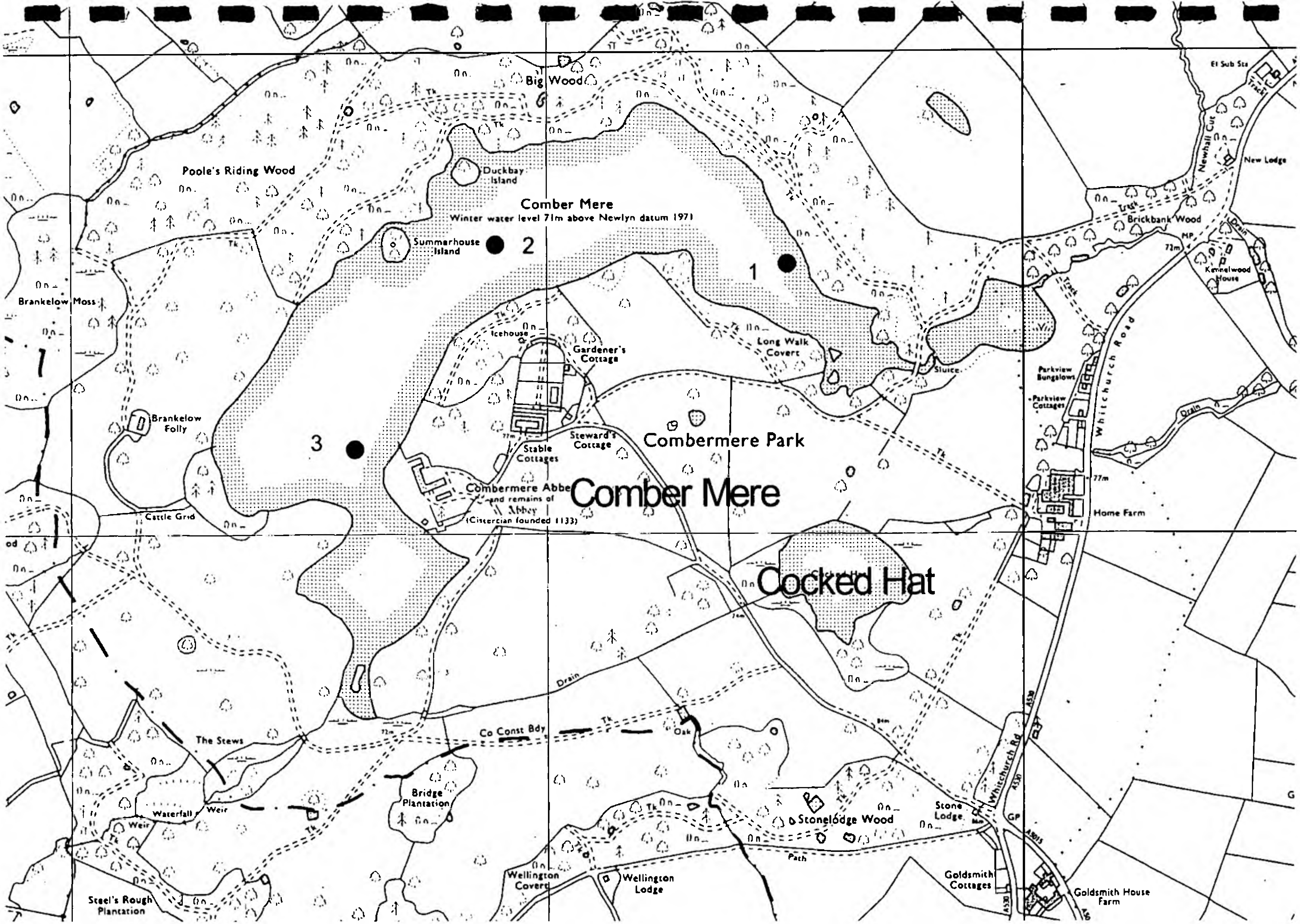

Big Wood
Poole's Riding Wood
Duckbay Island
Comber Mere
Winter water level 71m above Newlyn datum 1971
Summerhouse Island
1
2
3
Brankelow Moss
Brankelow Folly
Icehouse
Gardener's Cottage
Long Walk Covert
Sluice
Stable Cottages
Steward's Cottage
Combermere Park
Combermere Abbey and remains of Abbey (Cistercian founded 1133)
Comber Mere
Cattle Grid
Cocked Hat
Drain
Co Const Bdy
Oak
The Stews
Waterfall
Weir
Bridge Plantation
Stonelodge Wood
Stone Lodge
Wellington Covert
Wellington Lodge
Path
Steel's Rough Plantation
Goldsmith Cottages
Goldsmith House Farm
Whitchurch Road
Whitchurch Rd
Home Farm
Parkview Bungalows
Parkview Cottages
Brickbank Wood
Kennelwood House
New Lodge
Newhall Cut
El Sub Sta
Track

Figure Betley Mere

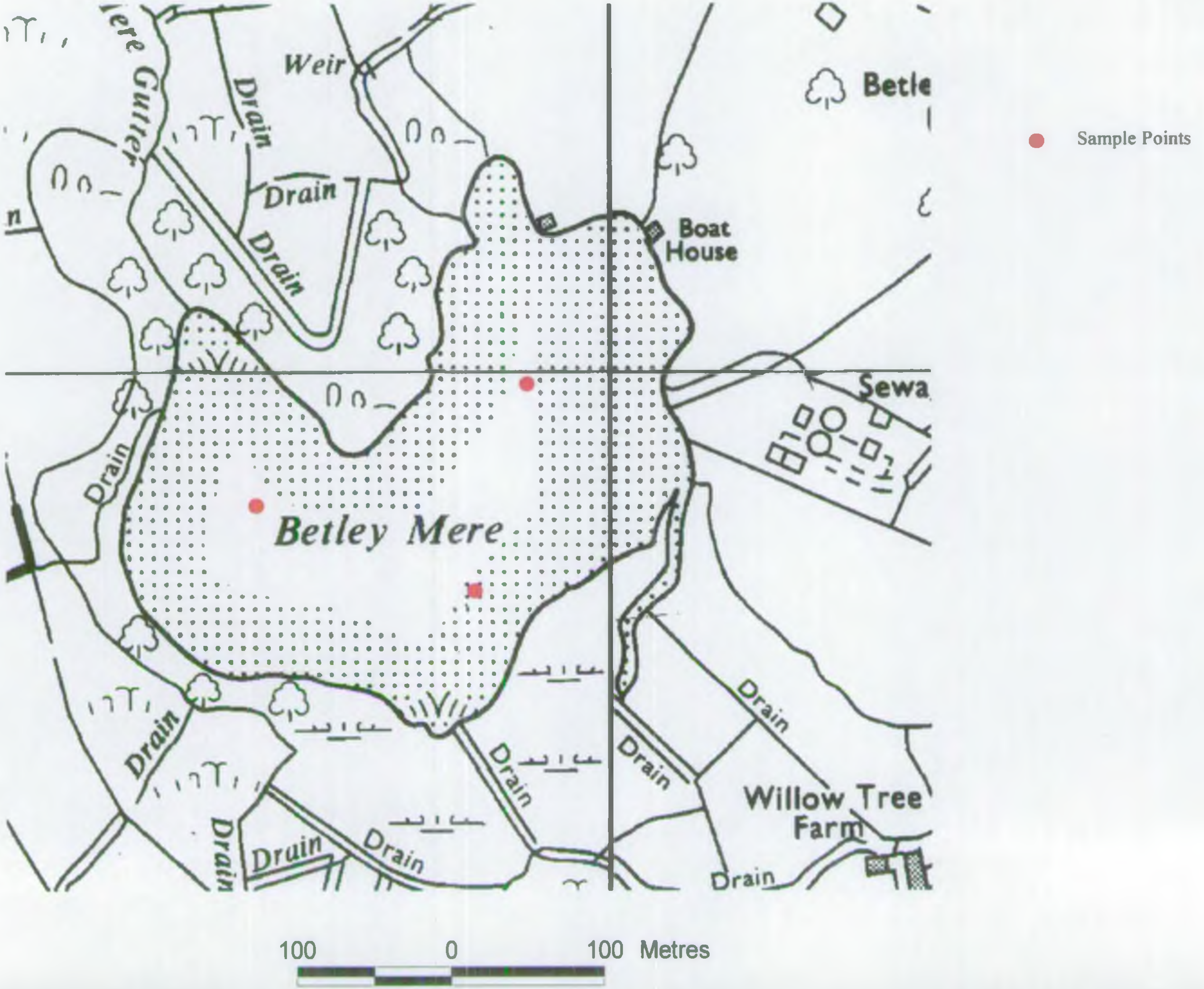
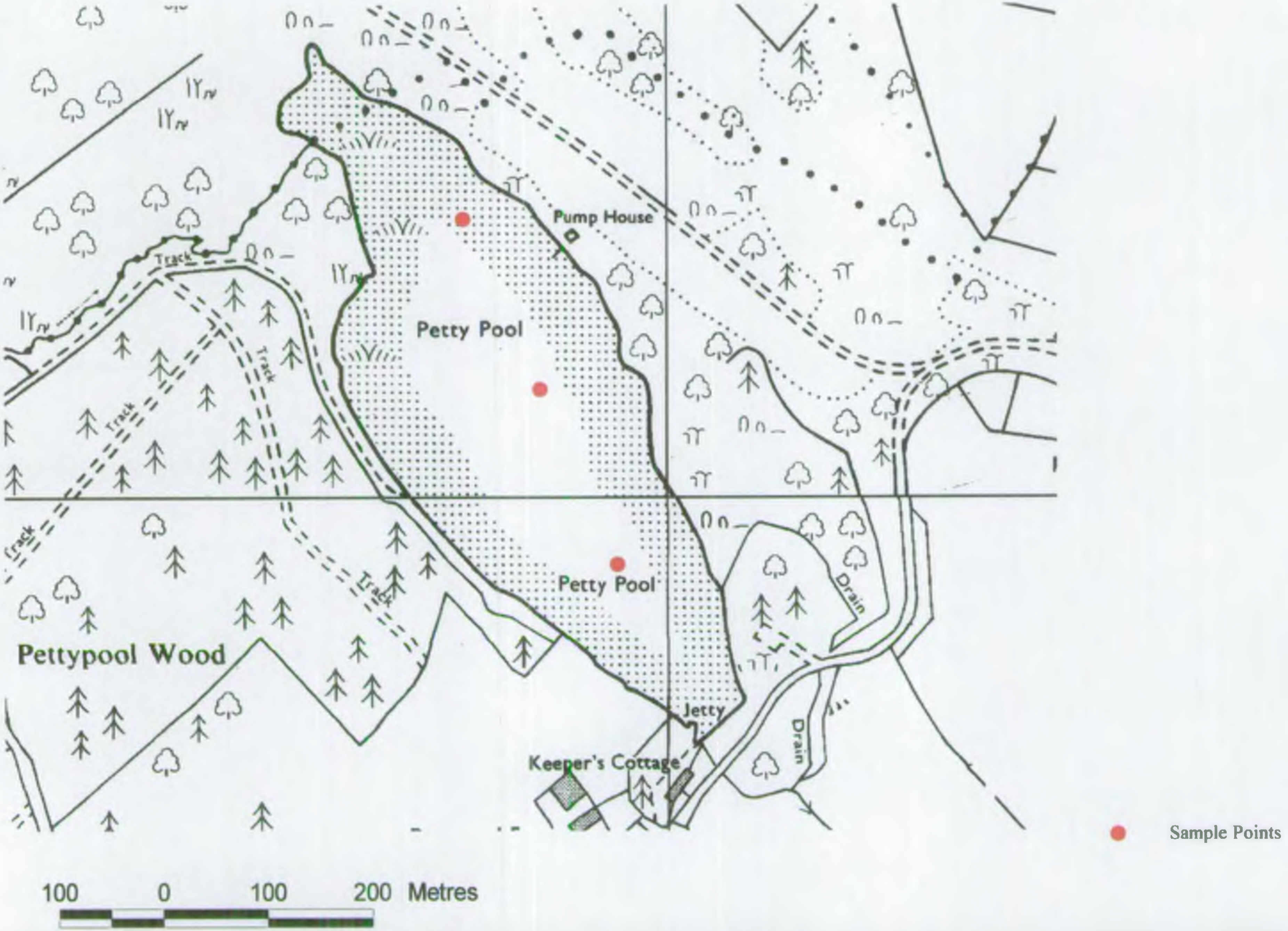
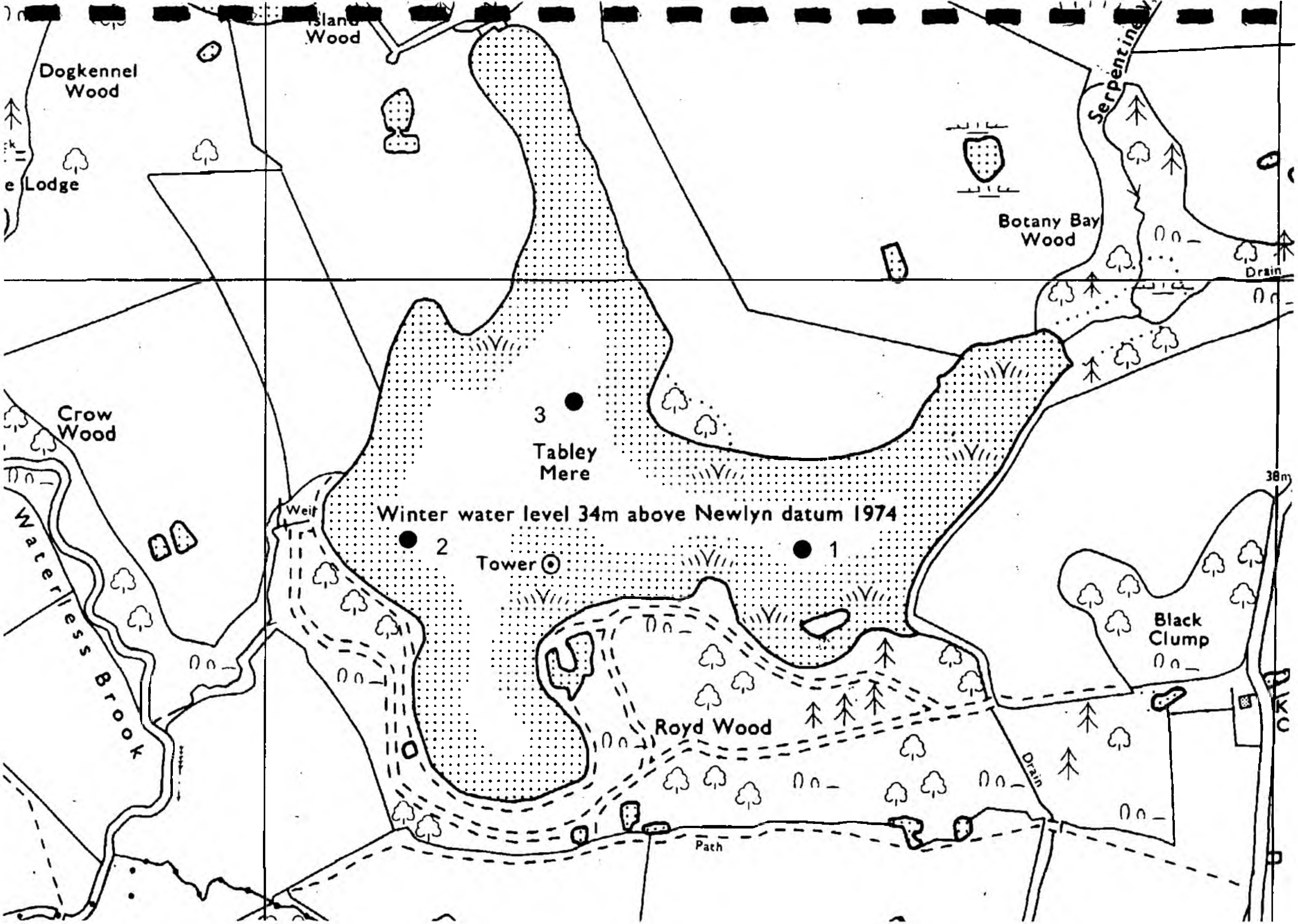


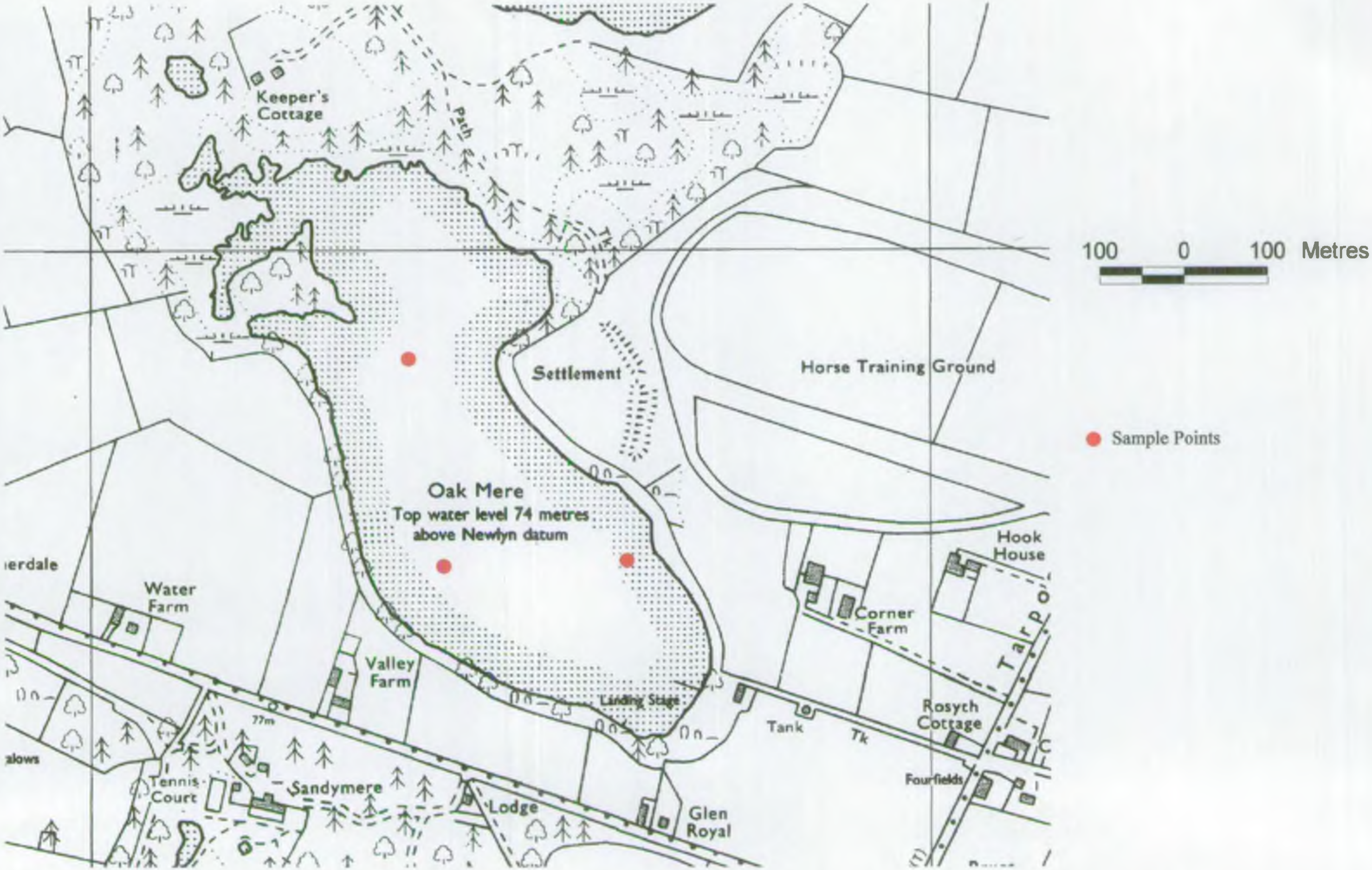
Figure Petty Pool





Wood
Dogkennel Wood
Lodge
Botany Bay Wood
Drain
Crow Wood
3
Tabley Mere
Weir
Winter water level 34m above Newlyn datum 1974
2
1
Tower
38m
Waterless Brook
Black Clump
Royd Wood
Drain
Path

Figure Oak Mere



APPENDIX 1

Cheshire Stillwaters – 1999 surveys

Date	Stillwater	Site		NGR	Time	Secchi (m)
Norbury Mere	07/04/99	1	SJ	55758 49242	10:00	
		2	SJ	55965 49458	10:25	
		3	SJ	56129 49348	10:50	
Comber Mere	07/04/99	1	SJ	59489 44553	12:11	0.8
		2	SJ	58878 44594	12:40	0.9
		3	SJ	58579 44168	13:01	1.1
	16/07/99	1	SJ	59336 44602	11:35	1.2
		2	SJ	58780 44559	12:00	1.2
		3	SJ	58600 44192	12:20	1.2
	04/10/99	1	SJ	59232 44713	11:25	2.0
		2	SJ	58828 44589	12:03	1.8
		3	SJ	58582 44209	12:31	1.4
Betley Mere	07/04/99	1	SJ	74749 47936	14:18	0.7
		2	SJ	74874 47831	14:29	0.7
		3	SJ	74999 47894	14:40	0.9
	16/07/99	1	SJ	74826 47838	09:42	0.8(b)
		2	SJ	74959 47903	09:50	0.5(b)
		3	SJ	74947 47912	10:05	1 (b)
	04/10/99	1	SJ	74811 47894	14:34	0.7
		2	SJ	74914 47962	14:48	0.7
		3	SJ	74949 48042	15:00	0.6
Oak Mere	09/04/99	1	SJ	57548 67532	09:30	1.4
		2	SJ	57390 67890	09:55	1
		3	SJ	57639 67626	10:10	1.2
	15/07/99	1	SJ	57540 67588	10:21	2.8
		2	SJ	57360 67807	10:53	1(b)
		3	SJ	57567 67614	11:07	1.8
	06/10/99	1	SJ	57524 67503	09:50	2.2
		2	SJ	57369 67891	10:13	1.5(b)
		3	SJ	57680 67612	10:25	2.4(b)

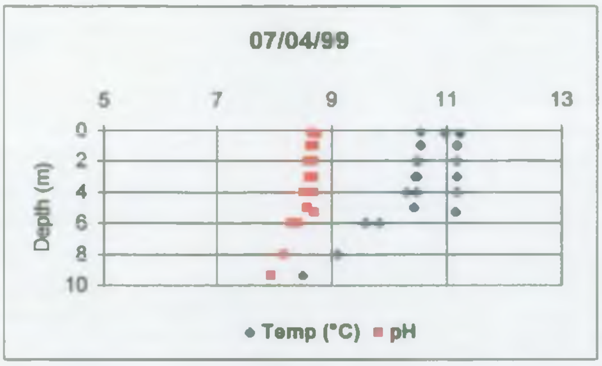
(b) Secchi Disc touched the bottom

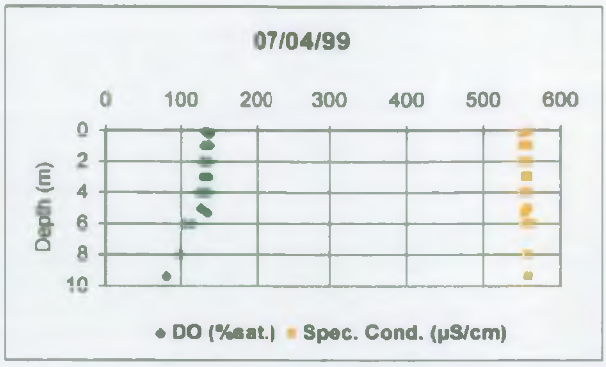
Date	Stillwater	Site		NGR	Time	Secchi (m)
Petty Pool	09/04/99	1	SJ	61951 69963	11:28	1.4
		2	SJ	61872 70124	11:43	1.4
		3	SJ	61806 70286	11:57	1.6
	15/07/99	1	SJ	61929 69938	13:39	0.6
		2	SJ	61901 70008	13:52	0.8
		3	SJ	61781 70329	14:03	0.8
Tabley Mere	09/04/99	1	SJ	72511 77045	13:50	0.3
		2	SJ	72134 76743	14:12	0.4
		3	SJ	72298 76878	14:32	0.3(b)
	15/07/99	1	SJ	72532 76884	16:22	0.6(b)
		2	SJ	72158 76553	16:36	1.2
		3	SJ	72327 76977	16:48	0.4(b)
	06/10/99	1	SJ	72464 76899	14:37	1.0
		2	SJ	72154 76804	14:52	0.7
		3	SJ	72299 76947	15:25	0.4(b)

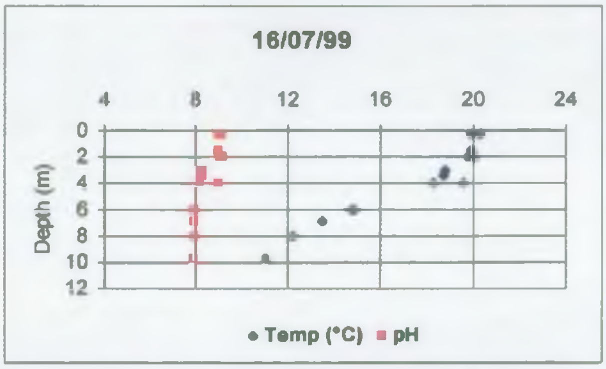
(b) Secchi Disc touched the bottom

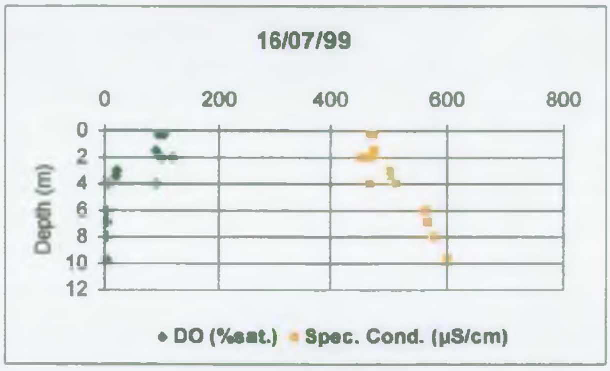
PHYSICO-CHEMICAL PROFILE READINGS, 1999

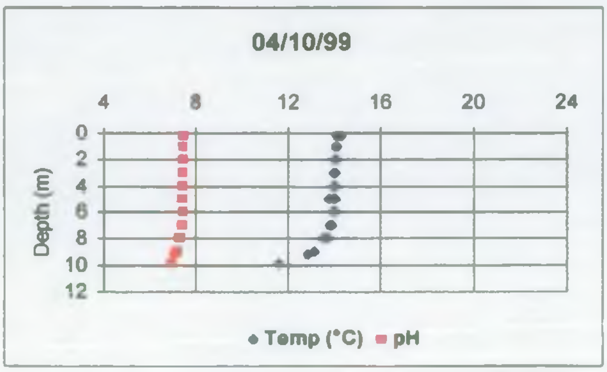
COMBER MERE

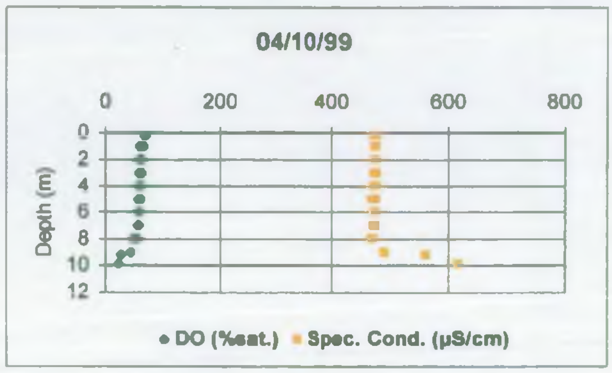






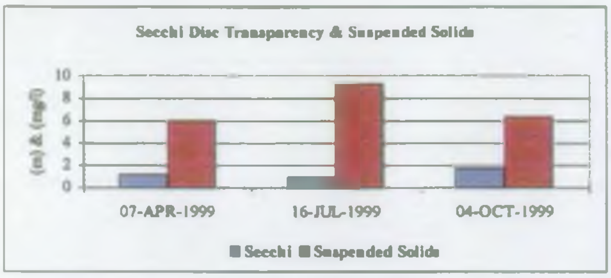


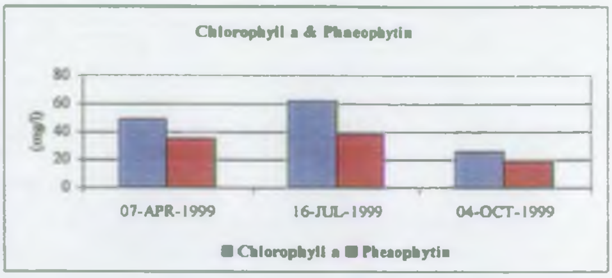


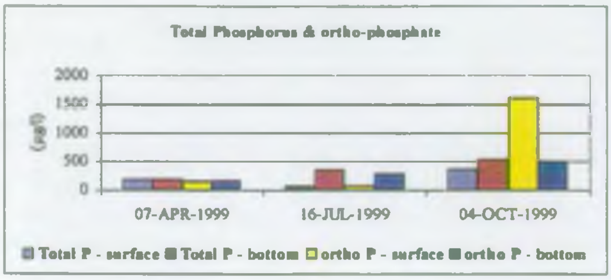


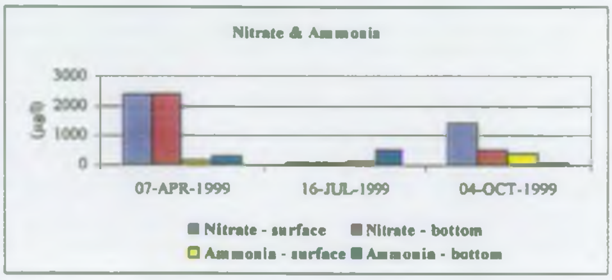
NUTRIENT READINGS, 1999

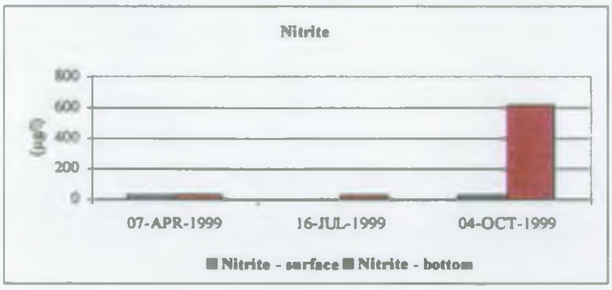
COMBER MERE

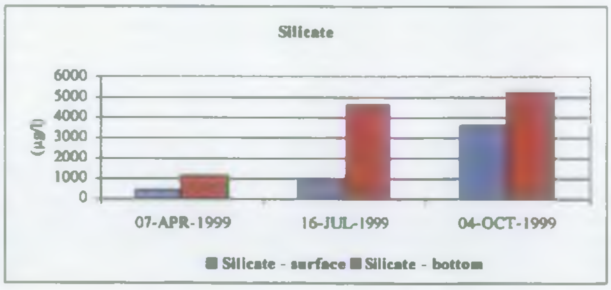






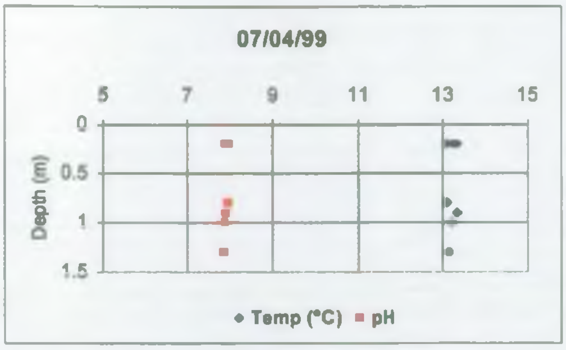


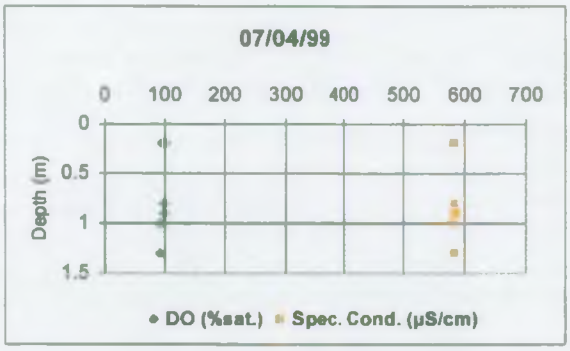


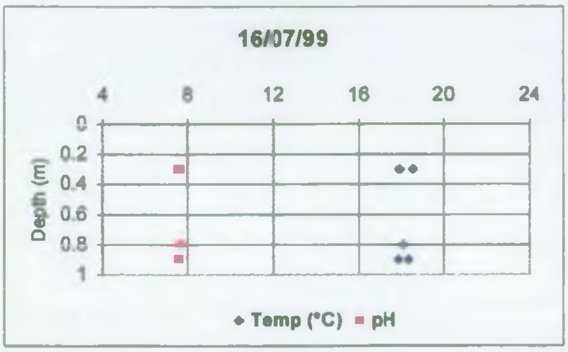


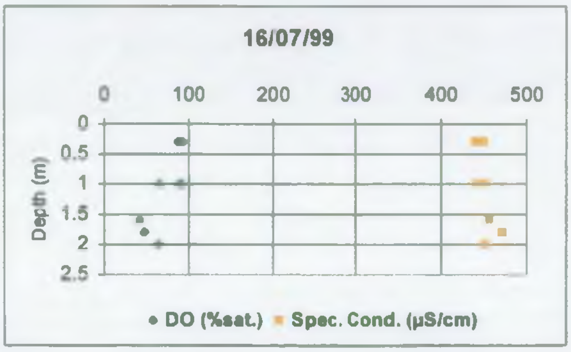
PHYSICO-CHEMICAL PROFILE READINGS, 1999

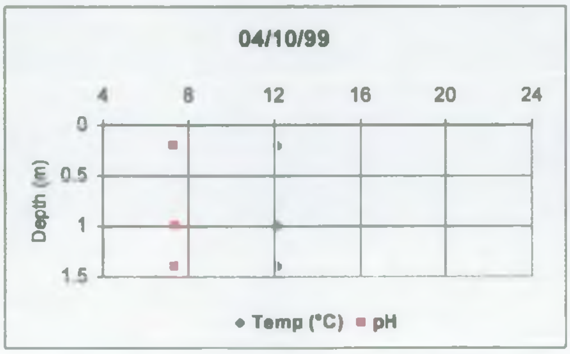
BETLEY MERE

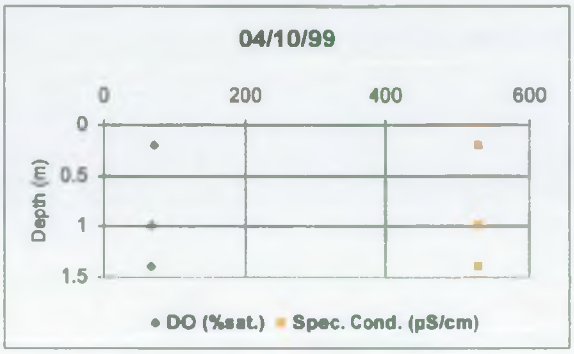






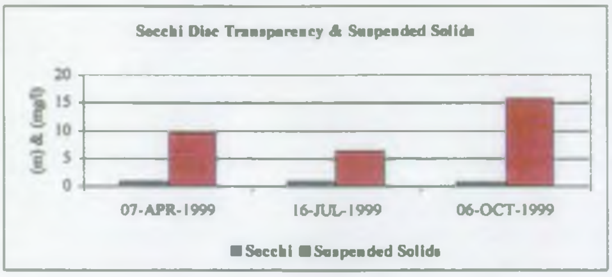


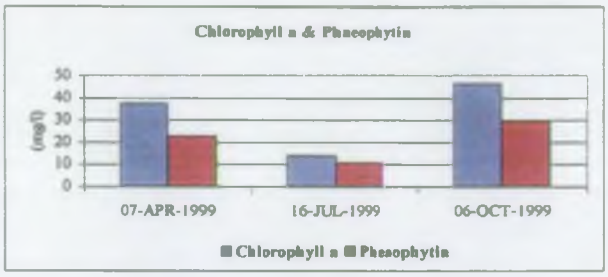


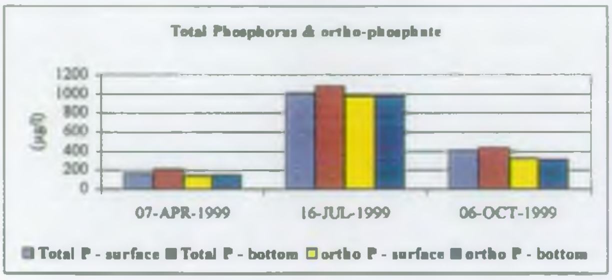


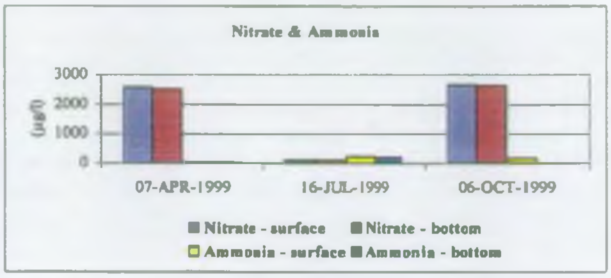
NUTRIENT READINGS, 1999

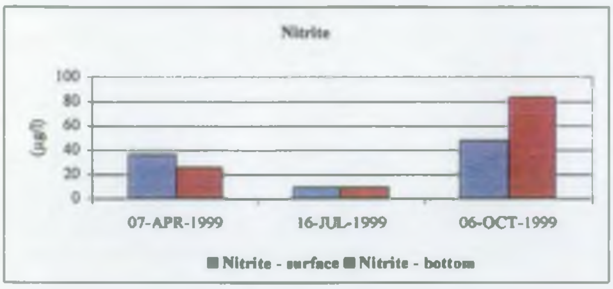
BETLEY MERE

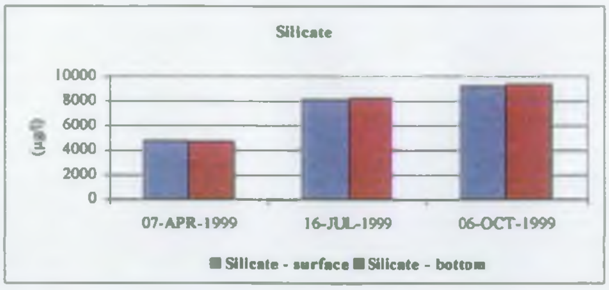




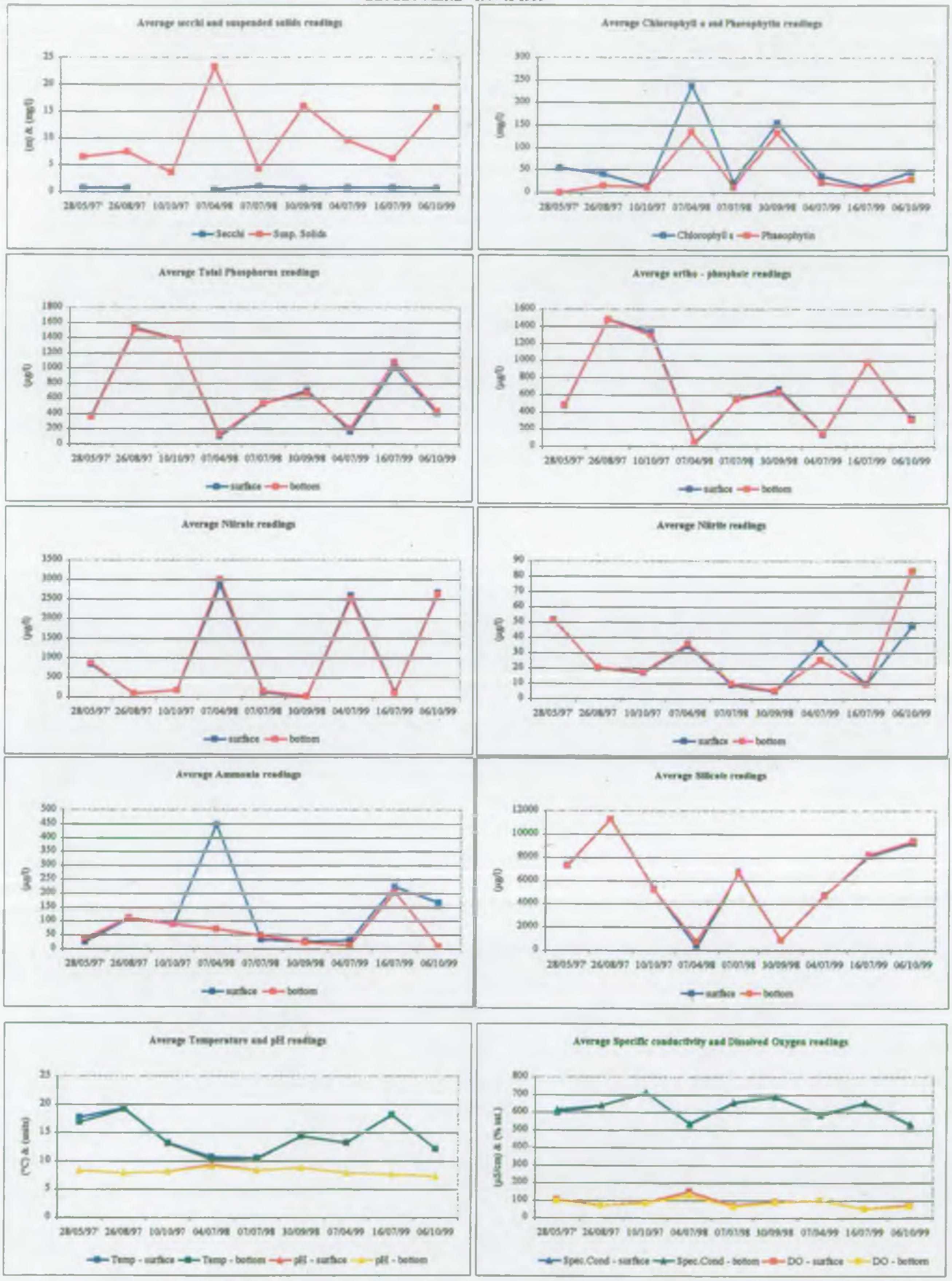






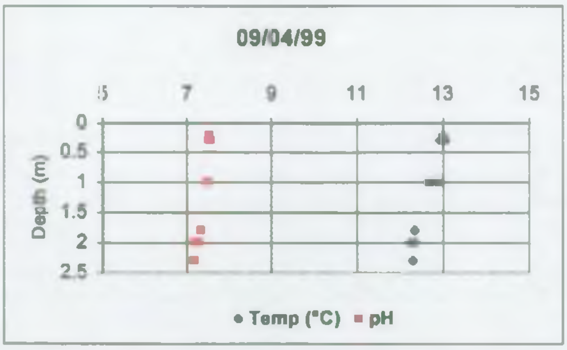


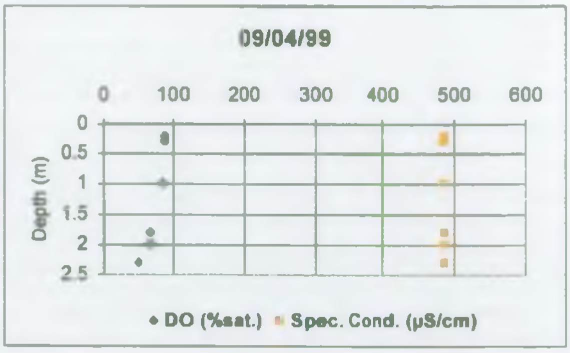
BETLEY MERE - 1997 to 1999

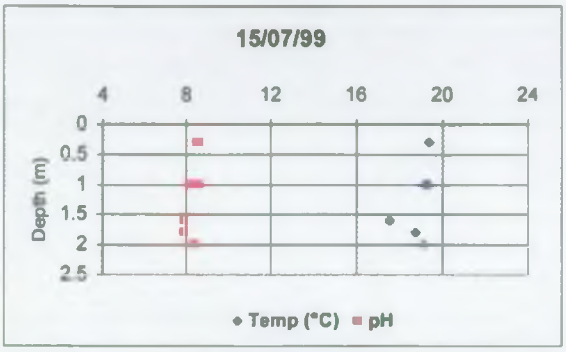


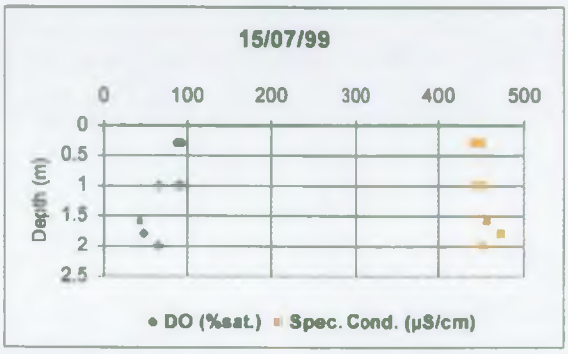
PHYSICO-CHEMICAL PROFILE READINGS, 1999

PETTY POOL



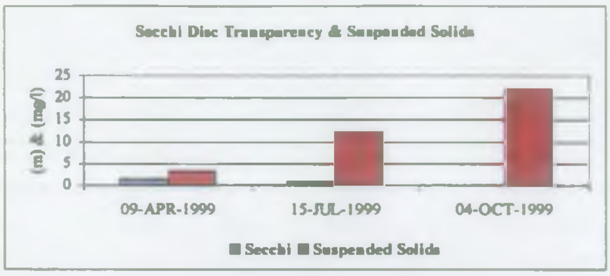


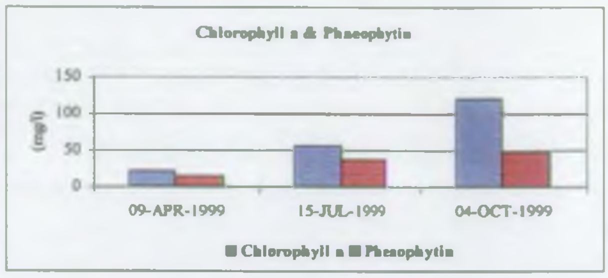


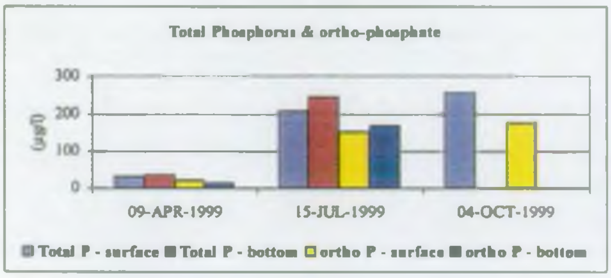


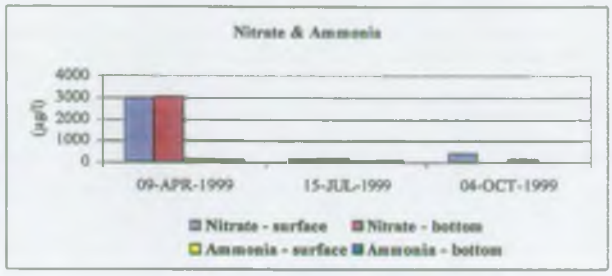
NUTRIENT READINGS, 1999

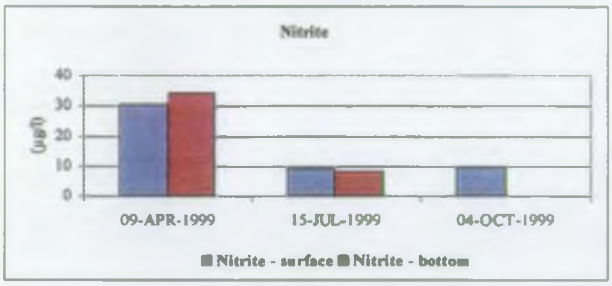
PETTY POOL

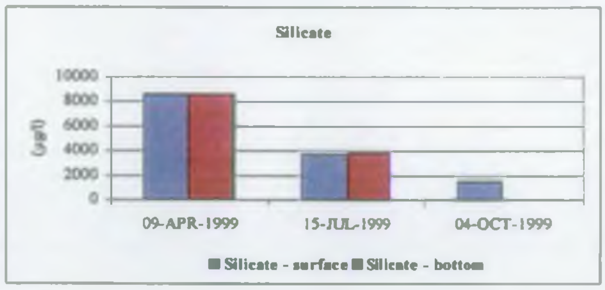




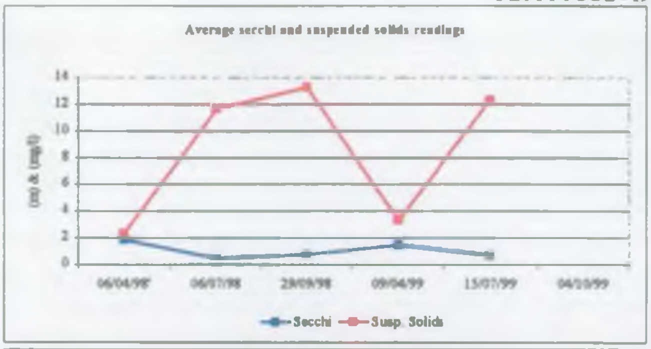


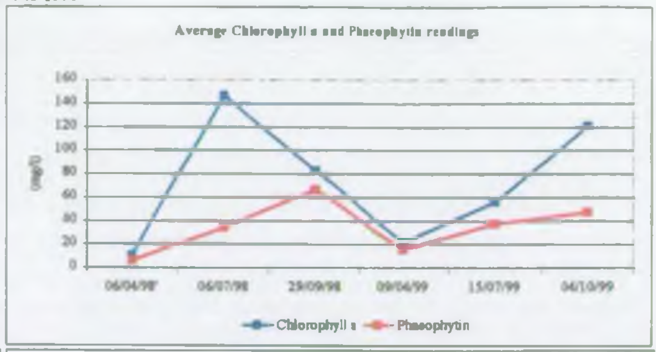


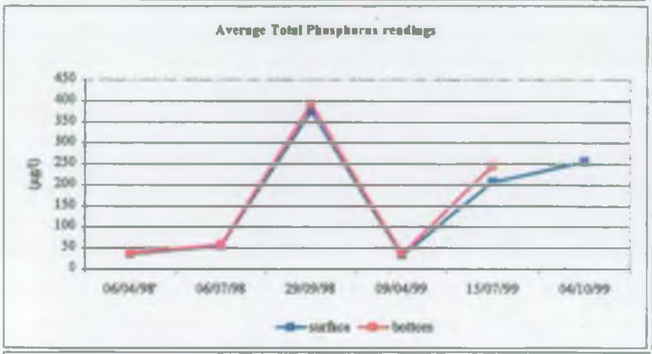


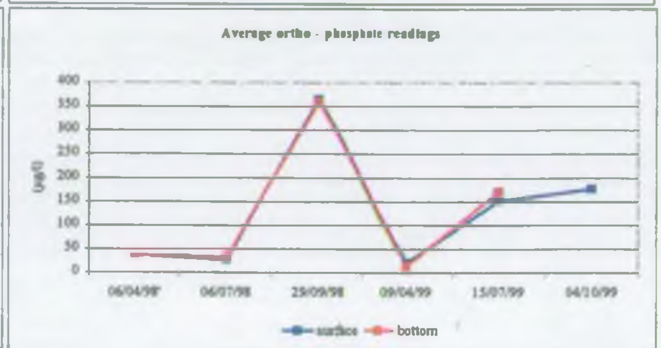


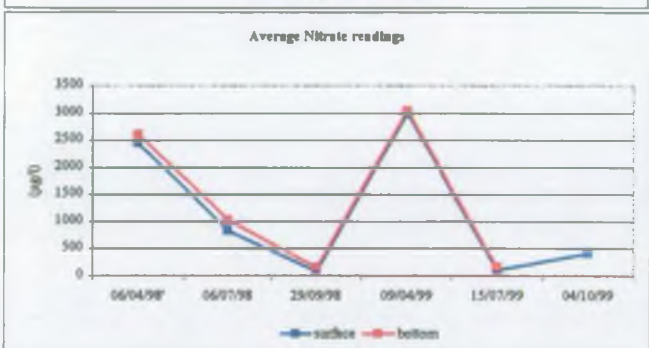
PETTY POOL - 1998 to 1999

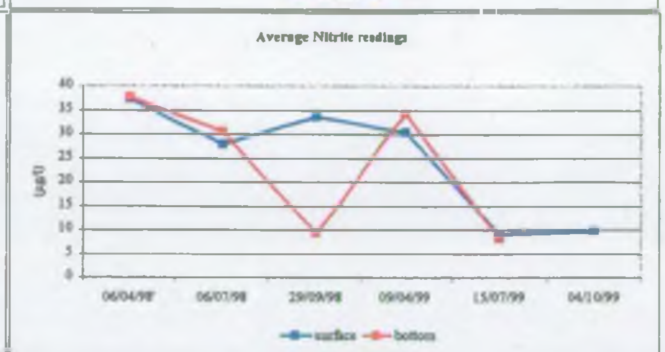


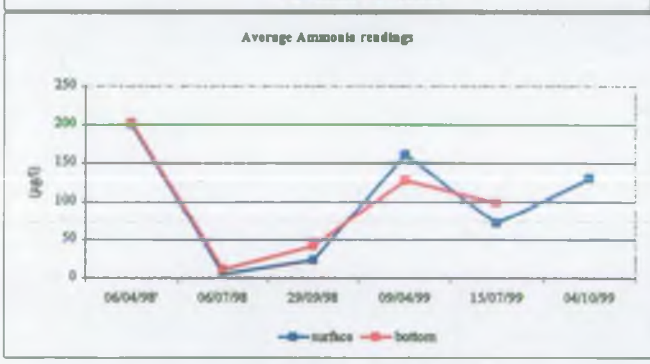


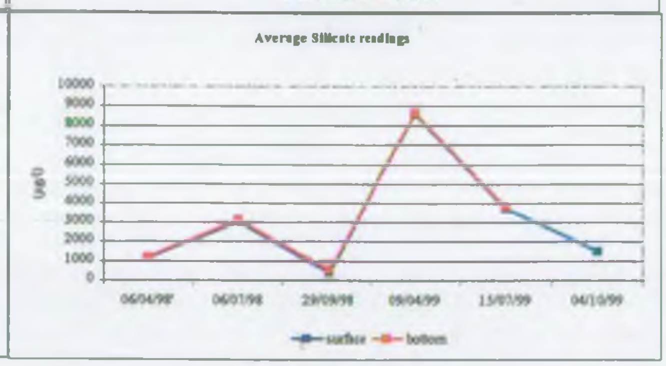


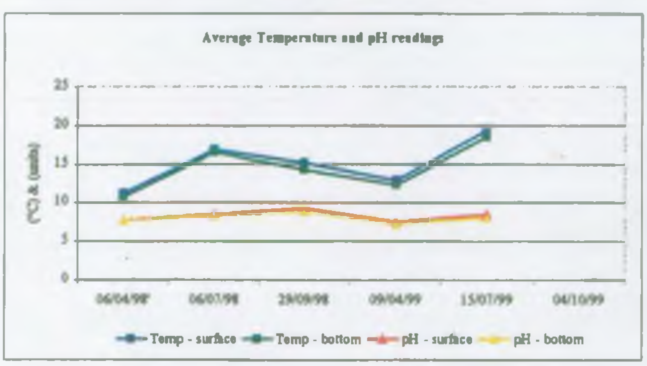


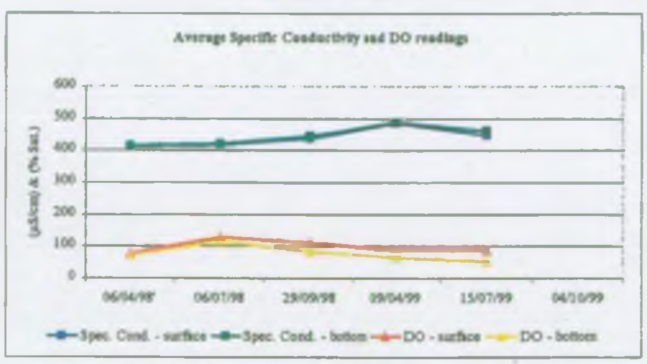






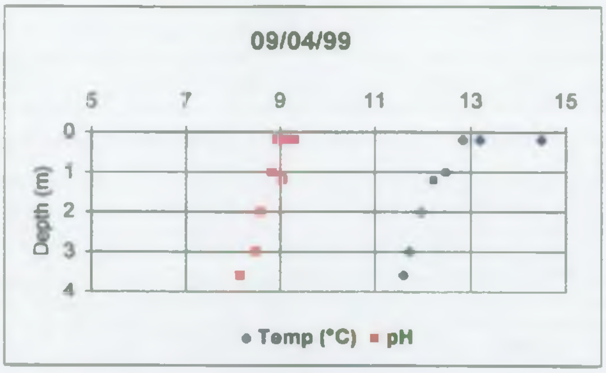


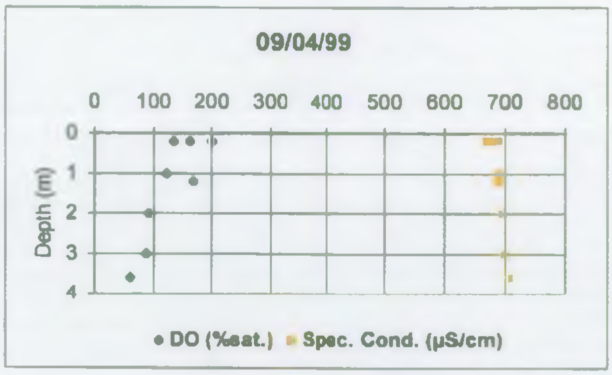


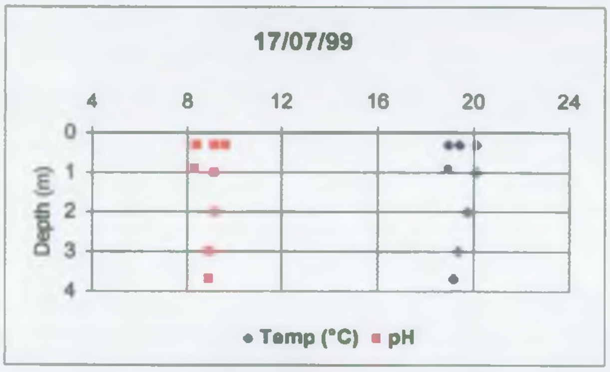


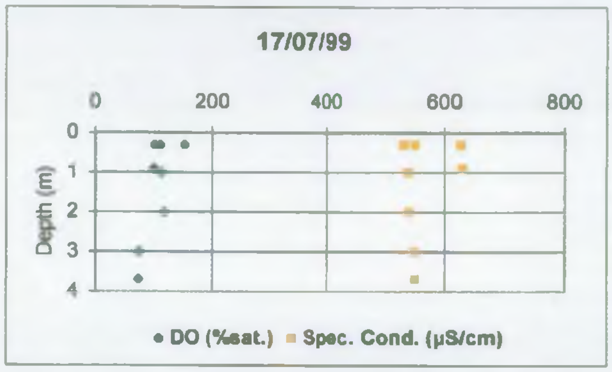
PHYSICO-CHEMICAL PROFILE READINGS, 1999

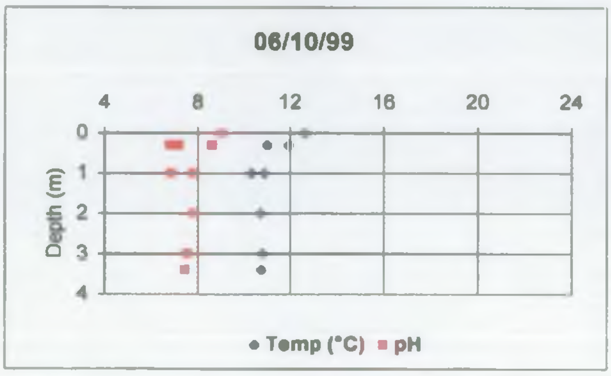
TABLEY MERE

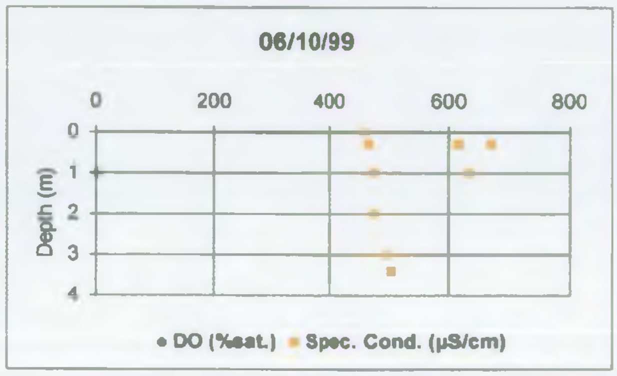






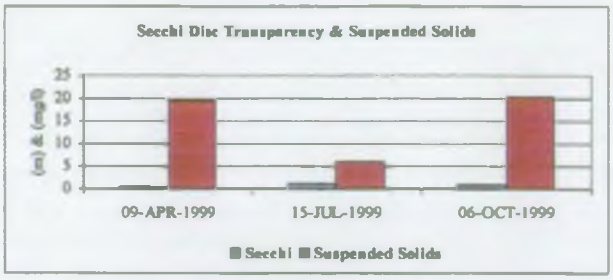


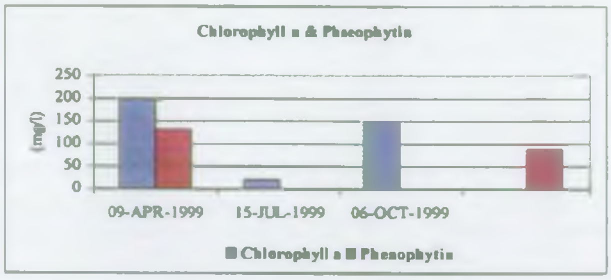


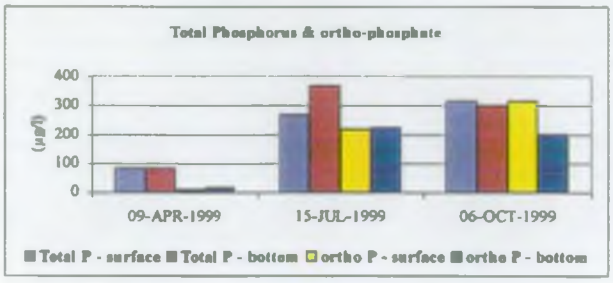


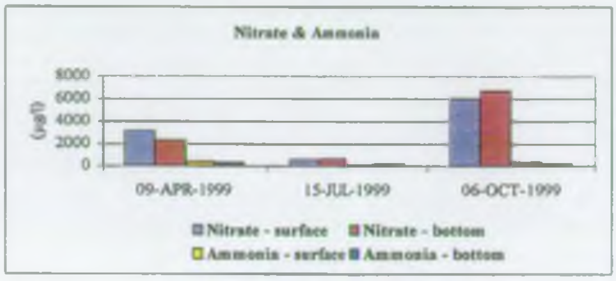
NUTRIENT READINGS, 1999

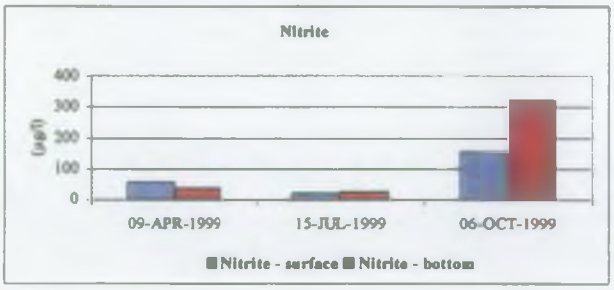
TABLEY MERE

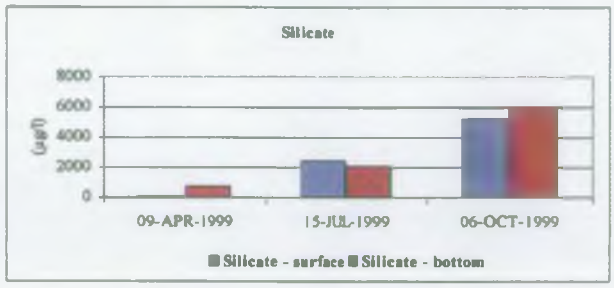






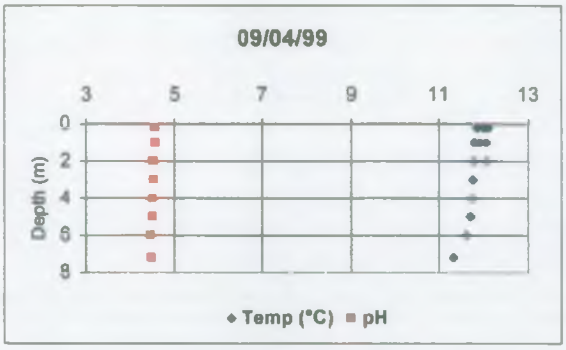


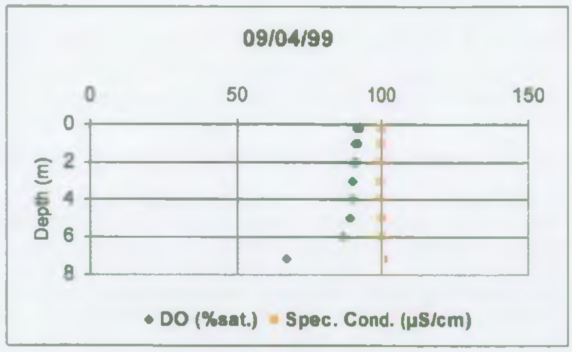


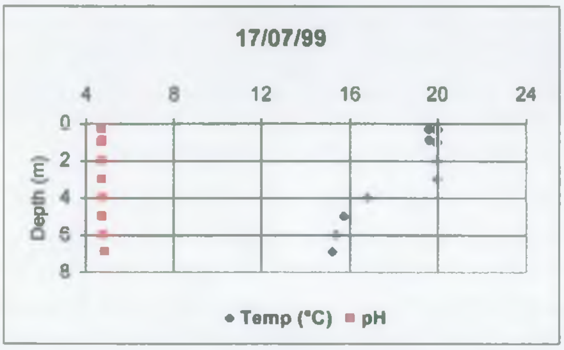


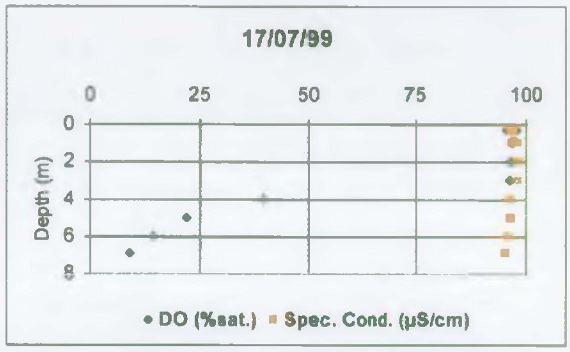
PHYSICO-CHEMICAL PROFILE READINGS, 1999

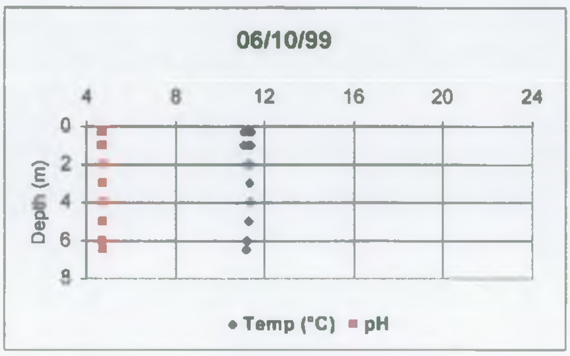
OAK MERE

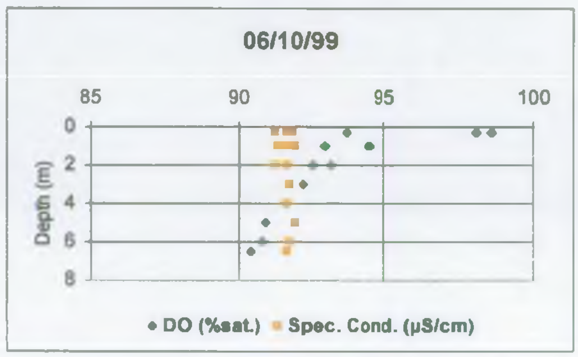






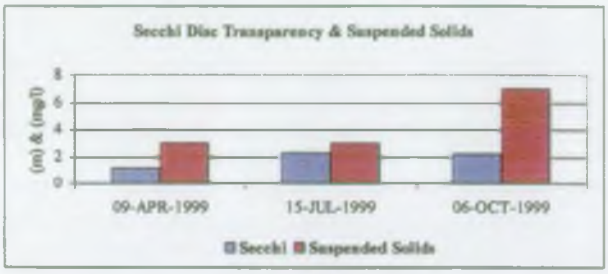


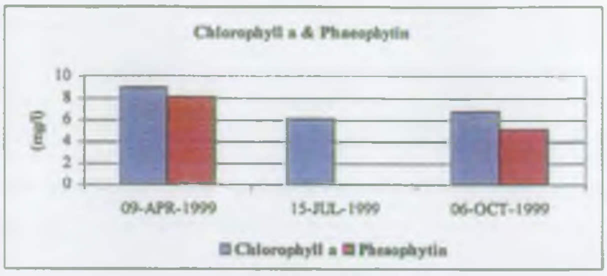


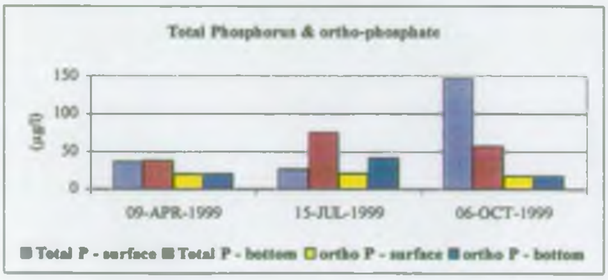


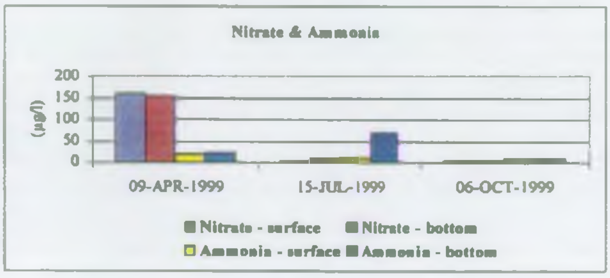
NUTRIENT READINGS, 1999

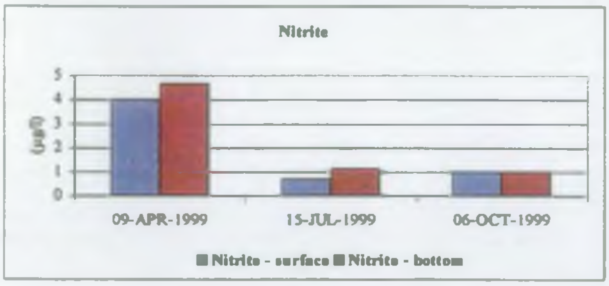
OAK MERE

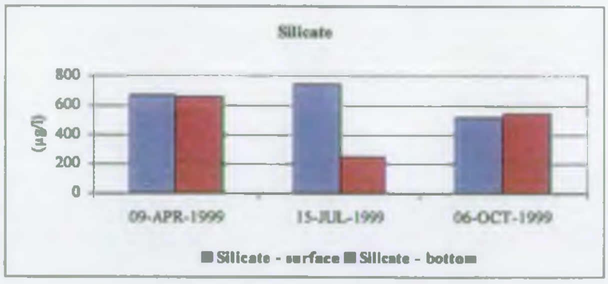




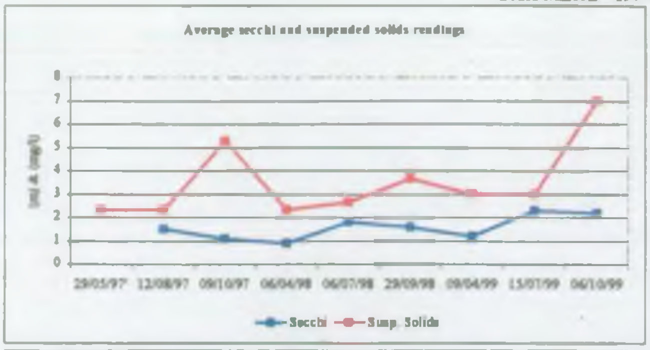


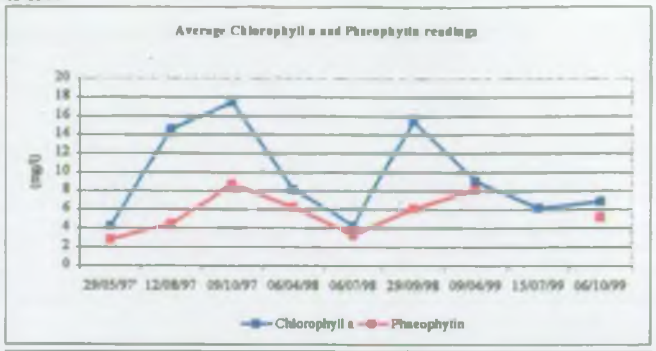


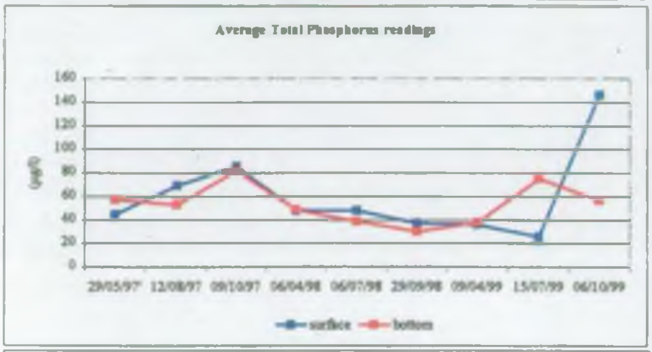


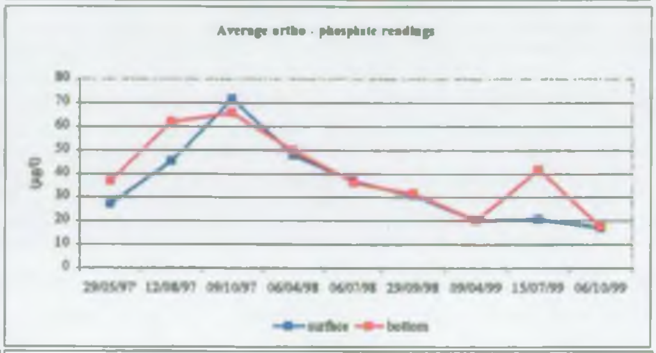


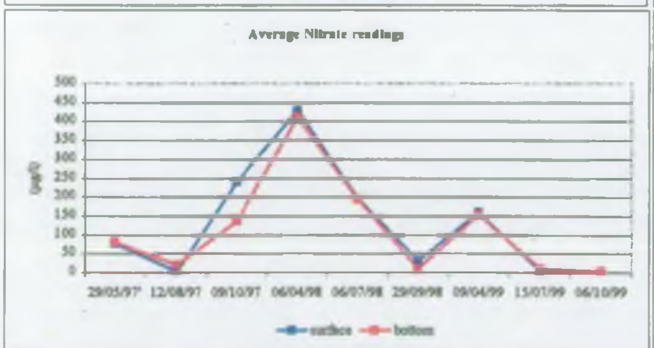
OAK MERE - 1997 to 1999

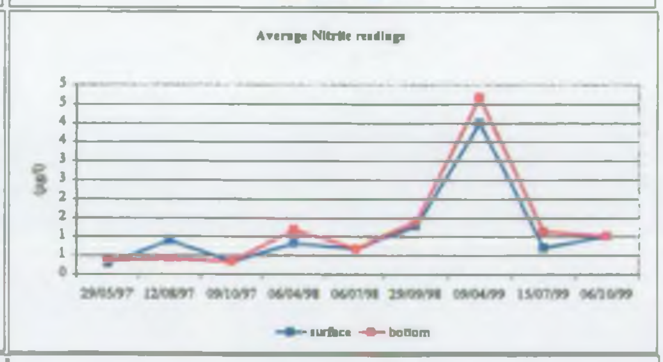


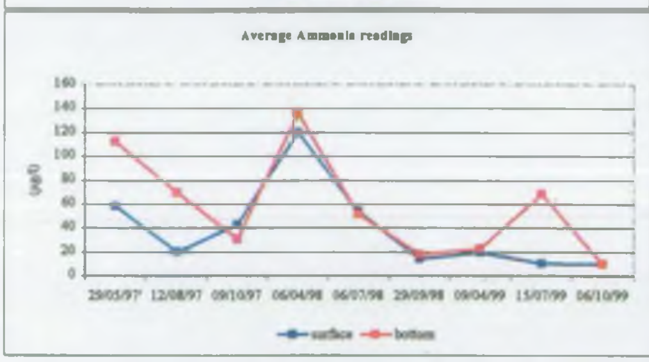


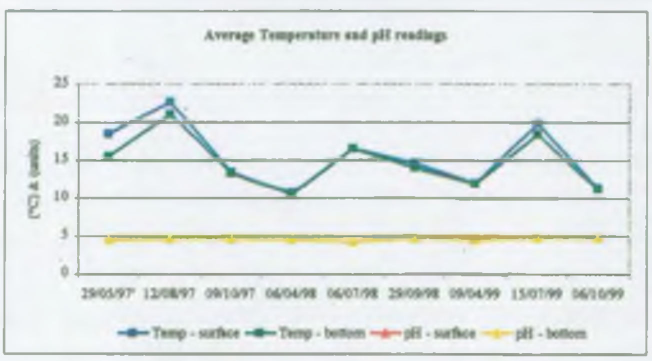


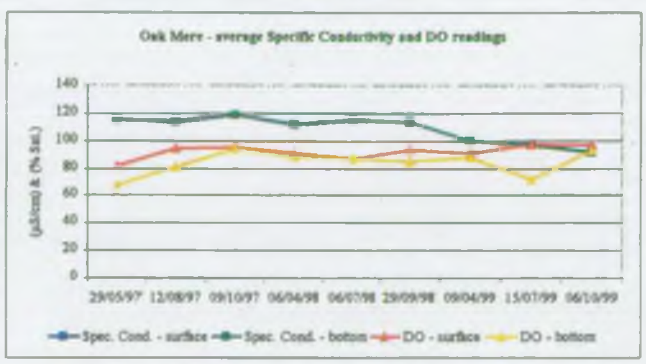




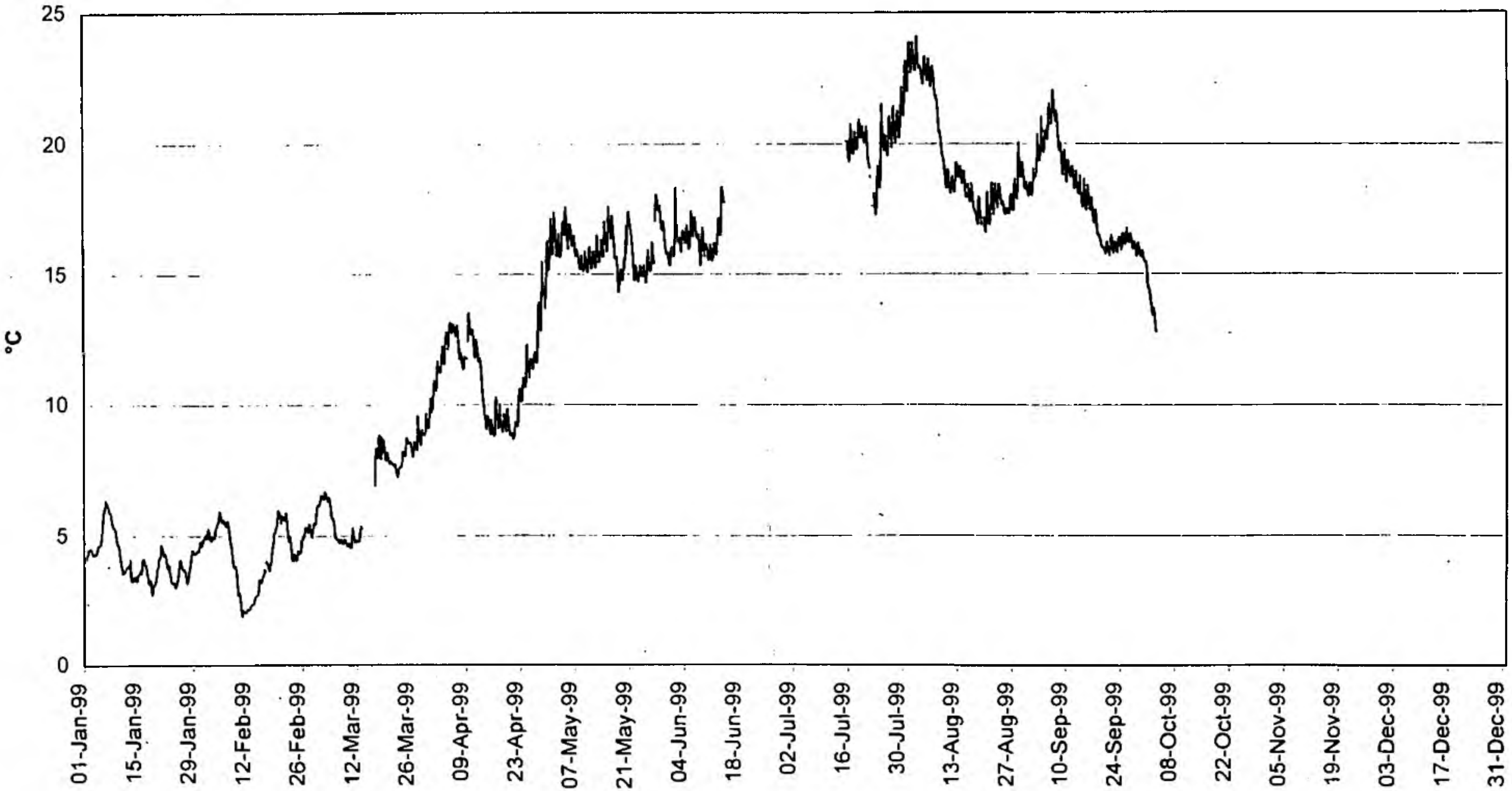


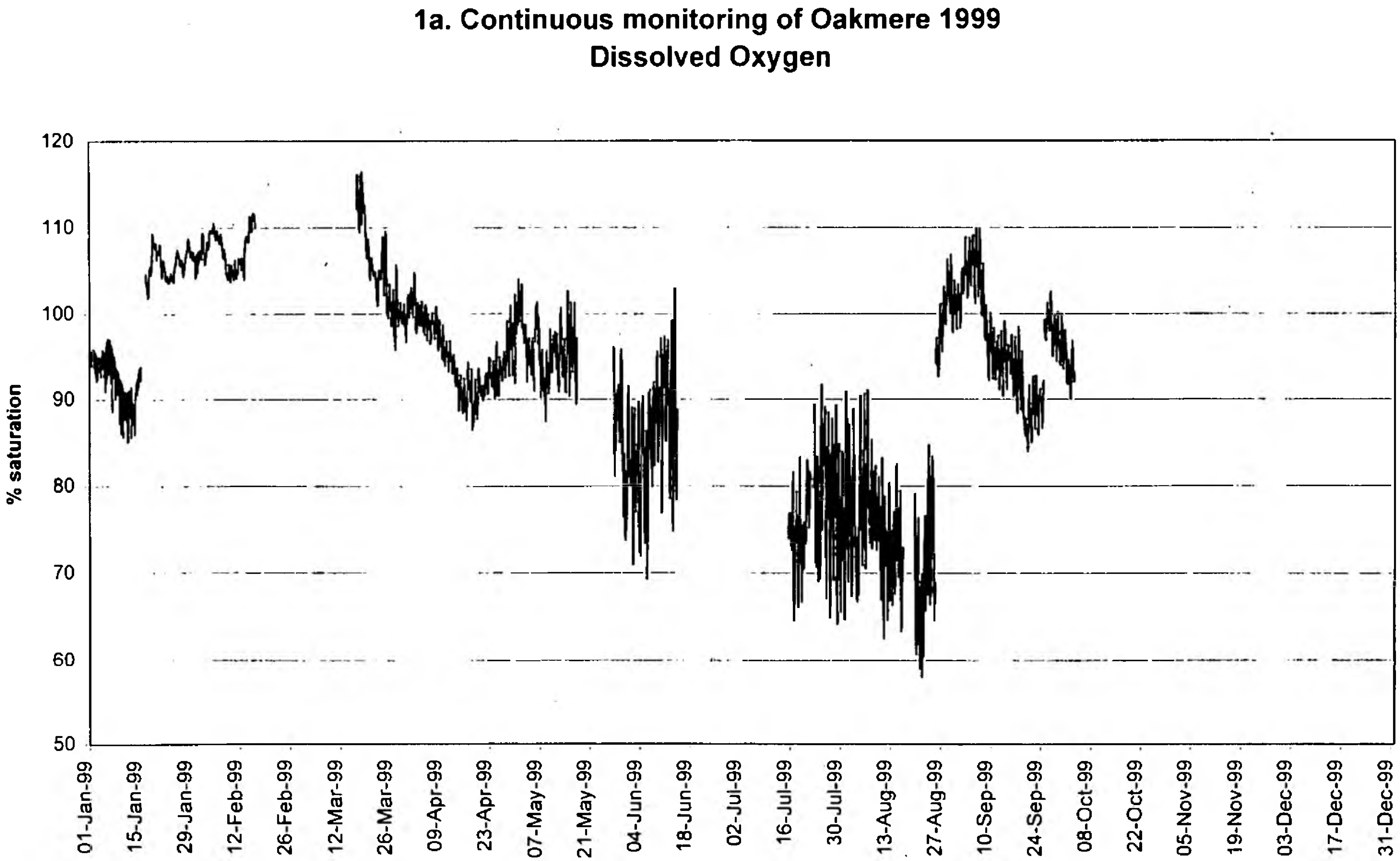




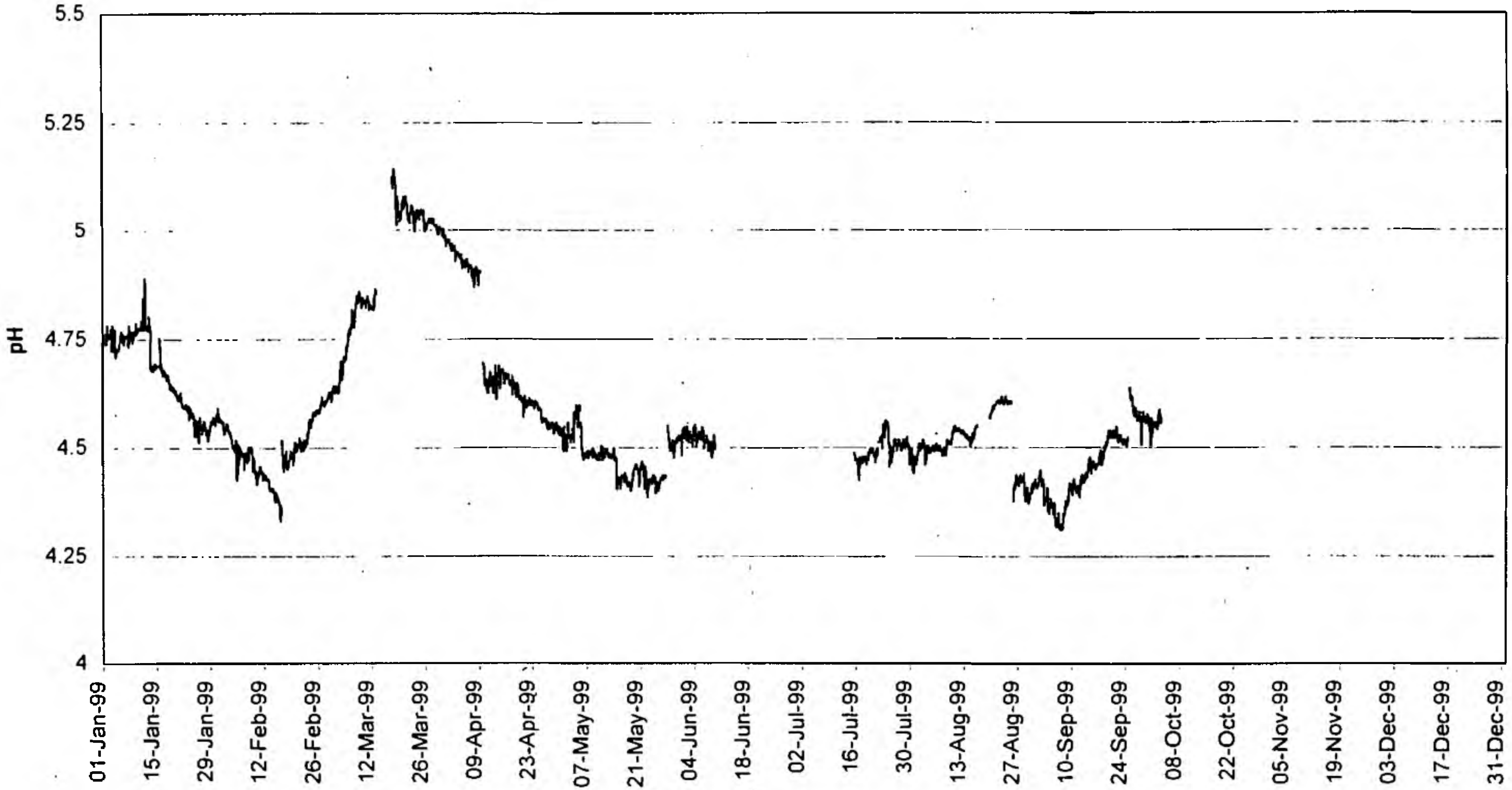


1b. Continuous monitoring of Oakmere 1999
Temperature

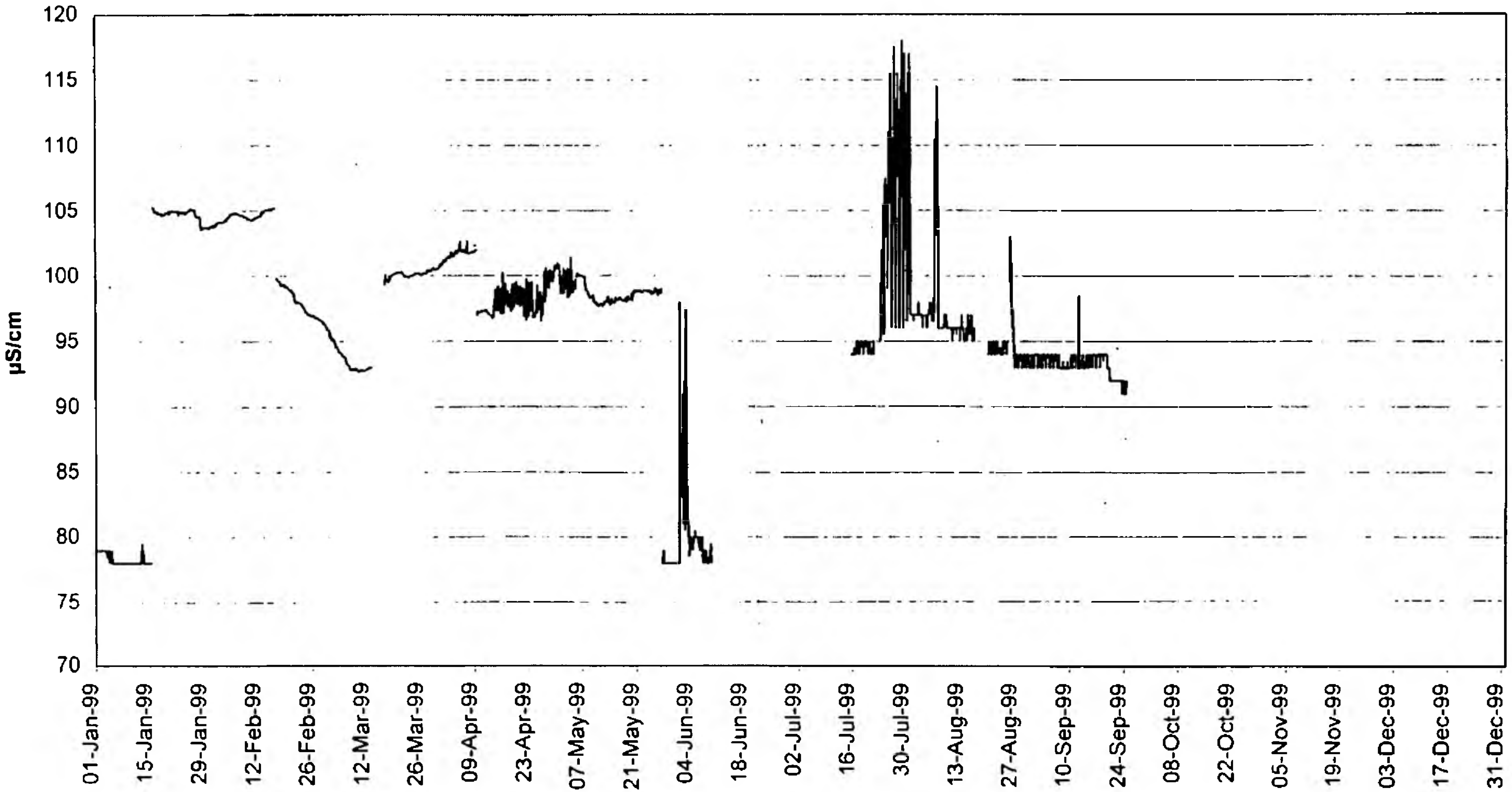



1a. Continuous monitoring of Oakmere 1999
Dissolved Oxygen
% saturation
120
110
100
90
80
70
60
50
01-Jan-99
15-Jan-99
29-Jan-99
12-Feb-99
26-Feb-99
12-Mar-99
26-Mar-99
09-Apr-99
23-Apr-99
07-May-99
21-May-99
04-Jun-99
18-Jun-99
02-Jul-99
16-Jul-99
30-Jul-99
13-Aug-99
27-Aug-99
10-Sep-99
24-Sep-99
08-Oct-99
22-Oct-99
05-Nov-99
19-Nov-99
03-Dec-99
17-Dec-99
31-Dec-99

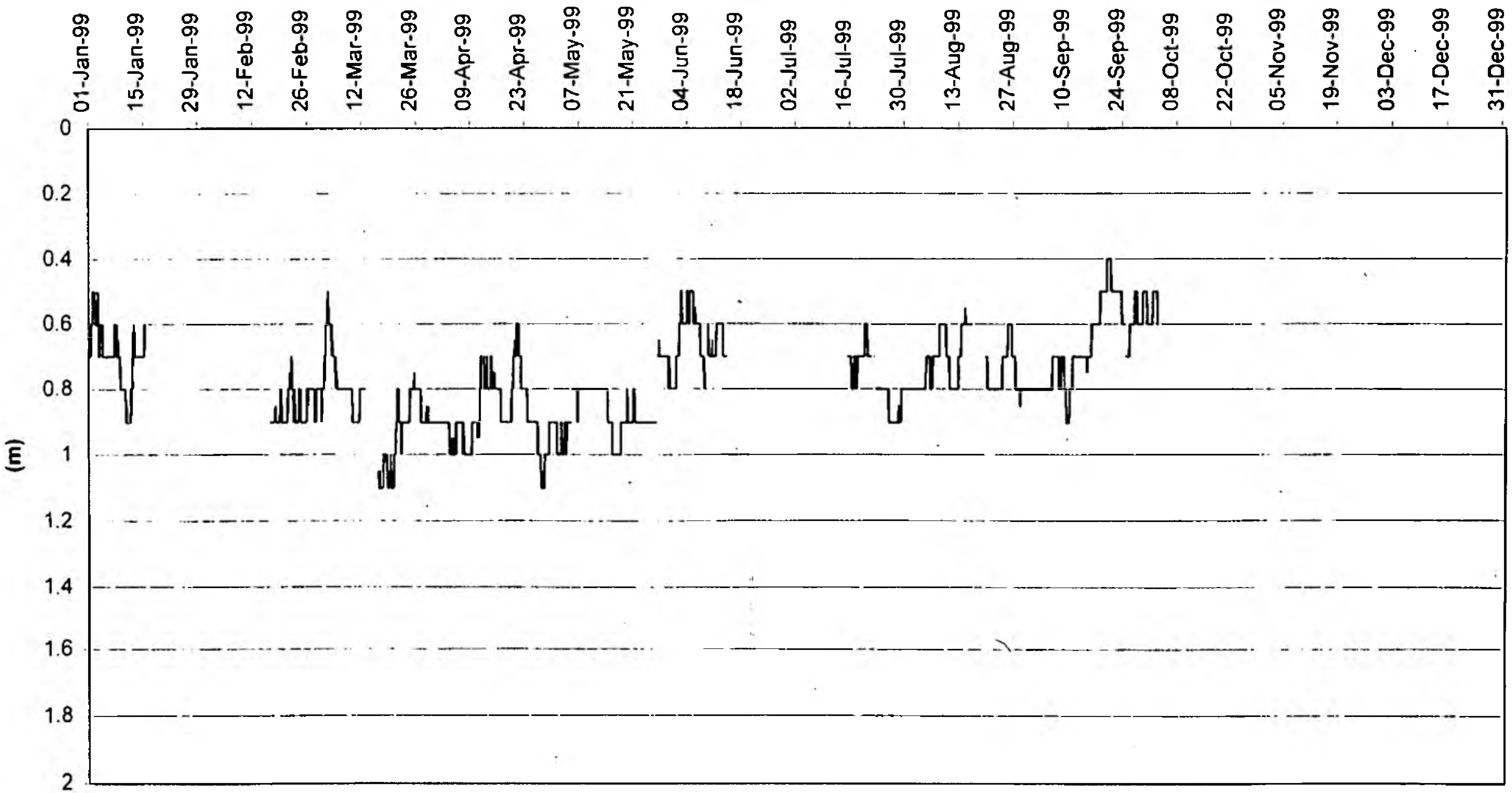
1c. Continuous monitoring of Oakmere 1999
pH



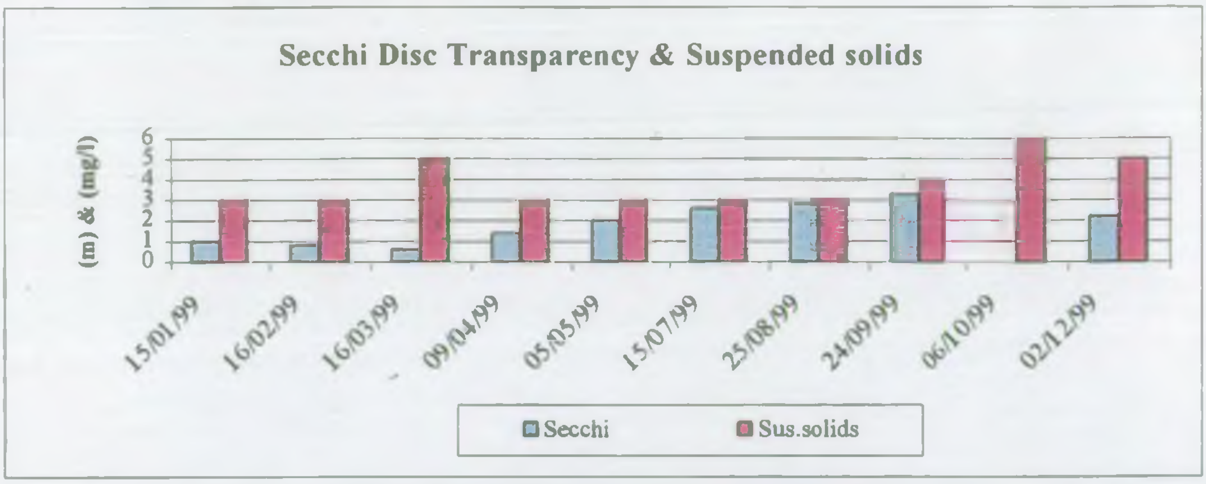
1d. Continuous monitoring of Oakmere 1999
Specific Conductivity

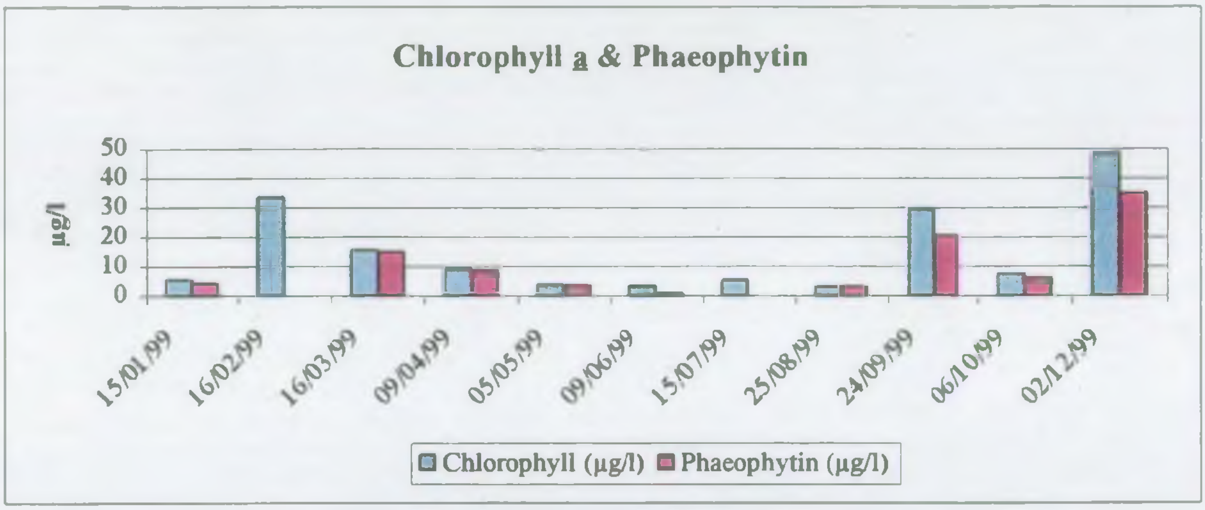


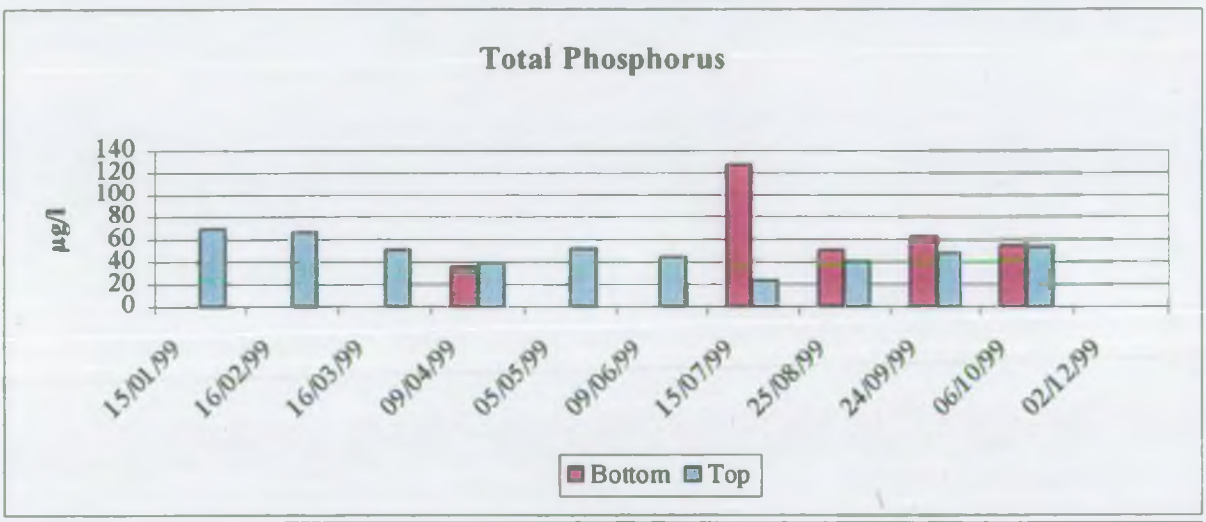
1e. Continuous monitoring of Oakmere 1999
Instrument depth

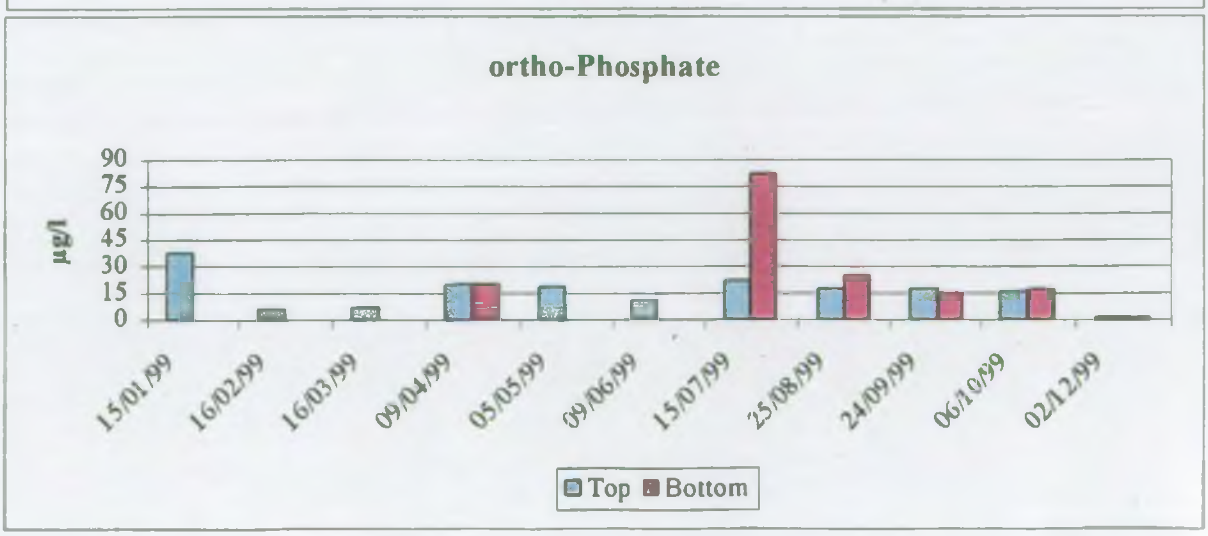


2a. Nutrient and Algal concentrations for Oakmere 1999

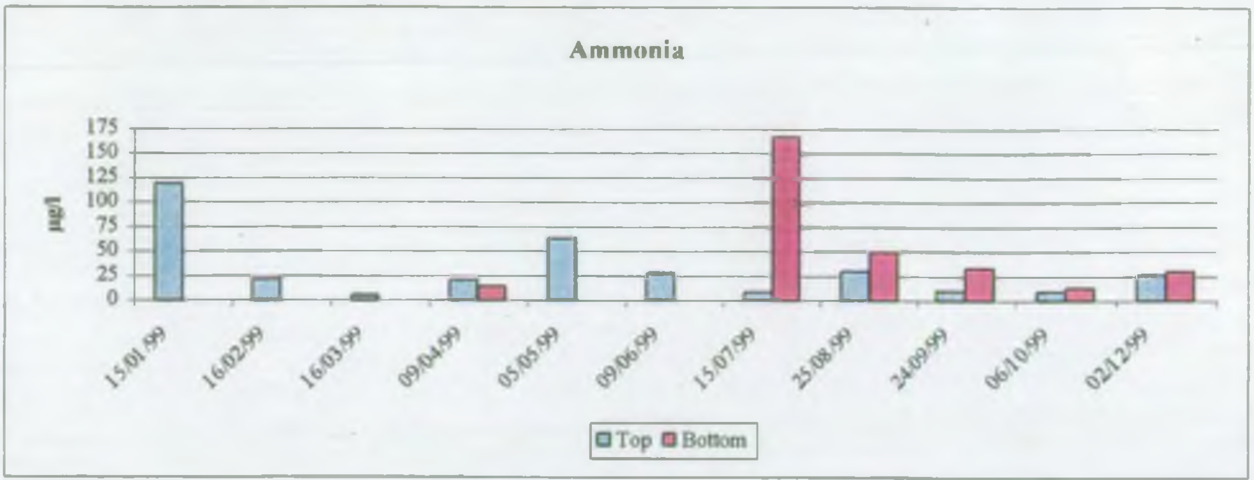


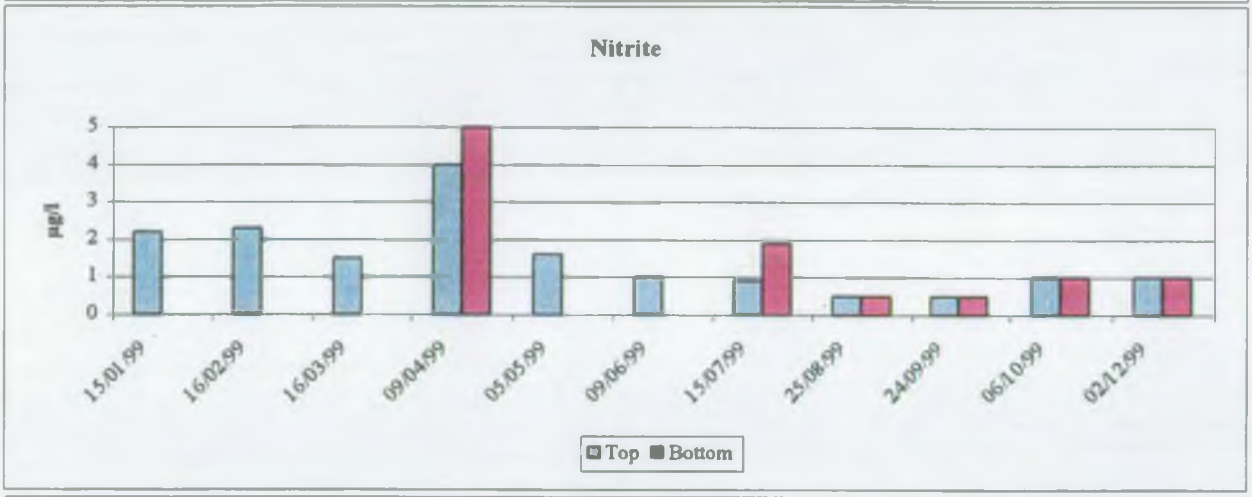


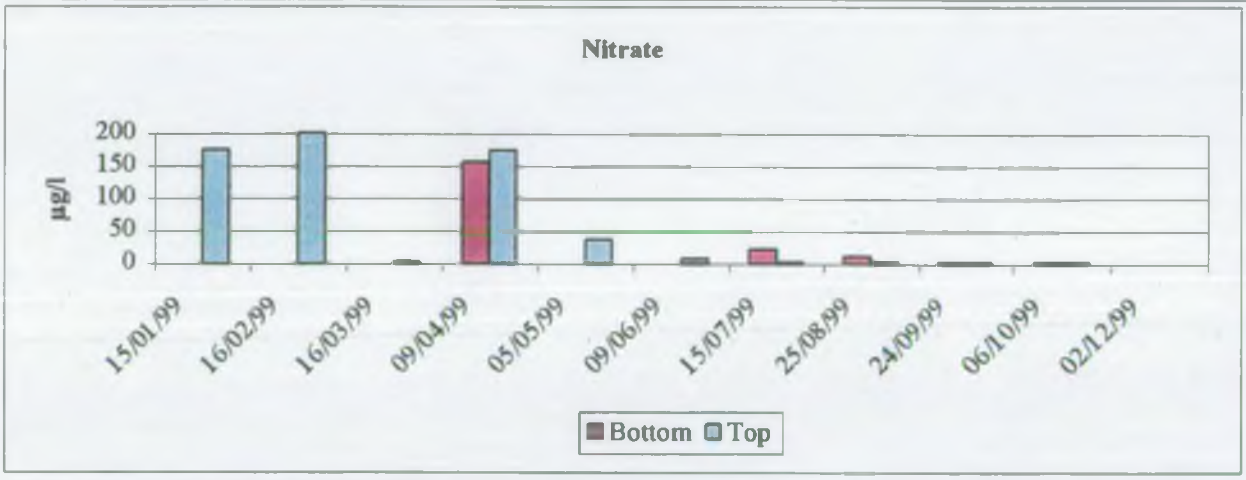


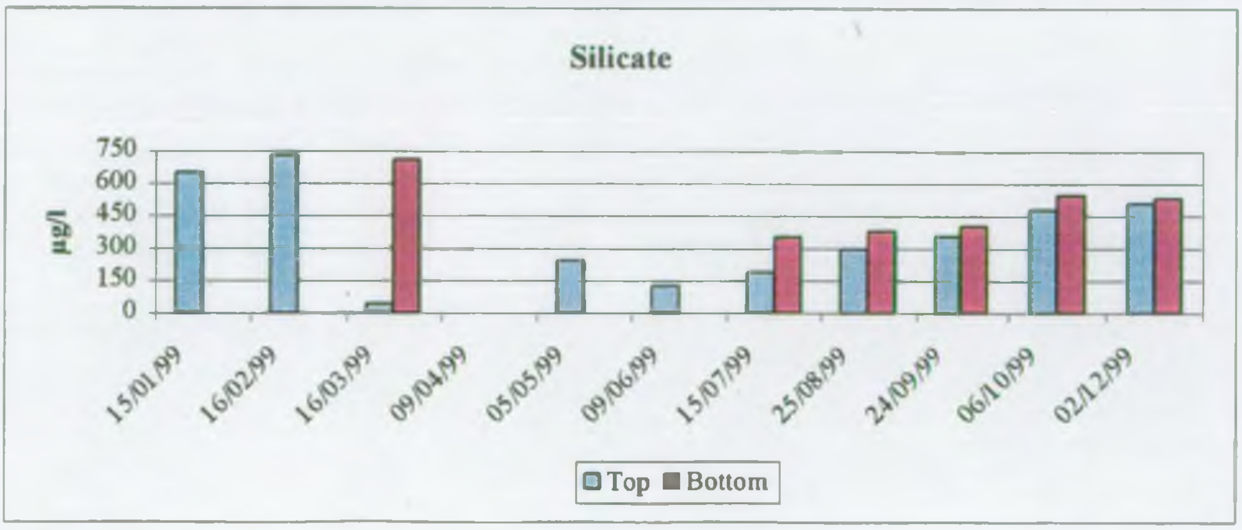


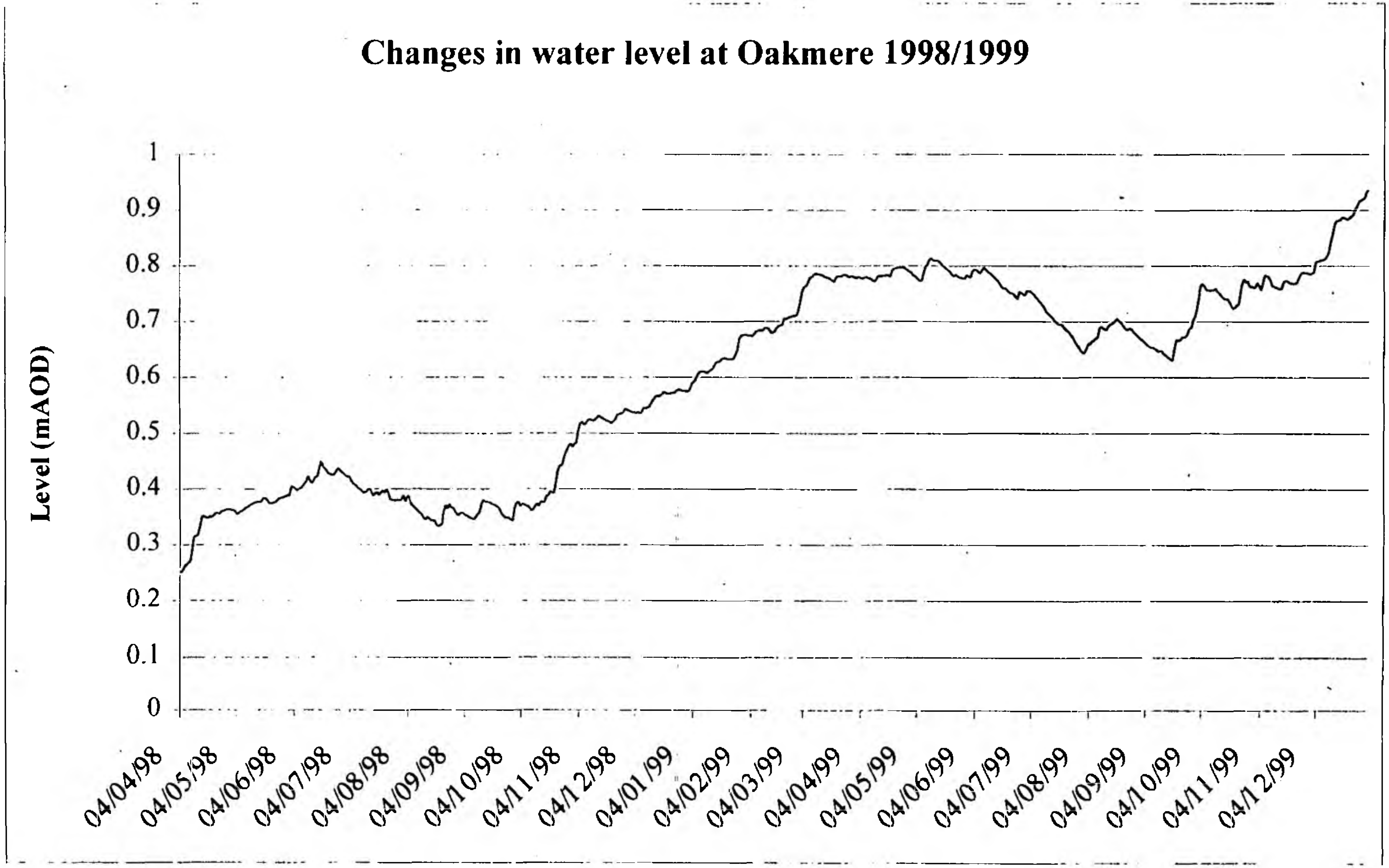
2b. Nutrient and Algal concentrations for Oakmere 1999











Changes in water level at Oakmere 1998/1999
Level (mAOD)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
04/04/98
04/05/98
04/06/98
04/07/98
04/08/98
04/09/98
04/10/98
04/11/98
04/12/98
04/01/99
04/02/99
04/03/99
04/04/99
04/05/99
04/06/99
04/07/99
04/08/99
04/09/99
04/10/99
04/11/99
04/12/99

APPENDIX 1: Raw Data - Profiles of pysico-chemical parameters

Site	Date/ Time	Depth m	Temp °C	pH units	SpCond µS/cm	DO % Sat	DO mg/l	TDS Kmg/l
NORBURY MERE	07/04/99							
1	100000	0.1	12.1	7.45	631	85.8	9.24	0.401
2	102500	0.1	12.28	8.22	632	125.2	13.43	
3	105000	0.1	12.44	8.28	637	127.5	13.61	
COMBER MERE	07/04/99							
1	11:11:30	0.2	11.22	8.73	551	137.1	15.04	0.353
	11:17:22	1	11.17	8.69	551	136.8	15.02	0.353
	11:18:34	2	11.17	8.67	554	136.4	14.98	0.354
	11:19:32	3	11.17	8.67	554	135.5	14.89	0.354
	11:20:47	4	11.17	8.68	553	135.5	14.89	0.354
	11:21:56	5.3	11.15	8.69	553	134.6	14.79	0.354
2	11:41:16	0.2	10.97	8.66	550	135.6	14.97	0.352
	11:43:03	2	10.48	8.57	550	127.7	14.25	0.352
	11:44:36	4	10.31	8.5	552	123.2	13.81	0.354
	11:46:18	6	9.82	8.4	555	114.2	12.94	0.355
	11:48:00	8	9.1	8.15	557	97.7		
	11:50:00	9.4	8.49	7.93	558	80.5		
3	12:02:04	0.1	10.55	8.64	558	132.1	14.72	0.357
	12:03:46	1	10.55	8.62	557	130.8	14.58	0.356
	12:05:06	2	10.5	8.6	558	129.5	14.45	0.357
	12:06:10	3	10.46	8.59	557	129.6	14.47	0.356
	12:06:38	3	10.49	8.59	557	129.1	14.4	0.356
	12:07:38	4	10.48	8.59	557	128.7	14.37	0.356
	12:08:58	4.9	10.43	8.56	557	126.6	14.14	0.356
	12:10:07	6	9.58	8.27	562	104.5	11.91	0.359
COMBER MERE	16/07/99							
1	104359	2	20.03	9.14	452.85	117.96	10.74	0.28
	104543	4	19.57	8.95	466.32	87.52	8.05	0.288
	104719	6	14.74	7.88	563.73	3.39	0.34	0.348
	104816	6.9	13.48	7.91	565.80	3.09	0.32	0.35
2	110637	0.3	19.91	9.08	467.36	102.20	9.33	0.289
	110742	2	19.76	9.03	488.39	97.31	8.91	0.289
	110906	4	18.28	8.09	511.92	4.39	0.41	0.316
	111010	6	14.86	7.94	561.66	3.29	0.33	0.347
	111110	8	12.2	7.94	577.20	2.99	0.32	0.357
	111204	9.7	11.02	7.85	600.00	2.79	0.31	0.37
3	112632	0.3	20.26	8.98	474.61	92.71	8.4	0.293
	112838	1.5	19.89	8.95	474.61	87.92	8.03	0.293
	113013	3	18.77	8.28	501.55	19.66	1.84	0.31
	113054	3.4	18.72	8.26	502.59	18.26	1.71	0.311

COMBER MERE	04/10/99							not temp. compensated	
1	113408	1	14.07	7.39	475.05	62.42	6.31 @		0.309
	113551	2	14.03	7.40	476.03	60.59	6.12 @		0.309
	113716	3	14.02	7.39	476.03	59.37	6.01 @		0.309
	113823	4	14.02	7.39	476.03	58.86	5.96 @		0.309
	113933	5	14.02	7.39	475.05	58.66	5.93 @		0.309
	114037	6	14	7.39	474.06	58.45	5.92 @		0.308
	114232	7	13.87	7.33	474.06	54.58	5.54 @		0.308
	114412	8	13.51	7.19	471.11	46.74	4.78 @		0.306
	114816	9.2	12.82	7.01	560.79	25.66	2.67 @		0.364
2	120132	0.2	14.28	7.43	478.00	65.68	6.61 @		0.31
	120422	1	14.08	7.39	474.06	58.25	5.89 @		0.308
	120530	2	14	7.38	475.05	56.72	5.74 @		0.309
	120659	3	13.97	7.39	474.06	56.62	5.73 @		0.308
	120821	4	13.97	7.38	473.08	56.31	5.71 @		0.307
	121007	5	13.97	7.38	474.06	56.11	5.68 @		0.308
	121121	6	13.92	7.38	473.08	56.01	5.67 @		0.307
	121319	7	13.8	7.35	471.11	56.72	5.76 @		0.306
	121454	8	13.7	7.28	468.15	54.99	5.6 @		0.304
	121703	9	13.1	7.12	489.83	42.97	4.44 @		0.318
	121946	9.9	11.6	6.88	615.99	21.89	2.34 @		0.4
3	123128	0.2	14.1	7.39	473.08	68.13	6.88 @		0.307
	123228	1	14.08	7.39	474.06	65.07	6.57 @		0.308
	123415	2	14.05	7.39	474.06	62.02	6.26 @		0.308
	123525	3	14	7.39	473.08	61.10	6.19 @		0.307
	123645	4	13.97	7.37	472.09	60.49	6.12 @		0.306
	123754	5	13.77	7.33	468.15	59.47	6.05 @		0.304

BETLEY MERE	07/04/99							
1	132150	0.2	13.24	7.89	583	97.2	10.19	0.373
	132258	1	13.2	7.86	583	93.9	9.85	0.373
	132354	1.3	13.14	7.85	584	93.4	9.81	0.374
2	133148	0.2	13.1	7.97	585	100.4	10.55	0.374
	133258	0.8	13.1	7.95	584	99.7	10.48	0.374
3	134018	0.2	13.33	7.93	585	101.5	10.6	0.374
	134118	0.9	13.33	7.92	586	99.8	10.44	0.375

BETLEY MERE	16/07/99							
1	85243	0.3	18.57	7.56	652.00	41.81	3.89	0.417
	85329	0.9	18.38	7.57	653.00	42.31	3.95	0.418
2	90231	0.3	17.97	7.68	652.00	55.68	5.25	0.417
	90333	0.8	18.14	7.67	653.00	53.47	5.02	0.416
3	91153	0.3	17.9	7.66	649.00	54.47	5.14	0.416
	91243	0.9	17.89	7.65	654.00	53.37	5.04	0.419

BETLEY MERE	04/10/99							not temp compensated	
	143506	0.2	12.16	7.27	530.17	73.10	7.56 @		0.336
	143835	1	12.16	7.36	530.17	68.85	7.12 @		0.336
	144016	1.4	12.14	7.35	530.17	67.91	7.02 @		0.336

OAK MERE		**09/04/99**								
1		83719	0.2	11.85	4.57	99.9	90.6	9.8	0.064	
		83833	1	11.79	4.56	99.9	89.8	9.73	0.0639	
		83925	2	11.78	4.51	99.8	89.7	9.72	0.0639	
		84025	3	11.76	4.53	99.8	89.2	9.67	0.0639	
		84135	4	11.73	4.51	100	89.2	9.67	0.064	
		84236	5	11.7	4.51	100.1	88.4	9.59	0.064	
		84405	6	11.62	4.46	100.2	86	9.35	0.0641	
		84711	7.2	11.32	4.47	101	67.1	7.35	0.0646	
2		85831	0.2	12	4.55	100.1	91.1	9.81	64	
		85924	1	11.91	4.56	100	90.5	9.77	0.064	
3		91141	0.2	12.09	4.57	100	91.8	9.88	0.064	
		91300	1	12.06	4.56	99.9	91.1	9.8	0.0639	
		91351	2	12.06	4.54	99.9	90.4	9.73	0.0639	
OAK MERE		**15/07/99**								
1		93747	0.3	20.02	4.72	96.63	95.60	7.98	0.0624	
		93916	1	20	4.72	98.12	96.81	8.02	0.0634	
		94042	2	19.96	4.71	98.02	96.37	7.98	0.0634	
		94151	3	19.96	4.71	98.02	96.26	7.97	0.0634	
		94332	4	16.78	4.75	96.44	39.56	3.58	0.0624	
		94422	5	15.71	4.74	96.44	21.98	2.2	0.0623	
		94531	6	15.36	4.77	95.74	14.29	1.33	0.0619	
		94630	6.9	15.21	4.87	95.25	9.01	0.83	0.0615	
2		95724	0.3	19.58	4.71	97.13	97.80	8.16	0.0628	
		95829	0.9	19.8	4.74	97.23	97.36	8.12	0.0628	
3		101205	0.3	19.91	4.67	96.44	96.70		0.0824	
		101335	1	19.91	4.69	96.73	96.70		0.0625	
OAK MERE		**06/10/99**								
1		95237	0.3	11.41	4.72	91.61	93.60	10.22 @		0.0592
		95434	1	11.41	4.69	91.61	92.90	10.15 @		0.0592
		95604	2	11.38	4.74	91.61	92.50	10.12 @		0.0592
		95732	3	11.34	4.74	91.71	92.20	10.08 @		0.0593
		95919	4	11.38	4.73	91.61	91.60	10.01 @		0.0592
		100051	5	11.31	4.72	91.90	90.90	9.95 @		0.0594
		100224	6	11.21	4.71	91.71	90.80	9.96 @		0.0593
		100341	6.5	11.18	4.72	91.61	90.40	9.93 @		0.0592
2		101414	0.3	11.1	4.70	91.80	98.10	10.79 @		0.0593
		101539	1	11.07	4.74	91.90	94.40	10.4 @		0.0594
3		102632	0.3	11.38	4.68	91.21	98.60	10.78 @		0.0589
		102816	1	11.28	4.68	91.31	94.50	10.36 @		0.059
		102915	2	11.21	4.72	91.21	93.10	10.22 @		0.0589
PETTY POOL		**09/04/99**								
1		103016	0.2	13	7.52	486	88.3	9.31	0.311	
		103136	1	12.65	7.46	485	84.5	8.97	0.311	
		103413	2	12.35	7.27	486	70.7	7.56	0.311	
		103856	2.3	12.3	7.17	486	49	5.25	0.311	
2		104443	0.3	12.92	7.55	486	88.4	9.34	0.311	
		104603	1	12.7	7.49	485	85.3	9.05	0.311	
		104734	2	12.24	7.2	487	65.1	6.98	0.311	

3	105800	0.3	13.05	7.5	484	87.5	9.21	0.31
	105941	1	12.88	7.48	486	85.8	9.06	0.311
	110207	1.8	12.34	7.33	486	67.9	7.26	0.311
PETTY POOL	15/07/99							
1	124603	0.3	19.39	8.57	441.45	92.99	8.54	0.273
	124811	1	19.38	8.56	443.52	92.28	8.48	0.274
	124927	2	19.13	8.37	451.81	65.53	6.05	0.279
2	125721	0.3	19.38	8.54	450.78	92.89	8.53	0.279
	125915	1	19.29	8.49	452.85	89.08	8.2	0.28
	130045	1.8	18.74	7.85	472.54	48.70	4.53	0.292
3	130838	0.3	19.38	8.49	443.52	88.18	8.1	0.274
	130953	1	19.15	8.18	449.74	68.43	6.13	0.278
	131103	1.6	17.58	7.88	456.99	43.19	4.11	0.282
TABLEY MERE	09/04/99							
1	125532	0.2	12.83	9.29	669	200		0.428
	125812	1.2	12.21	9.05	889	167.8	18	0.441
2	131524	0.2	13.18	8.94	689	133.2	13.98	0.441
	131703	1	12.47	8.83	690	121.1	12.91	0.442
	131850	2	11.94	8.57	695	91.6	9.89	0.445
	132302	3	11.71	8.48	699	88.7	9.4	0.447
	132456	3.6	11.58	8.15	705	60.3	6.56	0.451
3	133409	0.2	14.48	9.15	878	162.5	16.58	0.434
TABLEY MERE	15/07/99							
1	152852	0.3	18.93	8.36	626.94	98.69	9.08	0.387
	152929	0.9	18.91	8.28	630.05	97.88	9.01	0.389
2	154043	0.3	20.09	9.15	550.26	109.19	9.81	0.34
	154220	1	20.09	9.15	538.86	111.52	10.02	0.333
	154328	2	19.72	9.16	539.90	115.86	10.49	0.334
	154501	3	19.36	8.93	549.22	73.84	6.74	0.339
	154547	3.7	19.17	8.91	550.26	72.63	6.65	0.34
3	155414	0.3	19.41	9.60	531.61	151.01	13.75	0.328
TABLEY MERE	06/10/99						not temp. compensated	
1	144146	0.3	11.02	7.17	670.46	67.90	7.49 @	0.433
	144154	0.3	11.02	6.78	615.91	67.90	7.49 @	0.434
	144345	1	10.33	6.82	634.05	62.80	7.03 @	0.447
2	145940	0.3	11.92	8.63	467.15	127.70	13.79 @	0.33
	150521	1	10.89	7.79	476.22	90.80	10.04 @	0.336
	150826	2	10.72	7.80	476.22	90.2	10.01 @	0.336
	151148	3	10.79	7.54	497.99	83.00	9.2 @	0.351
	151342	3.4	10.75	7.45	504.34	77.60	8.6 @	0.356
3	152558	0.3	12.62	9.07	459.89	171.30	18.21 @	0.324

APPENDIX 2: RAW DATA - NUTRIENT & ALGAL CONCENTRATIONS

Name	Date / Time	Site	Secchi m	N Oxides mg/l	Susp. Solids mg/l	Solid (ash) mg/l	Chlorophyll mg/l	Phaeophytin mg/l
NORBURY MERE	07-APR							
	1000	Top 1		3.55	8	10	41	31.9
	1025	Top 2		2.21	12	10	115	83.8
	1050	Top 3		2.15	14	10	117	
OAK MERE	09-APR							
	0930	Top 1	1.4	0.2	3	10	9.01	8.58
	0931	Bott 1						
	0955	Top 2	1	0.2	3	10	9.19	7.02
	0956	Bott 2						
	1010	Top 3	1.20	0.2	3	10	8.75	8.75
	1011	Bott 3						
OAK MERE	15-JUL							
	1021	Top 1	2.80	0.2	3	10	5.18	
	1022	Bott 1						
	1053	Top 2	1.00 b	0.2	3	10	7.76	
	1054	Bott 2						
	1107	Top 3	1.80	0.2	3	10	5.44	
	1108	Bott 3						
OAK MERE	06-OCT							
	950	Top 1	2.2	0.2	5	200	7.41	5.89
	951	Bott 1						
	1013	Top 2	1.5 b	0.2	7	10	6.87	4.92
	1014	Bott 2						
	1025	Top 3	2.4 b	0.2	9	10	6.16	4.64
	1026	Bott 3						
PETTY POOL	09-APR							
	1128	Top 1	1.40	3.04	4	10	24.2	
	1129	Bott 1						
	1143	Top 2	1.40	3.01	3	10	19.6	14.8
	1144	Bott 2						
	1157	Top 3	1.60	3.02	3	10	21.8	15.3
	1158	Bott 3						
PETTY POOL	15-JUL							
	1339	Top 1	0.60	0.2	11	10		
	1340	Bott 1						
	1351	Top 2	0.80	0.2	14	10	55.8	37.8
	1352	Bott 2						
	1403	Top 3	0.80	0.2	12	10	56.3	
	1404	Bott 3						

Alkalinity mg/l	Total P µg/l	Total N µg/l	Nitrate µg/l	Nitrite µg/l	Ammonia µg/l	ortho - P µg/l	silicate µg/l
197	81	3550	3480	70.6	29.3	47.7	3760
200	101	2210	2160	52.4	340	35	615
201	100	2150	2110	41.4	412	19.8	554
5	38.8	179	175	4	20	20	711
	35.2	162	157	5	14	20	671
5	34.3	160	156	4	7	20	650
	40.1	160	156	4	23	20	645
5	33.9	153	149	4	30	20	644
	37.2	151	146	5	31	20	650
5	23	3	3	0.9	8.3	21.9	187.2
	127	24	22.1	1.9	167	82	352
5	27	3	3	0.7	8.8	19.1	196.3
	55	3	3	0.95	27.4	20.7	208.7
5	26	3	3	0.5	14.2	21.1	1840
	43	3	3	0.5	10.9	21.5	185.5
5	53	3	3	1	9	15.7	479
	54	3	3	1	12.8	17.1	546
5	56	1	3	1	14.1	17.8	540
	59	3	3	1	6.2	17.8	540
5	330	1	3	1	5.8	17.8	534
93.8	36	3050,	3020	29		27.46	
	27	3200	3170	33.6	128	13.3	8740
89	43	3010	2980	30.4	154	15.6	8520
	26	2990	2950	38.3	177	22.7	8470
91	20	3020	2990	31.9	169	18.6	8630
	57	3050	3020	30.9	77.6	5.7	8600
130	198	126	115.9	10.1	71.8	152	3661
	236	146.4	139.3	7.1	78.8	149	3646
129	218	122.9	114.1	8.8	63.5	156	3695
	255	192	185.4	6.6	104.2	174	3827
129	206	94.8	86.5	8.3	78	145	3751
	246	187.4	176.6	10.8	113	185	3980

COMBER MERE	16-JUL						
	1135	Top 1	0.80	0.2	12	10	84.3
	1136	Bott 1					
	1200	Top 2	0.90	0.2	9	10	63.7
	1201	Bott 2					
	1220	Top 3	1.10	0.2	7	10	38
	1221	Bott 3					
COMBER MERE	04-OCT						
	1125	Top 1	2	0.251	6	10	29.4
	1126	Bott 1					
	1203	Top 2	1.8	0.317	5	10	25.1
	1204	Bott 2					
	1231	Top 3	1.4	0.409	8	10	24.3
	1232	Bott 3					
TABLEY MERE	09-APR						
	1350	Top 1	0.30	4.56	35	19	362
	1351	Bott 1					
	1412	Top 2		2.79	10	10	121
	1413	Bott 2	0.40				
	1432	Top 3		2.29	14	10	110
	1433	Bott 3	0.30 b				
TABLEY MERE	15-JUL						
	1622	Top 1	0.60 b	2.03	7	10	20.5
	1623	Bott 1					
	1636	Top 2	1.20	0.2	6	10	17.6
	1637	Bott 2					
	1648	Top 3	0.40 b	0.2	5	10	22.8
	1649	Bott 3					
TABLEY MERE	06-OCT						
	1437	Top 1	1	11.1	19	10	50.4
	1438	Bott 1					
	1452	Top 2	0.7	4.45	20	10	192
	1453	Bott 2					
	1525	Top 3	0.4 b	4.08	22	10	198
	1526	Bott 3					

56.5	142	101	3	3	0.5	155.4	5.3	760
		258	229.7	173.7	56	293	211	4538
37.2	147	73	3	173.7	0.5	128.1	211	844
		688	62.2	42.1	20.1	1135	658	7471
20.4	149	41	3	3	1.7	71	11.1	1034
		122	3	3	2.4	155	14.6	1833
18.6	160	367	317.8	295.6	22.2	390	323	3504
		532	1676	749	927	191.9	493	5125
17.7	160	363	380.3	3566	23.7	398	325	3618
		763	2363	178.9	574	8.3	709	6916
18.4	159	362	409	379.7	29.3	389	4195	3682
		326	994	648	346	7	316	3752
241	127	138	4560	4460	98.3	559	11.7	6
82.4	134	75	2790	2750	36.6	312	6.7	47.6
		100	2290	2240	44.6	255	20.8	1420
68.4	128	34	2290	2260	32	317	10.8	19.2
		62	2400	2370	32	311	10.2	20.6
	137	273	1931	1772	59	131.8	178	2661
		514	1924	1766	58	256	200	1640
	126	295	2.5	3	0.9	19.8	264	2386
		322	125.4	108.5	16.8	125.4	267	2328
	122	238	19.7	16.5	3.2	50.9	214	2190
		271	19.7	16.8	2.9	75.9	202	2190
38	131	208	11100	9476	191	312	484	8564
		184	11618	11013	605	205	111	10029
110	121	405	4520	4388	132	335	237	3941
		371	5482	5257	225	195.6	279	5558
112	120	336	4465	4322	143	190	224	3102
		349	4102	3968	134	160	211	2602

PETTY POOL	06-OCT	surface		0 418	22	12	121
BETLEY MERE	07-APR						
	1418	Top 1	0.70	2.55	12	10	42.2
	1419	Bott 1					
	1429	Top 2	0.70	2.57	10	10	36.3
	1430	Bott 2					
	1440	Top 3	0.90	2.77	7	10	33.3
	1441	Bott 3					
BETLEY MERE	13-JUL						
	1430	Top 1		0.2	20	12	54
	1431	Bott 1					
	1437	Top 2		0.2	8	10	38.5
	1438	Bott 2					
	1444	Top 3		0.2	8	10	31 2
	1445	Bott 3					
BETLEY MERE	16-JUL						
	0942	Top 1	0.80 b	0.2	8	10	18.9
	0943	Bott 1					
	0950	Top 2	0.50 b	0.2	6	10	16.3
	0951	Bott 2					
	1005	Top 3	1.00 b	0.2	5	10	6.16
	1006	Bott 3					
BETLEY MERE	04-OCT						
	1434	Top 1	0 7	1.85	16	10	51
	1435	Bott 1					
	1448	Top 2	0.7	2.75	17	11	42.4
	1449	Bott 2					
	1500	Top 3	0.6	2.66	14	10	46.1
	1501	Bott 3					
COMBER MERE	07-APR						
	1211	Top 1	1.20	2.38	6	10	51.1
	1213	Bott 1					
	1240	Top 2	1.20	2.46	6	10	44 8
	1243	Bott 2					
	1301	Top 3	1.20	2.42	6	10	51.5
	1302	Bott 3					
COMBER MERE	13-JUL						
	1209	Top 1	1.00	0.2	19	10	92.2
	1210	Bott 1					
	1230	Top 2	1.00	0.2	19	10	94.2
	1231	Bott 2					
	1245	Top 3	1.00	0.2	23	10	66 9
	1246	Bott 3					

47.3	121	256	418	408.2	9.8	130	176	1494
25.1	165	155	2550	2520	30.6	13.9	136	4690
		223	2300	2290	14.2	8.7	147	4650
21.8	164	185	2570	2530	37.9	36.8	148	4850
		208	2560	2510	45.5	26.2	155	4810
21.6	167	152	2770	2730	40.8	37.4	143	4650
		198	2750	2730	16.9	6.8	146	4640
15.2	225	974	6.6	4.6	2	182	853	6444
		1006	42	38.6	3.4	302	829	6432
27.9	226	956	49.7	46.2	3.5	130	869	6446
		1032	49	45.2	3.8	172	879	6472
22.5	234	950	88.4	82	6.4	179	889	6368
		1019	91.7	85.7	6	189	883	6424
14.1	229	1046	103.1	94.4	8.7	237	997	8592
		1125	107.6	98.6	9	231	998	8468
11.8	230	994	112.2	103.5	8.7	221	980	8077
		1067	94.7	86.9	7.8	177	976	8419
6.16	230	993	152.3	140.5	11.8	213	983	7692
		1053	150.6	139.3	11.2	206	986	7765
34.7	163	425	1850	2707.3	42.7	104	337	9636
		420	2118	2040	78	8.9	328	9747
28.3	162	394	2750	2697.3	50.7	195.8	310	9040
		435	3128	3029	99	9.1	291	9157
26.6	162	391	2660	2610.4	49.6	198.9	315	9032
		446	2923	2849	74	8.2	308	9290
45.5	177	193	2380	2360	24.2	208	147	283
		187	2520	2490	25.2	832	156	251
30.1	176	185	2460	2430	26.8	112	155	497
		186	2540	2510	26	54.5	175	2290
30.2	177	185	2420	2390	29.3	104	152	457
		185	2300	2270	32.3	42.4	163	851
63.6	137	141	3	3	1.9	152	7.8	787
		237	337	265	72	264	198	4426
65.4	138	154	29	26.6	2.4	88	6	845
		794	90.2	70.6	19.6	1301	754	7796
47.2	138	152	3	3	0.5	72	5.7	808

APPENDIX 3: RAW DATA, OAKMERE CONTINUOUS MONITORING POINT, NUTRIENT AND ALGAL CONCENTRATIONS FOR 1997/1998

Date	Time	Position	Secchi	Sus.solids	Chlorophyll	Phaeophytin	Total P	ortho-P	Nitrate	Nitrite	Ammonia	Silicate
			m	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
29/05/97	1107	Top		3	4.23	2	44.67	27.17	116.67	0.5	58.13	85.9
	1108	Bottom					57.33	36.77	121	0.5	112.4	149.3
01/07/97	1300	Top		3	2.77	1.47	46	33.4	125	0.5	63.7	376
12/08/97	1010	Top	0.6	3	14.15	5.82	69.5	46.85	3	0.16	18.75	
	1011	Bottom					76.00	60.35	3.8	0.51	45.65	
09/10/97	1130	Top	1.1	6	17.54	5.21	85.67	71.7	241.33	0.5	42.9	72.33
	1131	Bottom					81.67	65.7	136.33	0.5	30.67	72.67
06/04/98	1010	Top	0.8	3.0	8.09		48	47.83	429	0.642	119.67	71.22
	1011	Bottom					48.33	49.73	411.33	1.31	135.67	149.67
06/07/98	1003	Top	1.8	3.0	4.25	2.67	47.67	36.53	195	1	53.63	210.67
	1004	Bottom					38.67	36.20	194.33	1	51.50	211.00
11/09/98	1120	Top		3.0	5.8	5.8	54	42.8	23.4	0.93	53.3	212.00
29/09/98	1047	Top	1.8	5.0	15.43		37	31	3.7	0.86	13.8	354.00
	1048	Bottom					30.00	31.43	10.7	0.67	17.77	326.67
21/10/98	1129	Top	0.7	4.0	10.3	7.05	43	35.3	6	1.6	42.3	395.00
13/11/98	1117	Top		3.0	6.16	5.51	51	28.1	52.7	5.1	73.2	211.00
14/12/98	1150	Top	0.8	3.0	6.96	6.96		39.7	113	2.4	109	558.00

APPENDIX 3 : RAW DATA, OAKMERE CONTINUOUS MONITORING POINT, NUTRIENT AND ALGAL CONCENTRATIONS FOR 1999

Date	Time	Position	Secchi	Sus.solids	Chlorophyll	Phaeophytin	Total P	ortho-P	Nitrate	Nitrite	Ammonia	Silicate
			m	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
15/01/99	1140	Top	1	3	5.53	4.45	69	37.2	176	2.2	119	650
16/02/99	1045	Top	0.8	3	33.5		66	5.9	201	2.3	21.7	730
16/03/99	1200	Top	0.6	5	15.4	15	50	7	3	1.5	5.2	41.8
09/04/99	0930	Top	1.4	3	9.01	8.58	38.8	20	175	4	20	711
	0931	Bottom					35.2	20	157	5	14	671
05/05/99	1100	Top	2	3	3.66	3.44	51	18.5	37.3	1.6	63.4	242
09/06/99	1130	Top	2.6	3	3.21	0.61	44	10.9	7.7	1	27.1	123.3
15/07/99	1021	Top	2.8	3	5.18		23	21.9	3	0.9	8.3	187.2
	1022	Bottom					127	82	22.1	1.9	167	352
25/08/99	1000	Top	3.25	4	3.12	3.12	40	17.6	3	0.5	30	296.9
	1001	Bottom					50	24.9	11.8	0.5	49.3	378
24/09/99	1645	Top		6	29.4	20.5	47	17.3	3	0.5	9.5	356.6
	1646	Bottom					62	14.4	3	0.5	33.4	404.7
06/10/99	0950	Top	2.2	5	7.41	5.89	53	15.7	3	1	9	479
	0951	Bottom					54	17.1	3	1	12.8	546
02/12/99	1130	Top	2.2	3	48.5	34.8		1		1	25.9	508
	1131	Bottom						1		1	29.9	532

BETLEY MERE **GR SJ 749 479**

	Apr-98	Apr-98	Apr-98	Jul-98	Jul-98	Jul-98	Sep-98	Sep-98	Sep-98	Apr-99	Apr-99	Apr-99	Jul-99	Jul-99	Jul-99	Oct-99	Oct-99	Oct-99
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	nr	p	p	p	nr	nr	p	p	p	p	p	p	p	p	p	p	p	p
CLADOCERA																		
Daphniidae																		
Daphnia longispina gp		6	17	6			11	23	11	1	3	3					2	
Daphnia pulex gp							6		114					1		1	2	
Daphnia spp.		6						1					2	9	7	4	13	15
Ceriodaphnia spp.							34	40	45	1		1	6	7	10	1	4	1
Bosminidae																		
Bosmina spp.							17	11	17				2	2	6	1	2	4
Chydoridae																		
Chydorus spp.													1		1			
CYCLOPOIDA																		
Cyclops spp.		28	34	17			23	34	11	5	3	1	53	23	60	17	20	21
CALANOIDA																		
Diaptomus spp.		187	124	45			23	17	28	4	2	2	15	33	81	30	36	45
ROTIFERA																		
Asplanchna spp.			6				6	11	6	1		1	13	6	16	10	5	19
Ascomorpha spp.													4	1	1			
Total	nr	227	181	68	nr	nr	120	137	232	12	8	8	96	82	182	64	84	105

nr = sample not received
All zooplankton species are measured in numbers/L.

OAK MERE **GR SJ 575 677**

	Apr-98	Apr-98	Apr-98	Jul-98	Jul-98	Jul-98	Sep-98	Sep-98	Sep-98	Apr-99	Apr-99	Apr-99	Jul-99	Jul-99	Jul-99	Oct-99	Oct-99	Oct-99
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	p	nr	p	nr	nr	nr	p	p	p	p	p	p	p	p	p	p	p	p
CLADOCERA																		
Daphniidae																		
Daphnia longispina gp	6		11				17	11	28	3	3	3	1					
Daphnia pulex gp								1					1					
Daphnia spp.	6						1						1					
Ceriodaphnia spp.	6		17				11	17					39	21	8	13	11	11
Bosminidae																		
Bosmina spp.	5868		6988				23	28	11	102	95	106		1	1	4	3	7
Chydoridae																		
Chydorus spp																1		
CYCLOPOIDA																		
Cyclops spp.							46	74	62				1					
CALANOIDA																		
Diaptomus spp.	113		141				11	17	11	1	1	1	12	5	2	15	7	18
ROTIFERA																		
Asplanchna spp.	11		17					1		1	2	2						
Total	6010	nr	7174	nr	nr	nr	109	149	112	107	101	112	55	27	11	33	21	36

nr = sample not received
All zooplankton species are measured in numbers/L.

PETTY POOL	GR SJ 619 701																	
	Apr-98	Apr-98	Apr-98	Jul-98	Jul-98	Jul-98	Sep-98	Sep-98	Sep-98	Apr-99	Apr-99	Apr-99	Jul-99	Jul-99	Jul-99	Oct-99	Oct-99	Oct-99
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	p	p	p	p	nr	nr	p	p	p	p	p	p	p	p	p	nr	nr	nr
CLADOCERA																		
Daphniidae																		
Daphnia longispina gp	509	736	645	11			11	17	11	2	4	5	1					
Daphnia pulex gp								1					12	7	7			
Daphnia spp.	11	34	23										7	3	3			
Bosminidae																		
Bosmina spp.	6		6	6						2	1	1						
CYCLOPOIDA																		
Cyclops spp.	11	11	17	23			23	23	17				1	2	1			
CALANOIDA																		
Diaptomus spp.	492	634	436	23			23	17	17	11	16	14	4	7	6			
ROTIFERA																		
Asplanchna spp.	11	11	17							5	12	4	13	3	3			
Ascomorpha spp.																		
Keratella spp.											1							
Notholca spp.											1							
Pompholyx spp.										1	1							
Total	1040	1426	1144	63	nr	nr	57	58	45	21	36	24	38	22	20	nr	nr	nr

nr = sample not received
All zooplankton species are measured in numbers/L.

COMBER MERE GR SJ 586 445

	Apr-99	Apr-99	Apr-99	Jul-99	Jul-99
	1	2	3	1	2
	p	p	p	p	p
CLADOCERA					
Daphniidae					
Daphnia longispina gp	11	13	11		14
Daphnia pulex gp				1	31
Daphnia spp.				7	97
Ceriodaphnia spp.				1	1
Leptodoridae					
Leptodora kindti				2	1
CYCLOPOIDA					
Cyclops spp.				7	1
CALANOIDA					
Diaptomus spp.	2	2	2	2	2
ROTIFERA					
Asplanchna spp.					
Total	**13**	**15**	**13**	**20**	**147**

nr = sample not received
All zooplankton species are measured in numbers/L.

Jul-99	Oct-99	Oct-99	Oct-99
3	1	2	3
p	p	p	p
2		1	
2	1	14	1
12	1	21	1
1			
1			
2	1	2	1
2	2	6	1
	1	1	1
22	**6**	**45**	**5**

TABLEY MERE **GR SJ 723 767**

	Apr-99	Apr-99	Apr-99	Jul-99	Jul-99	Jul-99	Oct-99	Oct-99	Oct-99
	1	2	3	1	2	3	1	2	3
	p	p	p	p	p	p	p	p	p
CLADOCERA									
Daphniidae									
Daphnia longispina gp	23	11	11			2			
Daphnia pulex gp				1		7			
Daphnia spp.				2	1	11		1	
Ceriodaphnia spp.						1			1
Bosminidae									
Bosmina spp.								1	1
Chydoridae									
Chydorus spp.									
CYCLOPOIDA									
Cyclops spp.	20	14	11	1		2		3	5
CALANOIDA									
Diaptomus spp.	1			1	1	1		7	1
ROTIFERA									
Asplanchna spp.	2	1						7	2
Total	**46**	**26**	**22**	**5**	**2**	**24**	**0**	**19**	**10**

nr = sample not received
All zooplankton species are measured in numbers/L.