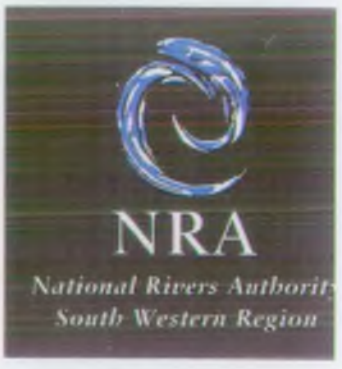
MONITORING OF THE PRIORY STORM OVERFLOW ON THE RIVER TONE AT TAUNTON

JUNE - NOVEMBER 1991

WATER QUALITY INVESTIGATIONS UNIT

JANUARY 1992



MONITORING OF THE PRIORY STORM OVERFLOW

ON THE RIVER TONE AT TAUNTON

JUNE - NOVEMBER 1991

WATER QUALITY INVESTIGATIONS UNIT

JANUARY 1992

C O N T E N T S

MONITORING OF THE PRIORY STORM OVERFLOW ON THE RIVER TONE AT TAUNTON, 1991

1.0 INTRODUCTION

Priory storm overflow on the River Tone at Taunton has 2 discharge points (see figure 1). As stated in the consent conditions, the outlets are used as follows:

A. NGR ST 2378 2552 for the discharge of partially treated effluent.

B. NGR ST 2361 2542 for the discharge of sewage effluent following minimal treatment.

In recent years, during the summer, the operation of the overflow, particularly the crude outlet, following sudden heavy rain at times of low river flow, has resulted in major fish mortalities. Fish mortality has been focussed on the stretch between the villages of Ruishton and Creech St. Michael where the river is very slow flowing. See Figure 1 and photographs 1-3.

Wessex Water Plc plans major improvements at Ham STW, which serves Taunton, to deal more effectively with increased volumes during periods of heavy rain, so that overflows from the sewer to the River Tone occur less frequently. A new storm tank is to be installed at the STW to help retain storm flows until the works can deal with them. In addition, a second storm settlement tank and new screens are to be added to the Priory overflow. However, this work is due to

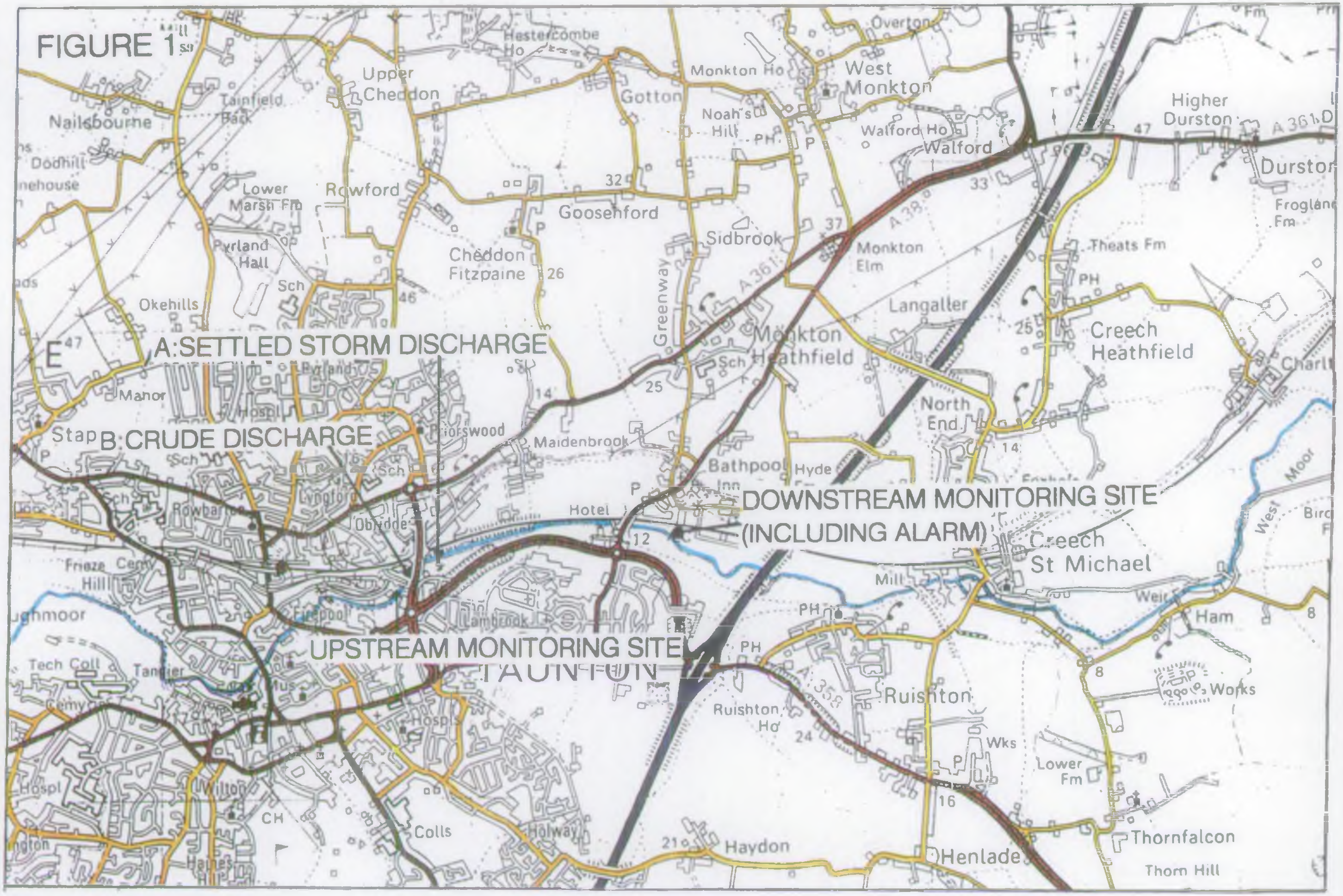


FIGURE 1
A:SETTLED STORM DISCHARGE
B:CRUDE DISCHARGE
DOWNSTREAM MONITORING SITE
(INCLUDING ALARM)
UPSTREAM MONITORING SITE
TAUNTON
Upper Cheddon
Nailsbourne
Gotton
West Monkton
Monkton Ho
Walford
Higher Durston
Goosenford
Rowford
Cheddon Fitzpaine
Sidbrook
Monkton Elm
Monkton Heathfield
Creech Heathfield
Langaller
North End
Bathpool
Creech St Michael
Ham
Ruishton
Henlade
Thornfalcon
Haydon
Priorswood
Maidenbrook
Hotel
Lower Marsh Fm
Pyrland Hall
Okehills
Theats Fm
Thorn Hill
Wilton
Colls
Halway

1 UPSTREAM MONITORING SITE AT FIREPOOL

2 DOWNSTREAM MONITORING SITE AT BATHPOOL

3.R.TONE AT BATHPOOL DURING PERIOD OF LOW FLOW (AUGUST '91)

4.R.TONE AT BATHPOOL DURING PERIOD OF HIGH FLOW (OCTOBER '91)

5 MONITORING UNIT AT FIREPOOL SECURED IN GLASS FIBRE BOX

be completed sometime during 1992 and until then, the river remains at risk when heavy storms occur in periods of low river flow.

There is informal arrangement for Wessex Water Plc to notify the NRA Control Room whenever the crude Priory Storm overflow is about to discharge. Normally, the settled storm outlet will have begun discharging before this.

Following discussions with Somerset Water Quality it was decided to monitor the operation of Priory storm overflow and its effects on the River Tone throughout the summer of 1991.

2.0 METHODS AND EQUIPMENT

In early July 1991 an automated monitoring and alarm system was installed by the Regional Monitoring Section on the bank of the river near Bathpool (NGR ST 2530 2570). The monitoring equipment consisted of dissolved oxygen and ammonium meters connected to a squirrel logger. At half hourly intervals, the logger recorded the readings measured by the meters. Pre-determined alarm levels were also set on the logger, so that if a deterioration in water quality was measured, a taped alarm message was transmitted to the NRA Control Room by a Cellnet phone. Control Room staff were then able to pass a warning on to Somerset Water Quality staff.

The entire monitoring unit, including Cellnet phone and meters, was housed in a secure glass fibre box, firmly anchored to the river bank (see photograph 5).

Initially, the alarm was set to go off if the dissolved oxygen concentration fell below 40% saturation or the ionised ammonia concentration rose above 5mg/l. A breach of either one of these limits was sufficient to set off the alarm.

A monitoring system comprising dissolved oxygen and ammonium meters and a squirrel logger was also placed on the river, 50 metres upstream of the crude storm overflow at Firepool (NGR ST 2344 2540).

During the summer months at Bathpool, where the river is deep and slow-flowing, the dissolved oxygen level regularly fell below 40% saturation at night due to diurnal variation. As a result, from August 30th onwards, the alarm was set to be triggered by an ionised ammonia concentration of 1.3mg/l or greater and not by any minimum oxygen level. This was sufficiently higher than the background concentration of 0.25mg/l and would therefore indicate a pollution incident. During the period 13th - 20th September, the ammonium meter developed a fault and so the alarm was set to trigger only if the dissolved oxygen saturation fell below 30%.

Both sites were visited weekly so that stored data could be retrieved, batteries changed and the meters recalibrated.

Initially, the alarm system was placed on the actual crude effluent outlet, and set to be triggered by a wet/dry sensor, so that as soon as a discharge occurred, the alarm was activated. However, despite security precautions, the equipment was vandalised and so the equipment was removed from this site. The alarm system was moved to the more secure downstream site on the river at Bathpool, and set to be triggered by low dissolved oxygen levels or a high ionised ammonia concentration.

3.0 RESULTS

Table 1 presents all the instances of reported Priory Storm discharges over the monitoring period, in chronological order. It tabulates the effects of the discharges on the river, in terms of dissolved oxygen and ionised ammonia, and indicates whether the alarm system was activated or not. The Table also shows the approximate time that the discharge began (according to Wessex Water), and the time that the NRA Control Room was notified. The time that elapsed between the discharge beginning and the NRA being contacted was generally between 26-40 minutes, although for the discharge of 25.9.91 the delay was 1 hr 55 mins.

TABLE 1

Instances of operation of Priory Storm overflow. July – November 1991

Date of operation	Approx. time of start of discharge	Time of call from PLC to control room	Logger alarm (Y/N)	River flow at start of d/c (cumecs)	Effect on river quality	Comments
3rd August	16:50	17:20	Y	1.065	DOmin=25% NH4max=1.95mg/l	Fish kill at Aulshton. 150–200 dead fish. Crude and settled sewage effluent discharge.
25th September	19:30	21:25	N	1.074	DOmin=57% NH4max=1.0mg/l	WQO reported no water quality problem
28th September	08:30	09:04	N	7.112	DOmin=58% No rise in NH4	Discharge from storm tank and crude chamber. Crude discharge ammonia < 2ppm.
11th October	21:15	21:45	N	2.417	NONE	Monitoring equipment not working. WQO reported no water quality problem.
29th October	19:45	20:11	Y	1.902	DOmin=68% Two NH4 peaks 2.65 and 1.05 mg/l	Large discharge of crude and settled sewage. No effect on river.
31st October	17:15	17:55	N	2.642	DOmin=76% No rise in NH4	Informal samples taken by WQO. No apparent impact on R.Tone.
3rd November	15:45	16:12	N	8.221	NONE	------

Table 2 displays measurements obtained from Wessex Water Plc showing the volumes of crude and settled sewage discharged from Priory Storm overflow.

For each storm overflow event, the results from the monitors at the upstream and downstream sites are presented, together with flow data, in graphical form (figures 2 to 6). The graphs for the downstream site at Bathpool show the impact of the storm discharge on the watercourse and the time taken for its recovery. Also highlighted are significant dissolved oxygen and ionised ammonia levels, times of the logger alarm and when the NRA Control Room was informed of the operation of the Priory Storm overflow by Wessex Water Plc. The graphs from the upstream sites cover the same time periods. The river flow data was calculated by summing the readings from 2 gauging stations, at Bishop's Hull, on the River Tone, and from Halse Water, a tributary of the Tone, about one mile upstream of the storm overflow.

Significant instances during the monitoring period are catalogued in the subsequent sections.

TABLE 2 **Volumes of crude and settled sewage discharged from Priory storm overflow.**

Date	Approx. time of discharge	Volume of settled sewage (River/M3)	Volume of crude sewage (River/M3)
3/8/91	16:50–18:15	1173	21
25/9/91	19:30–01:00	3227	12372
28/9/91	08:30–01:00	15668	77300
11/10/91	21:15–22:00	0	328
29/10/91	19:45–21:00	3051	3285
31/10/91	17:15–23:45	9154	2409
3/11/91	15:45–20:45	880	1204

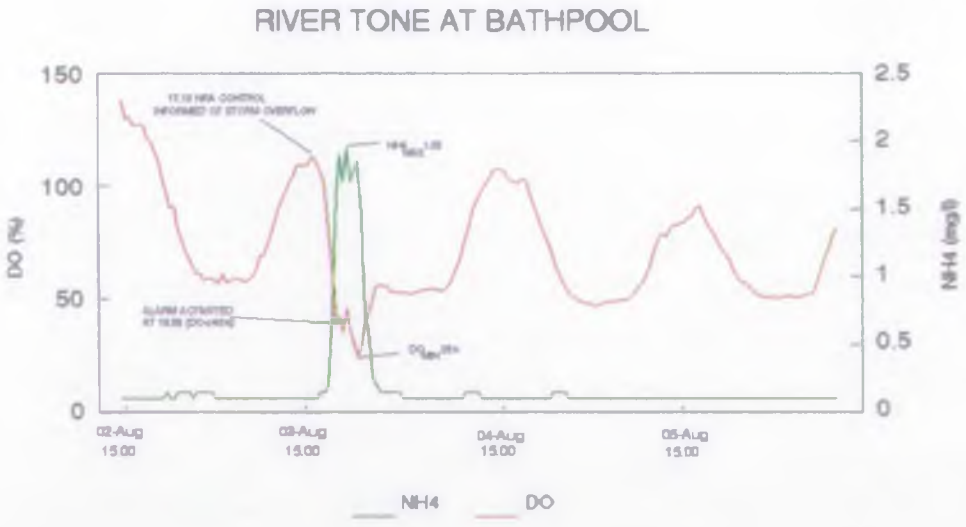
3.1 SATURDAY, 3RD AUGUST

The first storm overflow event to be recorded by the monitoring equipment, occurred on Saturday, 3rd August following heavy rain. At approximately 17.10 hours, Wessex Water Plc informed the NRA Control Room that Priory storm overflow was in operation. Somerset Water Quality staff responded to this call and crude sewage debris was seen in the river downstream of the overflow. A deterioration in river water quality set the logger alarm off approximately 2 hours after the initial call to the Control Room. Figure 2 shows the effect of the discharge as monitored by the equipment at Bathpool and associated river flow data. Unfortunately, due to the equipment being vandalised, no corresponding upstream data is available for this period. It can be seen from the graph that, before the discharge, the regular dissolved oxygen cycle produced a variation in concentration from 100% saturation mid-afternoon to a night time level of 50%, while background ionised ammonia levels of about 0.1mg/l were recorded. Following the discharge, the ionised ammonia level reached a peak of 1.95 mg/l at 19.00 hours, whilst dissolved oxygen reached a low of 25% at 19.36 hours.

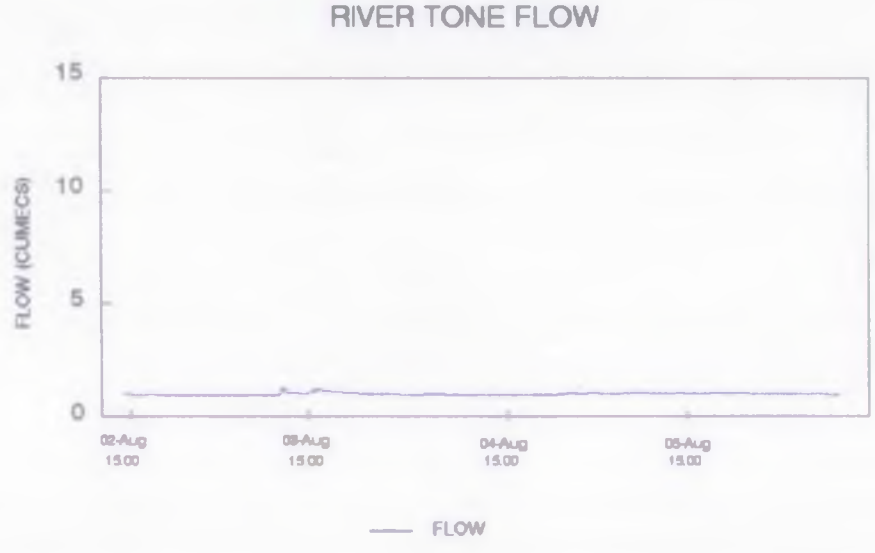
FIGURE 2

FRI 2nd AUG - TUES 6th AUG

a)



b)



The overflow operated for a period of 1.5 hours and 1173 m^3 of settled sewage and 21 m^3 of crude sewage was discharged. Two and a half hours after the logger alarm was activated, the dissolved oxygen and ionised ammonia concentrations appear to have returned to their normal levels. Over the period 2nd - 6th August flow in the River Tone was consistently about 1 cumec.

On the following day, Sunday, 4th August, 150 - 200 dead fish were found on the River Tone at Ruishton.

3.2 WEDNESDAY, 25TH SEPTEMBER

Figure 3 shows water quality information for the period 25-29th September. On Wednesday, 25th September at 21.25 hours, the NRA Control Room was informed by Wessex Plc that the crude sewage overflow was discharging to the river. Figure 3(b) shows that there was a gradual decline in dissolved oxygen at Bathpool sometime before this, starting at approximately 14.30 hours. Three hours after the call to the Control Room the monitoring equipment detected a marked rise in the river's ionised ammonia concentration which reached a peak of 1 mg/l at 08.04 hours on 26th September. This concentration was not high enough to trigger the alarm, which was set to 1.3 mg/l. The ionised ammonia concentration then fell to background level over a period of 7-8 hours.

The dissolved oxygen level at Bathpool was at a minimum concentration of 57% saturation at 19.34 hours on 25th September, almost 2 hours before the NRA Control Room was informed of a discharge, and had recovered to 80% saturation by 11.00 hours on 26th September.

3.3 SATURDAY, 28TH SEPTEMBER

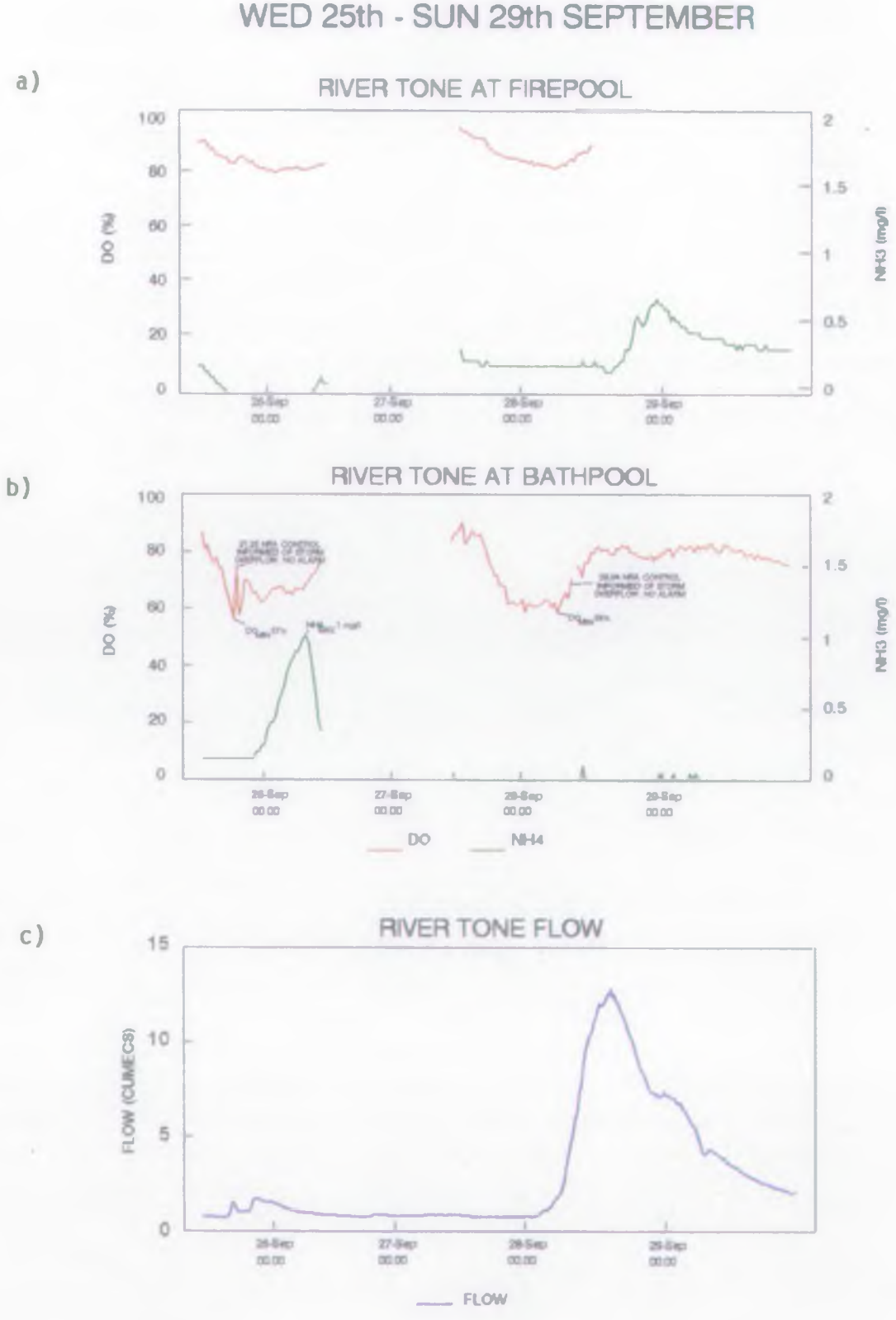
Figure 3 also shows the results obtained over the period of another Priory Storm discharge on 28th September. Again a gradual decline in dissolved oxygen at Bathpool began sometime before the Control Room was notified of a discharge at 09.04 hours.

The lowest dissolved oxygen recorded was 58% at 01.00 hours, 8 hours before the Control Room were contacted. 12 hours later dissolved oxygen had risen to about 80% saturation, and it remained at this level while river flows were high following the storm. No rise in ionised ammonia concentration was detected, probably because the high flows provided ample dilution.

3.4 FRIDAY, 11TH OCTOBER

Unfortunately, no data is available for the storm discharge that occurred on the 11th October as the monitoring equipment was not

FIGURE 3


WED 25th - SUN 29th SEPTEMBER
a)
RIVER TONE AT FIREPOOL
DO (%)
NH3 (mg/l)
b)
RIVER TONE AT BATHPOOL
DO (%)
NH3 (mg/l)
DO
NH4
c)
RIVER TONE FLOW
FLOW (CUMECS)
FLOW

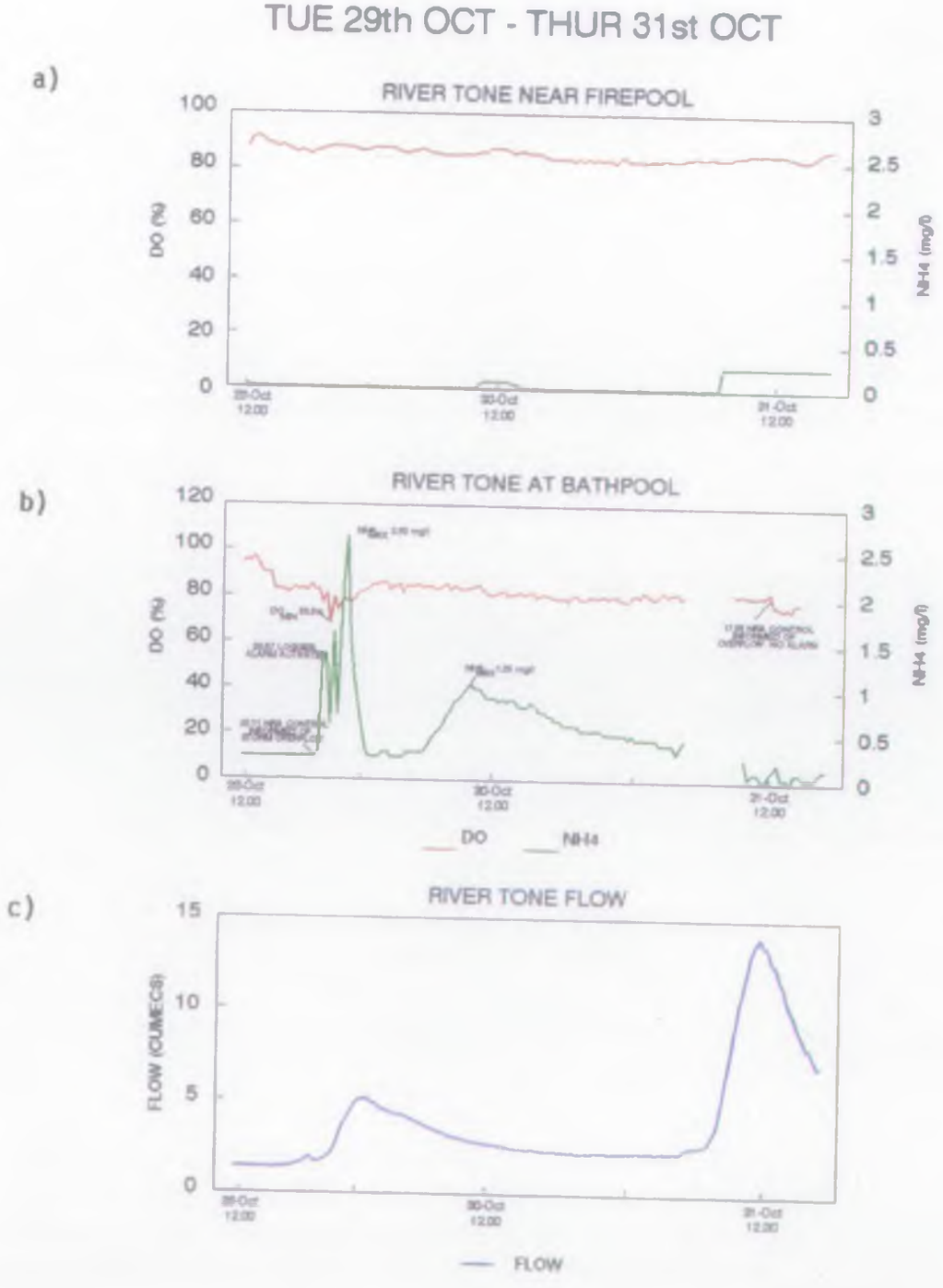
working properly. The overflow was a relatively small one with 328m^3 of crude sewage and no settled sewage being discharged. The Water Quality Officer that attended the incident reported that there was no deleterious effect on the River Tone.

3.5 TUESDAY, 29TH OCTOBER

At 20.11 on the 29th October, the Control Room was informed that the overflow was in operation (see figure 4). Forty six minutes later the logger alarm was triggered at the downstream site, when an ionised ammonia level of 1.35mg/l was detected at 20.57 hours. This went on to rise to a maximum concentration of 2.65mg/l at 21.27 hours. The dissolved oxygen level dropped from over 90% mid-afternoon to a low of 68% saturation at 21.00 hours. Oxygen levels had started to markedly decline over 4 hours before the NRA Control Room was informed of the discharge, and it is possible that the discharge of settled sewage, which will have begun sometime before the NRA Control Room was contacted, was responsible for this. By 23.27 hours the dissolved oxygen level had recovered to 80% saturation and the ionised ammonia concentration had fallen.

Approximately 7 hours after this first recorded rise in ionised ammonia, another peak of 1.0mg/l was detected at the Bathpool site at 12.27 hours. The concentration declined slowly over the next 34

FIGURE 4


TUE 29th OCT - THUR 31st OCT
a)
RIVER TONE NEAR FIREPOOL
DO (%)
NH4 (mg/l)
b)
RIVER TONE AT BATHPOOL
DO (%)
NH4 (mg/l)
DO
NH4
c)
RIVER TONE FLOW
FLOW (CUMECS)
FLOW

hours. There was no marked decline in the oxygen level associated with this rise in ionised ammonia. Dissolved oxygen and ionised ammonia concentrations at the upstream site did not vary much over this period with dissolved oxygen fluctuating between 80% and 90%, and ionised ammonia concentrations remaining close to the limit of detection.

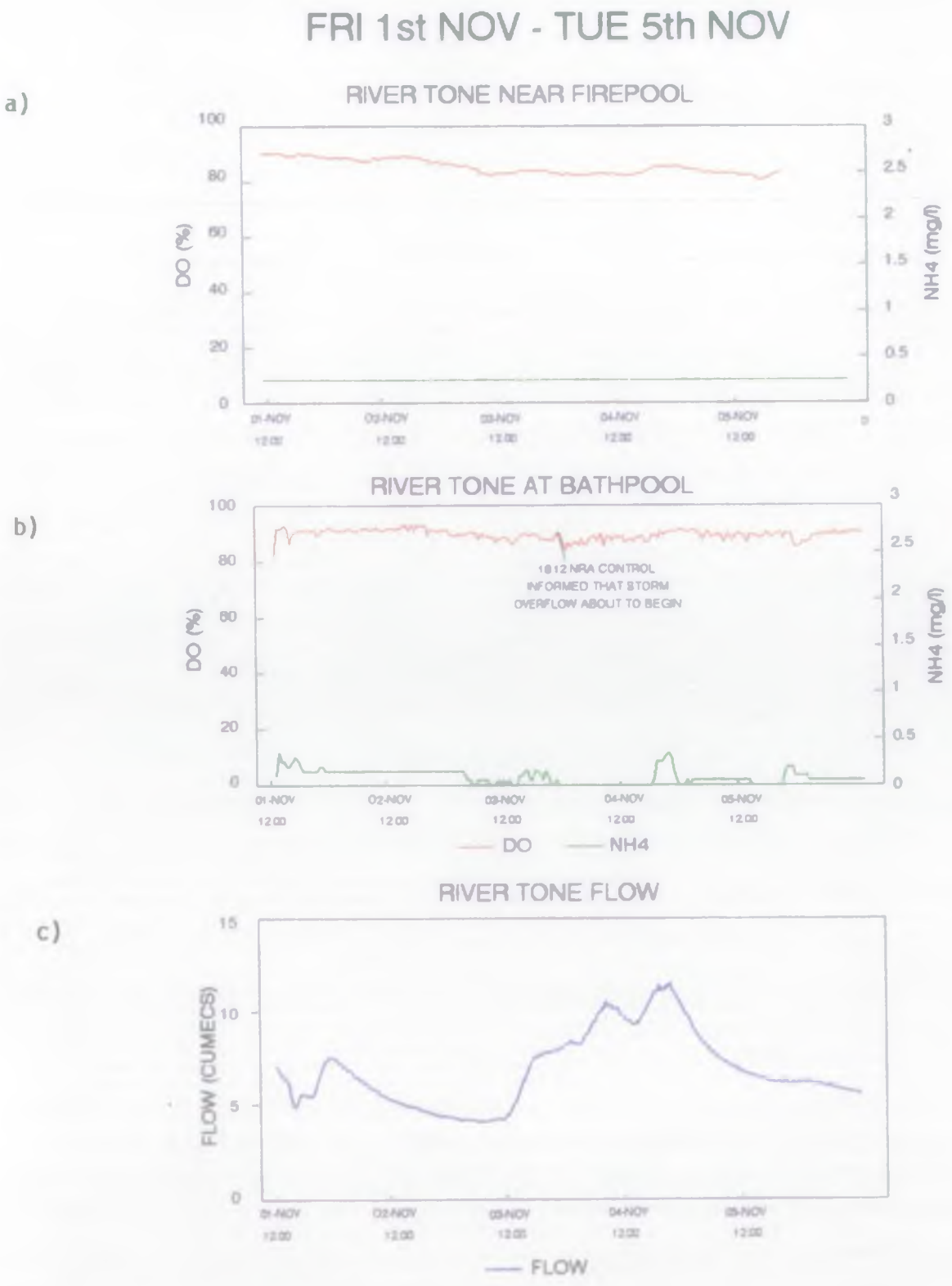
3.6 THURSDAY, 31ST OCTOBER

Figure 4 also shows the effect of the storm overflow reported at 17.55 hours on the 31st October. On this occasion 2409 m^3 of settled sewage and 9154 m^3 of crude sewage were discharged but the discharge had minimal effect on the river at Bathpool because flows were relatively high. See Figure 4(c). Dissolved oxygen fell to a low of 76% at 20.13 hours, but recovered to over 80% after only 2 hours. There was no significant rise in the ionised ammonia concentration, which fluctuated around a baseline of about 0.1mg/l.

3.7 SUNDAY, 3RD NOVEMBER

Figure 5 records the effect of the storm discharge on the 3rd November reported at 16.12 hours. At the upstream and downstream sites, the dissolved oxygen level was very similar, ranging from 80% to 90% saturation, and it is clear that the effluent had a minimal

FIGURE 5


FRI 1st NOV - TUE 5th NOV
a)
RIVER TONE NEAR FIREPOOL
DO (%)
NH4 (mg/l)
b)
RIVER TONE AT BATHPOOL
1812 NRA CONTROL
INFORMED THAT STORM
OVERFLOW ABOUT TO BEGIN
DO
NH4
c)
RIVER TONE FLOW
FLOW (CUMECS)
FLOW

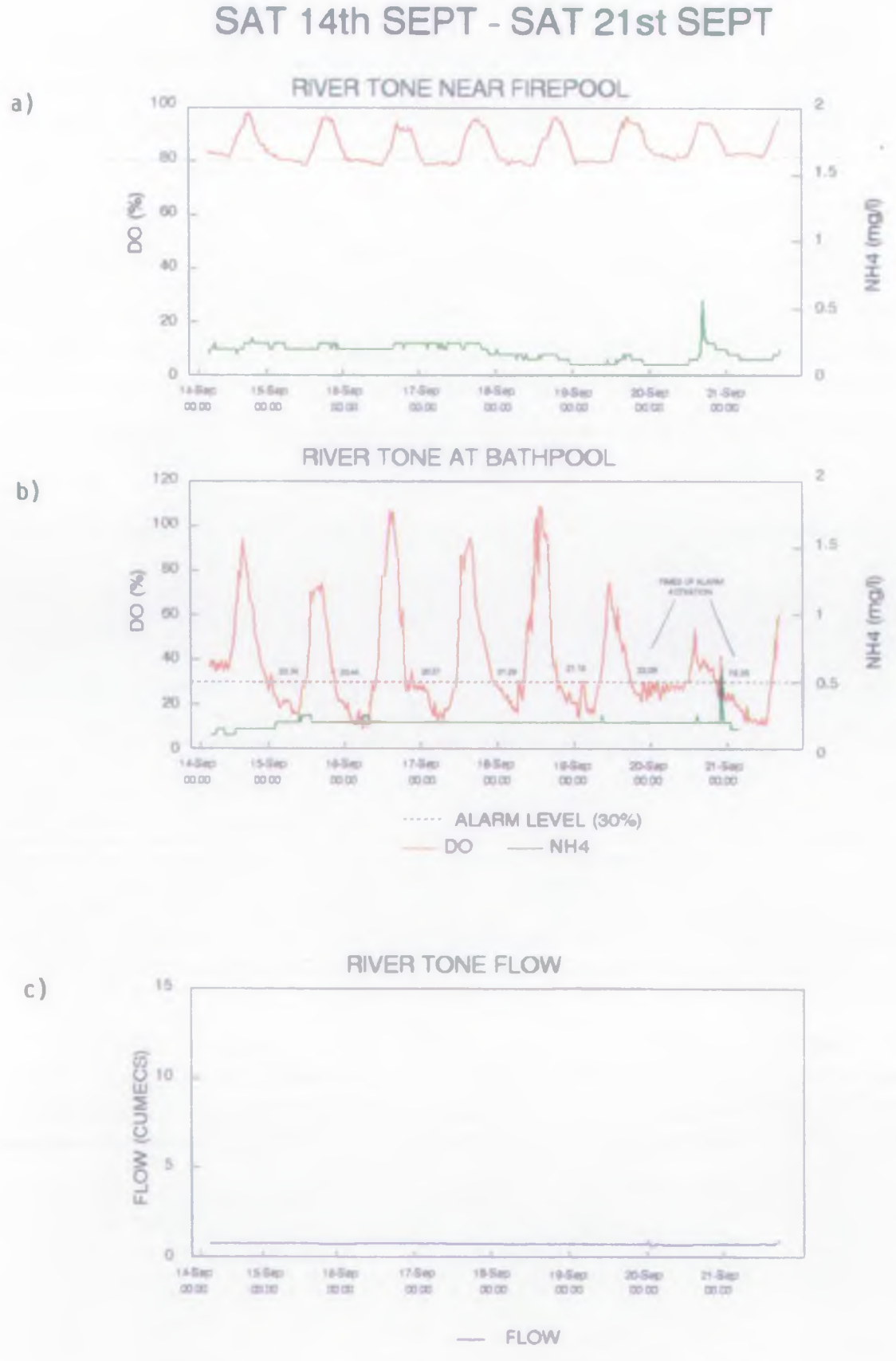
effect on river water quality. Again, river flow was high over the period of the discharge (see Figure 5(c), and ample dilution was available.

3.8 OTHER ALARMS DURING AUGUST/SEPTEMBER 1991

During late August and through September, the Control Room received a number of calls from the logger alarm although no reports, from the Plc, of a Priory storm discharge had been received. Figure 6 shows a period where several such alarms were recorded. It can be seen that at the Bathpool site there is a large diurnal range in dissolved oxygen concentration during that period, with oxygen levels peaking at over 100% saturation in the late afternoon, and sinking to as low as 15% during the early morning. The dissolved oxygen alarm, which at that time was set to go off at levels less than 30%, was frequently activated. The upstream site near Firepool also showed a strong diurnal cycle in oxygen concentration at that time, but the range of variation was much narrower; 80% to 100%.

During September river flow was consistently <1.0 cumecs and an algal bloom was clearly visible in the river at Bathpool. The photosynthesis and respiration of this bloom was responsible for the wide range of the diurnal dissolved oxygen cycle at Bathpool. Because of this, whenever possible, ionised ammonia concentration rather than dissolved oxygen was used to trigger the monitor alarm.

FIGURE 6


SAT 14th SEPT - SAT 21st SEPT
a)
RIVER TONE NEAR FIREPOOL
DO (%)
NH4 (mg/l)
b)
RIVER TONE AT BATHPOOL
DO (%)
NH4 (mg/l)
ALARM LEVEL (30%)
DO
NH4
c)
RIVER TONE FLOW
FLOW (CUMECS)
FLOW

4.0 DISCUSSION

From mid July to mid November 1991 discharges from the Priory storm overflow were reported by Wessex Water on seven occasions. Two of these events affected the river water quality sufficiently to set off the alarm at the downstream site, while during four others, the impact on the river was insufficient to trigger the alarm. During one discharge, on 11th October, the monitoring equipment was not functioning.

The discharge on the 3rd August was the most significant of 1991 and it had a deleterious effect on the River Tone which resulted in a large fish kill at Ruishton. A simultaneous increase in ionised ammonia to a concentration of 1.95 mg/l and a decline in dissolved oxygen to 25% saturation was recorded at the Bathpool site.

At this time of year, the diurnal variation in dissolved oxygen concentration at this downstream site ranged from 50% to 100% saturation, and the incident occurred as the concentration was nearing its low point during the early evening. The lack of dilution also resulted in the ionised ammonia concentration rising to almost 2 mg/l, and the combination of low oxygen and high ammonia led to the fish kill.

The discharges on September 25th and October 29th also produced sudden rises in ionised ammonia concentration but a more gradual decline in dissolved oxygen. The decline in dissolved oxygen concentration began before the rise in ionised ammonia was detected.

There was also a gradual decrease in dissolved oxygen prior to the report of a discharge on the 28th September, but no rise in ionised ammonia at Bathpool following the discharge. The fact that each of these three discharge events significantly affected either dissolved oxygen or ammonia concentrations, but not both, may account for why they did not cause large fish kills.

By late October, river flows had risen and were significantly higher than they had been during the summer. This meant that the dissolved oxygen concentration was maintained at a higher mean level and that the algal bloom at Bathpool, which affected dissolved oxygen so much at low flows, subsided. Also the increased dilution that higher flows provided meant that discharges from this time onwards (for example, the overflow on the 3rd November) had less of an effect on river water quality.

The one exception to this was on 29th October when a storm discharge did significantly elevate the ionised ammonia concentration at Bathpool, triggering the alarm there. However, dissolved oxygen concentration remained relatively high at about 68%, and no fish kill resulted.

Oxygen concentrations below 20% were recorded at Bathpool during September without fish kills resulting, but the absence of significant ionised ammonia concentrations may have made this more tolerable to fish. The very low oxygen levels were a result of the algal bloom at Bathpool.

On each occasion that the storm overflow began to discharge there was a delay of about 30 minutes before Wessex Water contacted the NRA Control Room. They should be able to contact the NRA immediately a discharge begins and the half hour or so this would save might prove valuable if environmental protection measures such as re-aeration of the river become necessary.

5.0 CONCLUSIONS

5.1 Ionised ammonia concentration proved to be a better indicator of the effects of the Priory Storm overflow on the River Tone than dissolved oxygen concentrations, and was a more effective trigger for the alarm system.

5.2 During the low summer flows an algal bloom developed in the river at Bathpool. This had a significant effect on the dissolved oxygen concentration often causing it to fall below 30% saturation at night.

5.3 Fish kills in the River Tone seem to occur when discharges from Priory Storm Overflow coincide with low flows in summer. A lack of available dilution means that discharges from the overflow can significantly elevate the ionised ammonia concentration in the river, and simultaneously reduce the dissolved oxygen level, which may already be very low at night due to the effects of algal activity.

5.4 Fish kills do not seem to occur if elevated ammonia concentrations do not coincide with oxygen concentrations of below 25% saturation.

6.0 RECOMMENDATIONS

6.1 A water quality monitoring system should be deployed on the River Tone each year from June until October until it is demonstrated that the planned improvements at Ham STW provide an effective solution to the problems caused by Priory Storm Overflow.

6.2 Any system deployed should monitor ammonia and dissolved oxygen concentrations in the river downstream of the overflow, and ionised ammonia concentrations in excess of about 1.3 mg/l should be set to trigger an alarm.

6.3 If this alarm is activated during periods when river flow is less than 1.0 m^3/sec immediate re-aeration of the river at Ruishton should be considered by Somerset Water Quality Staff in order to reduce the possibility of a significant fish kill.

6.4 Wessex Water Plc's consent to discharge from the Priory Storm Overflow (consent number 070111) should be revised so that it includes a commitment for them to contact the NRA immediately that a discharge commences. This would formalise the present informal agreement by which the NRA is notified about 30 minutes after a discharge has started, and would give the NRA time to put the staff and equipment required for re-aeration of the river on stand-by should it become necessary to deploy them.

CCM/217