OSCAR FABER

CLIENT: NATIONAL RIVERS AUTHORITY

SOUTH WESTERN REGION

PROJECT: TIME OF TRAVEL OF POLLUTANTS STUDY

RIVER TAW – Q22/Q25

DATE: 13 JANUARY 1995

OSCAR FABER WATER
NORTHERNHAY HOUSE
NORTHERNHAY PLACE
EXETER
DEVON
EX4 3RY

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Revision	Purpose	Originated	Checked	Reviewed	Authorised	Date
Final	To Client for Approval	J Harris	M Spry	G Howells	J Harris	13 Jan 95

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1.0 SUMMARY

Oscar Faber Water was commissioned by the National Rivers Authority, South Western Region, to undertake a study of the time of travel of pollutants in the River Taw between Junction Pool (the confluence of the Rivers Taw and Mole) and New Bridge during high flow conditions. The study was carried out over the period 13th to the 14th December 1994.

The river was divided into eight reaches and these were studied in succession in an upstream direction using Rhodamine-B as the tracer. Average daily flow reduced during the study period from a Q22 percentile (Umberleigh gauge, 26.682 m^3/s) to a Q25 percentile (Umberleigh gauge, 23.739 m^3/s.)

The combined time of travel for the overall distance of 19.61 km for Junction Pool to New Bridge was 5 hours 11 minutes. The average velocity of travel was 1.05 m/s.

2.0 INTRODUCTION

Study of the time of travel of pollutants (TTP) in a river is an important aid to effective river management. If a pollution incident should occur, the results of such studies can provide accurate prediction of the arrival time of pollutants at any point downstream of the incident. This knowledge allows timely action to be taken to minimise the impact of polluting matter in the river upon legitimate uses such as abstraction for potable supply.

Oscar Faber Water was instructed to undertake time of travel of pollutants studies on the Rivers Axe, Taw and Torridge. This document details the results of the study carried out on the River Taw over the period 13th to 14th December 1994. The objective of the study was to determine the time of travel of pollutants in the River Taw from Junction Pool to New Bridge at high flow, approximately Q20.

3.0 STUDY AREA

The length of river considered was that between Junction Pool (NGR: SS 661 176) and New Bridge, (NGR: SS 570282). The Study Area is shown in Figure 1.

4.0 EQUIPMENT AND MATERIALS

The major items of equipment and materials used in undertaking the study were as follows:

- Chelsea Instruments Aquatracka III submersible fluorimeter
- *Data taker* digital logger
- Compaq 386 PC
- 12 v batteries and chargers
- Chart Recorder
- Rhodamine-B dye

5.0 METHODOLOGY

5.1 Reach Selection

The total length of river studied was approximately 19.61 km and this was divided into eight reaches varying in length between 0.610 km and 4.030 km. The reaches were selected primarily for their ease of access and their proximity to major abstraction points and flow gauging stations. The length of each reach was measured from 1:50 000 scale Ordnance Survey sheets. The length of each reach is defined by dye input and monitoring points at their upstream and downstream ends. The locations of injection and monitoring points are shown on Figure 1 and National Grid References (NGR) are given in table 5.1 below.

SITE	NATIONAL GRID REFERENCE
Junction Pool	SS 661 176
Abbotts Marsh Farm	SS 643 197
Kingford Bridge	SS 623 192
Snape Wood	SS 619 197
Weir Marsh Farm	SS 615 221
Umberleigh Bridge	SS 607 237
Hawkridge Farm	SS 595 252
Chapelton	SS 582 261
New Bridge	SS 570 282

Table 5.1 Dye Injection and Monitoring Points

5.2 Fieldwork

At each dye injection point, the appropriate weight of dye was mixed in a container with river water. The mixed solution was then injected into the main river flow and the time of injection recorded.

At the downstream end of each reach a fluorimeter was sited at an appropriate location in the main river flow to record the passing of the dye cloud. The fluorimeter signal was digitally logged at 15-second intervals and showed background level and levels as the dye cloud passed the submersed fluorimeter.

The signal was recorded by the datataker with real-time numerical and graphical display generated via an interface to a PC. As a backup, the signal was recorded manually with a continuous chart recorder.

6.0 RESULTS AND DISCUSSION

6.1 Flow

Flow in the River Taw is monitored on a routine basis by the NRA, at Umberleigh gauging station. Figure 2 shows the flow record for the study period recorded at the gauging station. The study period ran between 08.30 hrs 13th December 1994 to approximately 11.30 hrs on 14th December 1994. In terms of percentile flow, an average of Q22 (Umberleigh gauge 26.682 m^3/s) was recorded on the 13th December and an average of Q25 (Umberleigh gauge, 23.739 m^3/s) was recorded on 14th December. These represent lower flows than those defined in the Brief, but were considered acceptable as presenting 'high' flow conditions.

6.2 Concentrations

Figures 3 to 10 show concentration of dye against time for each of the 8 monitoring sites. From each graph it is possible to determine, for each dye cloud, the time of first arrival of the dye at the fluorimeter, the time to reach peak concentration and the time for the peak to diminish by 50 percent. This information is summarised in Table 6.1 below.

Monitoring Point	Dye Injection Point	Reach Length (km)	Time of Travel		
			First Arrival	Peak	50% of Peak
Abbotts Marsh Farm	Junction Pool	3.020	1hr 02m	1hr 18m	1hr 28m
Kingford Bridge	Abbotts Marsh Farm	2.200	0hr 30m	0hr 38m	0hr 49m
Snape Wood	Kingford Bridge	0.610	0hr 12m	0hr 18m	0hr 27m
Weir Marsh Farm	Snape Wood	4.030	1hr 02m	1hr 19m	1hr 38m
Umberleigh Bridge	Weir Marsh Farm	2.525	0hr 34m	0hr 39m	0hr 50m
Hawkridge Farm	Umberleigh Bridge	2.610	0hr 39m	0hr 52m	1hr 12m
Chapelton	Hawkridge Farm	1.745	0hr 28m	0hr 38m	0hr 54m
New Bridge	Chapelton	2.870	0hr 44m	0hr 56m	1hr 10m

Table 6.1 Summary of Time of Travel

Relatively little 'noise' is visible in the graphs. Where 'noise' does occur it may be as a result of vegetation or other matter interfering with the fluorimeter signal. The river was at 'high' flow for the duration of the study and significant quantities of suspended matter may have generated 'noise' by temporarily wrapping around the base of the fluorimeter.

Figure 10 demonstrates a case in point where, at Abbotts Marsh Farm the fluorimeter was positioned not in midstream but at a point 3.5 metres from the bankside. Although of sufficient depth the site was, however, adjacent to aquatic vegetation.

At two of the other monitoring point locations (Weir Marsh Farm, Figure 7 and Snape Wood, Figure 8) the fluorimeter was secured from one bank of the river and floated out into the main stream. Neither chart relating to these sites displays noise levels significantly different from those for data monitored in midstream at the remaining five locations, where the fluorimeter was secured from bridge level.

The time of first arrival of the dye cloud at each site has been plotted against distance in Figure 1-1. This allows the time of travel of pollutants to be estimated between any two points within the area of study. From the graph an average velocity of 1.05 m/s can be inferred for the overall stretch of river between Junction Pool and New Bridge.

7.0 CONCLUSIONS

The study of the River Taw undertaken between 13th – 14th December 1994 successfully achieved the objective of determining the time of travel of pollutants in the specified reaches at high flow. The data collected accurately shows the passing of individual dye clouds in the river at each of the monitoring stations. The velocity of travel of the dye varied from approximately 1.24 m/s (observed in the mid reaches 13/12/94) to approximately 0.81 m/s (in the upper reaches 14/12/94). A mean velocity of approximately 1.05 m/s was recorded at an average flow rate of Q23.

APPENDIX A – FLOW DURATION ANALYSIS

SURFACE FLOW ANNUAL REPORT

STATION NO. SS62F001
STATION NAME UMBERLEIGH RIVER TAW
NGR SS 6080 2366
CATCHMENT AREA 826.2 SQ KM

MINIMUM DAILY MEAN FLOW 0.202 CUMECS
MAXIMUM DAILY MEAN FLOW 334.580 CUMECS
MEAN DAILY FLOW 17.930 CUMECS

FLOW DURATION ANALYSIS FOR 1959 TO 1992

FLOW IN CUMECS	% OF MEAN DAILY FLOW	% OF DAILY VALUES GREATER THAN FLOW
334.580	1866.078	0.000
261.328	1457.527	0.032
204.115	1138.426	0.064
159.427	889.185	0.209
124.523	694.512	0.548
97.261	542.459	1.498
75.967	423.696	3.301
59.335	330.935	6.257
46.345	258.482	10.234
36.198	201.891	15.050
28.273	157.690	20.066
22.083	123.167	25.791
17.248	96.201	31.854
13.472	75.139	38.715
10.523	58.689	45.487
8.219	45.840	52.758
6.419	35.804	59.642
5.014	27.965	66.165
3.916	21.843	72.099
3.059	17.061	77.470
2.389	13.325	82.615
1.866	10.408	87.688
1.458	8.129	92.640
1.138	6.350	95.507
0.889	4.959	97.697
0.695	3.874	99.122
0.542	3.026	99.678
0.424	2.363	99.831
0.331	1.846	99.879
0.258	1.442	99.944
0.202	1.126	99.992

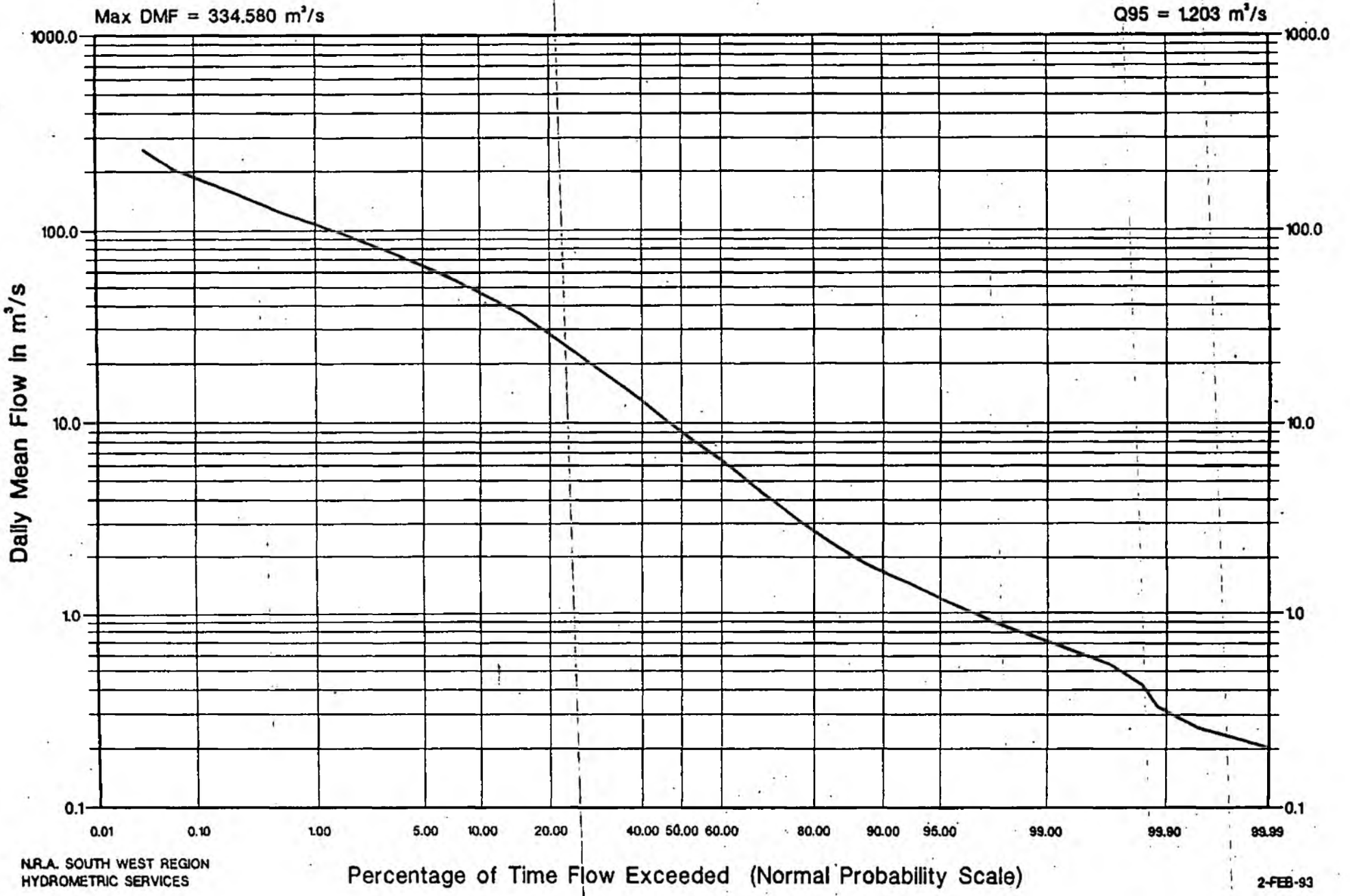
FLOW FREQUENCY ANALYSIS FOR 1959 TO 1992

FLOW RANGE (CUMECS)	NUMBER OF DAILY VALUES IN FLOW RANGE
>334.580	0
261.329 - 334.580	4
204.116 - 261.328	4
159.428 - 204.115	18
124.524 - 159.427	42
97.262 - 124.523	118
75.968 - 97.261	224
59.336 - 75.967	367
46.346 - 59.335	494
36.199 - 46.345	598
28.274 - 36.198	623
22.084 - 28.273	711
17.249 - 22.083	753
13.473 - 17.248	852
10.524 - 13.472	841
8.220 - 10.523	903
6.420 - 8.219	855
5.015 - 6.419	810
3.917 - 5.014	737
3.060 - 3.916	667
2.390 - 3.059	639
1.867 - 2.389	630
1.459 - 1.866	615
1.139 - 1.458	356
0.890 - 1.138	272
0.696 - 0.889	177
0.543 - 0.695	69
0.425 - 0.542	19
0.332 - 0.424	6
0.259 - 0.331	8
0.203 - 0.258	6
<= 0.202	1

TOTAL NO. DAILY VALUES 12419

RIVER TAW AT UMBERLEIGH

FLOW DURATION CURVE 1959-1992



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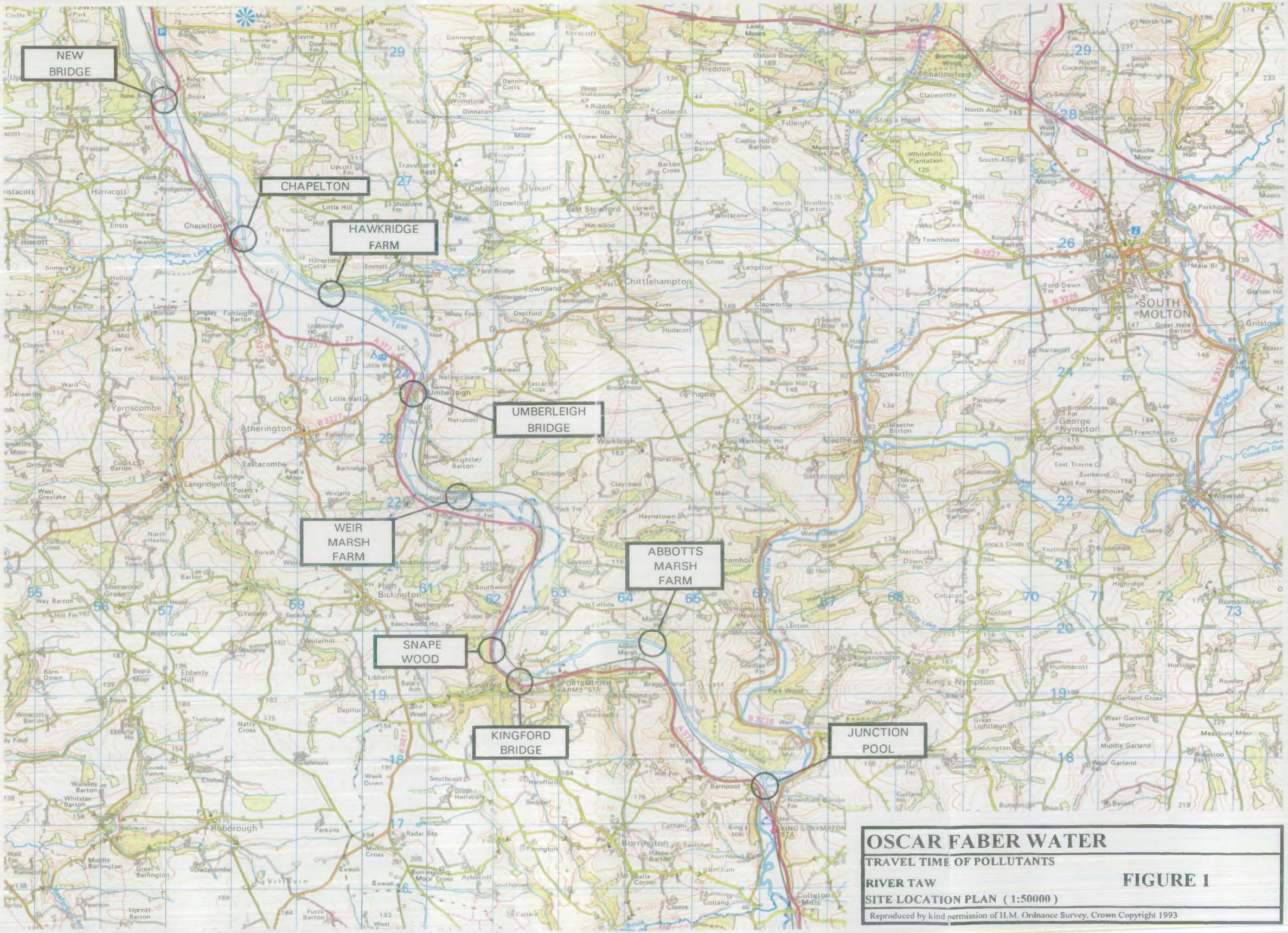
HYDROMETRIC SERVICES

2-FEB-93

FIGURES



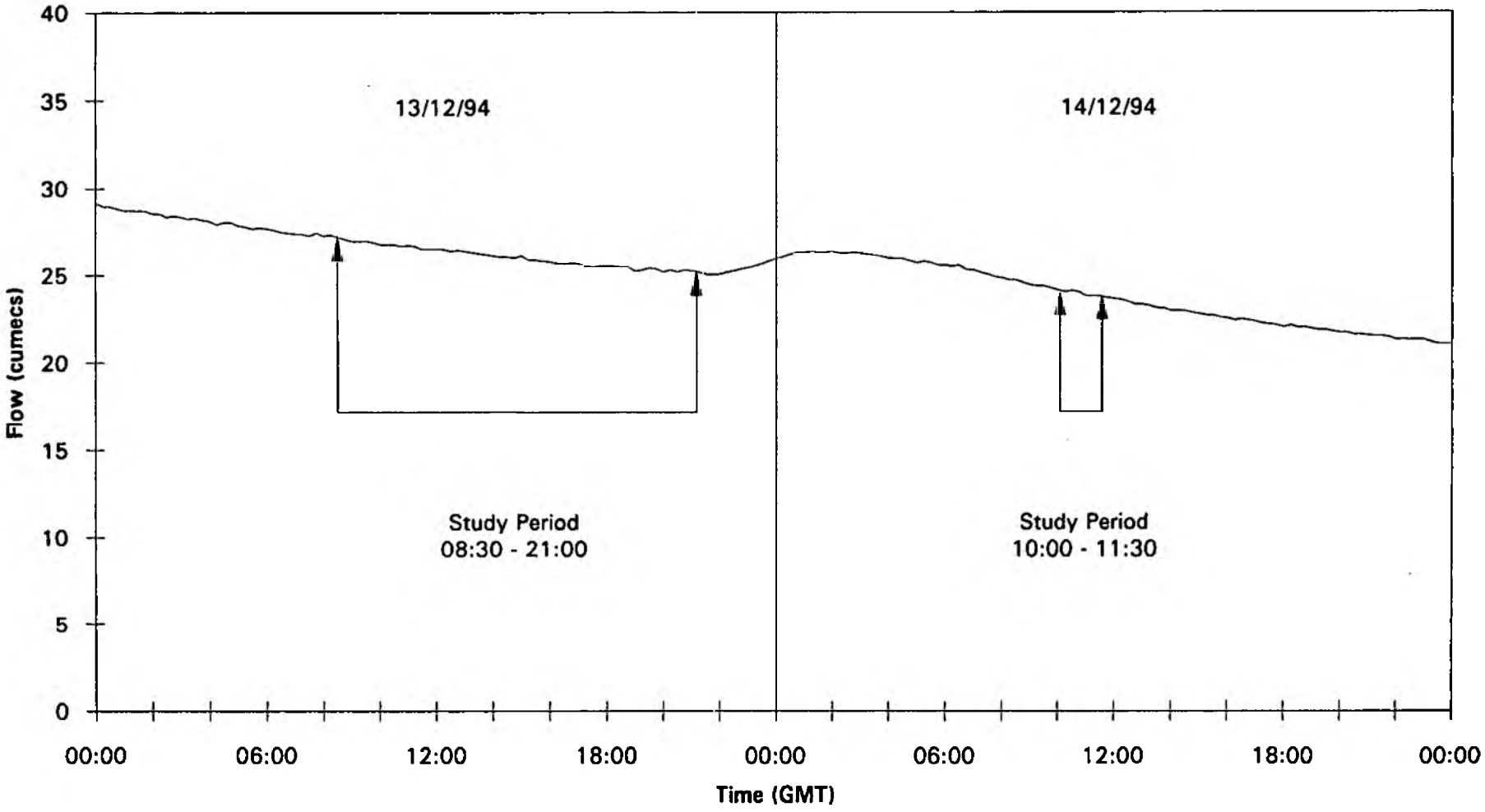
OSCAR FABER WATER

TRAVEL TIME OF POLLUTANTS

RIVER TAW **FIGURE 1**

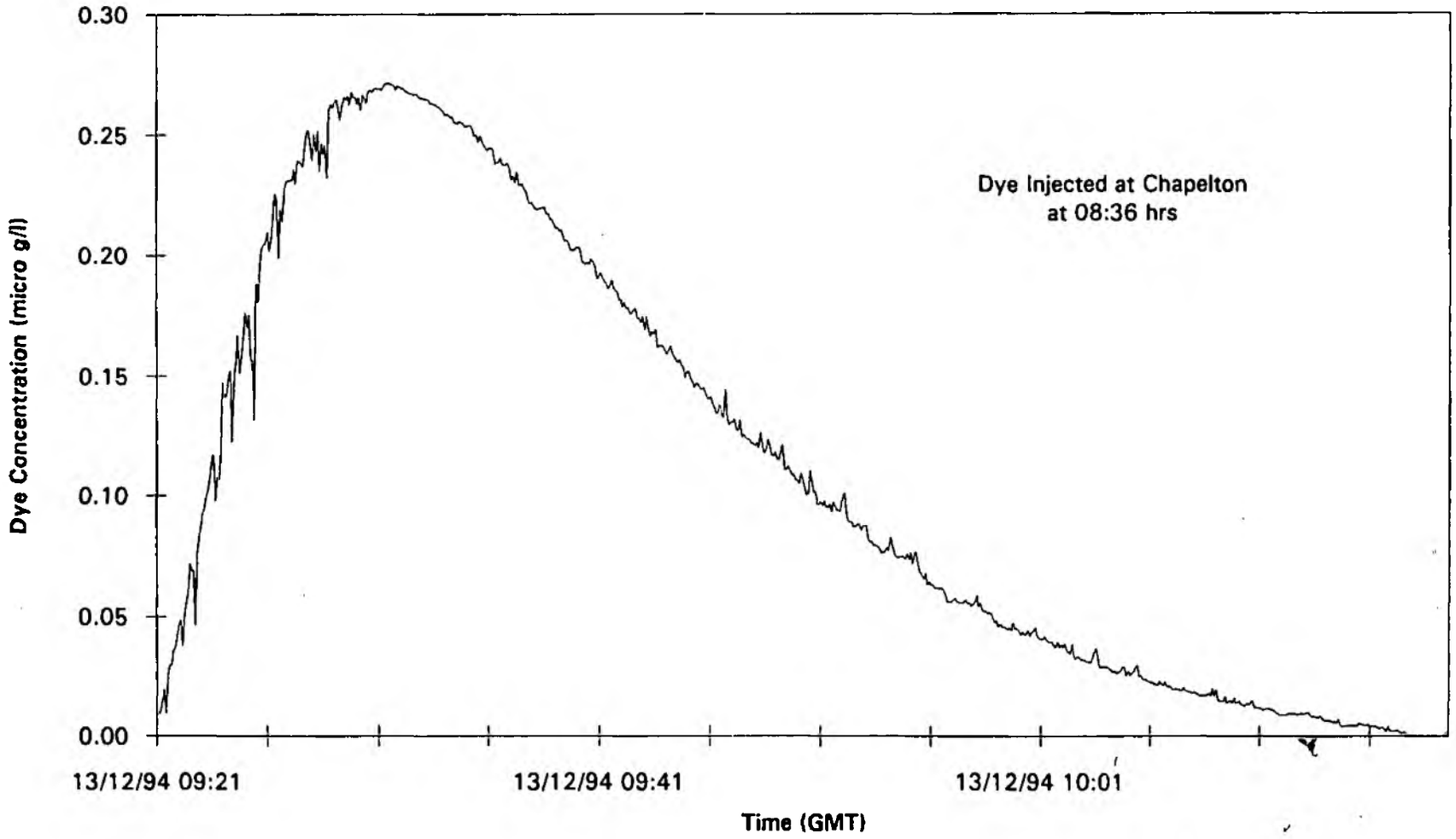
SITE LOCATION PLAN (1:50000)

Figure 2 - River Taw 15 Minute Flows 13-14/12/94



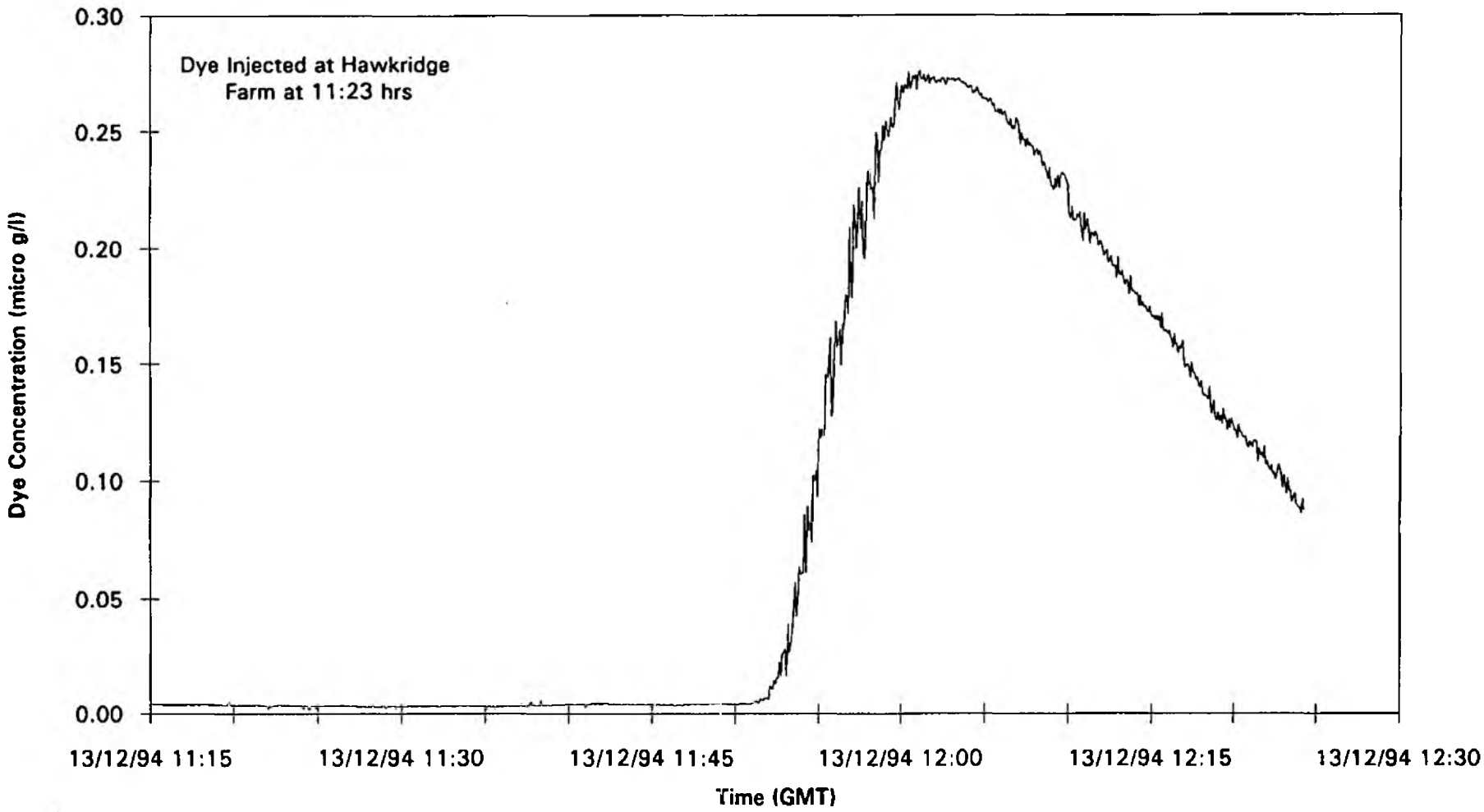
NGR Monitoring Point
SS 570282
NGR Injection Point
SS 582261

Figure 3 - New Bridge 13/12/94



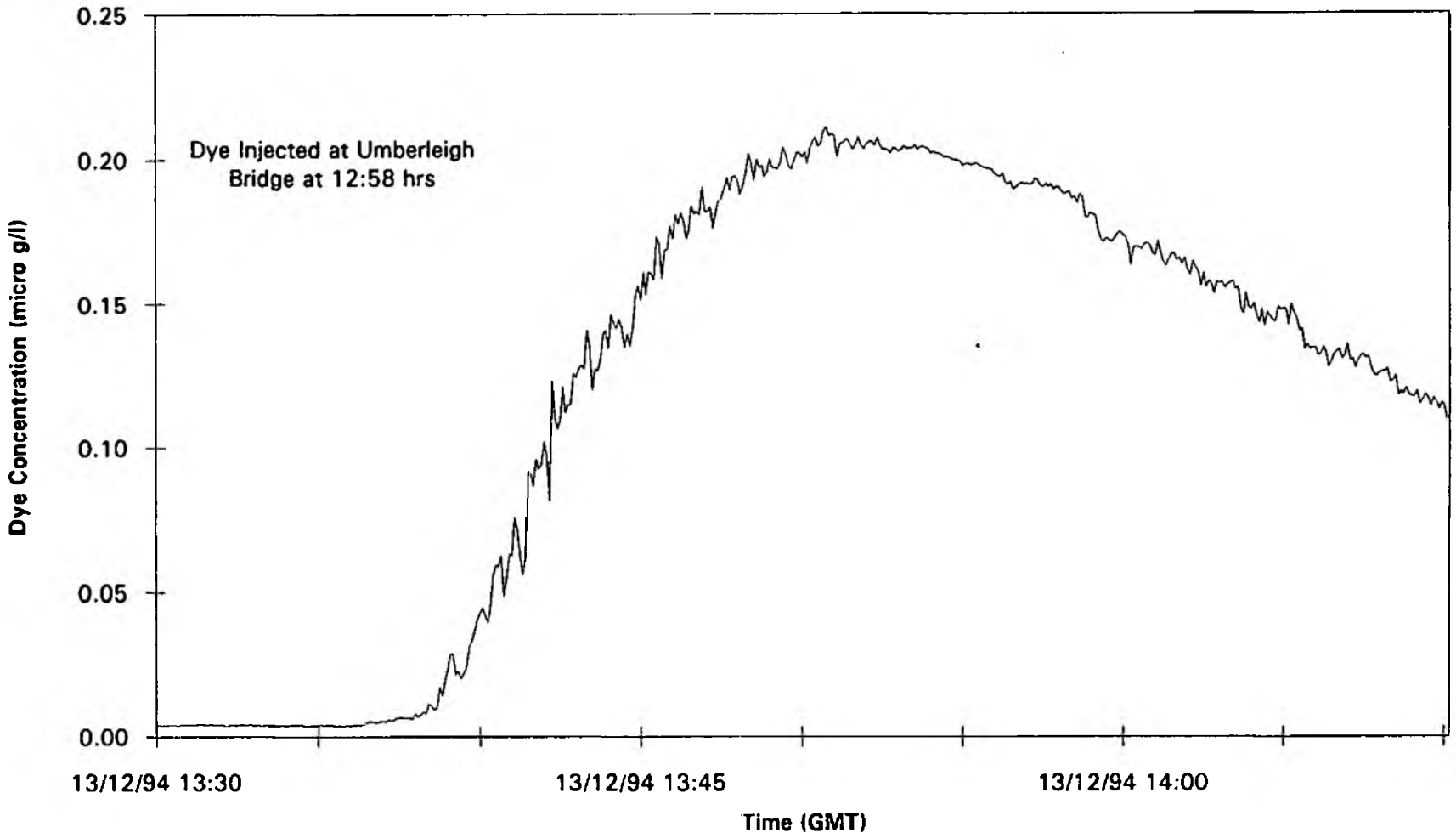
NGR Monitoring Point
SS 582261
NGR Injection Point
SS 595252

Figure 4 : New Intake Chapelton 13/12/94



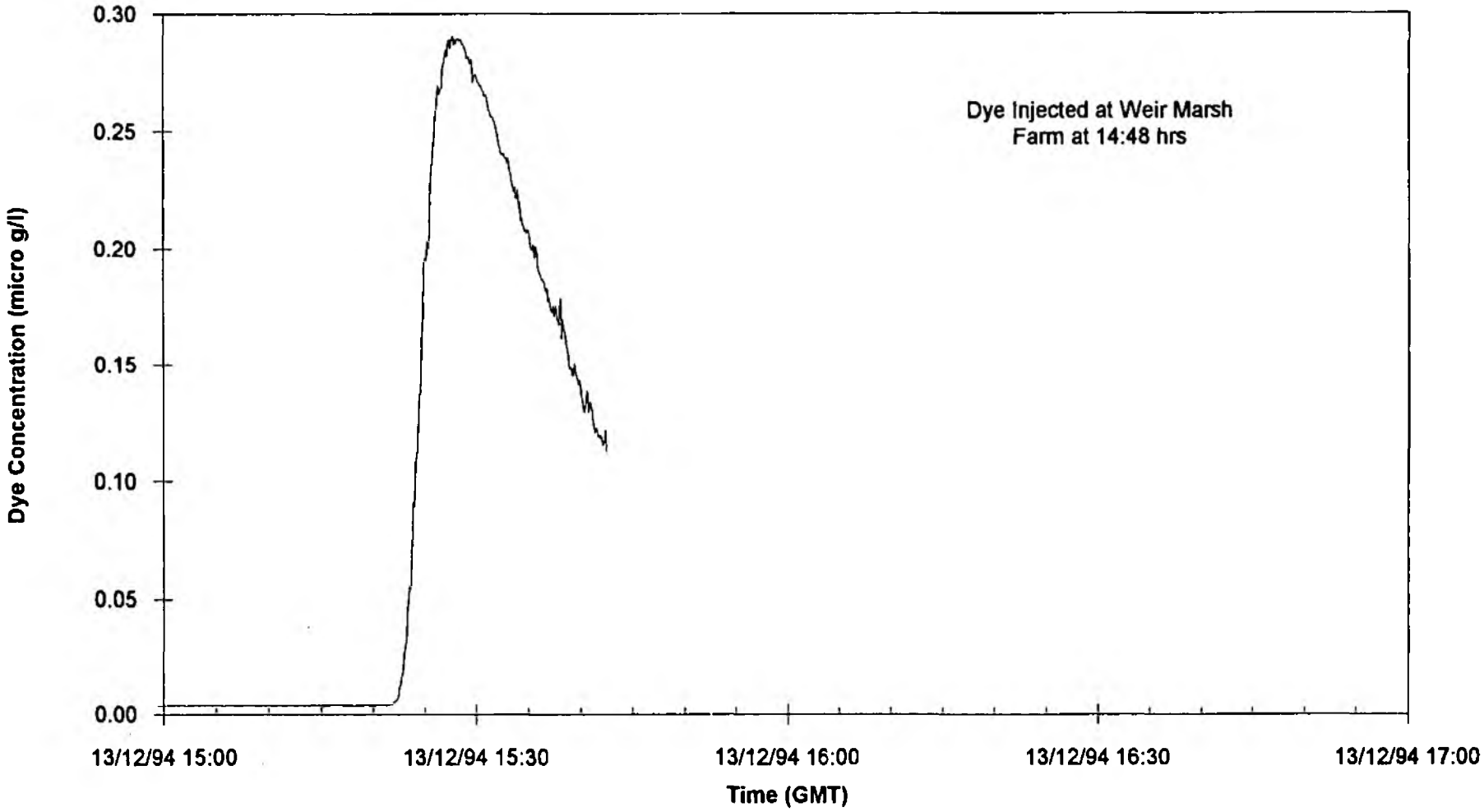
NGR Monitoring Point
SS 595252
NGR Injection Point
SS 607237

Figure 5 : Hawkridge Farm 13/12/94



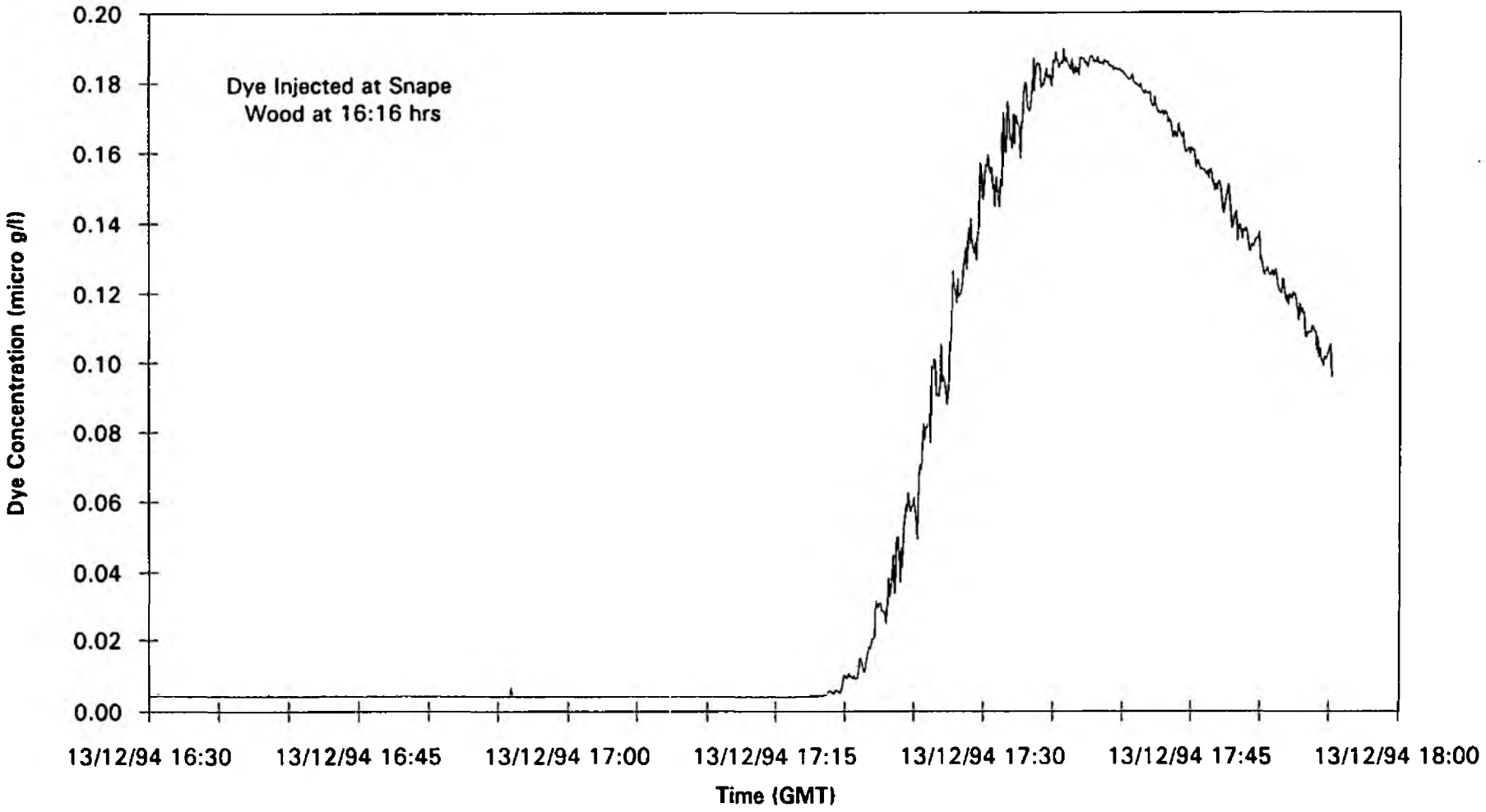
NGR Monitoring Point
SS 607237
NGR Injection Point
SS 615221

Figure 6 : Umberleigh Bridge 13/12/94



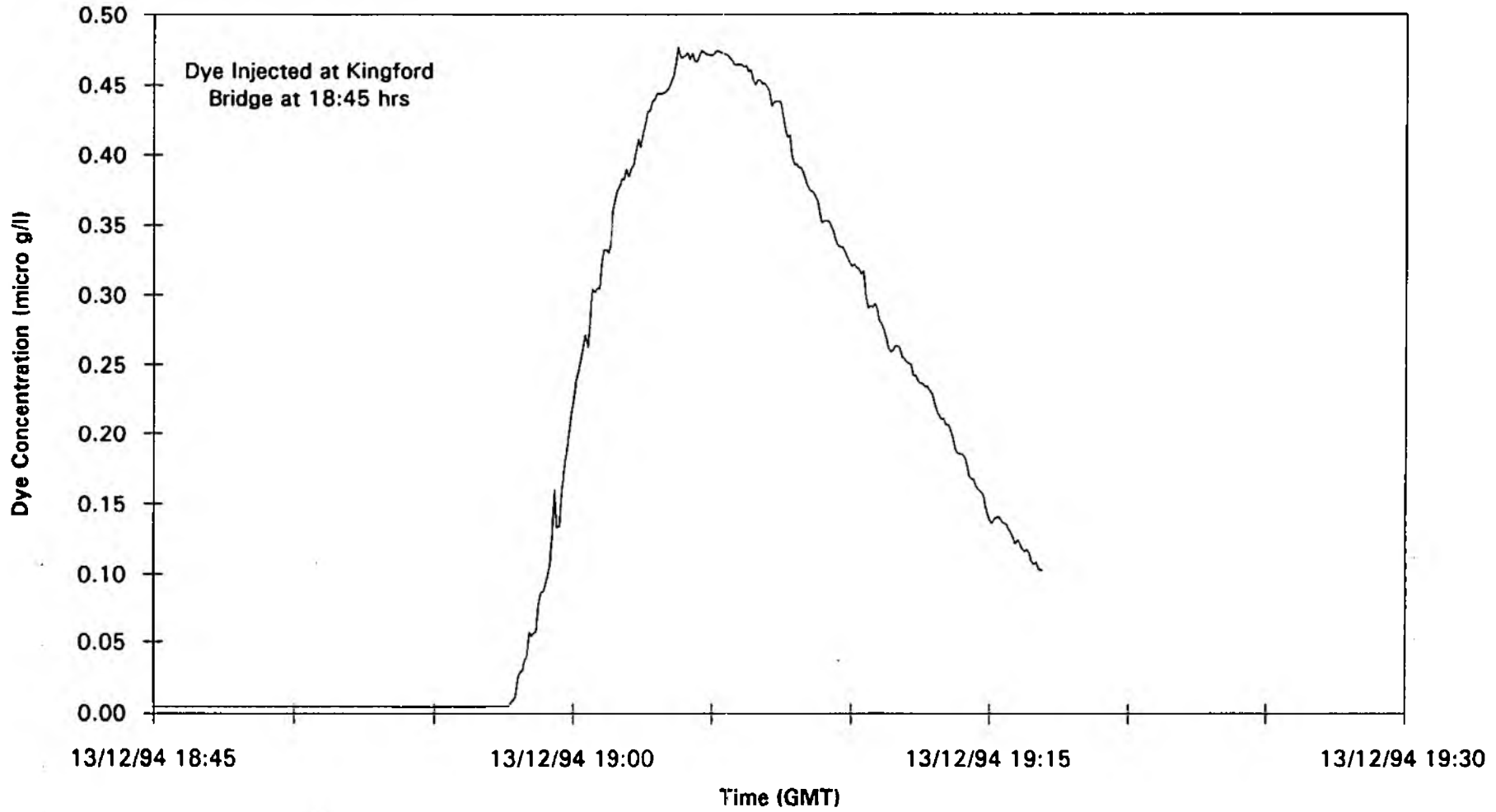
NGR Monitoring Point
SS 615221
NGR Injection Point
SS 619197

Figure 7 : Weir Marsh Farm 13/12/94



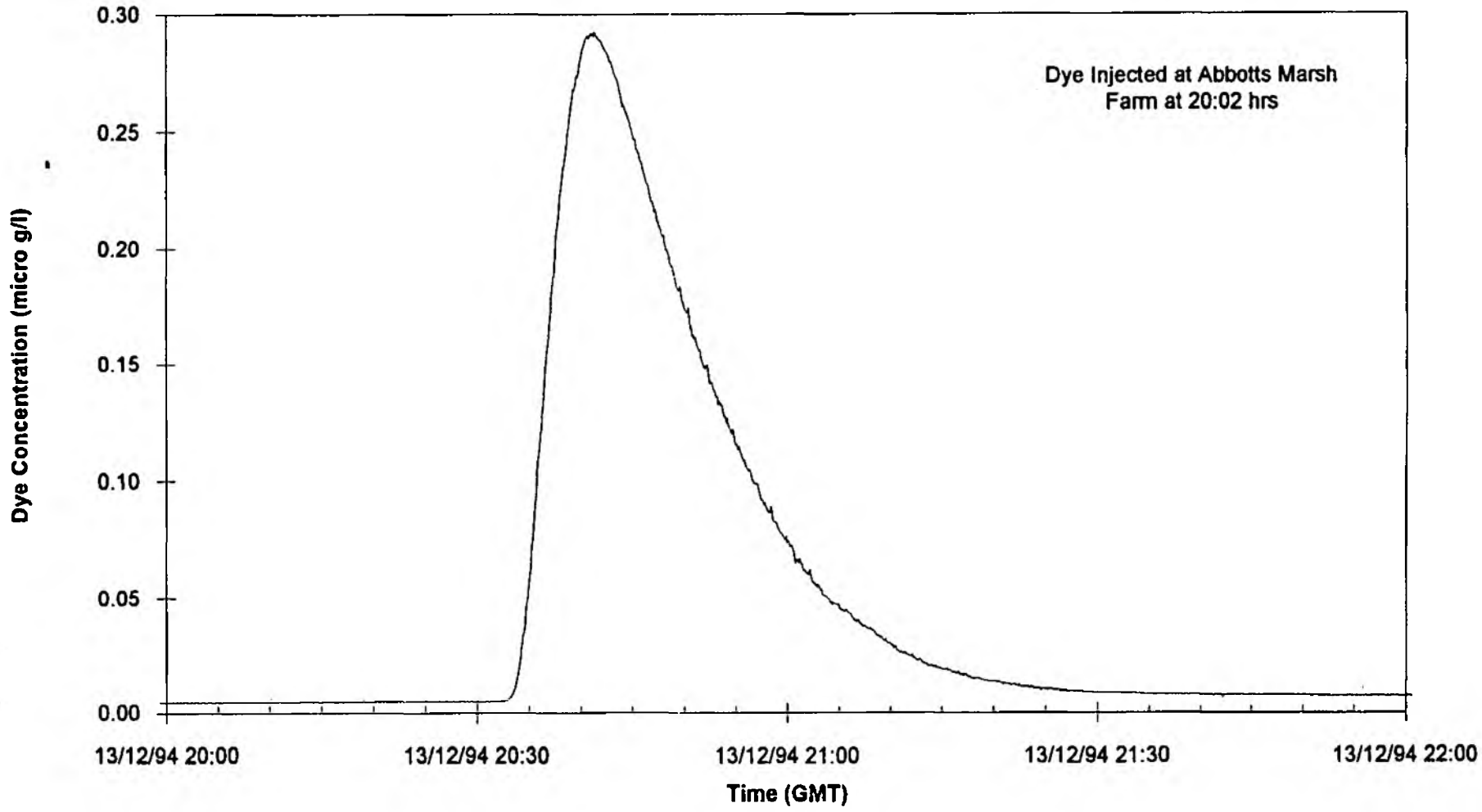
NGR Monitoring Point
SS 619197
NGR Injection Point
SS 623192

Figure 8 : Snape Wood



NGR Monitoring Point
SS 623192
NGR Injection Point
SS 643197

Figure 9 : Kingford Bridge 13/12/94



NGR Monitoring Point
SS 643197
NGR Injection Point
SS 661176

Figure 10 : Abbotts Marsh Farm 14/12/94

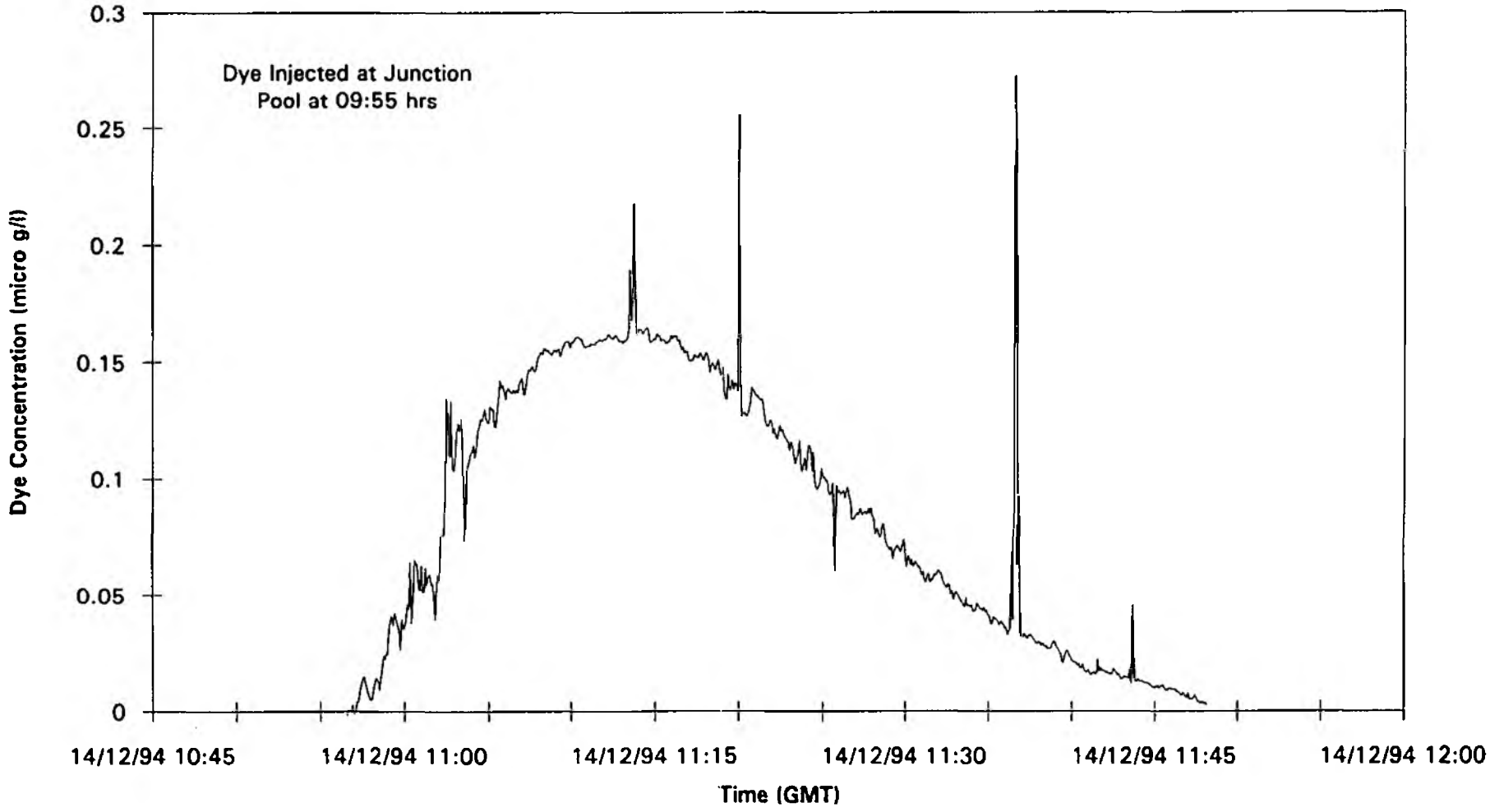
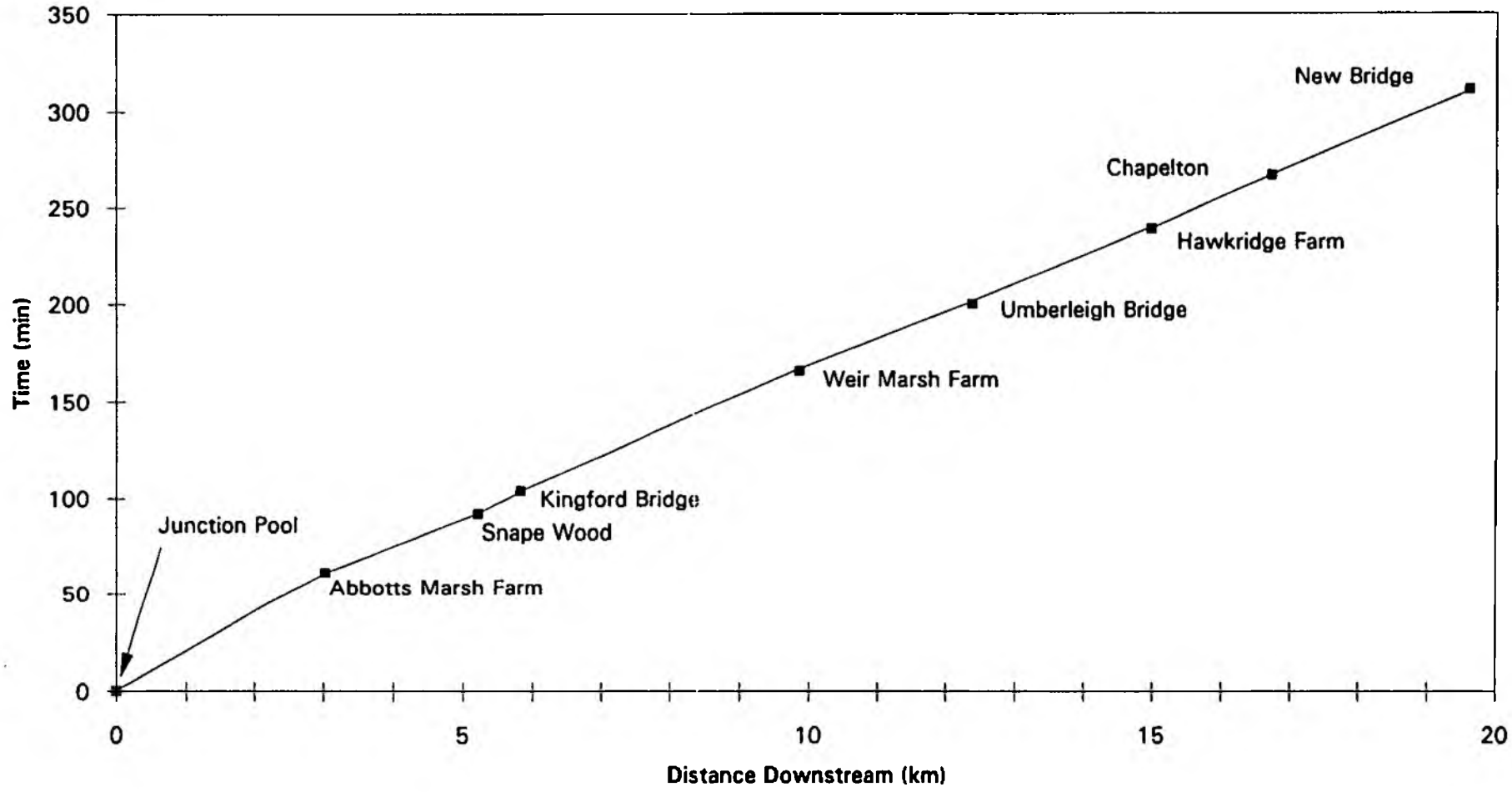


Figure 11 - Time of Travel of Tracer Dye along River Taw
Junction Pool to New Bridge



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