Hydraulics Research
Wallingford

GRANGEMOUTH FLUID MUD STUDY

Field investigation

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CONTRACT

This report describes work funded by Hydraulics Research and by the Department of the Environment under Research Contract PECD 7/6/110 for which the nominated officer was Dr R P Thorogood. It is published on behalf of the Department of the Environment, but any opinions expressed in this report are not necessarily those of the Department of the Environment. The field work was carried out jointly by personnel from Hydraulics Research and Liverpool University in close collaboration with the Forth Ports Authority.

This report was compiled by Mr N G Feates in Mr T N Burt's section in the Tidal Engineering Department, under the management of Mr M F C Thorn.

ABSTRACT

Hydraulics Research (HR) and the Department of the Environment (DoE) have jointly funded research with the objective of collaborating with University and Polytechnic researchers in the field of cohesive sediments. one such collaboration was undertaken with the Department of Civil Engineering at Liverpool University, which received a grant from the Science and Engineering Council commencing October 1988, to study mud process modelling. Hydraulics Research had committed to provide support for this research by assisting in the execution of a field survey at the site at which the mud process modelling was to be investigated. Assistance was also given in the testing of mud from the site (Ref 1). The site chosen for the study was Grangemouth on the Firth of Forth, Scotland.

An intensive programme of field measurements was undertaken at the site by staff from HR and Liverpool University in close collaboration with the Forth Ports Authority who provided the necessary survey vessels. The programme comprised standard anchored vessel measurements and measurements of suspended solids concentrations at six positions in the vicinity of Grangemouth Harbour to gain an insight into patterns of water and silt movement during the tidal cycle. A new investigation technique was implemented to measure the movement of fluid mud.

During the field survey new techniques were used in order to attempt to observe the settling of cohesive sediment on bed slopes and the entrainment of fluid mud by flowing water. Both of these processes were postulated as being important in the transport mechanisms at Grangemouth. The results of the studies described in this report and the results of earlier laboratory investigations (Ref 1) will be used in the development of a three dimensional mud transport numerical model at Liverpool University.

Anchored vessel measurements were made during a period when the tidal range at Grangemouth was mid way between that of a mean spring and a mean neap range. At each of the six monitoring positions, measurements of tidal flow components were made for a full tidal cycle (approximately 12.5 hours). Information collected during this exercise will be used to create a calibration data base for the numerical model.

In addition to the above tidal measurements, sensors installed at the entrance to Grangemouth Dock recorded suspended solids concentrations during the entire duration of the field survey. This information was to be predominantly used by HR in the developing of a dredging experiment in order to determine siltation rates at ship berths.

A new measurement technique was employed in an attempt to record the movement of fluid mud on the intertidal banks and in the harbour bellmouth. The instrument used was a 'Sonatest' oscilloscope and echo sounder transducer. With the small transducer fixed to a purpose built bed frame it was possible to measure bed levels to an accuracy of better than 0.1 mm. An additional capability of the instrument is that it can "see" through the bed, depending on the density of the material, up to a depth of several centimetres.

Detection of the bed and its underlying layers are displayed on the oscilloscope by spikes of variable amplitude, the amplitude depending on the density of the material and the position of the detected bed relative to the transducer. During the observations the bed level was seen to change by up to 50 mm during a tidal cycle, there being definite phases of erosion and deposition. It was also considered that a layer of fluid mud about 5 mm thick was observed late during an ebb tide to be flowing down a steep bank into the harbour bellmouth.

In all it was considered that the technique had substantial potential and that the measurement system could provide considerable insight into physical processes in any similar field study.

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1. INTRODUCTION

During April 1989 a team of hydrographic surveyors carried out an intensive programme of field measurements in the vicinity of Grangemouth Harbour. The work was carried out jointly by members of staff from both Hydraulics Research Ltd (HRL) and Liverpool University in close collaboration with the Forth Ports Authority who provided valuable local knowledge and two vessels used during the survey.

There were three main objectives of the survey, these were to collect sufficient quality data to

i) provide calibration data for an updated version of a sediment transport model developed by Liverpool University;
ii) give an insight into whether the movement of fluid mud on the intertidal banks and in the harbour bellmouth could be recorded;
iii) provide a basis on which HR could design a dredging experiment in order to determine siltation rates at the BP oil berths.

To this end, three measurement techniques were adopted and are described briefly below :-

a) Anchored vessel measurements at six positions off of Grangemouth harbour. Typically observations of suspended solids concentration, salinity, temperature and current velocity and direction were made at each of the positions for the duration of a full tidal cycle (about 12.5 hours).

b) Longer-term measurement of suspended solids concentrations 0.5m above the bed at two positions, one either side of the harbour

bellmouth. These measurements were made automatically over a period during the survey of about 3½ days.

c) Observations using a high resolution echo sounder in order to attempt to record the movement of the fluid mud layers at the east lead-in jetty. This element of the survey was very experimental and although some very interesting phenomena were observed and recorded on video tape there are no 'hard' results to include in this report.

2. INSTRUMENTATION

2.1 Suspended solids concentration

The monitoring system used at each of the six anchored vessel positions and the long-term shore based positions alongside the east and west lead-in jetties were almost identical to each other. The only difference was the range of concentrations over which each sensor was calibrated to measure.

The sensors installed on the lead-in jetties were calibrated to measure concentrations ranging between 0-5000 mg/l formazin. Out of the six anchored vessel positions A-F (Fig. 1), A, C and E employed two sensors, one for near bed measurements and the other for bed + 1m to the surface. The remaining boat positions utilised a single solids sensor to measure through-depth concentrations. The calibration ranges are summarised below :-

Position		Calibrated range (mg/l formazin)
East lead-in jetty		0-5000
West lead-in jetty		0-5000
Boat Position A	Upper head	0-10000
	Lower head	0-2000
Boat Position B		0-2000
Boat Position C	Upper head	0-10000
	Lower head	0-2000
Boat Position D		0-2000
Boat Position E	Upper head	0-5000
	Lower head	0-2000
Boat Position F		0-2000

The sensors were calibrated using standard Formazin solutions as shown in the table above in order that normal tidal suspended solids concentrations would be recorded with reasonable clarity whilst any exceptional events would still be within the calibrated range.

Both the high range (0-10000 and 0-5000) and the low range (0-2000) sensors operate on the photo-extinction principle. The low range instrument (Plate 1) is 150 mm long and has a central light source and a photo cell at each end. Turbid water passing through the gaps between the light source and the photo cells obstructs a proportion of the light so that the voltage generated at the photo cells is a function of the suspended solids concentration and the gap

lengths. The dual path, unequal gap system compensates for uniform clouding of the lenses and ambient diffused light. The higher range sensor (Plate 2) is essentially the same as that described above except that it has only one photo cell, in effect it is half the low range instrument. It has the disadvantage of not allowing for the clouding of the lenses, although since the instruments were regularly inspected this was not anticipated to be a problem.

In the case of the shore based sensors installed alongside the east and west lead-in jetties the sensors were attached to cables anchored to the bed. The sensors were attached such that they were 0.5m above the bed. In the case of the anchored vessel positions the sensors were attached to the steel support cable just above the current meter. At the six anchored vessel positions data was collected by reading an analogue logger output. Automatic logging onto a chart recorder was utilised at the two shore based positions.

2.2 Current velocity and direction

Flow velocities and directions were measured at three of the boat positions (A, C and E) between the surface and 1m above the bed. Between the bed and 1m above the bed velocities were measured using a different type of current meter which did not have the direction facility. This type of meter was also used at Positions B, D and F.

Current meters were lowered over the side of the survey vessel via a davit and winch arrangement to the required depth, the weight of the instrument being supported by a steel cable. To prevent the current

meter from streaming away from the vessel during periods of high velocities a heavy streamlined lead weight is supported beneath the current meter by the steel cable.

The current meters are calibrated in the HRL Current Meter Rating Tank prior to any field use. Calibration equations relate the number of revolutions of the impeller in a given time to velocity.

2.3 Salinity and temperature

Salinity and temperature were measured using a standard salinometer with an incorporated temperature sensor for conductivity compensation. The instrument is strapped to the steel support cable just above the current meter, alongside the suspended solids meter.

Salinity was recorded at all six boat positions. Temperature was recorded at positions A, D and E only.

3. LOCATIONS

The positions chosen for the survey measurements are shown in Figure 1. Each position was chosen to give an insight into the flow behaviour in certain areas of the estuary. The positions are described below :-

Position A (19/4/89) was in the main river channel in line with the discharge of the River Carron, 600m upstream of the dock entrance.

Position B (19/4/89) was in the mouth of the River Carron.

Position C (18/4/89) was in the main deepwater river channel about 200m upstream of the dock entrance.

Position D (18/4/89) was inshore of Position C, about 30m off of the old lock entrance. This position provided information about the flows which were going into and out of the lock bellmouth.

Position E (20/4/89) was in the lock bellmouth itself.

Position F (20/4/89) was in the main deepwater channel about 350m downstream of the dock entrance.

In addition the the above anchored vessel positions, near-bed suspended solids concentrations were measured from shore based positions alongside each of the lead-in jetties to the lock (Fig. 1).

4. MEASUREMENTS

The survey measurements were carried out during a period when the tidal range at Grangemouth was approximately mid way between that of a mean spring (5.2m) and a mean neap (2.6m) range. The predicted tidal ranges for the duration of the survey in fact varied between 3.3m and 4.4m.

The tide curves shown in Figures 2-5 are extracted from the Grangemouth tide recorder records and cover the survey period.

4.1 Anchored vessel measurements

Through-depth measurements were made from each of the anchored vessel positions every 30 minutes. At positions A, C and E detailed measurements were made

in the bottom 1 metre (ie 0.05, 0.10, 0.15, 0.30 and 0.60m above the bed). Throughout the remainder of the depth measurements were made every 1 or 2 metres depending on the total depth. The latter procedure was adopted throughout the depth at positions B, D and F.

Observations made at each of the survey positions are shown below :-

Positions A, C and E :

i) Velocity; through-depth
ii) Suspended solids; through-depth
iii) Temperature; bed to bed + 1m
iv) Direction ; bed to bed + 1m
v) Salinity ; bed to bed + 1m

Positions B, D and F :

i) Velocity; through-depth
ii) Suspended solids; through-depth
iii) Salinity; surface and bed

The results of these observations are shown in Tables A to F.

Measurements of the water depth are reproduced for each of the six anchored vessel positions in Figures 6 to 11. It should be noted here that these are measurements of true water depth and therefore any swinging of the vessel off of station may have resulted in spurious readings being taken during that period.

4.2 Shore based measurements

The suspended solids meters installed alongside each of the east and west lead-in jetties automatically recorded the in-situ concentration onto a chart recorder at intervals of 2 seconds. The recorded data were subsequently analysed and converted into time related formazin concentrations.

These results are reproduced in Tables G and H for the East and West lead-in jetty respectively. The data is also presented in a graphical format in Figures 12 and 13.

Figure 12 (West lead-in jetty) demonstrates very clearly a double-peaked cycle which regularly occurred during the monitoring period. The first peak of about 550 mg/l was recorded late on 17 April, a period when the tide was in early to mid flood. This peak event had a duration of approximately 3¼ hours. The recorded concentrations then settled at about 50 mg/l for a further 7¼ hours before the second, a much higher peak was observed at slack, low water. Although this peak was higher (3,200 mg/l) it was of a much shorter duration, about 1¼ hours. The pattern described then repeated on approximately a 12.4 hour cycle.

The peaks observed at low water are probably a result of the suspended material settling out of suspension at the time of slack water. The peaks recorded during the early to mid flood tide, which were generally smaller in amplitude than those recorded at low water, occurred as a result of the material which had settled onto the bed at low water being resuspended by the rising flood tide.

A similar pattern was also recorded at the East lead-in jetty position (Fig. 13), although the peaks were not as well defined and appeared to occur in general about 1 hour later than those at the West lead-in position. This apparent time shift is difficult to account for, the only likely explanation being that the East lead-in position is in an area of low flow and out at the main run of-the-river.

5. WIND RECORDS

Records of wind speeds and directions were obtained from the Forth Ports Authority's anemometer covering the period of the survey. The records were analysed to produce a table of mean hourly wind speeds and directions. This data is reproduced in Table 9 and Figure 14. The peak wind speed recorded during the survey period was 20 mph (17.5 knots) on 19 April. Speeds were generally in the region of 5 mph with peaks of 15 mph. Further analysis of the records showed that the majority of the periods of high wind speed came from a south-westerly direction (110°).

6. FLUID MUD MEASUREMENTS

The instrument used was a 'Sonatest' oscilloscope and echo sounder transducer. The small transducer was rigged up on a bed frame on the inshore side of the East Lead-in Jetty so that it was supported at a fixed height of about 20 cm above the bed. The Sonatest controls allowed a considerable range of adjuctment of the operating frequency, the signal amplitude, scale and dumping. Bed level measurements could be made to an accuracy of better than 0.1 mm. The instrument also "sees" into the bed to a depth of up to several cms depending on the density of the bed and operating frequency range used.

Qualitative observations were made of the following phenomena.

1. Clouds of suspended solids appeared as many spikes dynamically changing in amplitude. Events were transient and easily attributed for example to the effect of a passing ship.

2. Individual large particles were occasionally seen, usually as a single spike moving towards and sometimes settling on the bed. In the latter event there was evidence of the top 2 or 3 mm of bed being disturbed.

3. The bed was usually identifiable as a strong echo particularly after a long period without disturbance. At other times the transition in depth from suspended solids to a low density bed material was indistinct and took place over 1 or 2 cms.

4. The bed level was observed to change by up to 5 cm during a tidal cycle, there being definite phases of erosion and deposition.

5. Erosion phases were marked by the bed interface signal becoming agitated. On one occasion only a remarkable phenomena was observed, 'spikes' within the bed signal began to move in a uniform way across the oscilloscope screen giving the appearance of a progressive wave. This was contained entirely within the bed. The speed of movement accelerated and decelerated on about a 2½ second cycle. This was observed to be the same frequency as some waves generated by an increasing wind strength from the north east on a late ebb tide. It is hypothesised that the phenomena being observed was a layer of mud about

5 mm thick flowing down the steep bank under the jetty into the bellmouth.

6. Deposition phases were marked by a strong unchanging 'hard bed' spike with similar spikes of lesser amplitude below it and an active zone above it. The active zone was marked by spikes of slowly increasing amplitude which moved slowly (hours rather than minutes) towards the hard bed spike. As they did so new spikes appeared above them. This seemed to indicate deposition and consolidation taking place.

In all it was considered that the technique had considerable potential but for a rigorous analysis it would be necessary to somehow measure the phenomena under laboratory conditions. There is considerable ambiguity in the possible interpretations of the various signals seen. After 3 days of almost continual observation the writer felt confident that in the hands of an experienced operator the method could provide considerable insight into physical processes in any similar field studies.

7. CONCLUSIONS

1. Measurements of tidal flow components were undertaken at six anchored vessel positions in the vicinity of Grangemouth Harbour throughout the duration of a mean tide. It is proposed that this information be used as a calibration data base in the development of a three dimensional mud transport numerical model at Liverpool University.

2. Near-bed suspended solids concentrations were recorded at both the East and West Lead-in Jetties throughout the duration of the field

survey. This information will be used by HR in the development of a dredging experiment with the aim of determining siltation rates at ship berths.

3. A new development measurement technique was adopted in an attempt to record the movement of fluid mud on the intertidal banks and in the harbour bellmouth. Extensive observations were made during the survey period and some very valuable information was collected. It is considered that the instrument has substantial potential in providing an insight into the physical processes which exist in environments similar to that at Grangemouth. In order to fully understand the phenomena observed, further comparisons with laboratory controlled conditions will be necessary.

8. ACKNOWLEDGEMENTS

The cooperation and assistance of personnel from both Liverpool University and the Forth Ports Authority is gratefully acknowledged.

9. REFERENCES

1. Delo E A. "Grangemouth mud properties". Hydraulics Research, Wallingford, England. Report SR 197.

TABLES

TABLE 1 : Tidal observations at position A, 19-4-89

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
0800	4.5	0.05		230	0.00		
0804		0.10		243	0.00		
0808		0.15		230	0.00		
0812		0.30		236	0.00		
0814		0.60		236	0.00		
0800		1.00	7.9	322	0.00	100	22
0804		2.00	7.9	252	0.03	030	22
0808		4.00	7.9	252	0.13	150	21
0834	4.6	0.05		243	0.00		
0837		0.10		230	0.00		
0841		0.15		243	0.00		
0845		0.30		230	0.00		
0847		0.60		230	0.00		
0834		1.00	7.9	252	0.12	300	23
0837		2.00	7.9	183	0.12	280	22
0841		4.00	8.0	183	0.00	230	22
0900	4.4	0.05		243	0.00		
0904		0.10		230	0.00		
0908		0.15		243	0.00		
0912		0.30		230	0.00		
0914		0.60		243	0.00		
0900		1.00	7.9	183	0.10	320	24
0904		2.00	8.0	183	0.06	310	23
0908		4.00	8.1	183	0.07	360	21
0930	4.6	0.05					
0933		0.10					
0937		0.15					
0940		0.30					
0943		0.60					
0930		1.00	7.9	183	0.27	300	25
0934		2.00	7.9	252	0.22	320	24
0937		4.00	8.2	252	0.12	80	21
1000	4.7	0.05		230	0.06		
1005		0.10		243	0.08		
1008		0.15		230	0.16		
1011		0.30		243	0.16		
1013		0.60		243	0.12		
1000		1.00	8.0	252	0.11	240	27
1005		2.00	8.0	252	0.23	290	25
1008		4.00	8.5	322	0.05	120	20

TABLE 1 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1030	5.1	0.05		230	0.21		
1038		0.10		230	0.32		
1041		0.15		243	0.37		
1044		0.30		230	0.23		
1045		0.60		243	0.22		
1030		1.00	7.9	678	0.42	310	28
1038		2.00	7.9	534	0.52	310	28
1041		4.00	8.0	606	0.45	320	25
1105	6.1	0.05		257	0.36		
1109		0.10		271	0.54		
1114		0.15		230	0.59		
1118		0.30		230	0.58		
1123		0.60		230	0.64		
1105		1.00	7.8	1270	0.58	290	29
1109		2.00	7.7	1346	0.77	300	29
1114		4.00	7.8	1346	0.83	320	25
1118		5.10	8.4	1423	0.72	330	23
1131	6.9	0.05		257	0.62		
1136		0.10		243	0.63		
1138		0.15		243	0.62		
1141		0.30		230	0.63		
1144		0.60		243	0.63		
1131		1.00	7.4	606	0.67	280	30
1136		2.00	7.4	534	0.77	300	30
1138		4.00	7.8	463	0.71	320	26
1141		5.90	8.3	463	0.69	340	24
1200	7.5	0.05		257	0.53		
1203		0.10		243	0.54		
1206		0.15		243	0.55		
1209		0.30		230	0.54		
1212		0.60		243	0.55		
1200		1.00	7.4	463	0.55	280	30
1203		2.00	7.4	392	0.59	290	30
1206		4.00	7.5	392	0.78	310	29
1209		6.50	7.6	392	0.62	330	29
1232	7.9	0.05		257	0.36		
1234		0.10		243	0.34		
1237		0.15		243	0.32		
1239		0.30		230	0.36		
1241		0.60		243	0.32		
1232		1.00	7.4	392	0.27	270	30
1234		2.00	7.4	322	0.37	290	30
1237		4.00	7.4	392	0.46	300	30
1239		6.90	7.6	392	0.38	330	29

TABLE 1 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1302	8.1	0.05		230	0.17		
1305		0.10		230	0.19		
1308		0.15		243	0.19		
1310		0.30		230	0.12		
1314		0.60		243	0.08		
1302		1.00	7.2	392	0.14	300	31
1305		2.00	7.2	322	0.19	280	31
1308		4.00	7.2	322	0.24	270	31
1310		7.10	7.6	392	0.23	320	30
1330	8.1	0.05		257	0.00		
1334		0.10		230	0.00		
1337		0.15		243	0.00		
1340		0.30		230	0.00		
1342		0.60		243	0.00		
1330		1.00	7.2	392	0.08	130	31
1334		2.00	7.2	252	0.07	090	31
1337		4.00	7.2	252	0.06	130	31
1340		7.10	7.8	252	0.00	030	30
1400	8.1	0.05		216	0.00		
1403		0.10		230	0.00		
1406		0.15		243	0.00		
1409		0.30		230	0.07		
1412		0.60		230	0.09		
1400		1.00	7.2	252	0.05	090	31
1403		2.00	7.2	183	0.05	070	31
1406		4.00	7.4	183	0.08	330	30
1409		7.10	8.2	183	0.07	310	29
1432	8.4	0.05		243	0.14		
1436		0.10		230	0.15		
1440		0.15		243	0.16		
1442		0.30		216	0.18		
1445		0.60		230	0.19		
1432		1.00	7.2	183	-	180	31
1436		2.00	7.3	183	-	220	31
1440		4.00	7.4	183	0.17	280	30
1444		8.00	8.8	183	0.19	280	29
1502	8.6	0.05		216	0.27		
1505		0.10		230	0.28		
1508		0.15		230	0.29		
1511		0.30		216	0.29		
1514		0.60		230	0.29		
1502		1.00	7.3	183	0.16	290	31
1505		2.00	7.3	183	0.24	290	31
1508		4.00	7.4	183	0.37	290	30
1511		8.00	8.7	183	0.21	220	29

TABLE 1 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1535	8.7	0.05		243	0.00		
1538		0.10		230	0.13		
1541		0.15		243	0.14		
1543		0.30		216	0.12		
1544		0.60		230	0.11		
1535		1.00	7.3	114	0.11	270	31
1538		2.00	7.3	183	0.13	270	31
1541		4.00	7.4	114	0.24	290	31
1543		8.00	8.6	183	0.16	300	29
1605	8.5	0.05		243	0.13		
1608		0.10		216	0.19		
1611		0.15		243	0.21		
1615		0.30		216	0.25		
1618		0.60		230	0.24		
1605		1.00	7.2	183	0.16	100	31
1608		2.00	7.2	183	0.25	100	31
1611		4.00	7.2	183	0.23	090	31
1615		8.00	8.2	114	0.24	080	30
1630	8.2	0.05		243	0.39		
1632		0.10		230	0.48		
1635		0.15		243	0.47		
1638		0.30		216	0.49		
1641		0.60		230	0.51		
1630		1.00	7.4	114	0.35	110	31
1632		2.00	7.2	183	0.54	120	30
1635		4.00	7.5	114	0.53	090	30
1638		8.00	10.3	114	0.42	080	29
1700	7.3	0.05		257	0.70		
1703		0.10		230	0.72		
1706		0.15		230	0.70		
1709		0.30		216	0.67		
1711		0.60		230	0.71		
1700		1.00	7.4	322	0.64	100	30
1703		2.00	7.6	114	0.78	110	30
1706		4.00	8.8	183	0.77	100	29
1709		6.20	9.9	322	0.88	090	27
1730	6.6	0.05		243	0.65		
1734		0.10		230	0.66		
1736		0.15		230	0.65		
1738		0.30		216	0.74		
1741		0.60		230	0.75		
1730		1.00	8.6	183	0.52	110	29
1734		2.00	8.8	183	0.71	110	29
1736		4.00	9.3	252	0.79	110	28
1738		5.60	10.6	252	0.95	080	27

TABLE 1 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1800	6.1	0.05		243	0.72		
1804		0.10		230	0.66		
1807		0.15		243	0.60		
1809		0.30		216	0.64		
1812		0.60		243	0.71		
1800		1.00	7.8	322	0.71	110	28
1804		2.00	7.9	392	0.76	110	28
1807		4.00	8.1	392	0.88	110	28
1810		5.10	8.5	534	1.11	110	27
1830	5.3	0.05		243	0.45		
1833		0.10		230	0.52		
1837		0.15		243	0.53		
1840		0.30		230	0.52		
1842		0.60		230	0.56		
1830		1.00	8.2	463	0.63	100	27
1833		2.00	8.2	392	0.73	100	27
1837		4.00	8.4	392	1.00	110	25
1840		4.30	8.4	392	1.03	120	25
1900	4.5	0.05		271	0.11		
1903		0.10		243	0.09		
1906		0.15		243	0.10		
1908		0.30		230	0.11		
1911		0.60		243	0.13		
1900		1.00	8.4	823	0.73	110	26
1902		2.00	8.4	896	0.80	110	25
1905		4.00	8.4	970	1.02	110	24
1934	4.1	0.05		298	0.37		
1936		0.10		243	0.38		
1939		0.15		243	0.35		
1934		1.00	8.4	1736	0.56	110	23
1936		2.00	8.4	1896	0.73	110	23
1939		3.10	8.4	1976	0.79	110	22
2005	4.2	0.05		163	0.14		
2007		0.10		163	0.10		
2010		0.15		149	0.07		
2012		0.30		149	0.00		
2005		1.00	8.4		0.17	110	21
2007		2.00	8.4		0.26	110	21
2009		3.20	8.4		0.21	130	21
2033		0.05		149	0.09		
2036		0.10		149	0.11		
2038		0.15		149	0.14		
2041		0.30		149	0.16		
2043		0.60		203	0.17		
2033		1.00	8.4		0.15		
2036		2.00	8.4		0.11		
2039		-	8.4		0.08		

TABLE 2 : Tidal observations at position B, 19-4-89

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
0739	2.1	1.83	154	0.06	17
0742		0.91	101	0.05	
0746		0.30	11	0.07	16
0810	2.1	1.83	194	0.11	
0815		0.91	37	0.14	
0821		0.30	11	0.07	
0841	2.4	2.13	37	0.06	21
0845		1.52	11	0.06	
0848		0.61	11	0.00	18
0910	2.4	2.13	37	0.05	
0913		1.52	37	0.07	
0917		0.30	24	0.07	
1011	1.8	1.52	49	0.11	23
1014		0.91	-	0.17	
1018		0.30	11	0.16	15
1040	2.7	2.44	154	0.09	24
		1.52	154	0.25	
		0.30	11	0.26	20
1110	3.4	3.05	180	0.28	20
		1.52	194	0.36	
		0.30	37	0.35	15
1140	4.0	3.66	347	0.22	21
		3.05	318	0.29	
		1.52	101	0.32	
		0.30	11	0.38	17
1210	4.6	4.27	290	0.23	20
		3.66	290	0.24	
		2.13	180	0.27	
		1.52	75	0.25	
		0.30	11	0.29	15
1240	5.5	5.18	140	0.13	24
		4.57	114	0.13	
		3.05	101	0.15	
		1.52	49	0.12	
		0.30	11	0.12	18

TABLE 2 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1310	5.2	4.88	49	0.05	25
		3.96	49	0.06	
		3.05	49	0.00	
		1.52	49	0.00	
		0.30	11	0.08	20
1346	5.2	4.88	37	0.00	25
		3.05	37	0.00	
		1.52	24	0.06	
		0.30	11	0.06	21
1410	5.2	4.88	37	0.06	25
		3.05	37	0.07	
		1.52	37	0.07	
		0.30	11	0.06	21
1440	4.9	4.57	37	0.09	22
		3.05	37	0.11	
		1.52	37	0.10	
		0.30	11	0.13	21
1510	5.2	4.88	62	0.10	22
		3.05	62	0.09	
		1.52	49	0.09	
		0.30	11	0.11	20
1540	4.9	4.57	37	0.06	24
		3.05	37	0.06	
		1.52	37	0.05	
		0.30	11	0.00	19
1610	5.5	5.18	49	0.09	
		4.57	37	0.14	
		3.05	37	0.16	
		1.52	11	0.17	21
		0.30	11	0.22	
1640	4.9	4.57	101	0.19	27
		3.35	49	0.23	
		2.13	49	0.26	
		0.30	11	0.27	24
1710	1.8	1.52	114	0.30	
		0.30	11	0.34	24
1748	2.1	1.83	140	0.26	17
		0.91	37	0.43	
		0.30	11	0.47	17

TABLE 2 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1810	2.4	2.13	654	0.32	18
		1.52	420	0.26	
		0.30	11	0.46	16
1840	1.8	1.52	1347	0.20	17
		0.91	573	0.27	
		0.30	347	0.34	17
1910	2.1	1.83	1016	0.24	14
		0.91	826	0.28	
		0.30	826	0.28	15
1940	1.8	1.52	1016	0.12	10
		0.91	918	0.14	
		0.30	495	0.17	15
2010	1.5	1.22	88	0.00	6
		0.91	75	0.00	
		0.30	37	0.06	5

TABLE 3 : Tidal observations at position C, 18-4-89

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
0900	7.4	0.05		189	0.13		
0905		0.10		189	0.13		
0907		0.15		196	0.15		
0910		0.30		230	0.15		
0913		0.60		230	0.13		
0900		1.00	7.5	183	0.15	280	29
0905		2.00	7.5	148	0.20	290	29
0908		4.00	7.8	141	0.35	290	28
0910		6.40	7.8	141	-	050	23
0930	8.0	0.05		236	0.13		
0934		0.10		250	0.12		
0937		0.15		236	0.12		
0941		0.30		243	0.09		
0943		0.60		243	0.07		
0930		1.00	7.5	155	0.34	310	29
0936		2.00	7.5	183	0.33	310	29
0940		4.00	7.8	252	0.37	280	28
0944		7.00	7.8	252	0.31	330	24
1000	8.8	0.05		271	0.08		
1002		0.10		264	0.18		
1004		0.15		243	0.19		
1007		0.30		230	0.26		
1010		0.60		243	0.28		
1000		1.00	7.2	392	0.12	290	30
1002		2.00	7.2	498	0.24	300	30
1005		4.00	7.4	498	0.46	300	29
1010		7.80	7.8	498	0.31	280	23
1035	9.4	0.05		284	0.33		
1037		0.10		284	0.27		
1040		0.15		278	0.22		
1044		0.30		250	0.25		
1047		0.60		250	0.26		
1035		1.00	7.3	1194	0.43	290	30
1037		2.00	7.3	1270	0.51	280	30
1040		4.00	7.6	1119	0.60	300	29
1048		8.40	7.8	859	0.55	320	24
1100	9.8	0.05		257	0.17		
1103		0.10		264	0.21		
1106		0.15		250	0.28		
1109		0.30		250	0.35		
1112		0.60		236	0.37		
1100		1.00	7.1	859	0.44	280	31
1104		2.00	7.1	823	0.50	270	31
1108		4.00	7.2	678	0.64	300	29
1112		8.00	7.3	678	0.35	320	27

TABLE 3 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1135	10.5	0.05		250	0.40		
1138		0.10		230	0.33		
1141		0.15		236	0.31		
1144		0.30		223	0.29		
1147		0.60		216	0.25		
1135		1.00	7.0	322	0.34	280	31
1138		2.00	7.0	252	0.35	290	31
1143		4.00	7.0	252	0.39	290	31
1145		8.00	7.3	252	0.35	330	30
1200	11.0	0.05		216	0.22		
1202		0.10		223	0.13		
1204		0.15		223	0.14		
1207		0.30		230	0.22		
1210		0.60		230	0.18		
1200		1.00	6.9	252	0.29	290	31
1203		2.00	7.0	252	0.26	280	31
1206		4.00	7.0	183	0.31	300	31
1209		8.00	7.2	183	0.19	270	30
1230	10.8	0.05		216	0.00		
1232		0.10		216	0.00		
1235		0.15		216	0.00		
1238		0.30		216	0.00		
1241		0.60		216	0.00		
1230		1.00	7.0	252	0.07	350	31
1232		2.00	7.0	183	0.04	340	31
1236		4.00	7.0	183	0.00	320	31
1239		8.00	7.1	183	0.00	320	30
1300	10.6	0.05		216	0.00		
1302		0.10		196	0.00		
1305		0.15		203	0.06		
1308		0.30		196	0.00		
1311		0.60		196	0.00		
1300		1.00	7.0	183	0.00	080	31
1303		2.00	7.0	183	0.00	070	31
1306		4.00	7.0	183	0.00	070	31
1309		8.00	7.1	183	0.00	060	30
1340	10.7	0.05		209	0.00		
1342		0.10		209	0.00		
1345		0.15		183	0.00		
1348		0.30		189	0.00		
1351		0.60		189	0.00		
1340		1.00	7.0	183	0.00	190	31
1343		2.00	7.0	183	0.00	180	31
1345		4.00	7.0	183	0.00	180	31
1349		8.00	7.1	183	0.00	240	30
1400	10.8	0.05		236	0.00		
1402		0.10		230	0.00		
1404		0.15		216	0.00		

TABLE 3 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1406		0.30		230	0.00		
1409		0.60		223	0.00		
1400		1.00	7.0	183	0.00	090	31
1402		2.00	7.0	183	0.00	130	31
1404		4.00	7.0	183	0.00	190	31
1407		8.00	7.0	183	0.00	300	30
1430	10.9	0.05		250	0.17		
1432		0.10		230	0.17		
1435		0.15		243	0.20		
1438		0.30		216	0.20		
1442		0.60		203	0.28		
1430		1.00	6.9	183	0.29	280	31
1434		2.00	6.9	183	0.29	260	31
1438		4.00	7.0	183	0.30	260	30
1442		8.00	7.2	114	0.32	260	30
1500	10.9	0.05		209	0.14		
1502		0.10		216	0.06		
1505		0.15		209	0.11		
1508		0.30		203	0.09		
1511		0.60		209	0.09		
1500		1.00	6.8	183	0.21	220	31
1503		2.00	6.8	183	0.25	350	31
1507		4.00	6.9	183	0.29	280	31
1510		8.00	7.2	183	0.30	350	30
1530	11.1	0.05		216	0.14		
1533		0.10		209	0.15		
1536		0.15		209	0.21		
1539		0.30		209	0.16		
1542		0.60		209	0.13		
1530		1.00	6.7	183	0.29	160	31
1534		2.00	6.8	183	0.26	080	31
1539		4.00	6.9	183	0.24	160	31
1542		8.00	7.1	114	0.12	090	30
1600		0.05		216	0.10		
1602		0.10		203	0.19		
1604		0.15		209	0.11		
1607		0.30		209	0.08		
1609		0.60		216	0.09		
1600		1.00	6.9	534	0.39	120	31
1603		2.00	7.0	392	0.43	120	31
1607		4.00	7.0	534	0.51	100	30
1610		8.00	7.6	498	0.44	100	29
1630	9.8	0.05		230	0.11		
1635		0.10		216	0.14		
1638		0.15		216	0.18		
1643		0.30		216	0.20		
1648		0.60		216	0.27		

TABLE 3 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1630		1.00	7.0	534	0.41	100	30
1632		2.00	7.0	606	0.24	100	30
1638		4.00	7.0	606	0.51	110	29
1641		8.00	8.0	606	0.69	090	28
1700		0.05		236	0.18		
1703		0.10		236	0.18		
1706		0.15		216	0.21		
1708		0.30		209	0.24		
1711		0.60		209	0.19		
1700		1.00	7.6	534	0.45	110	29
1704		2.00	7.6	463	0.46	100	29
1707		4.00	8.0	392	0.61	110	28
1712		8.00	8.6	322	0.69	100	27
1730	8.8	0.05		223	0.17		
1733		0.10		230	0.16		
1736		0.15		230	0.20		
1739		0.30		223	0.19		
1743		0.60		236	0.20		
1730		1.00	8.1	463	0.42	110	28
1734		2.00	8.1	534	0.52	120	28
1738		4.00	8.1	606	0.67	100	27
1743		8.00	8.5	606	0.77	080	26
1800	8.2	0.05		264	0.58		
1802		0.10		250	0.58		
1805		0.15		236	0.58		
1808		0.30		230	0.49		
1810		0.60		223	0.53		
1800		1.00	7.9	678	0.60	100	27
1802		2.00	7.9	606	0.67	110	27
1805		4.00	8.0	606	0.87	100	26
1811		7.20	8.2	534	0.89	090	25
1830	7.5	0.05		230	0.62		
1832		0.10		243	0.49		
1834		0.15		243	0.48		
1836		0.30		243	0.54		
1839		0.60		236	0.56		
1830		1.00	7.8	678	0.71	120	26
1833		2.00	7.8	750	0.79	100	26
1836		4.00	7.8	606	0.78	100	26
1840		6.50	7.9	606	0.82	080	24
1900	6.7	0.05		257	0.35		
1902		0.10		257	0.33		
1905		0.15		250	0.36		
1908		0.30		250	0.40		
1911		0.60		250	0.36		
1900		1.00	8.0	678	0.57	110	25
1903		2.00	8.0	606	0.64	100	24

TABLE 3 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1906		4.00	8.0	534	0.58	090	24
1911		5.70	8.0	463	0.62	100	23
1930	7.0	0.05		250	0.00		
1933		0.10		230	0.00		
1936		0.15		230	0.00		
1939		0.30		230	0.06		
1942		0.60		223	0.06		
1930		1.00	8.2	463	0.14	110	24
1933		2.00	8.2	392	0.25	110	24
1936		4.00	8.0	392	0.31	100	22
1939		6.00	8.0	322	0.34	150	22
2000	6.9	0.05		243	0.00		
2003		0.10		223	0.00		
2006		0.15		216	0.00		
2009		0.30		216	0.00		
2010		0.60		216	0.00		
2000		1.00	8.2	183	0.05	290	23
2003		2.00	8.2	183	0.10	090	22
2006		4.00	8.1	183	0.11	180	22
2010		5.90	8.0	183	0.06	320	20
2030	7.1	0.05		209	0.00		
2032		0.10		209	0.00		
2035		0.15		203	0.00		
2038		0.30		203	0.06		
2040		0.60		203	0.14		
2030		1.00	8.2	183	0.19	280	24
2032		2.00	8.0	183	0.24	280	23
2035		4.00	8.0	114	0.15	270	23
2040		6.10	8.0	114	0.07	010	21
2100	7.4	0.05		216	0.00		
2103		0.10		209	0.06		
2106		0.15		203	0.07		
2108		0.30		209	0.10		
2110		0.60		203	0.12		
2100		1.00	7.9	322	0.28	270	26
2103		2.00	7.9	392	0.30	270	26
2106		4.00	8.2	392	0.18	280	24
2109		6.40	8.2	322	0.03	360	22
2130	7.6	0.05		230	0.00		
2132		0.10		216	0.07		
2134		0.15		216	0.07		
2136		0.30		209	0.12		
2139		0.60		209	0.10		
2130		1.00	8.0	322	0.18	280	27
2132		2.00	8.0	322	0.22	280	27
2134		4.00	8.0	322	0.17	290	26
2136		6.60	8.2	252	0.10	320	24

TABLE 4 : Tidal observations at position D, 18-4-89

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
0903	7.3	7.01	75	0.07	28
0907		6.55	207	0.08	
0910		6.10	207	0.08	
0915		5.18	140	0.07	
0917		3.05	49	0.07	
0922		0.30	11	0.09	20
0936	7.6	7.32	49	-	28
0938		6.40	49	-	
0940		5.49	37	-	
0943		3.05	24	-	
0944		0.30	11	-	20
0956	7.9	7.62	37	0.09	28
1003		7.32	37	0.06	
1006		5.49	37	0.00	
1007		3.05	24	0.00	
1008		0.30	11	0.07	20
1024	7.9	7.62	62	0.09	28
1026		6.10	75	0.10	
1029		4.57	101	0.11	
1032		3.05	49	0.13	
1034		0.30	11	0.17	24
1052	8.2	7.92	248	0.11	
1057		7.01	207	0.12	
1059		6.10	194	0.12	
1101		4.57	140	0.11	
1102		3.05	75	0.10	
1105		0.30	11	0.16	20
1124	9.1	8.84	207	0.09	30
1127		8.23	194	0.12	
1129		7.62	180	0.10	
1131		6.10	140	-	
1140		4.57	75	0.10	
1142		3.05	75	0.11	
1144		0.30	11	0.00	24
1207	9.6	9.30	114	0.06	30
1209		8.53	75	0.06	
1212		7.62	75	0.06	
1214		6.10	75	0.05	
1216		4.57	62	0.00	
1216		3.05	49	0.00	
1217		0.30	11	0.00	24

TABLE 4 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1234	9.8	9.45	75	0.07	31
1236		8.53	75	0.08	
1238		7.62	75	0.08	
1240		6.10	49	0.09	
1242		4.57	49	0.10	
1244		3.05	49	0.09	
1247		0.30	24	0.09	26
1315	9.8	9.45	37	0.06	
1319		8.84	37	0.07	
1321		7.62	49	0.08	
1323		6.10	49	0.09	
1326		4.57	37	0.09	
1328		3.05	37	0.08	
1330		0.30	11	0.06	
1341	9.8	9.45	37	0.07	31
1344		8.84	37	0.06	
1346		7.62	37	0.07	
1349		6.10	37	0.07	
1351		4.57	37	0.00	
1353		3.05	37	0.00	
1355		0.30	11	0.00	26
1415	9.9	9.60	37	0.10	
1417		8.84	37	0.11	
1419		7.62	37	0.11	
1421		6.10	37	0.10	
1423		4.57	37	0.10	
1425		3.05	24	0.09	
1427		0.30	11	0.08	28
1505	9.8	9.45	37	0.05	
1507		8.53	37	0.00	
1510		7.62	37	0.00	
1512		6.10	37	0.00	
1514		0.30	11	0.00	
1527	9.8	9.45	37	0.00	
1530		7.62	37	0.08	
1531		6.10	37	0.09	
1533		4.57	37	0.11	
1536		3.05	37	0.08	
1538		0.30	11	0.06	32
1556	9.8	9.45	37	0.12	
1558		8.53	49	0.14	
1600		7.62	62	0.15	
1602		6.10	37	0.20	
1605		4.57	37	0.19	
1608		3.05	24	0.22	
1611		0.30	11	0.19	

TABLE 4 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1633	9.1	8.84	88	0.17	
1635		8.53	75	0.19	
1637		7.62	88	0.17	
1639		6.10	49	0.23	
1641		4.57	37	0.24	
1643		3.05	37	0.28	
1654		0.30	11	0.27	30
1708	8.5	8.23	101	0.21	
1711		7.62	101	0.17	
1713		6.10	101	0.19	
1716		4.57	75	0.21	
1718		3.05	88	0.00	
1720		0.30	37	0.28	
1745	7.3	7.01	75	0.19	28
1747		6.10	207	0.21	
1749		4.57	127	0.28	
1752		3.05	101	0.28	
1754		0.30	11	0.18	27
1815	6.7	6.40	75	0.23	
1818		5.18	101	0.26	
1821		4.57	101	0.28	
1825		3.05	75	0.30	
1828		0.30	24	0.23	
1845	6.4	6.10	140	0.23	
1847		5.49	114	0.24	
1849		4.57	114	0.28	
1852		3.05	207	0.28	
1854		0.30	207	0.29	25
1915	6.1	5.79	248	0.19	
1923		4.57	276	0.17	
1926		3.05	140	0.18	
1928		0.30	75	0.20	
1944	5.8	5.49	140	0.06	
1946		4.57	101	0.08	
1948		3.05	75	0.09	
1950		0.30	49	0.08	
2015	5.6	5.33	49	0.00	
2018		4.57	62	0.05	
2021		3.05	49	0.05	
2124		0.30	62	0.00	23

TABLE 4 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
2044	5.8	5.49	88	0.00	
2047		4.57	75	0.08	
2050		3.05	75	0.05	
2053		0.30	62	0.08	
2114	5.2	4.88	88	0.12	
2116		4.27	88	0.11	
2118		3.05	62	0.08	
2121		0.30	37	0.00	

TABLE 5 : Tidal observations at position E, 20-4-89

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
0800	7.1	0.05		250	0.00		
0802		0.10		250	0.00		
0804		0.15		250	0.00		
0806		0.30		264	0.00		
0808		0.60		257	0.00		
0800		1.00	8.0	475	0.15	090	21
0802		2.00	8.0	511	0.22	100	21
0804		4.00	8.0	565	0.36	090	21
0807		6.10	8.0	421	0.34	150	21
0905	7.7	0.05		250	0.00		
0907		0.10		236	0.00		
0915		0.15		223	0.00		
0919		0.30		230	0.00		
0921		0.60		223	0.00		
0905		1.00	8.0	493	0.17	110	21
0907		2.00	8.0	421	0.16	040	21
0915		4.00	8.4	298	0.16	060	23
0919		6.70	8.5	263	0.03	170	21
0930	8.0	0.05		250	0.00		
0933		0.10		236	0.00		
0936		0.15		230	0.00		
0939		0.30		223	0.00		
0945		0.60		216	0.00		
0930		1.00	8.4	457	0.20	230	27
0933		2.00	8.4	457	0.18	320	27
0938		4.00	8.4	386	0.31	230	25
0944		7.00	8.4	280	0.07	170	22
1010	8.0	0.05		243	0.10		
1011		0.10		236	0.07		
1015		0.15		230	0.14		
1018		0.30		223	0.00		
1020		0.60		223	0.00		
1010		1.00	8.4	315	0.17	170	27
1012		2.00	8.4	298	0.13	280	27
1015		4.00	8.4	280	0.16	110	27
1018		7.00	8.4	280	0.09	120	24
1030	7.9	0.05		257	0.00		
1033		0.10		230	0.00		
1036		0.15		216	0.09		
1040		0.30		216	0.08		
1043		0.60		216	0.07		
1030		1.00	8.4	457	0.00	-	28
1033		2.00	8.4	386	0.11	290	27
1036		4.00	8.4	245	0.10	300	27
1040		6.90	8.4	245	0.17	280	22

TABLE 5 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1100	8.3	0.05		243	0.00		
1102		0.10		189	0.00		
1105		0.15		163	0.00		
1107		0.30		176	0.00		
1109		0.60		163	0.00		
1100		1.00	8.4	386	0.10	230	29
1102		2.00	8.4	350	0.15	270	29
1105		4.00	8.4	211	0.04	270	28
1108		7.30	8.4	245	0.25	210	22
1130	9.1	0.05		230	0.00		
1132		0.10		216	0.00		
1135		0.15		203	0.00		
1138		0.30		189	0.00		
1142		0.60		203	0.10		
1130		1.00	8.0	1180	0.22	230	30
1132		2.00	8.0	529	0.35	280	30
1135		4.00	8.0	333	0.12	330	29
1138		8.00	8.4	280	0.31	310	22
1200	9.9	0.05		355	0.06		
1203		0.10		257	0.00		
1205		0.15		257	0.06		
1210		0.30		189	0.22		
1213		0.60		203	0.20		
1200		1.00	7.9	1386	0.13	210	30
1203		2.00	7.9	903	0.41	260	30
1205		4.00	8.0	602	0.20	260	28
1210		8.00	8.4	245	0.05	090	23
1300	11.3	0.05		284	0.00		
1302		0.10		230	0.00		
1304		0.15		230	0.00		
1306		0.30		223	0.07		
1309		0.60		203	0.07		
1300		1.00	7.5	980	0.18	270	22
1302		2.00	7.5	529	0.26	270	22
1304		4.00	7.5	457	0.18	250	22
1307		8.00	8.0	333	0.09	270	22
1330	11.5	0.05		203	0.00		
1332		0.10		203	0.08		
1334		0.15		216	0.10		
1338		0.30		209	0.11		
1340		0.60		189	0.00		
1330		1.00	7.4	565	0.09	190	22
1332		2.00	7.4	565	0.11	180	22
1334		4.00	7.4	529	0.11	180	25
1340		8.00	7.8	280	0.19	150	30

TABLE 5 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1400	11.5	0.05		230	0.16		
1403		0.10		216	0.12		
1405		0.15		196	0.10		
1408		0.30		203	0.09		
1412		0.60		183	0.12		
1400		1.00	7.5	529	0.10	230	22
1403		2.00	7.5	386	0.15	150	22
1406		4.00	7.6	280	0.19	150	22
1412		8.00	8.0	245	0.26	130	30
1430	11.5	0.05		176	0.00		
1432		0.10		189	0.07		
1435		0.15		189	0.08		
1436		0.30		176	0.00		
1439		0.60		176	0.00		
1430		1.00	7.5	245	0.17	030	30
1433		2.00	7.5	211	0.17	180	31
1436		4.00	7.5	211	0.12	190	31
1439		8.00	7.9	211	0.04	180	30
1500	11.7	0.05		176	0.00		
1502		0.10		176	0.06		
1504		0.15		196	0.07		
1510		0.30		176	0.10		
1512		0.60		189	0.08		
1500		1.00	7.8	211	0.10	250	23
1504		2.00	7.8	211	0.07	300	23
1510		4.00	7.6	211	0.06	350	28
1512		8.00	8.0	211	0.14	300	30
1530	11.8	0.05		203	0.11		
1532		0.10		203	0.09		
1534		0.15		196	0.11		
1536		0.30		189	0.11		
1540		0.60		189	0.11		
1530		1.00	7.6	245	0.04	070	30
1533		2.00	7.6	245	0.08	300	30
1535		4.00	7.6	245	0.12	270	30
1540		8.00	7.6	245	0.06	340	30
1600	-	0.05		203	0.10		
1602		0.10		189	0.14		
1604		0.15		203	0.11		
1606		0.30		203	0.07		
1610		0.60		203	0.00		
1600		1.00	7.5	211	0.08	010	31
1602		2.00	7.5	245	0.09	210	31
1604		4.00	7.5	245	0.13	340	31
1607		8.00	7.6	245	0.04	310	30

TABLE 5 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
1700	11.4	0.05		230	0.00		
1702		0.10		203	0.00		
1705		0.15		209	0.00		
1708		0.30		196	0.07		
1712		0.60		203	0.07		
1700		1.00	7.6	421	0.13	010	22
1703		2.00	7.6	315	0.47	110	22
1706		4.00	7.6	263	0.48	110	22
1709		8.00	7.8	280	0.41	100	21
1730	10.7	0.05		216	0.10		
1732		0.10		216	0.27		
1735		0.15		189	0.32		
1737		0.30		183	0.35		
1740		0.60		183	0.36		
1730		1.00	8.0	386	0.25	070	30
1733		2.00	8.0	298	0.40	080	30
1736		4.00	8.0	211	0.39	090	30
1740		8.00	8.0	211	0.36	090	30
1830	8.9	0.05		257	0.22		
1832		0.10		203	0.25		
1835		0.15		203	0.32		
1838		0.30		196	0.17		
1841		0.60		196	0.28		
1830		1.00	8.4	421	0.04	100	28
1833		2.00	8.4	350	0.16	130	28
1836		4.00	8.6	333	0.22	140	28
1839		8.00	8.8	315	0.48	120	27
1900	8.3	0.05		216	0.08		
1902		0.10		203	0.09		
1904		0.15		209	0.33		
1907		0.30		203	0.26		
1910		0.60		203	0.17		
1900		1.00	8.4	421	0.00	130	22
1903		2.00	8.7	421	0.25	110	25
1906		4.00	9.0	493	0.34	100	27
1910		8.00	9.0	386	0.43	090	26
1930	7.6	0.05		85	0.19		
1932		0.10		216	0.16		
1935		0.15		216	0.20		
1937		0.30		216	0.22		
1940		0.60		209	0.16		
1930		1.00	8.4	74	0.03	010	22
1933		2.00	9.0	386	0.10	290	26
1936		4.00	9.0	421	0.13	100	26
1939		6.60	9.0	333	0.44	090	25

TABLE 5 (Continued)

Time (BST)	Water depth (m)	Height above bed (m)	Temp (deg C)	Formazin conc (mg/l)	Velocity (m/s)	Dir'n (deg)	Salinity (ppt)
2000	7.2	0.05		216	0.06		
2002		0.10		216	0.16		
2005		0.15		216	0.08		
2008		0.30		209	0.00		
2012		0.60		209	0.19		
2000		1.00	9.0	457	0.03	110	24
2003		2.00	9.0	493	0.20	050	24
2006		4.00	9.0	493	0.20	080	23
2009		6.20	9.0	493	0.62	090	22
2030	-	0.05		243	0.00		
2032		0.10		189	0.00		
2034		0.15		189	0.00		
2036		0.30		189	0.00		
2038		0.60		183	0.00		
2030		1.00	9.0	386	0.03	360	22
2032		2.00	9.0	315	0.05	040	22
2034		4.00	9.0	350	0.12	070	21
2037		5.80	9.0	350	0.33	100	20

TABLE 6 : Tidal observations at position F, 20-4-89

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
0743	1.8	1.52	-	0.21	22
		0.30	-	0.24	22
0810	1.8	1.52	127	0.08	22
		0.30	101	0.21	20
0840	2.1	1.83	62	0.08	20
		0.91	114	0.07	
		0.30	62	0.07	20
0910	2.4	2.13	62	0.00	19
		0.91	75	0.06	
		0.30	11	0.07	19
0940	2.4	2.13	75	0.00	20
		1.52	62	0.06	
		0.30	11	0.08	19
1010	2.4	2.13	62	0.06	20
		1.52	49	0.06	
		0.30	11	0.00	19
1040	2.7	2.44	37	0.00	19
		1.52	49	0.00	
		0.30	11	0.06	19
1110	3.0	2.74	62	0.06	20
		1.52	49	0.11	
		0.30	11	0.07	19
1145	2.1	1.83	154	0.00	
		0.91	11	0.00	
		0.30	11	0.00	20
1240	5.5	5.18	333	0.11	26
		4.57	276	0.10	
		3.05	207	0.12	
		1.52	75	0.16	
		0.30	11	0.07	26
1310	4.9	4.57	248	0.05	27
		3.05	167	0.00	
		1.52	101	0.06	
		0.30	11	0.05	26

TABLE 6 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1340	5.5	5.18	62	0.08	28
		4.57	62	0.10	
		3.05	62	0.08	
		1.52	49	0.05	
		0.30	11	0.06	25
1410	5.5	5.18	75	0.12	
		4.57	49	0.13	
		3.05	49	0.12	
		1.52	11	0.12	
		0.30	11	0.13	27
1440	5.5	5.18	37	0.08	29
		4.57	37	0.09	
		3.05	11	0.07	
		1.52	11	0.06	
		0.30	11	0.09	28
1510	5.8	5.49	49	0.08	30
		4.57	11	0.08	
		3.05	11	0.09	
		1.52	11	0.09	
		0.30	11	0.12	29
1540	6.1	5.79	37	0.11	30
		4.57	24	0.12	
		3.05	11	0.11	
		1.52	11	0.11	
		0.30	11	0.13	30
1610	6.1	5.79	37	0.08	30
		4.57	37	0.08	
		3.05	37	0.09	
		1.52	11	0.08	
		0.30	11	0.07	29
1640	6.1	5.79	37	0.13	30
		4.57	37	0.17	
		3.05	37	0.17	
		1.52	11	0.19	
		0.30	11	0.19	30
1710	5.2	4.88	88	0.23	30
		3.66	62	0.25	
		3.05	37	0.28	
		1.52	37	0.29	
		0.30	11	0.29	30

TABLE 6 (Continued)

Time (BST)	Water depth (m)	Depth below surface (m)	Formazin conc (mg/l)	Velocity (m/s)	Salinity (ppt)
1740	4.9	4.57	88	0.19	30
		3.96	62	0.22	
		2.74	49	0.26	
		1.22	62	0.28	
		0.30	49	0.29	30
1810	4.0	3.66	114	0.20	29
		3.05	114	0.24	
		1.52	62	0.26	
		0.30	75	0.31	29
1840	3.0	2.74	207	0.25	27
		2.13	101	0.30	
		0.30	75	0.30	27
1910	2.4	2.13	140	0.23	27
		1.52	88	0.31	
		0.30	49	0.33	26
1940	1.8	1.52	167	0.31	24
		0.30	114	0.33	24
2010	1.5	1.22	276	0.25	22
		0.30	101	0.29	22

TABLE 7 : West lead-in jetty measurements

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
17.4.89	2035	0		0523	37
	2047	10		0535	65
	2059	10		0547	37
	2111	37		0559	37
	2123	65		0611	37
	2135	92		0623	37
	2147	92		0635	10
	2159	317		0647	10
	2211	203		0659	10
	2223	203		0711	10
	2235	374		0723	65
	2247	404		0735	92
	2259	433		0747	203
	2311	552		0759	3211
	2323	492		0811	1197
	2335	345		0823	928
	2347	433		0835	203
	2359	37		0847	65
18.4.89	0011	37		0859	231
	0023	10		0911	65
	0035	0		0923	37
	0047	0		0935	37
	0059	0		0947	175
	0111	0		0959	65
	0123	0		1011	147
	0135	0		1023	433
	0147	0		1035	492
	0159	10		1047	374
	0211	10		1059	404
	0223	0		1111	288
	0235	0		1123	260
	0247	10		1135	175
	0259	37		1147	175
	0311	37		1159	147
	0323	37		1211	92
	0335	65		1223	65
	0347	37		1235	92
	0359	10		1247	37
	0411	37		1259	10
	0423	65		1311	37
	0435	37		1323	37
	0447	37		1335	10
	0459	92		1347	0
	0511	37		1359	10
				1411	10

TABLE 7 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	1423	10		2359	175
	1435	10	19.4.89	0011	147
	1447	37		0023	147
	1459	0		0035	37
	1511	0		0047	92
	1523	0		0059	65
	1535	0		0111	65
	1547	92		0123	10
	1559	37		0135	10
	1611	120		0147	0
	1623	37		0159	0
	1635	65		0211	0
	1647	147		0223	0
	1659	37		0235	0
	1711	37		0247	0
	1723	65		0259	10
	1735	37		0311	10
	1747	374		0323	37
	1759	552		0335	37
	1811	92		0347	65
	1823	92		0359	37
	1835	65		0411	65
	1847	1962		0423	65
	1859	492		0435	10
	1911	863		0447	37
	1923	1267		0459	10
	1935	928		0511	37
	1947	147		0523	65
	1959	705		0535	231
	2011	203		0547	993
	2023	37		0559	120
	2035	65		0611	92
	2047	120		0623	92
	2059	37		0635	92
	2111	10		0647	175
	2123	37		0659	147
	2135	10		0711	175
	2147	10		0723	203
	2159	0		0735	120
	2211	0		0747	37
	2223	10		0759	37
	2235	433		0811	2048
	2247	863		0823	374
	2259	260		0835	203
	2311	492		0847	374
	2323	260		0859	65
	2335	260		0911	37
	2347	175		0923	92

TABLE 7 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	0935	37		1911	317
	0947	37		1923	462
	0959	120		1935	433
	1011	65		1947	317
	1023	203		1959	374
	1035	643		2011	203
	1047	799		2023	120
	1059	643		2035	65
	1111	492		2047	65
	1123	374		2059	65
	1135	552		2111	203
	1147	612		2123	92
	1159	552		2135	120
	1211	120		2147	120
	1223	92		2159	37
	1235	92		2211	10
	1247	65		2223	10
	1259	10		2235	37
	1311	0		2247	37
	1323	0		2259	65
	1335	0		2311	674
	1347	0		2323	674
	1359	92		2335	552
	1411	288		2347	674
	1423	92		2359	433
	1435	175	20.4.89	0011	552
	1447	120		0023	462
	1459	37		0035	522
	1511	0		0047	374
	1523	10		0059	260
	1535	37		0111	203
	1547	37		0123	147
	1559	0		0135	120
	1611	10		0147	92
	1623	10		0159	10
	1635	37		0211	10
	1647	120		0223	0
	1659	674		0235	0
	1711	404		0247	0
	1723	120		0259	0
	1735	492		0311	0
	1747	317		0323	1599
	1759	175		0335	736
	1811	260		0347	147
	1823	374		0359	0
	1835	175		0411	0
	1847	404		0423	0
	1859	175		0435	0

TABLE 7 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	0447	0		1523	37
	0459	0		1535	37
	0511	65		1547	37
	0523	147		1559	10
	0535	37		1611	10
	0547	404		1623	37
	0559	92		1635	37
	0611	92		1647	65
	0623	260		1659	120
	0635	582		1711	374
	0647	120		1723	92
	0659	345		1735	92
	0711	92		1747	65
	0723	288		1759	92
	0735	260		1811	92
	0747	345		1823	203
	0759	928		1835	260
	0811	433		1847	260
	0823	147		1859	317
	0835	65		1911	317
	0847	37		1923	288
	0859	37		1935	317
	0911	10		1947	231
	0923	10		1959	492
	0935	120		2011	612
	0947	37		2023	612
	0959	65		2035	582
	1011	37		2047	492
	1023	37		2059	433
	1035	10		2111	260
	1047	260		2123	92
	1059	92		2135	10
	1111	374		2147	10
	1123	433		2159	92
	1135	674		2211	65
	1147	612		2223	65
	1159	552		2235	10
	1211	522		2247	65
	1223	374		2259	65
	1235	345		2311	65
	1247	345		2323	37
	1259	288		2335	37
	1311	231		2347	147
	1323	203		2359	612
	1335	175	21.4.89	0011	2092
	1347	92		0023	928
	1359	203		0035	705
	1411	65		0047	767
	1423	37		0059	863
	1435	37		0111	674
	1447	37		0123	462
	1459	37		0135	345
	1511	37		0147	404

TABLE 7 (Continued)

Date	Time	Formazin concentration (mg/l)
	0159	317
	0211	231
	0223	147
	0235	92
	0247	92
	0259	10
	0311	10
	0323	0
	0335	0
	0347	0
	0359	0
	0411	0
	0423	0
	0435	0
	0447	0
	0459	0
	0511	0
	0523	37
	0535	175
	0547	260
	0559	374
	0611	288
	0623	92
	0635	203
	0647	288
	0659	404
	0711	492
	0723	120
	0735	203
	0747	175
	0759	120
	0811	260
	0823	433
	0835	317
	0847	345
	0859	175
	0911	92
	0923	65
	0935	37
	0947	10
	0959	37
	1011	147
	1023	345
	1035	37
	1047	10
	1059	10
	1111	120
	1123	37
	1135	37
	1147	10

TABLE 8 : East lead-in jetty measurements

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
17.4.89	2010	39		0510	11
	2022	11		0522	11
	2034	11		0534	11
	2046	11		0546	11
	2058	11		0558	11
	2110	11		0610	11
	2122	11		0622	11
	2134	11		0634	11
	2146	11		0646	11
	2158	11		0658	11
	2210	11		0710	11
	2222	11		0722	11
	2234	11		0734	11
	2246	11		0746	11
	2258	181		0758	11
	2310	39		0810	39
	2322	67		0822	356
	2334	67		0834	39
	2346	39		0846	268
	2358	39		0858	95
18.4.89	0010	39		0910	67
	0022	39		0922	39
	0034	39		0934	39
	0046	39		0946	39
	0058	11		0958	39
	0110	181		1010	39
	0122	67		1022	39
	0134	39		1034	11
	0146	11		1046	11
	0158	11		1058	11
	0210	11		1110	95
	0222	11		1122	67
	0234	11		1134	39
	0246	11		1146	67
	0258	11		1158	67
	0310	11		1210	67
	0322	11		1222	152
	0334	11		1234	67
	0346	11		1246	39
	0358	11		1258	39
	0410	11		1310	39
	0422	11		1322	11
	0434	11		1334	11
	0446	11		1346	11
	0458	11			

TABLE 8 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	1358	11		2334	67
	1410	11		2346	297
	1422	11		2358	181
	1434	11	19.4.89	0010	67
	1446	11		0022	297
	1458	11		0034	95
	1510	11		0046	39
	1522	11		0058	39
	1534	11		0110	327
	1546	11		0122	327
	1558	39		0134	181
	1610	39		0146	67
	1622	39		0158	39
	1634	39		0210	39
	1646	11		0222	39
	1658	11		0234	11
	1710	39		0246	11
	1722	39		0258	11
	1734	39		0310	39
	1746	67		0322	39
	1758	67		0334	11
	1810	181		0346	11
	1822	39		0358	39
	1834	67		0410	67
	1846	67		0422	95
	1858	67		0434	39
	1910	95		0446	11
	1922	152		0458	11
	1934	181		0510	11
	1946	152		0522	11
	1958	599		0534	11
	2010	95		0546	39
	2022	67		0558	39
	2034	210		0610	39
	2046	181		0622	11
	2058	124		0634	39
	2110	95		0646	39
	2122	67		0658	39
	2134	39		0710	95
	2146	39		0722	67
	2158	39		0734	67
	2210	39		0746	39
	2222	39		0758	11
	2234	39		0810	11
	2246	39		0822	11
	2258	39		0834	95
	2310	39		0846	95
	2322	39		0858	725

TABLE 8 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	0910	210		1846	239
	0922	152		1858	95
	0934	268		1910	239
	0946	67		1922	356
	0958	39		1934	95
	1010	11		1946	124
	1022	11		1958	152
	1034	11		2010	181
	1046	11		2022	124
	1058	39		2034	297
	1110	39		2046	210
	1122	67		2058	152
	1134	95		2110	39
	1146	599		2122	152
	1158	210		2134	39
	1210	476		2146	39
	1222	181		2158	11
	1234	239		2210	11
	1246	239		2222	11
	1258	210		2234	11
	1310	124		2246	11
	1322	124		2258	11
	1334	67		2310	11
	1346	152		2322	11
	1358	39		2334	11
	1410	152		2346	39
	1422	11		2358	39
	1434	11	20.4.89	0010	239
	1446	11		0022	446
	1458	11		0034	67
	1510	11		0046	95
	1522	11		0058	67
	1534	11		0110	67
	1546	11		0122	152
	1558	11		0134	181
	1610	11		0146	297
	1622	39		0158	95
	1634	95		0210	11
	1646	67		0222	11
	1658	39		0234	11
	1710	67		0246	11
	1722	39		0258	11
	1734	11		0310	11
	1746	11		0322	11
	1758	67		0334	11
	1810	39		0346	11
	1822	39		0358	297
	1834	67		0410	95

TABLE 8 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	0422	39		1358	95
	0434	39		1410	39
	0446	11		1422	11
	0458	39		1434	11
	0510	11		1446	11
	0522	11		1458	11
	0534	11		1510	11
	0546	11		1522	11
	0558	11		1534	11
	0610	11		1546	11
	0622	11		1558	11
	0634	39		1610	11
	0646	11		1622	11
	0658	95		1634	11
	0710	39		1646	11
	0722	124		1658	11
	0734	67		1710	95
	0746	39		1722	67
	0758	39		1734	39
	0810	210		1746	11
	0822	476		1758	11
	0834	210		1810	11
	0846	297		1822	11
	0858	67		1834	11
	0910	152		1846	39
	0922	39		1858	39
	0934	11		1910	39
	0946	67		1922	39
	0958	11		1934	39
	1010	11		1946	152
	1022	11		1958	124
	1034	11		2010	152
	1046	11		2022	446
	1058	11		2034	210
	1110	11		2046	95
	1122	11		2058	39
	1134	11		2110	210
	1146	11		2122	268
	1158	11		2134	181
	1210	39		2146	39
	1222	67		2158	124
	1234	39		2210	11
	1246	181		2222	11
	1258	239		2234	11
	1310	124		2246	67
	1322	124		2258	67
	1334	95		2310	39
	1346	95		2322	11

TABLE 8 (Continued)

Date	Time	Formazin concentration (mg/l)	Date	Time	Formazin concentration (mg/l)
	2334	11		0910	11
	2346	11		0922	39
	2358	11		0934	11
21.4.89	0010	11		0946	11
	0022	39		0958	11
	0034	67		1010	239
	0046	95		1022	39
	0058	693		1034	11
	0110	152		1046	11
	0122	181			
	0134	67			
	0146	95			
	0158	124			
	0210	39			
	0222	152			
	0234	67			
	0246	95			
	0258	11			
	0310	11			
	0322	11			
	0334	11			
	0346	11			
	0358	11			
	0410	11			
	0422	11			
	0434	11			
	0446	11			
	0458	11			
	0510	11			
	0522	67			
	0534	181			
	0546	39			
	0558	11			
	0610	11			
	0622	11			
	0634	11			
	0646	11			
	0658	11			
	0710	39			
	0722	11			
	0734	39			
	0746	11			
	0758	11			
	0810	11			
	0822	39			
	0834	39			
	0846	11			
	0858	39			

TABLE 9 : Wind records

Date	Time (BST)	Mean hourly wind speed (mph)	Mean hourly wind direction (deg)
17/4/89	0100	3	280
	0200	4	290
	0300	7	320
	0400	8	345
	0500	4	310
	0600	1	260
	0700	1	310
	0800	1	340
	0900	7	010
	1000	5	340
	1100	6	040
	1200	6	100
	1300	5	150
	1400	0	160
	1500	16	130
	1600	18	120
	1700	16	120
	1800	14	110
	1900	14	105
	2000	16	120
	2100	13	110
	2200	8	105
	2300	5	090
	2400	0	042
18/4/89	0100	0	300
	0200	1	260
	0300	2	290
	0400	5	310
	0500	5	330
	0600	5	300
	0700	2	310
	0800	4	290
	0900	3	320
	1000	4	300
	1100	3	360
	1200	5	130
	1300	5	150
	1400	6	130
	1500	5	120
	1600	4	110
	1700	14	110
	1800	16	120
	1900	14	110
	2000	11	110
	2100	11	120
	2200	10	110
	2300	7	090
	2400	2	100

TABLE 9 (Continued)

Date	Time (BST)	Mean hourly wind speed (mph)	Mean hourly wind direction (deg)
19/4/89	0100	7	080
	0200	10	050
	0300	11	020
	0400	14	010
	0500	7	360
	0600	5	030
	0700	10	030
	0800	12	030
	0900	16	060
	1000	12	050
	1100	20	060
	1200	18	070
	1300	14	120
	1400	12	140
	1500	12	135
	1600	16	140
	1700	16	130
	1800	14	130
	1900	13	130
	2000	12	125
	2100	7	110
	2200	4	080
	2300	10	040
	2400	6	040
20/4/89	0100	6	010
	0200	10	030
	0300	10	020
	0400	8	050
	0500	7	015
	0600	2	060
	0700	2	050
	0800	5	010
	0900	7	050
	1000	5	080
	1100	5	090
	1200	4	130
	1300	8	120
	1400	16	120
	1500	15	100
	1600	14	120
	1700	16	120
	1800	15	120
	1900	16	120
	2000	15	110
	2100	11	100
	2200	11	100
	2300	10	100
	2400	5	110

TABLE 9 (Continued)

Date	Time (BST)	Mean hourly wind speed (mph)	Mean hourly wind direction (deg)
21/4/89	0100	1	080
	0200	1	320
	0300	5	040
	0400	6	040
	0500	12	090
	0600	14	100
	0700	12	100
	0800	14	090
	0900	14	090
	1000	14	090
	1100	12	100
	1200	10	100
	1300	10	130
	1400	7	130
	1500	8	100
	1600	5	120
	1700	3	170
	1800	5	180
	1900	3	220
	2000	2	280
	2100	2	300
	2200	4	320
	2300	3	180
	2400	6	180
22/4/89	0100	10	150
	0200	8	150
	0300	5	160
	0400	5	150
	0500	4	140
	0600	2	120
	0700	3	060
	0800	6	310
	0900	7	330
	1000	6	330
	1100	5	340
	1200	10	350
	1300	8	350
	1400	12	340
	1500	12	330
	1600	11	350
	1700	12	350
	1800	10	340
	1900	12	340
	2000	14	350
	2100	12	360
	2200	12	010
	2300	6	270
	2400	7	270

TABLE 9 (Continued)

Date	Time (BST)	Mean hourly wind speed (mph)	Mean hourly wind direction (deg)
23/4/89	0100	5	280
	0200	7	270
	0300	8	270
	0400	7	270
	0500	8	280
	0600	7	290
	0700	8	280
	0800	5	300
	0900	10	290
	1000	7	280

FIGURES

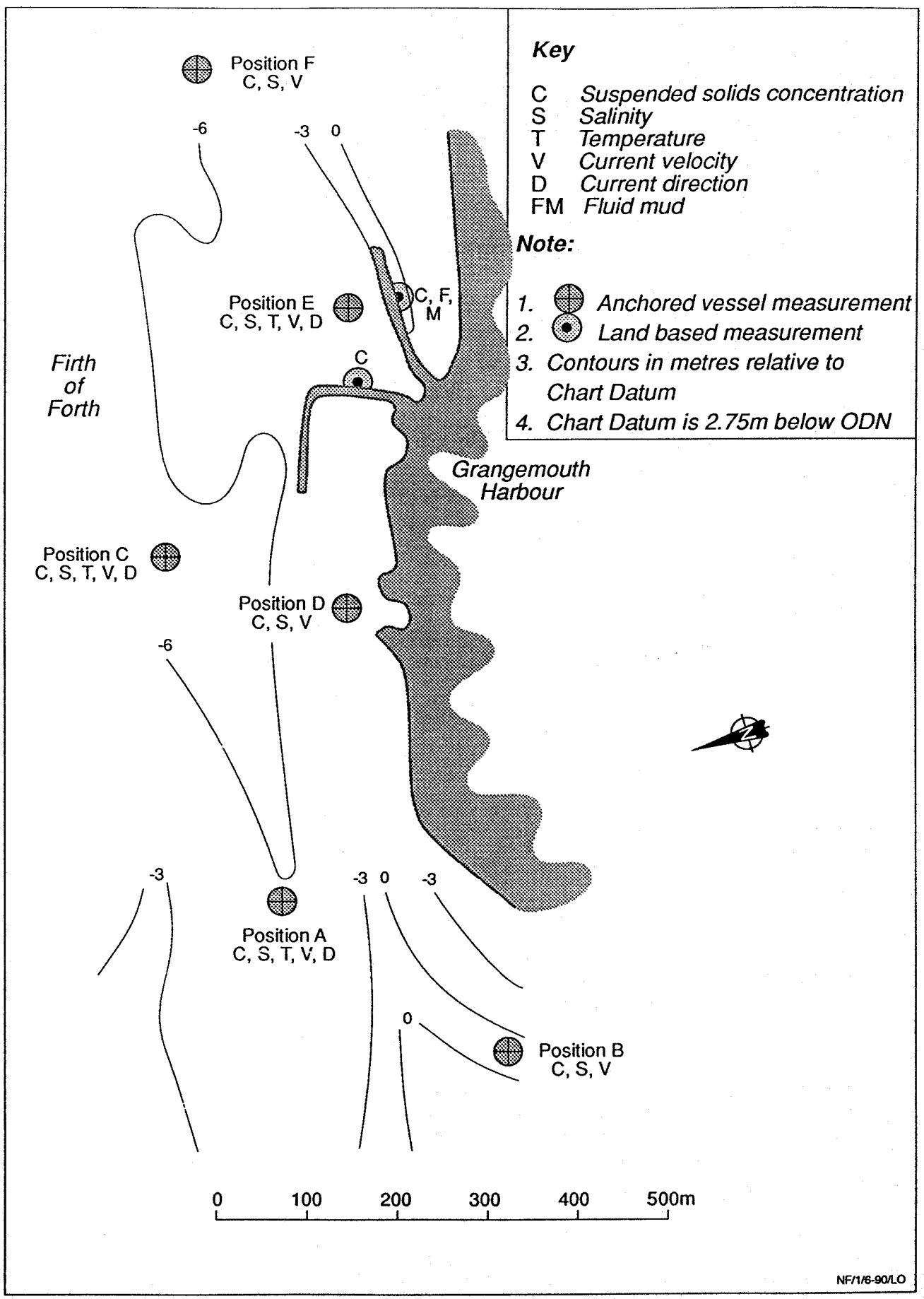

Fig 1 Location plan

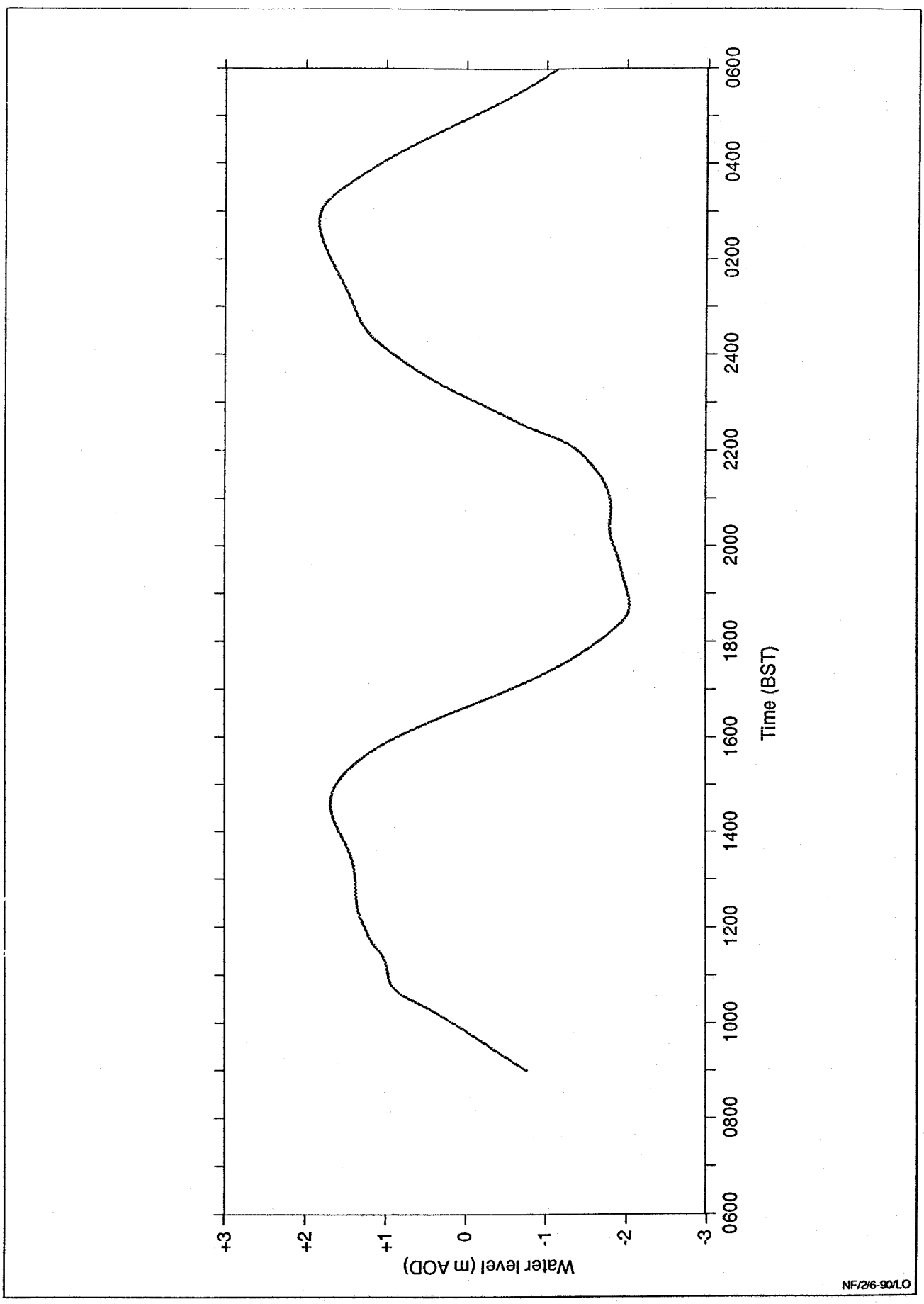

Fig 2 Grangemouth tide recorder record (17/4/89-18/4/89)

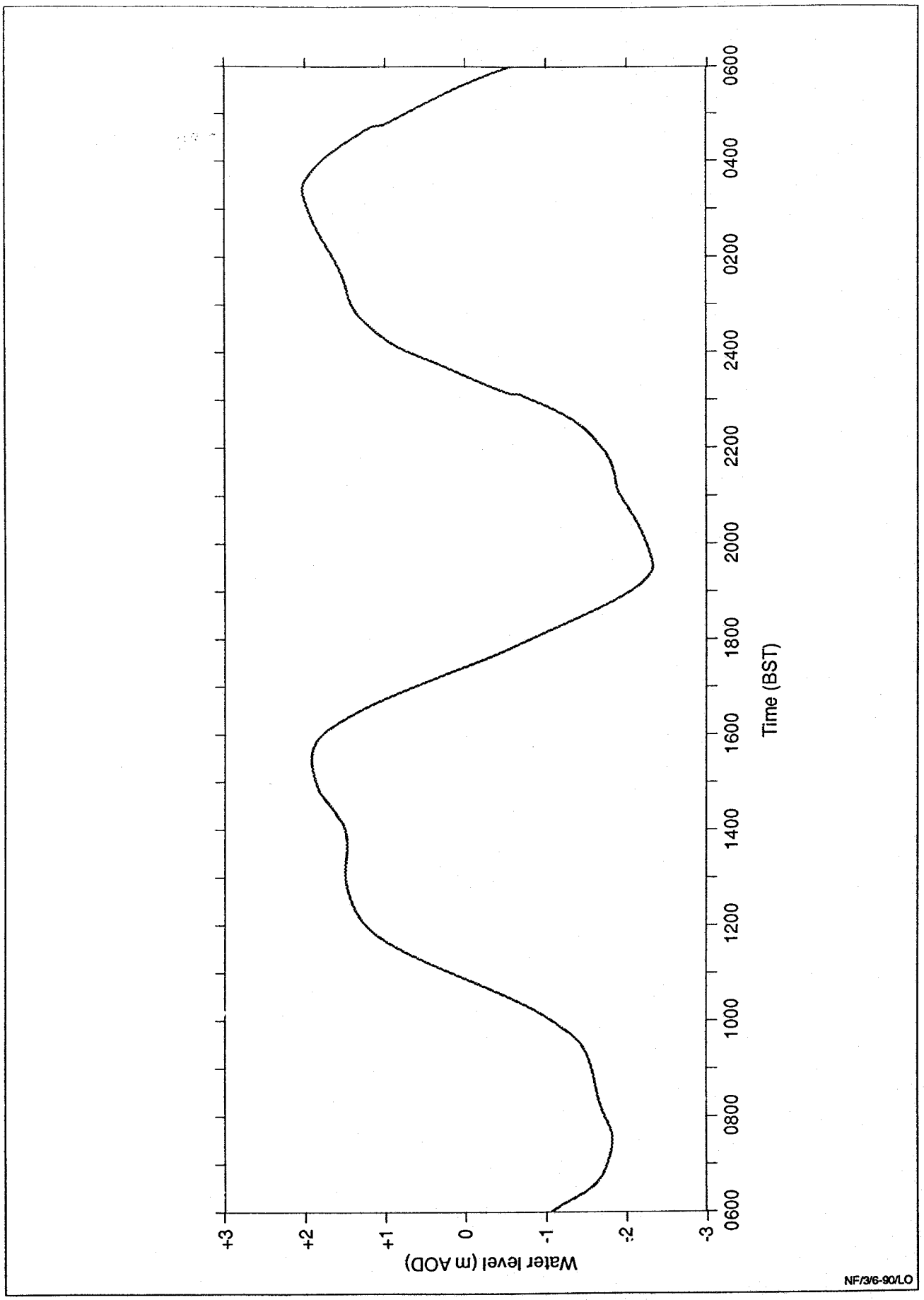

Fig 3 Grangemouth tide recorder record (18/4/89-19/4/89)

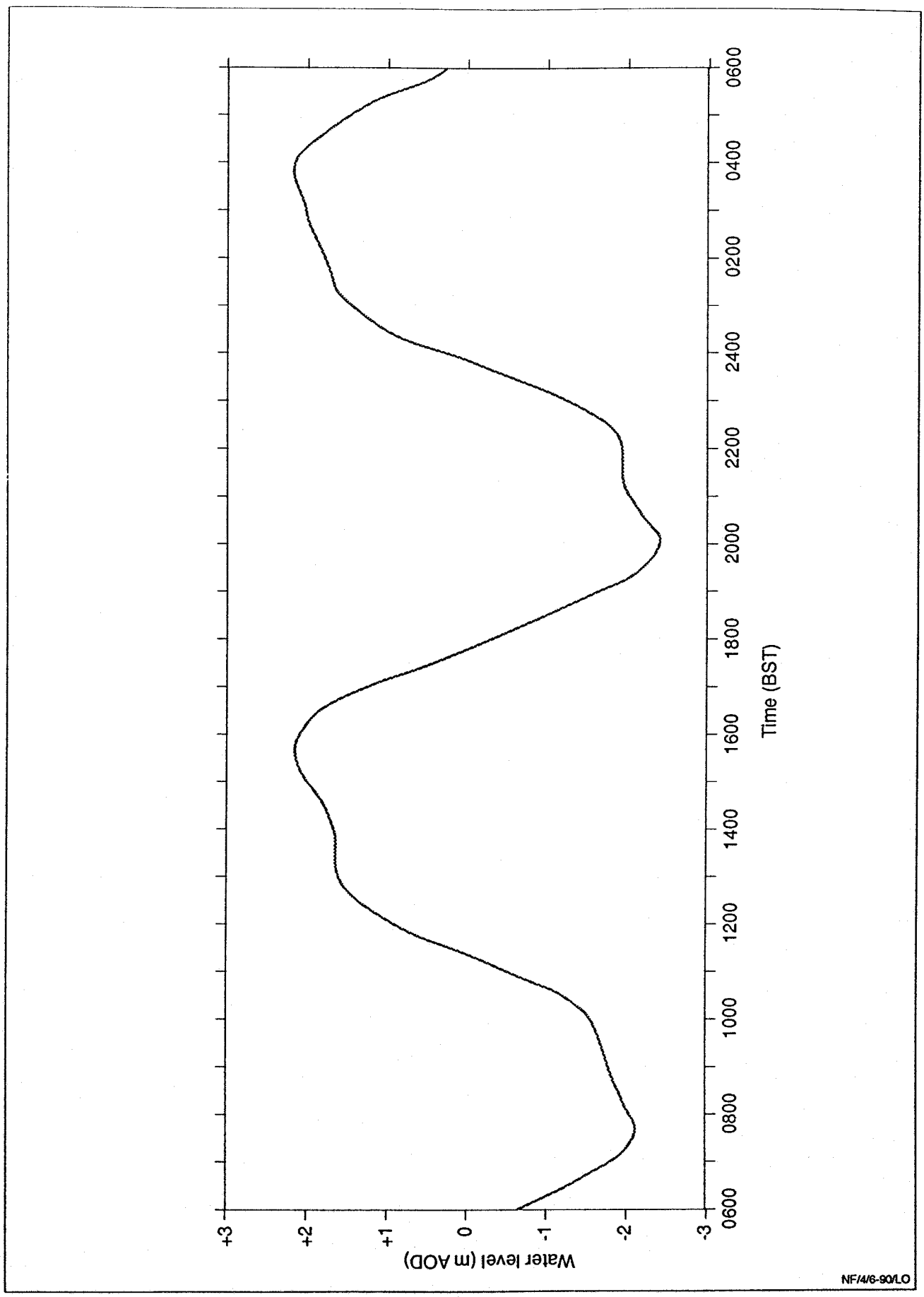

Fig 4 Grangemouth tide recorder record (19/4/89-20/4/89)

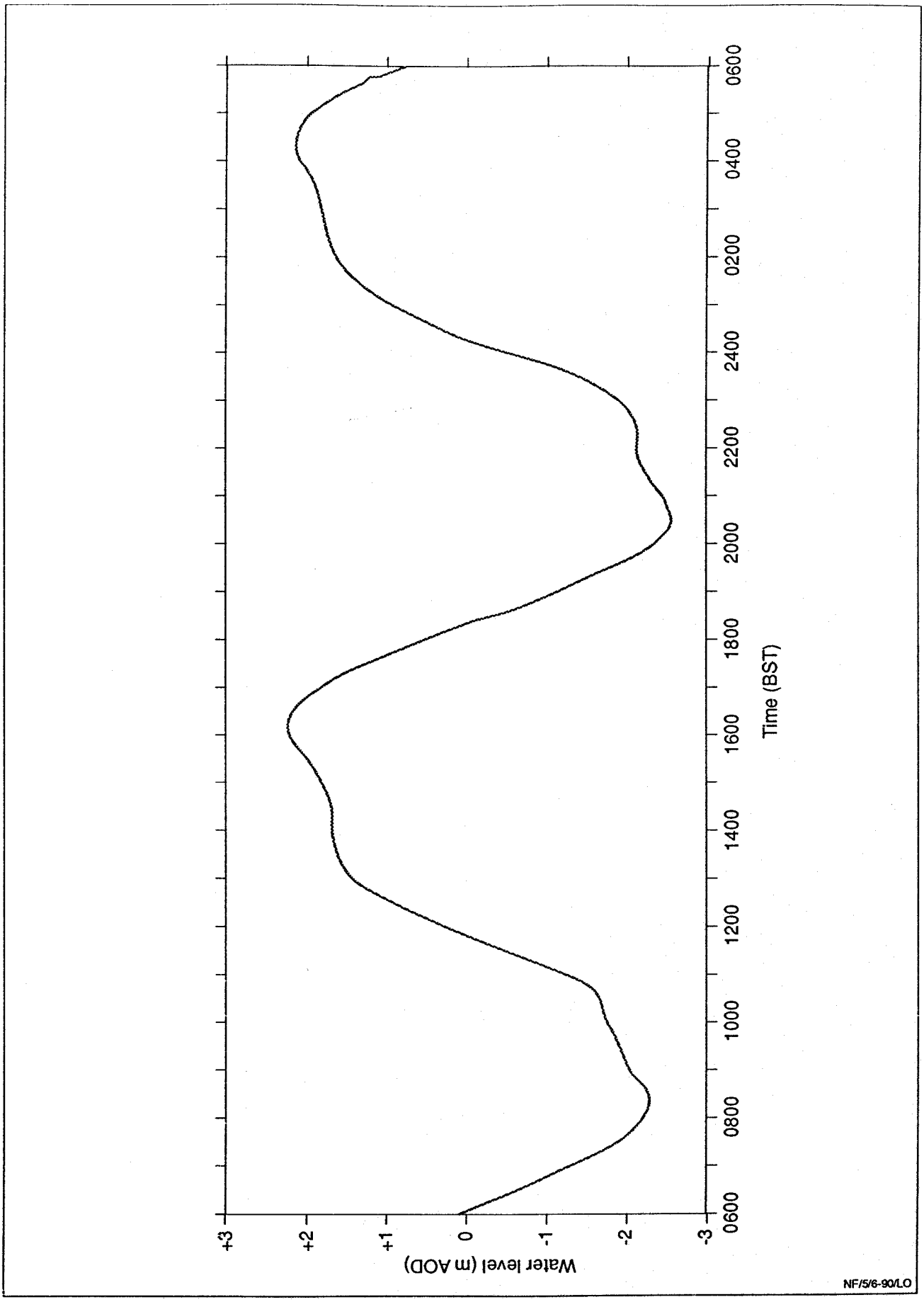

Fig 5 Grangemouth tide recorder record (20/4/89-21/4/89)

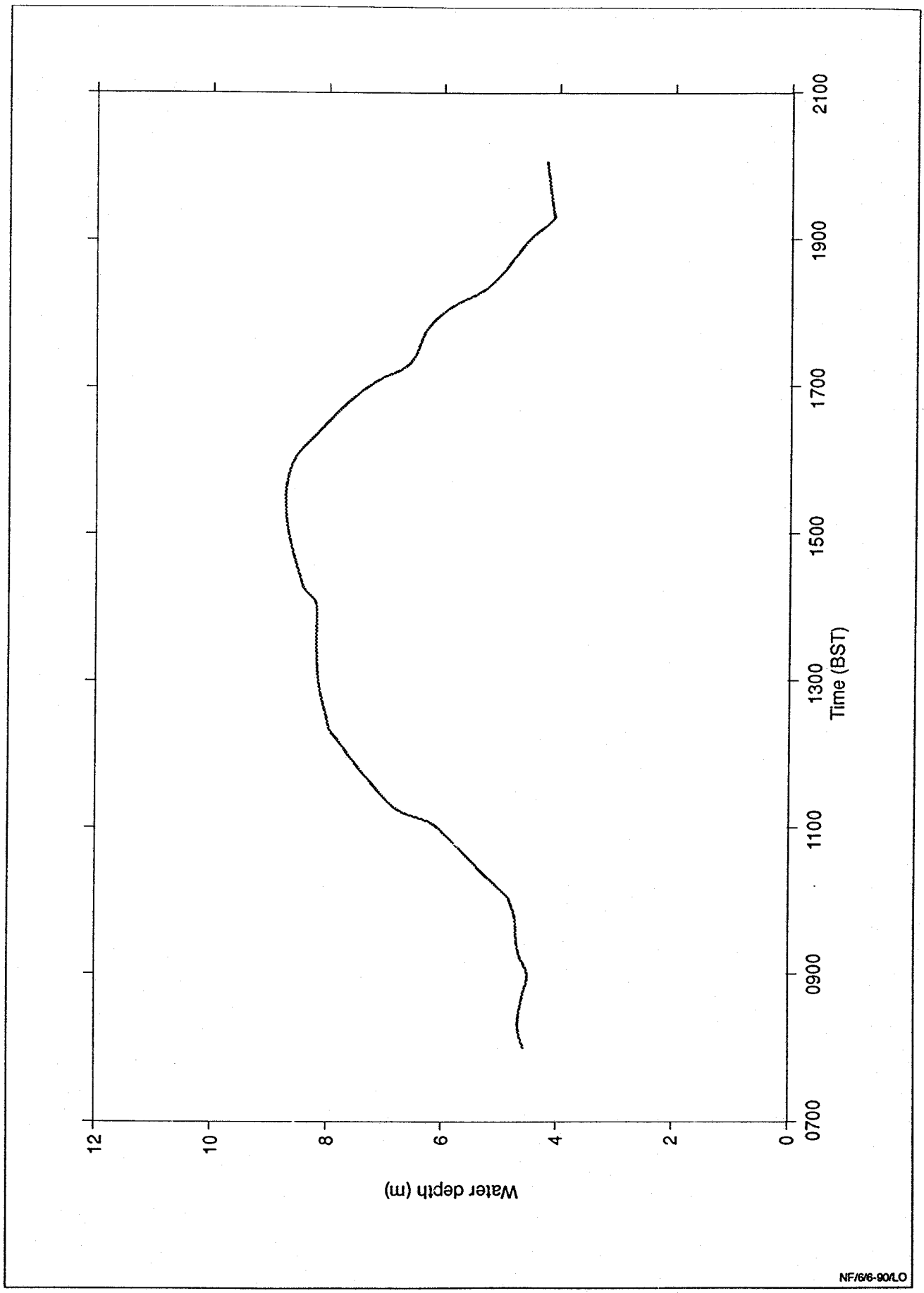

Fig 6 Measured water depths at Position A (19/4/89)

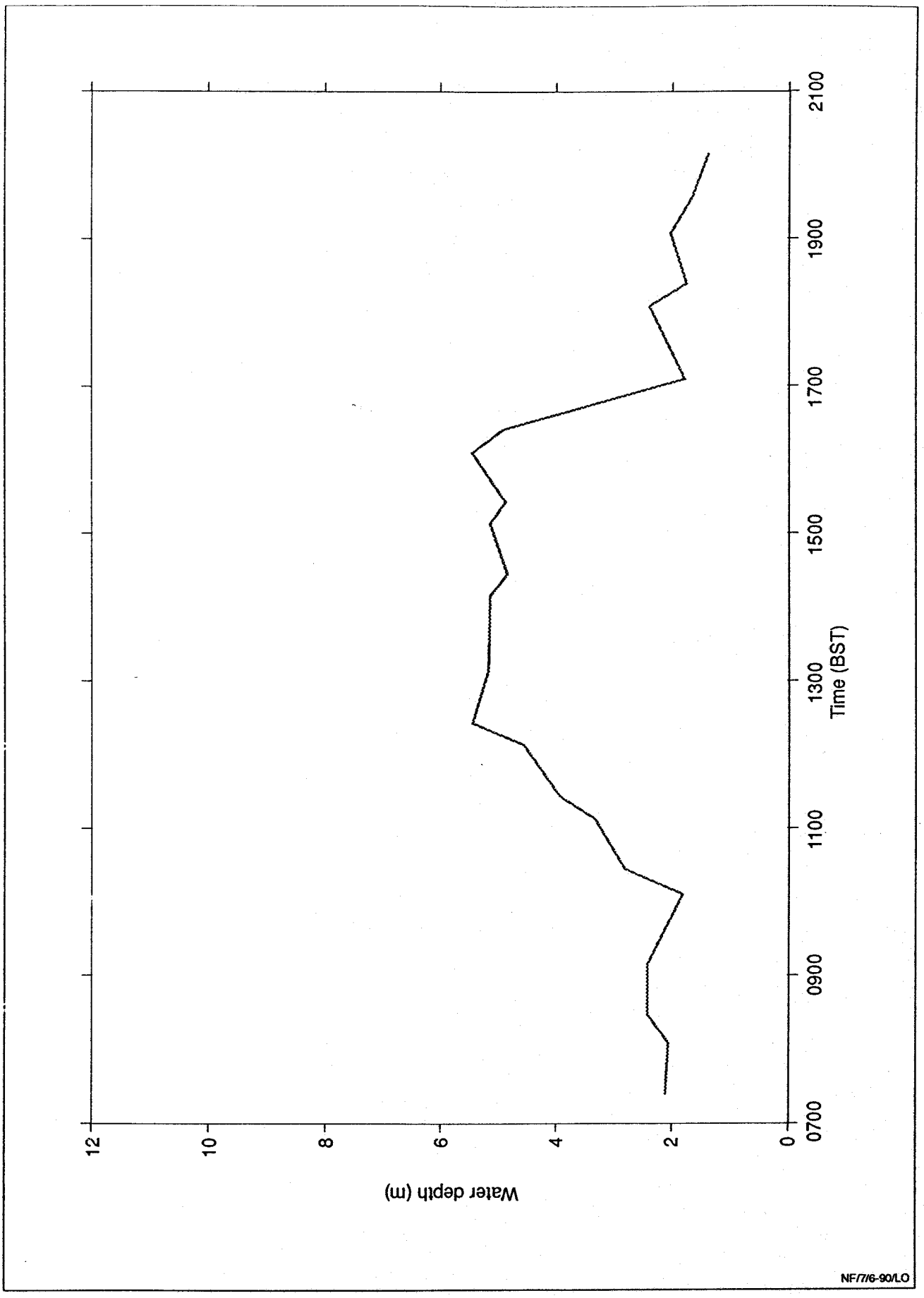

Fig 7 Measured water depths at Position B (19/4/89)

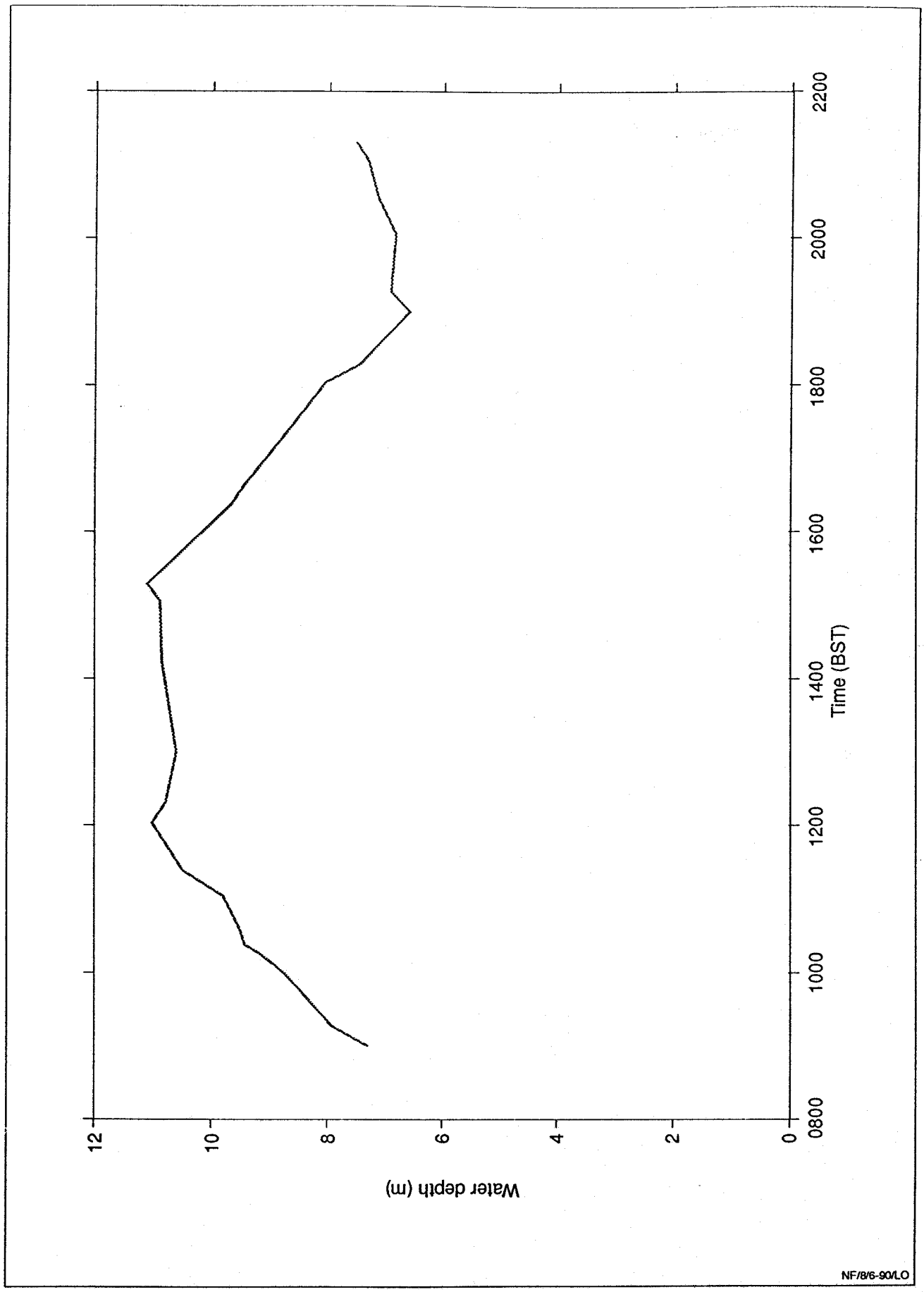

Fig 8 Measured water depths at Position C (18/4/89)

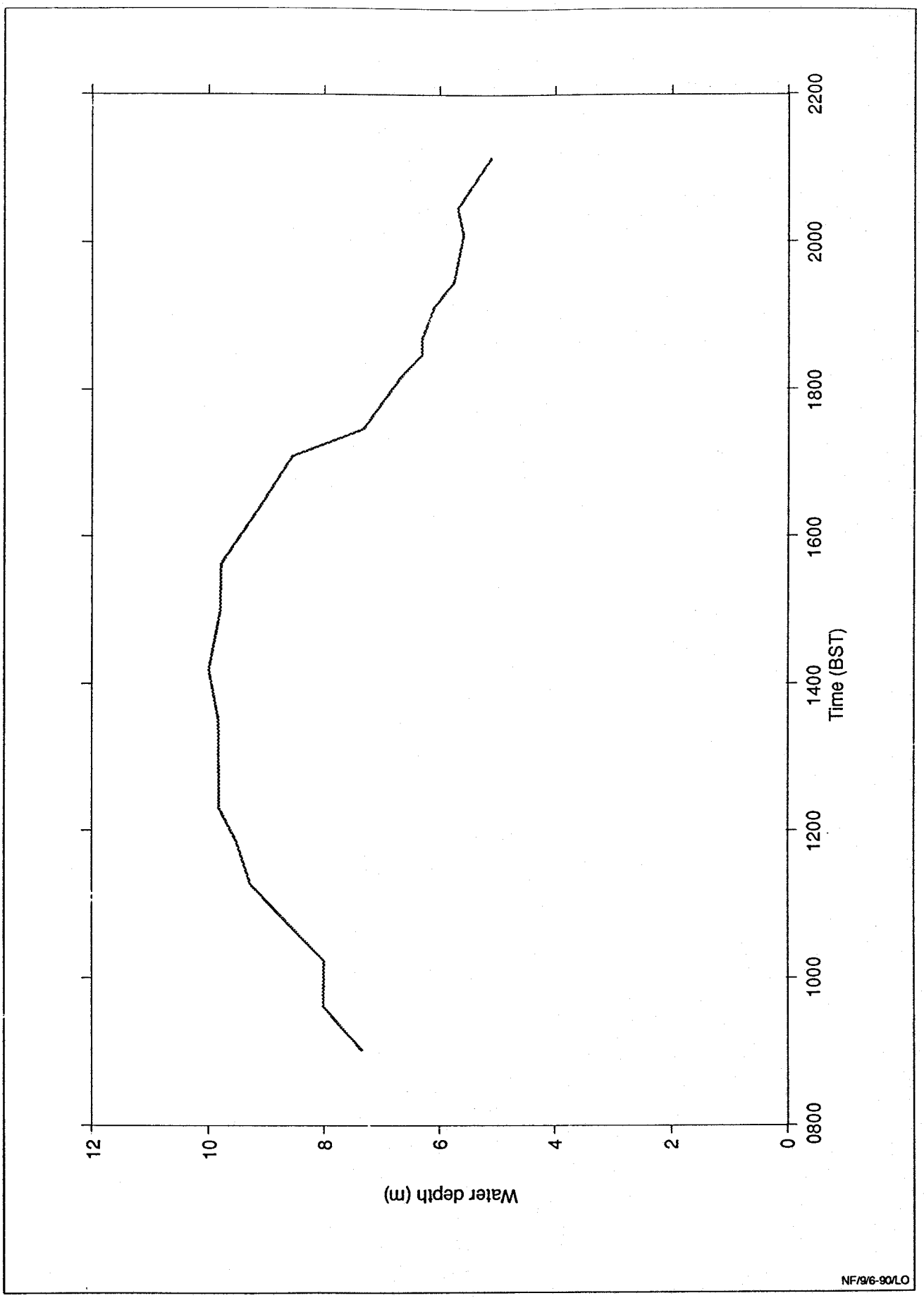

Fig 9 Measured water depths at Position D (18/4/89)

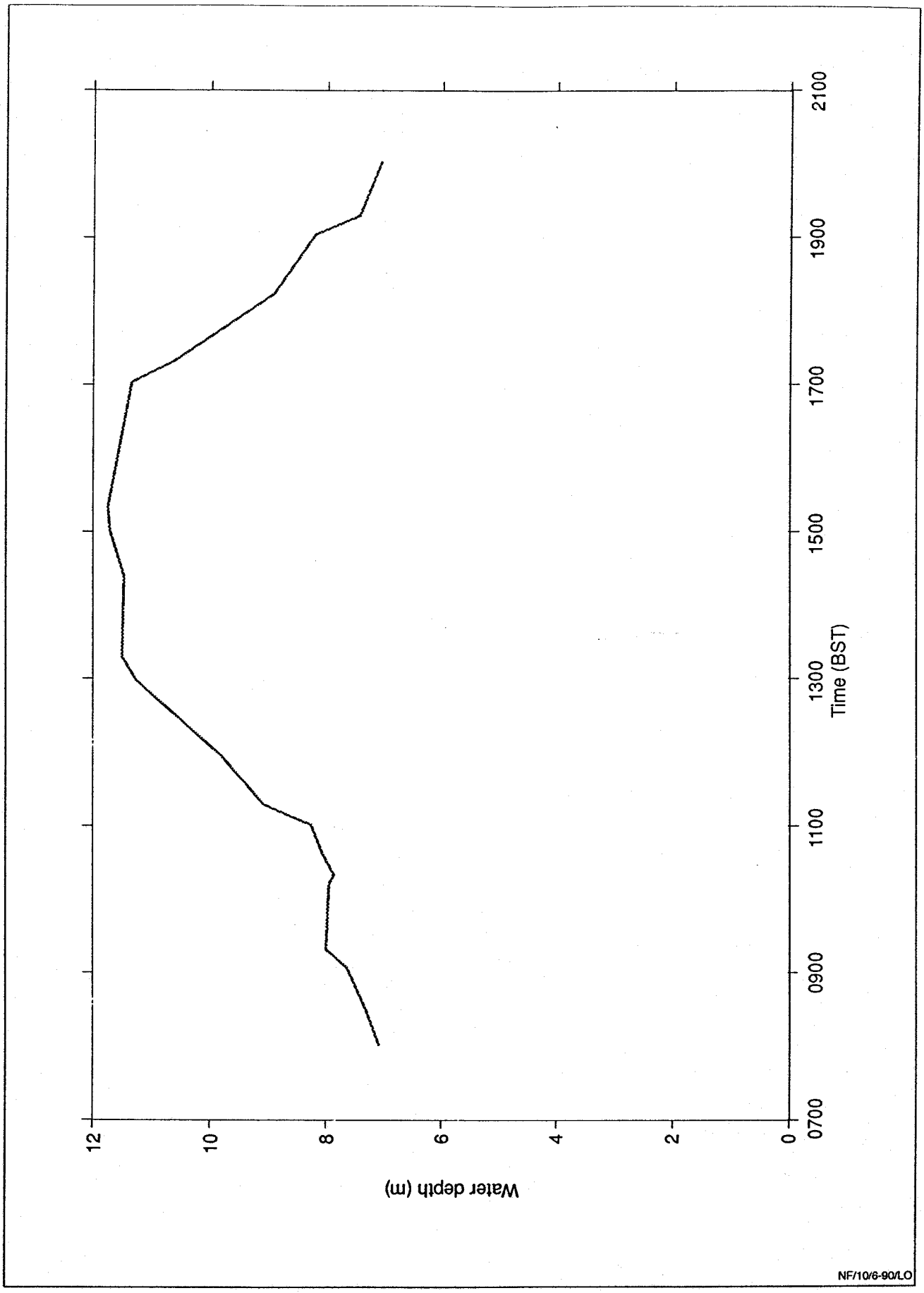

Fig 10 Measured water depths at Position E (20/4/89)

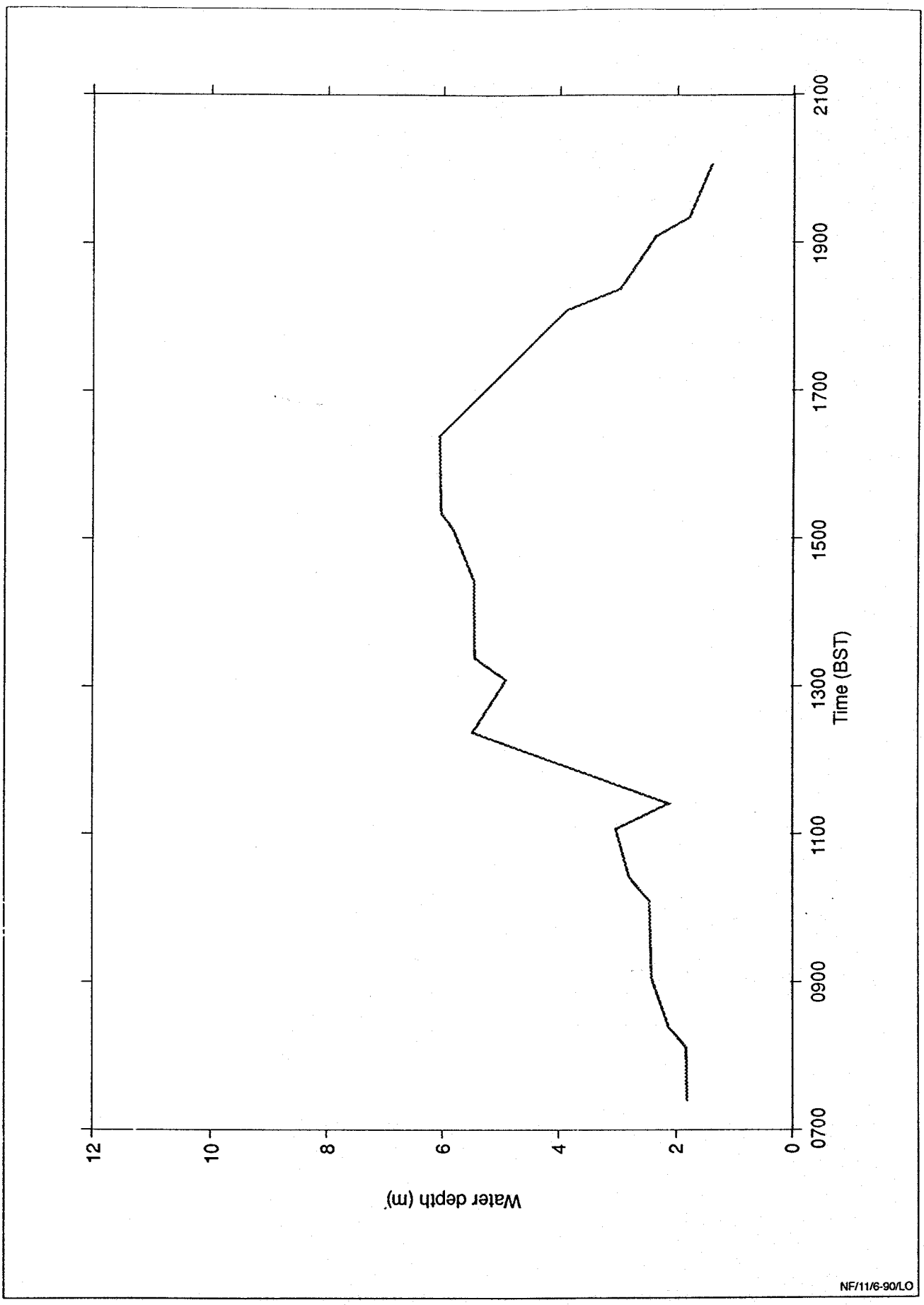

Fig 11 Measured water depths at Position F (20/4/89)

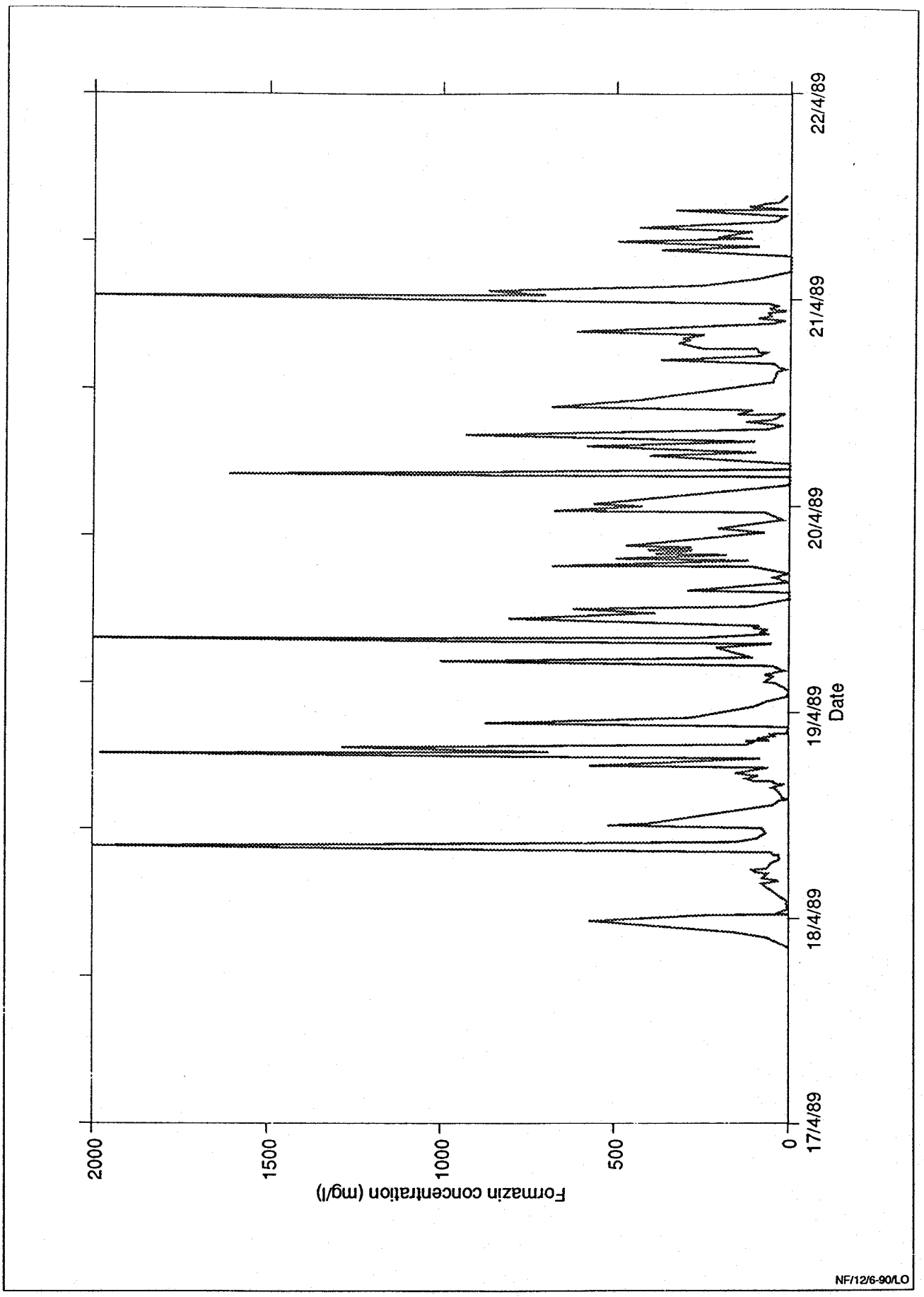

Fig 12 West lead-in jetty concentration record

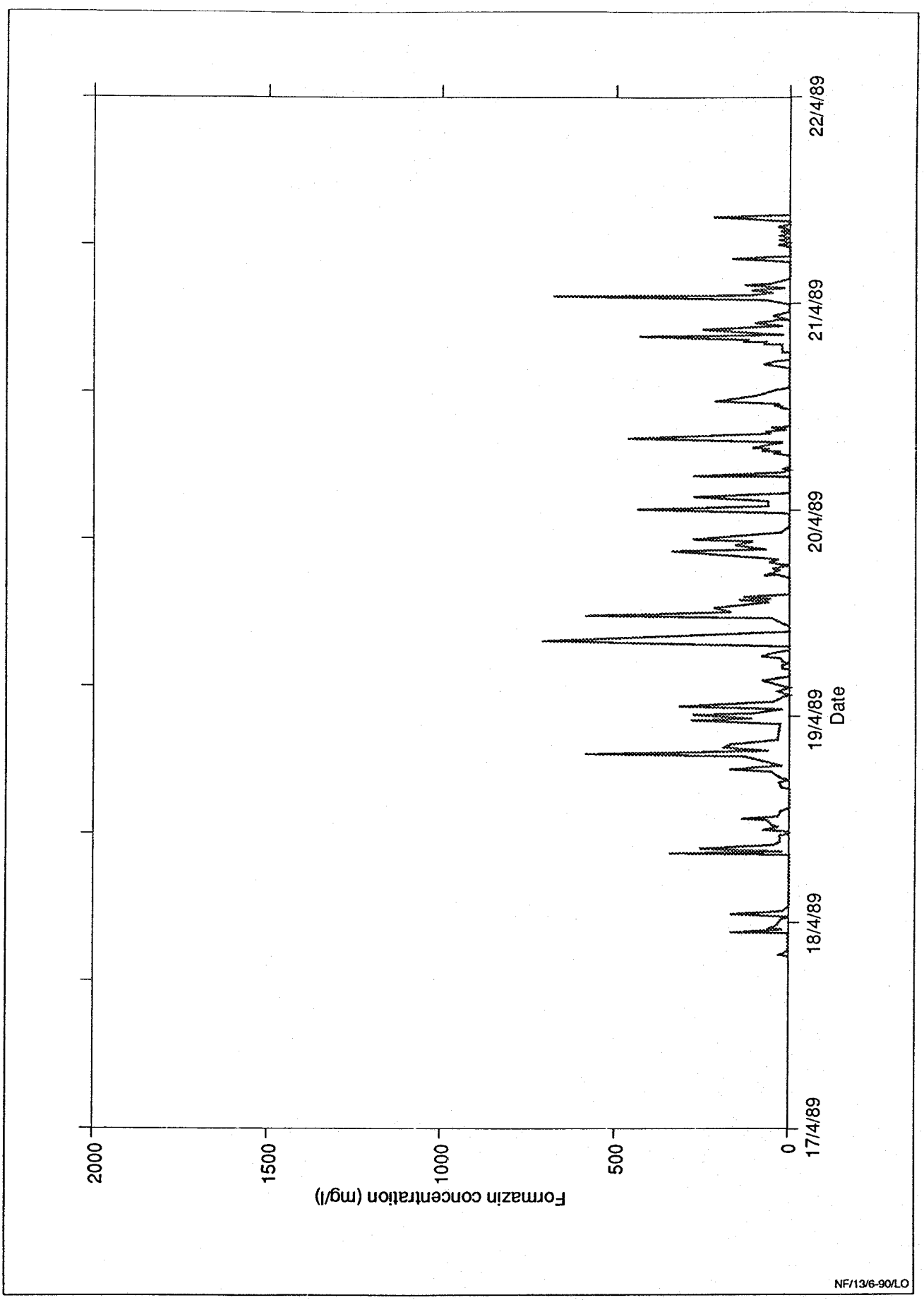

Fig 13 East lead-in jetty concentration record

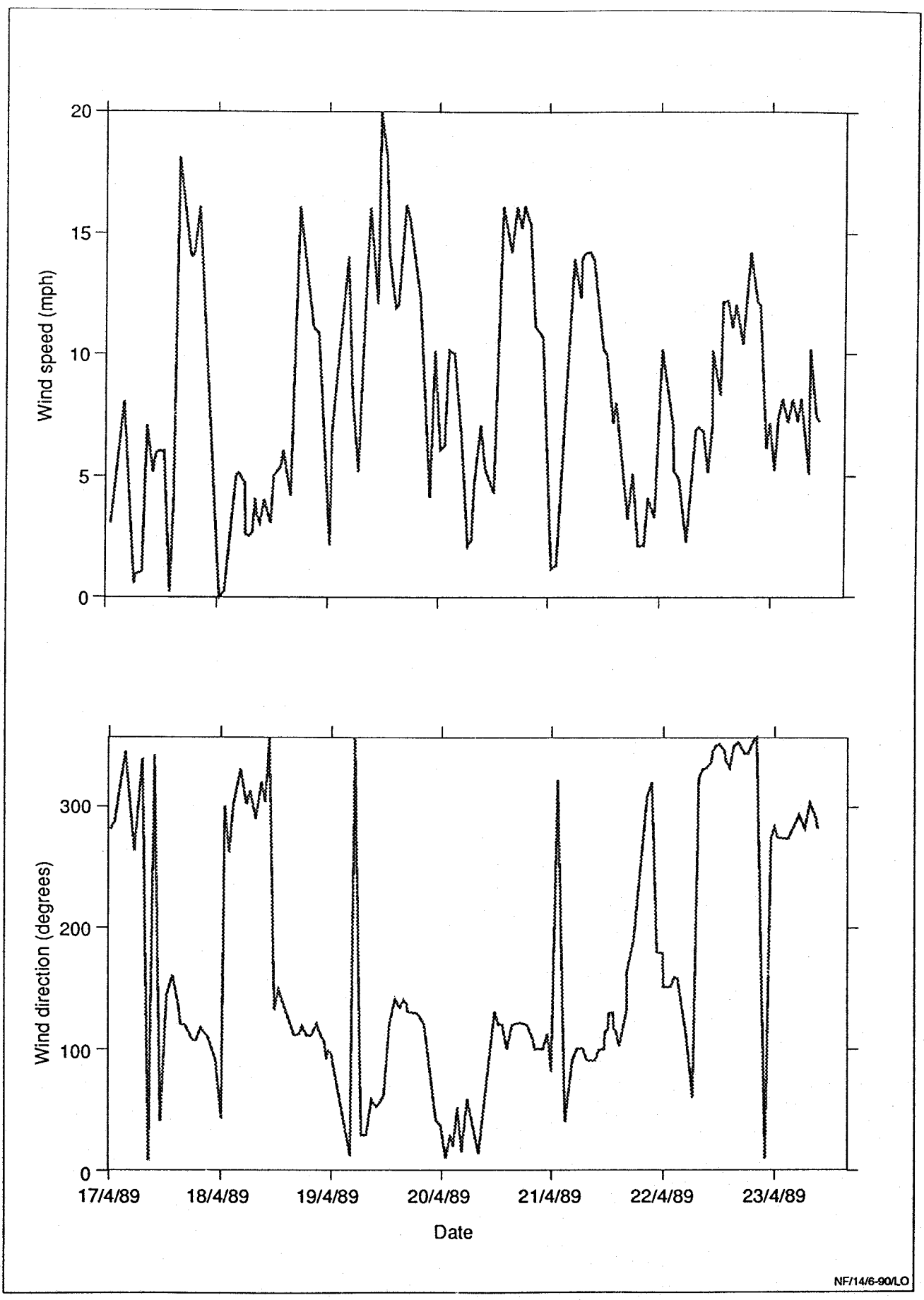

Fig 14 Wind records

PLATES

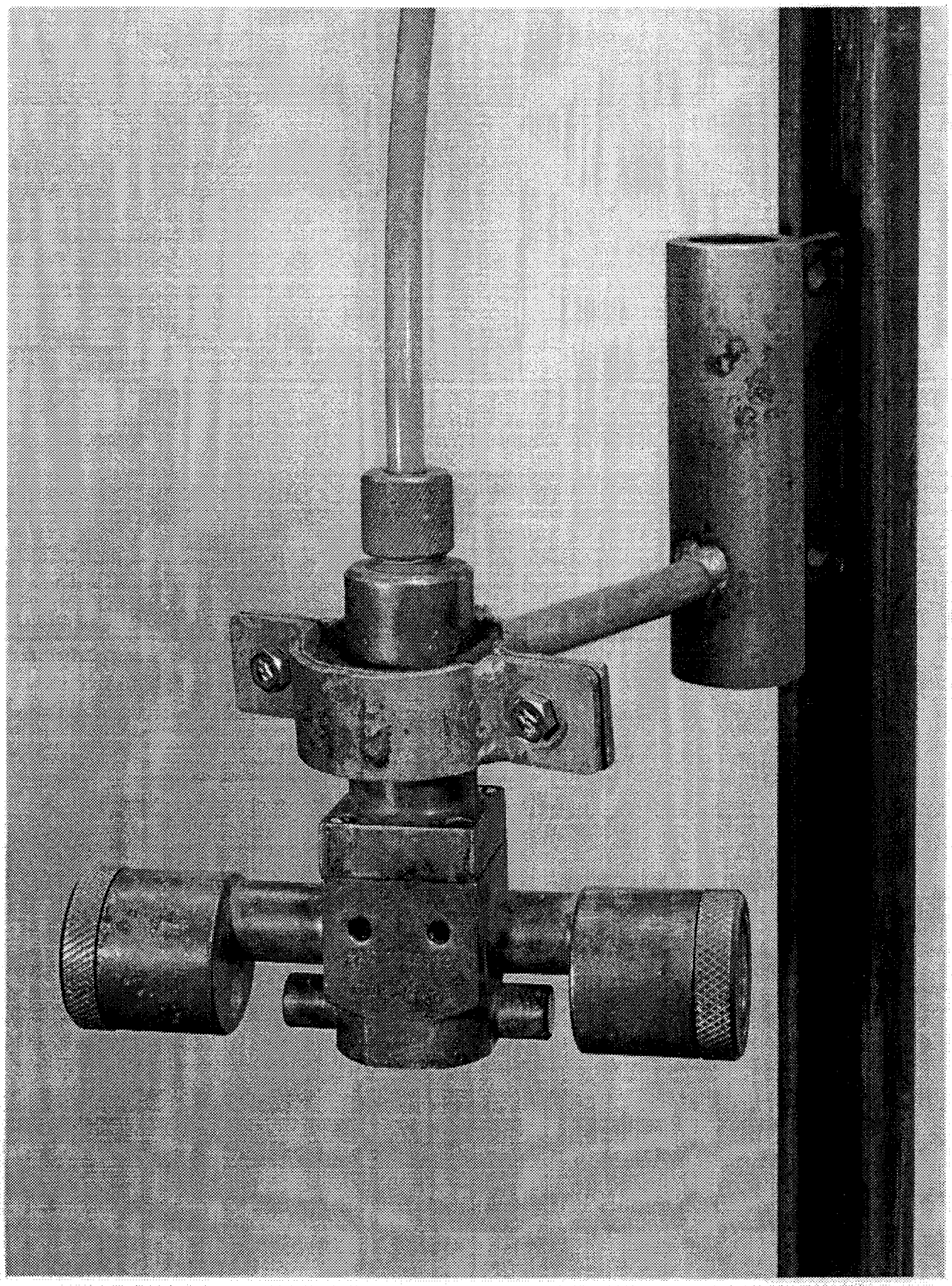

Plate 1 0-1000 mg/l range suspended solids sensor

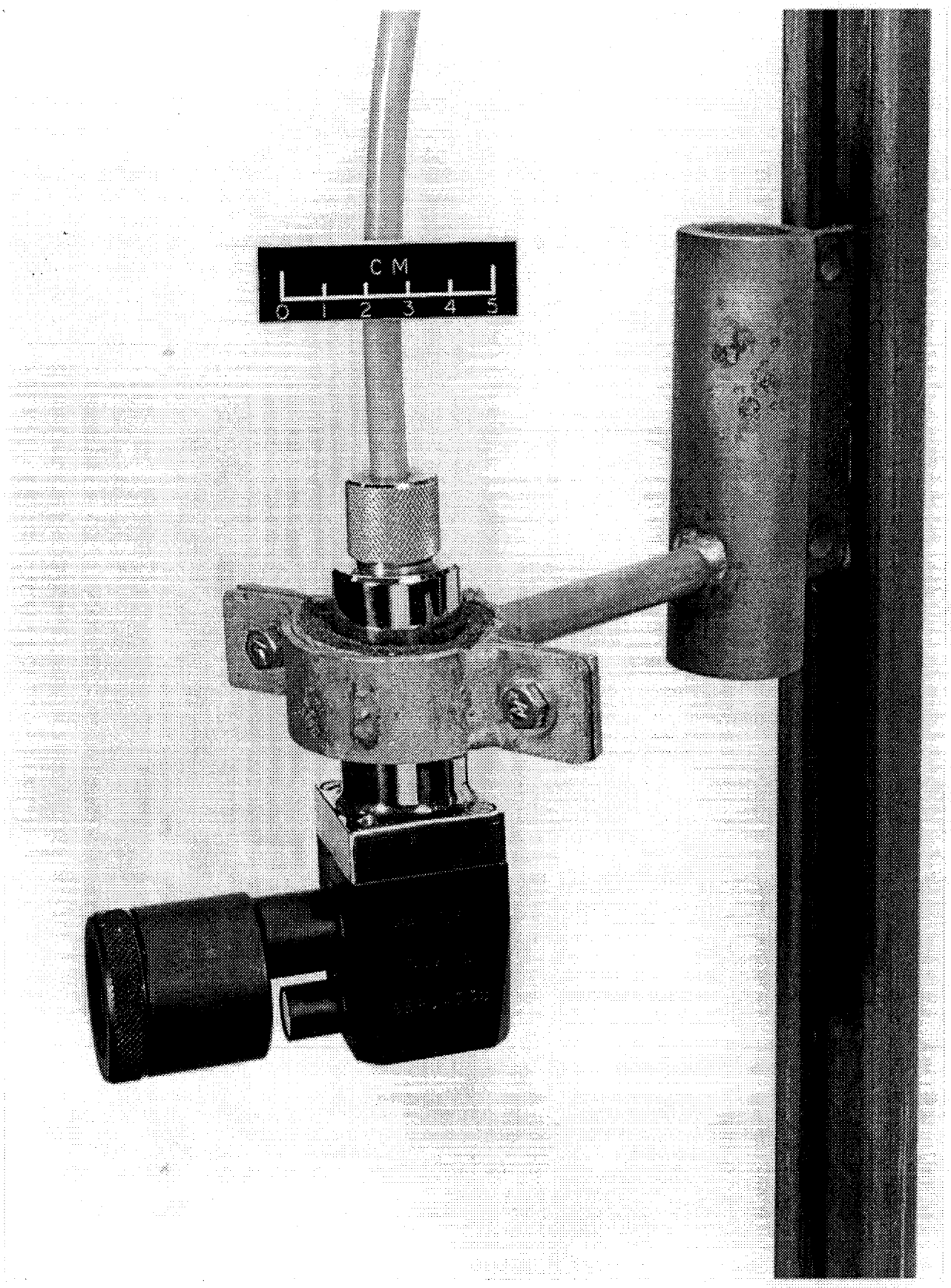

Plate 2 0-5000 mg/l range suspended solids sensor