

Environment Agency Midlands Region

Autumn 2000 Floods Review Regional Report



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Guildbourne House, Chatsworth Road,
Worthing, West Sussex BN11 1LD

John Fitzsimons
Regional Flood Defence Manager
Environment Agency
Sapphire East
550 Streetsbrook Road
Solihull B91 1QT

Tel 0121 711 2324
Fax 0121 711 5824

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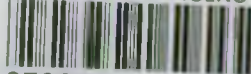
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CHAPTER 1-EXECUTIVE SUMMARY

The flood event of October and November 2000 due to its severity and scale has been described as the worst event for 50 years. It impacted on the whole region and in places was more severe than the 1947 floods. For the purposes of this report the duration of the event has been considered as from the 28th October, when the first Flood Watches were issued, until the 20th November when for a brief period there were no flood warnings in force. Further significant flooding has occurred since that date which has been as severe as the November event at some locations in the Severn Basin but less widespread.

Rainfall totals from 28th October to 11th November reached 331mm at Dolydd in the Welsh Mountains and 228mm at Derwent Dam in the Peak District. Highest one-day totals were 79.5mm and 68.5mm respectively at these two gauging station sites.

Flood Warnings were issued for 73 of the 76 Flood Warning Areas within the region. A total of 297 Flood Warnings and 36 Severe Flood Warnings were issued over the duration of the event; several more than once as river levels fell and rose again with each new band of heavy rain. Lead times between the issue of flood warnings and the onset of flooding were more than 6 hours in the majority of cases.

A total of 1955 properties are believed to have flooded across the region plus a further 1088 caravans and chalets. Major disruption was caused to transport with flooding of some major trunk roads, railways and numerous minor roads occurring. Agricultural land was also severely affected with thousands of hectares being underwater for several weeks. In general flood defences performed well with the vast majority of properties flooded being in undefended areas.

Media and political interest was intense with the Prime Minister and Deputy Prime Minister each visiting the region twice.

The costs of the event to the Agency and others have been high. Initial estimates of Agency costs suggest the cost of the response during the event may be as much as £1.125m with a further £1.75m being identified for repairs to defences which were damaged or shown to be deficient.

The floods were the first significant event since the flood defence function was reorganised under the Changing Needs In Flood Defence review as well as being the first major trial of the changes to the flood warning system following the abandonment of the old colour codes.

Recent development in the floodplain was not as major an issue in Midlands Region as it may have been in other parts of the country. A relatively small proportion of the properties which flooded were less than 10 years old and many of those which fell into this category had not been objected to by the Agency or its predecessors as they were believed to be in defended areas.

This report attempts to document the event as well as highlight any lessons learned.

CHAPTER 2-EVENT MANAGEMENT

Considering the scale of the flood event and the recent Change in Needs in Flood Defence re-organisation, most of the existing procedures worked well.

All 5 of the Regions Area Incident Rooms (2 rooms in Lower Trent Area) were operational throughout the event and provided an excellent point of contact for all parties involved. Even so, all Areas have identified further improvements, which can be made to provide an even better more effective working environment. The role of Base Controller was better utilised in this event than had been evident before. This provided a clearer strategic overview and made space for the 'hands on' teams to concentrate on fulfilling their duties. Where local resources were stretched, the Base Controller roles were successfully filled by senior staff from adjoining Regions, a good reason for National consistency. There was much evidence of successful cross-functional working, providing support and assistance to both Incident Rooms and data collection exercises in the field. Approximately 200 staff were involved across the Region manning the various Incident Rooms. Local geographic knowledge was particularly useful and was a worthy substitute for any apparent lack of 'flood defence' knowledge. This type of support was essential during an event of this scale. The Flood Defence function alone simply cannot meet the demands now expected of the Agency during such exceptional conditions.

It was most evident that our professional partners who have prepared and planned emergency procedures, which include flooding events, added considerably to the effectiveness of all operational activities. Most of the Gold and Silver Controls which were set up worked well, but there may be opportunities to improve the Agency contribution to these in the future. Much liaison and work from the Environment Agency, Emergency Services and Local Authorities, has contributed towards these procedures and plans and it is evident that a combined effort of all concerned parties is the only way to successfully manage such events without a major catastrophe.

Generally, liaison both internally and externally was reasonably effective, but as with any system of communication there will always be lessons to learn and improvements to be made.

Clear communication lines need to be maintained when Gold and Silver Controls are in operation, it is crucial that relevant and timely information is able to transfer from one group to another.

The recent Flood Awareness Campaign has undoubtedly raised public expectation of the Agency and a general interest in flood related matters. This now attracts more general, as opposed to specific, external enquiries to Area Incident Rooms during flood events. Whilst we are keen to encourage the general public to take action and be prepared, the Incident Rooms must not become the host to 'is the road closed?' calls.

The preparation of situation reports from Areas, on a twice-daily basis at specific times, was seen as a significant improvement and one that could be planned and accommodated into the working day. These reports provided the platform not only for PR, but also for the overall Regional management of the situation. Previous working practice had resulted in reports and updates being called for on an ad hoc basis which had inevitably led to frustration on the part of the provider.

It was felt that some Agency staff were not being kept informed of event developments and had to rely on the media for information. Progress has already been made and the twice-daily

flood situation reports are now available on the Regional Bulletin Board, which give the latest situation both morning and afternoon.

Many issues have arisen from the event and much work is already in hand to carry out improvements and modifications to existing working practices.

The need to encourage and embrace the co-operation and support from our professional partners is one, which was well and truly illustrated during these significant floods. Without their help the Agency may well have found itself exposed in some areas and we should encourage the development of local Flood Plans with our partners. With such plans in place, the role of Gold and Silver Controls should be more structured and the requirements of representatives will be clearer. Future exercises should accommodate the roles and responsibilities of all staff expected to attend such control stations in the future.

Table 2.1 – Key Statistics for the Event

	Regional Office	Upper Severn	Lower Severn	Upper Trent	Lower Trent
Dates Agency Incident Rooms Opened		28 th Oct – 12 th Nov	29 th Oct – 20 th Nov	30 th -31 st Oct & 5 th –10 th Nov	29 th Oct – 3 rd Nov & 5 th Nov – 11 th Nov
Staff Number worked (Flood Defence)	10	9	17	19	25
Staff Number worked (Others)	23	38	29	12	40
Staff time worked	53 days + 872 hours overtime	103 days + 320 hours overtime	135 days + 1750 hours overtime	48 days + 700 hours overtime	215 days + 840 hours overtime
Number of calls taken in Incident Rooms		4500	4200	3000	3900 (+ 3900 to call handlers outside Incident Room)

Recommendations

We should build upon and continue to reinforce the relationships between ourselves and other Agencies, Organisations and Local Authorities. We all have a role to play during these major incidents and it is critical that the major players dovetail together.

CHAPTER 3-FLOOD FORECASTING

3.1 Weather Forecast Accuracy & Timeliness

Weather forecasts for the Midlands Region are received by the Monitoring and Forecasting team on a daily basis from the Met Office's Birmingham Weather Centre. These forecasts are disseminated to flood warning staff via the flow forecasting system and the e-mail bulletin board.

The daily forecast is issued after 14:00hrs and gives predicted rainfall totals for a three hour block and five subsequent six hour blocks for six forecast areas that cover the region. A confidence level is also assigned to each of these predicted totals. The forecast also includes an amplification and outlook text section, which covers five 24-hour periods for the next five days and then gives a brief summary for the subsequent five days.

During the flood event a verbal update on the weather forecast was requested each morning so that the most up to date data was continually-available.

Analysis has been carried out on the accuracy of the forecast precipitation totals from the daily afternoon forecasts for the period 28th October 2000 to 7th November 2000 (Table 3.1). This table compares the precipitation that was forecast for the first 24 hours of the forecast period (allowing a 3mm margin of error), for each of the six forecast areas, with the rainfall that actually fell. Actual rainfall was calculated by taking an average figure from the raingauges in the area.

Table 3.1 shows that daily success rates in accurately forecasting the precipitation amounts vary between 16% and 100%. The forecast errors can be classified as either under-forecasts or over forecasts. In general, over-forecasting was more common, particularly on the 30th October when the daily success rate was down to 16%. 100% success rates were achieved on days when very little rain actually fell. Under-forecasting was a problem particularly on 29th October and the 5th November when rain fell that was heavier than had been forecast.

Precipitation forecasts were particularly successful for the Welsh Mountains and Trent Lowlands forecast areas, which both achieved a 73% success rate for the period. The worst performance was for the Severn Lowlands forecast area where over-forecasts for 5 of the 11 days analysed led to a success rate for the period of only 36%.

The analysis in Table 3.2 shows that the weather forecast was most successful when forecasting totals between 10-20mm and least successful when forecasting totals of over 20mm. It also highlights the fact that over-forecasting tends to occur more when actual rainfall totals are less than 20mm. There is also a tendency for the Met Office to under-forecast when actual totals are greater than 20mm.

The impact of inaccurate under-forecasts was lessened by the fact that Severe Weather Warnings had been issued from the Met Office at Bracknell. These gave an early warning of intense rainfall and meant that increased monitoring had been triggered prior to the rain falling. The impact of the inaccurate over-forecasts was less serious as it meant that increased monitoring was taking place when flooding was already occurring and monitoring activity would have been high anyway.

Table 3.1													
Date 24hrs starting 00:00 on:	WELSH H MOUNTAINS		WELSH FOOTHILLS/ SHROPSHIRE HILLS		SEVER N LOWLANDS		STAFFS MOORLANDS/ HIGH PEAKS		AVON/SOAR HEADWATERS		TRENT LOWLANDS		DAILY SUCCE SS RATE
	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	
28/10/00	18 - 36	26	8 - 29	16	18 - 30	13	8 - 29	9	8 - 20	9	13 - 41	14	83%
29/10/00	13 - 30	56	8 - 30	41	8 - 27	36	8 - 27	32	8 - 27	25	8 - 30	30	33%
30/10/00	18 - 44	22	16 - 40	13	11 - 29	6	14 - 37	9	11 - 29	3	14 - 32	4	16%
31/10/00	1 - 26	10	4 - 16	4	<8	3	5 - 18	5	<8	1	<8	2	100%
01/11/00	5 - 23	5	5 - 17	2	<8	1	3 - 21	2	<8	0	<8	1	66%
02/11/00	9 - 27	11	7 - 26	7	5 - 23	13	6 - 34	10	5 - 26	11	5 - 25	8	100%
03/11/00	4 - 22	7	3 - 21	2	5 - 17	1	3 - 21	6	6 - 12	0	3 - 21	1	33%
04/11/00	<6	1	<6	0	<6	0	<6	1	<6	0	<6	0	100%
05/11/00	17 - 44	39	23 - 44	33	9 - 28	29	24 - 41	44	16 - 28	26	17 - 30	38	50%
06/11/00	6 - 24	3	6 - 24	11	8 - 19	6	13 - 37	12	7 - 25	3	8 - 14	9	33%
07/11/00	11 - 21	5	8 - 20	3	5 - 17	3	10 - 25	11	7 - 20	4	6 - 19	6	33%
AREA													
SUCCESS RATE	73%		55%		36%		55%		64%		73%		
	0 - 10	= Under-Forecast											
	20 - 30	= Over-Forecast											

Table 3.2									
Actual	<10m m			10 - 20mm			>20m m		
Range									
Forecasts	Over	Correct	Under	Over	Correct	Under	Over	Correct	Under
Welsh	2	3	0	0	2	0	0	3	1
Mountains									
Welsh	3	3	0	1	2	0	0	1	1
Foothills									
Severn	4	3	0	1	1	0	0	0	2
Lowlands									
Staffs	2	4	0	1	2	0	0	0	2
Moors/Hig h									
Peaks									
Avon/Soar	4	4	0	0	1	0	0	2	0
Headwaters									
Trent	2	6	0	0	1	0	0	1	1
Lowlands									
Regional	17	19	0	3	9	0	0	7	7
Total									
% Correct	47%	53%	0%	25%	75%	0%	0%	50%	50%

3.2 Agency Telemetry, Outstation & System Performance

Upper Severn

Three river gauges experienced problems recording data during the event. At Dolwen the shaft encoder was submerged, at Leintwardine the stilling well was overtopped and at Buttington recorded levels were inaccurate. Cosford raingauge was flooded during the event. Problems relating to access at a number of river gauges were experienced as a result of high water levels. This meant that some peaks were unable to be gauged.

Lower Severn

Problems were recorded at two level gauges – the tide level recorded at Avonmouth and the river level at Sharpness. In addition there was a failure of the wind speed recorder at Avonmouth. All of the problems were caused by equipment failures not directly related to the flood event. There were no problems related to telemetry or raingauges and a number of successful gaugings were carried out.

Upper Trent

Two river level gauges were affected by high river levels leading to loss of data from Froghall and Wall Grange. Milford gauge hut was flooded but the equipment continued to perform satisfactorily. British Telecom failures were experienced at Marston and Silkmoor Lane, also leading to data loss. Access to a number of sites became impossible as river levels rose.

Lower Trent

A British Telecom fault in the North Muskham area caused the only telemetry problem for the Area during the flood event. An alternative method of getting level data from North Muskham was instigated with only a short period of data loss. Chapel Reservoir raingauge was flooded causing it to operate incorrectly for two days until the turf wall protecting the compound was reconstructed. Problems were experienced at a number of new technology gauges, which related to equipment failures and a number of sites failed to record peak levels as they had reached their maximum recording level.

Regional Flow Forecasting System

a) Polling/Model Runs

A total of 87513 calls were made to outstations by the Flow Forecasting System (FFS). Data collection rates were 98.5% with 1267 collection errors. It is thought that some collection errors were as a result of the line being busy due to the outstations being accessed by duty officers, and possibly by members of the public, through the ODIN direct dial system. Communication with outstations proved difficult in some areas due to phone lines being down due to the high water levels.

The VAX computer that FFS runs on had to be rebooted twice during the event with a total downtime of about five hours. The cause of the problems is currently under investigation.

b) Verbal Forecasts

Duty logs kept during the flood event show at least 250 verbal single site forecasts were issued by Forecasting Duty Officers. It is likely more verbal forecasts were issued but not logged due to time constraints during the event.

c) System Usage

The FFS was accessed by Area and Regional Headquarters staff on a total of 1250 occasions during the event. Nineteen different users accessed the VAX with 9 of these being primarily concerned with flow forecasting.

d) RECS Alarm Generated Statistics

RECS received 334 outstation alarms, 274 from river and 60 from rainfall sites. Additionally RECS also continued to receive routine emergency alarms from other Flood Operations and Business Services sites giving a total of over 1000 alarms during the event.

3.3 Ability of Agency to Predict Levels Using Current Models

The FFS model produced just short of 500 separate forecasts for the Severn and Trent basins. The reliability and accuracy of the forecasts were considered generally very good.

The accuracy of the forecasting model in terms of predicting the timing of thresholds being crossed is shown in Figures 3.1 for sites at or near severe threshold. The first two graphs in this set show the models performance in forecasting the peak level where the severe threshold is not quite reached. The first graph shows that on the River Trent at Drakelow the model tends to overestimate the peak level, this could be due to inaccuracies at upstream routing reaches. The second graph shows the performance of the model on the River Avon at Rugby. The model consistently underestimated the level of the peak. It is likely that there was not enough water in the system for the model to simulate the correct peak, or that the water available was not simulated through the reaches in the correct timeframe. This missing volume of water could have been a result of under simulation of the ungauged River Swift that joins the River Avon just upstream of Rugby.

The remaining graphs show the models performance in forecasting the timing of severe thresholds being crossed. The graph for River Wye at Ashford shows the model behaving well, the threshold was forecast to cross 8 hours before it occurred and throughout these forecasts the model was never more than 1 hour early or late. The model performed well for the River Severn at Welsh Bridge. From the graph you can see that the model is simulating an earlier crossing time but gradually reaches the correct time 8 hours before the threshold is actually crossed.

Further downstream at Bewdley, graphs have been produced for both of the Severe Flood Warnings issued during the event. For the first event, the model was systematically over estimating the time that the threshold would be crossed, whereas in the second event the model first estimated the crossing early and then late. In the early stages of the forecast you can see a similar pattern in the forecasts timing.

One site where the model did not perform well is at Shardlow on the River Trent. From the graph you can see that in the early stages of the forecasts, the model estimates that the

threshold will be crossed later than actually occurs. The model assumes no backing up from the Derwent and consequently forecasts a later peak.

The final graph shows the models performance for the River Dove at Marston. During the flood event the gauge at Marston failed, this graph shows how the model performed without any observed data to update its simulation.

However, the forecasts given by the computer model were always interpreted by trained forecasters who were able to improve upon the model results and give greater confidence to predictions.

Because of the extreme nature of the event a number of inadequacies in FFS were experienced. The ELFs system was used extensively in the later stages of the event to predict heights of peaks in river levels by comparing against historical events. This additional information gave an increased level of confidence in the forecasts that were provided.

3.4 Issues Arising

- The analysis of the Weather Forecast showed some cause for concern following the conclusion that it was least accurate when high rainfall amounts were recorded.
- Concerns were raised during the flood event about the health and safety issues surrounding some of the gauging station and rainguage sites
- Although the model was seen as producing generally good forecasts, it has again highlighted the inability of the current model to deal with exceptional situations arising at confluences and in tidal reaches.

3.5 Recommendations

- Seek improvements in weather forecast, updates to forecasts and changes to information included in forecast
- Consider changes to hydrometric station location. Share information about access to sites when roads closed
- Carry out further calibration of forecasting model and add data to the ELFS system in order to make peak to peak correlation more reliable.
- FFS 3 will introduce a hydrodynamic element into our modelling system which it is hoped will combat the problems encountered in forecasting for confluences and tidal reaches

Figure 3.1a

Flow Forecasting Performance Graphs

Site: Drakelow (4019)

Severe Flood Warning Issued: 07/11/00 12:14

Severe Flood Warning Threshold: 3.8 m (DNC)

Actual Peak Stage: 3.791 m (07/11/00 19:30)

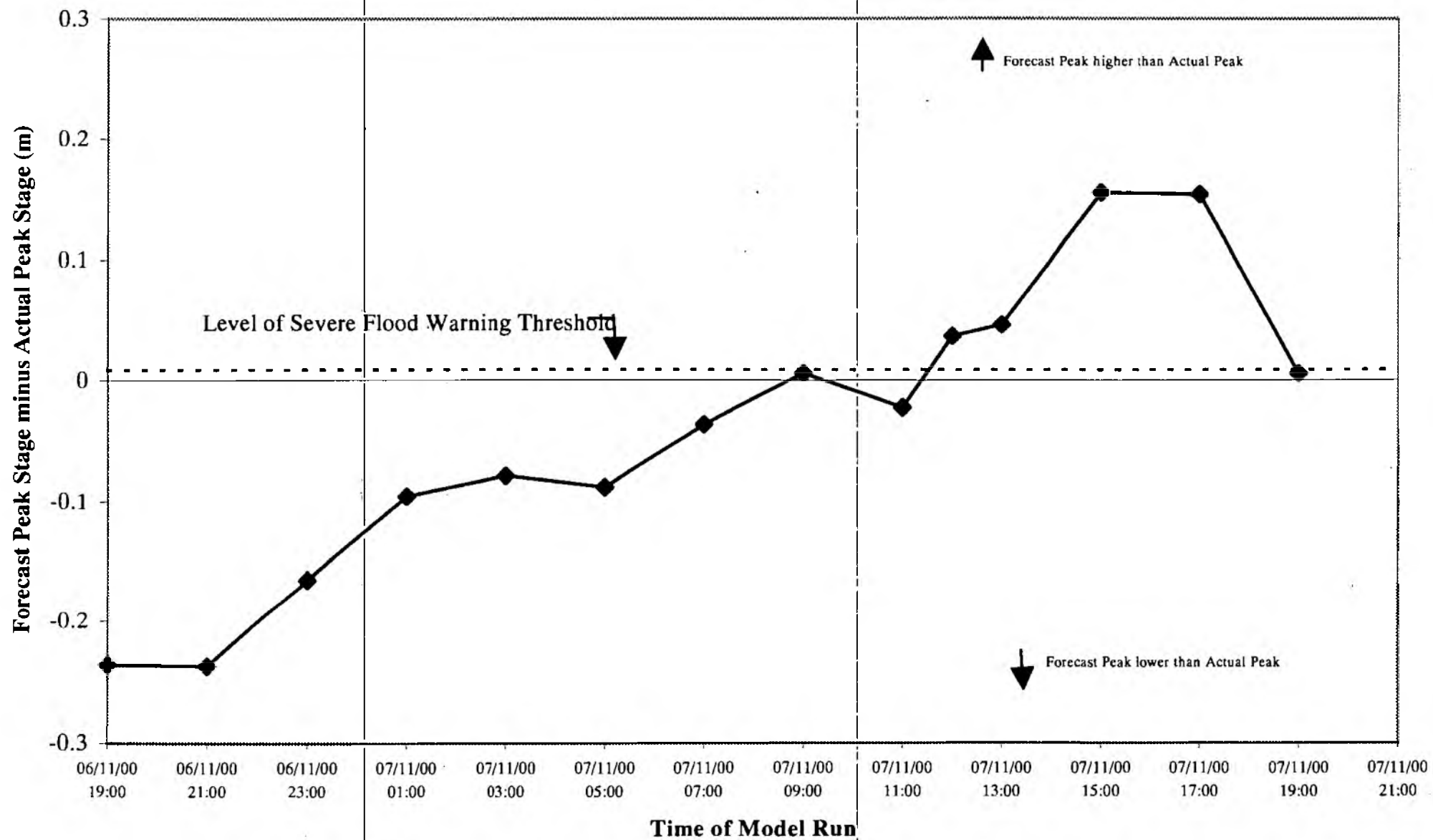


Figure 3.1b

Flow Forecasting Performance Graphs
Site: Rugby (2090)

Severe Flood Warning Issued: 06/11/00 16:33
Severe Flood Warning Threshold: 3.4 m (DNC)
Actual Peak Stage: 3.313 m (06/11/00 17:15)

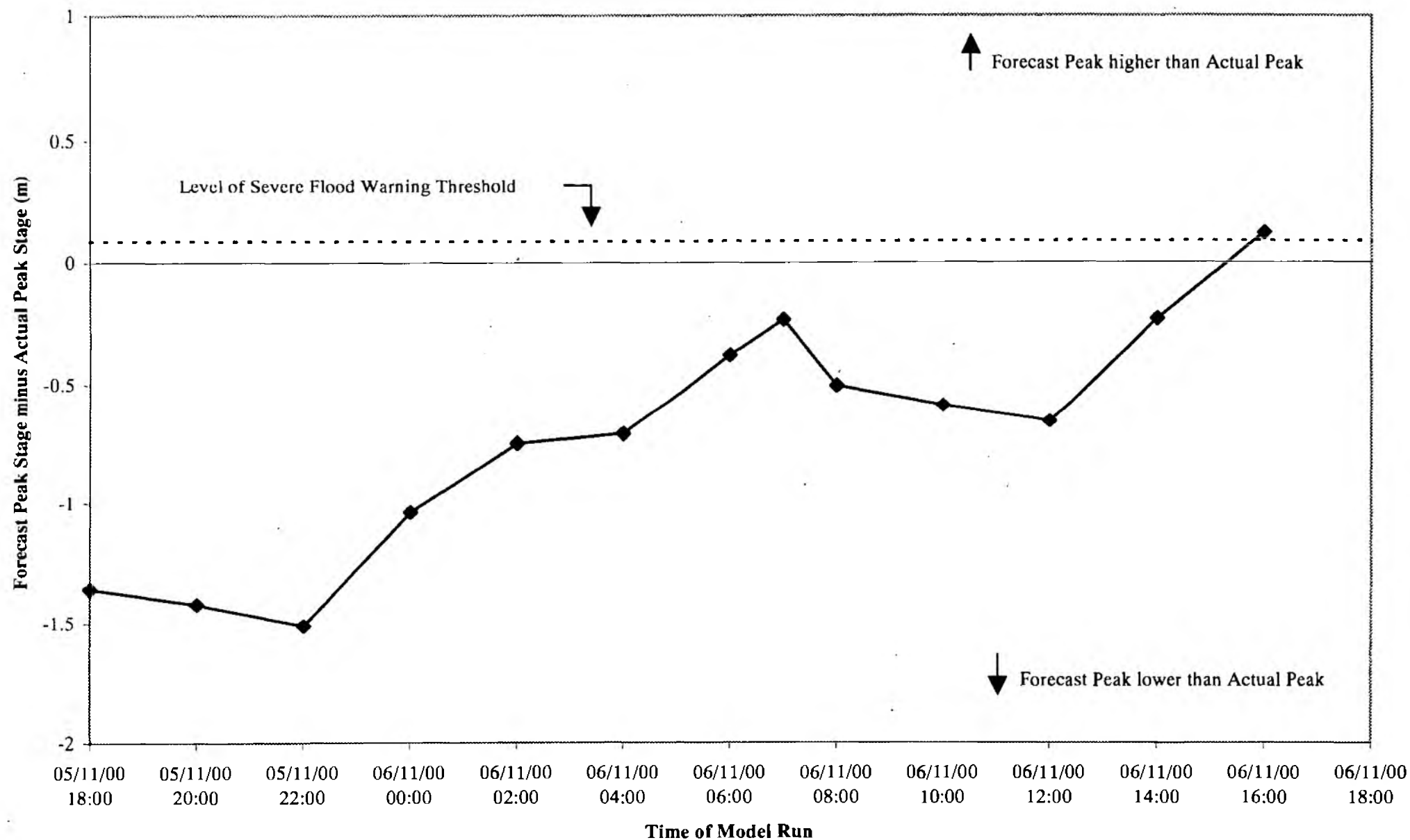


Figure 3.1c

Flow Forecasting Performance Graphs

Site: Ashford (4023)

Severe Flood Warning Issued: 06/11/00 08:57

Severe Flood Warning Threshold Crossed: 06/11/00 11:45

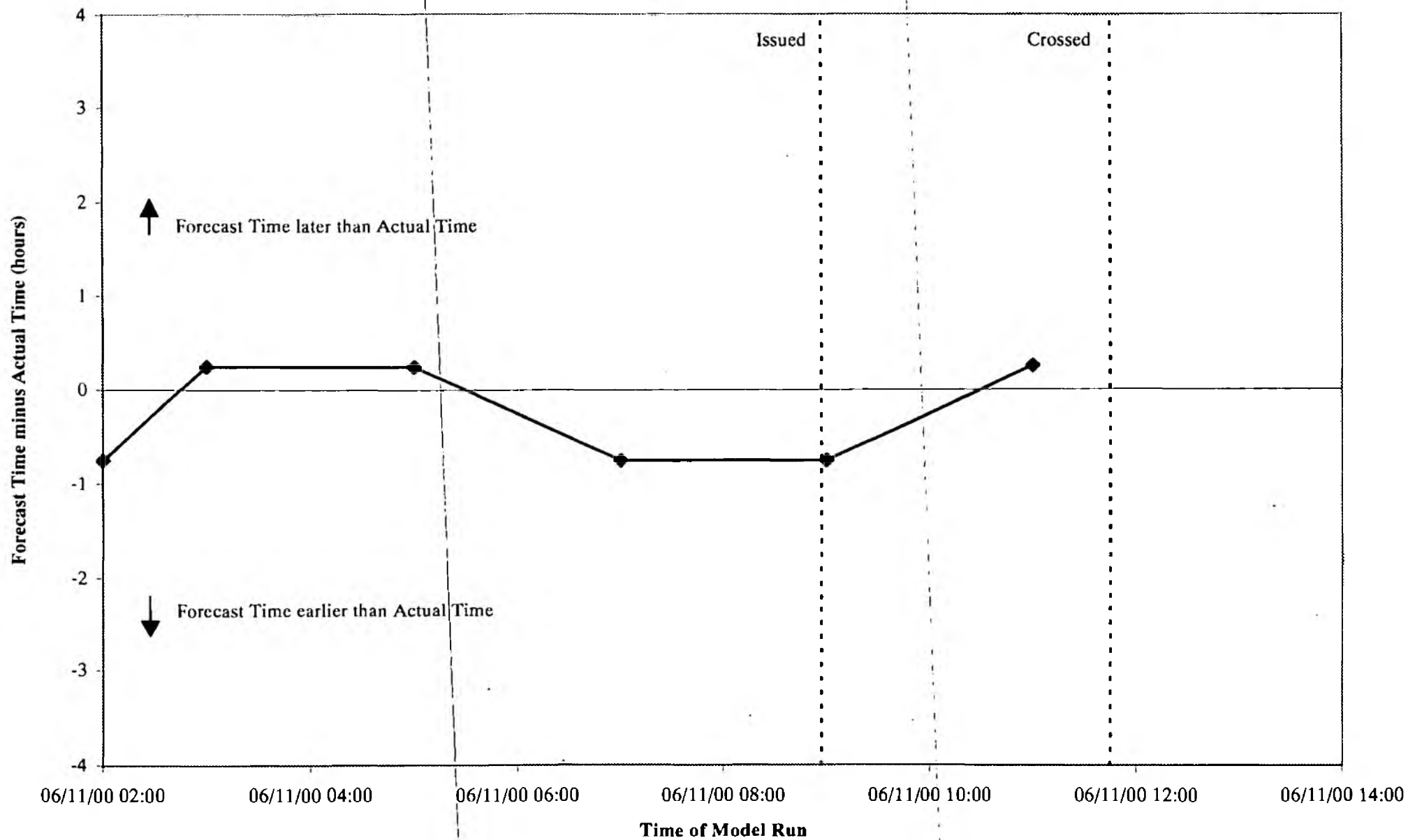


Figure 3.1d

Flow Forecasting Performance Graphs

Site: Welsh Bridge (2077)

Severe Flood Warning Issued: 30/10/00 15:09

Severe Flood Warning Threshold Crossed: 31/10/00 09:00

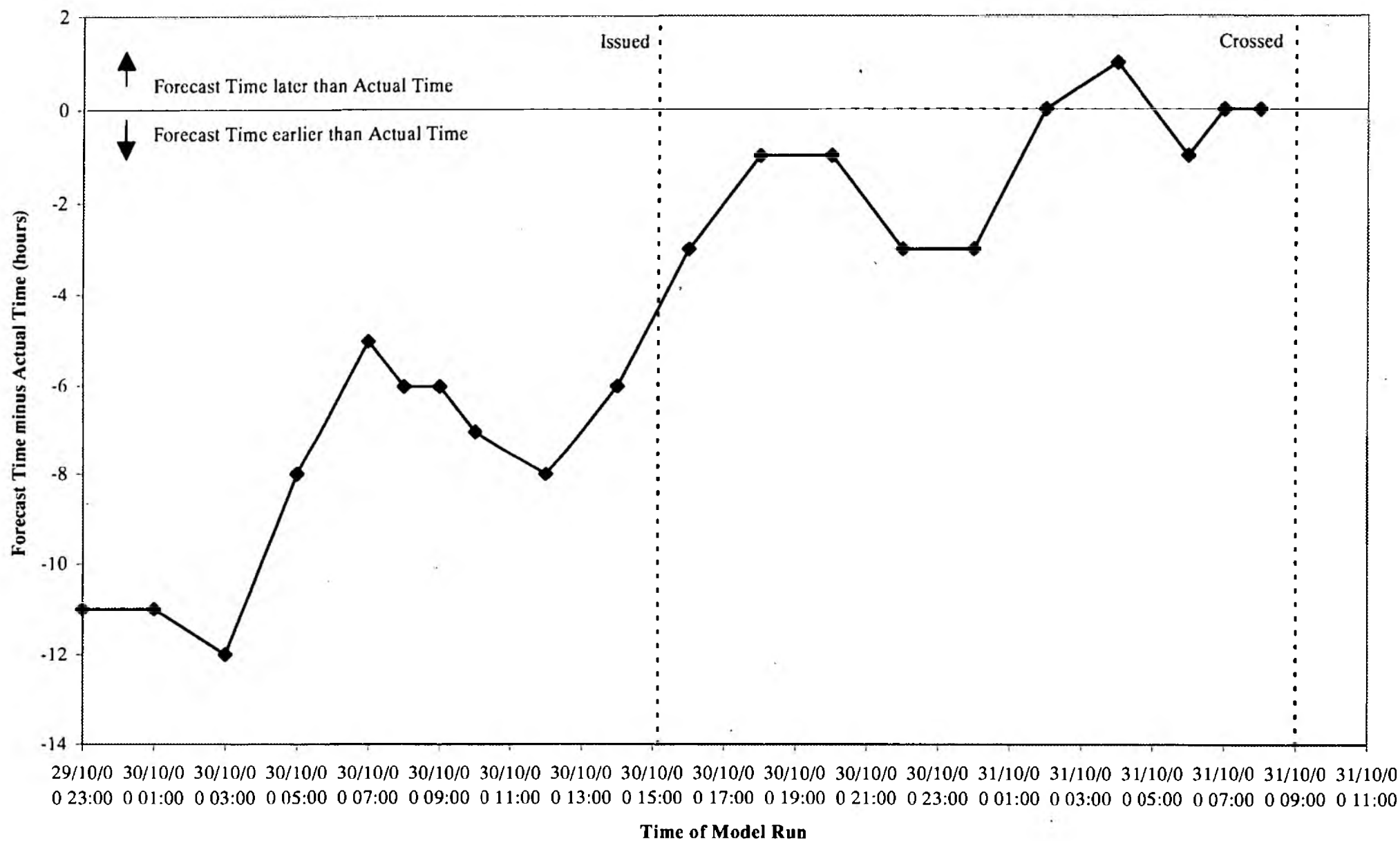


Figure 3.1e

Flow Forecasting Performance Graphs

Site: Bewdley (2001)

Severe Flood Warning Issued: 31/10/00 15:56

Severe Flood Warning Threshold Crossed: 01/11/00 03:30

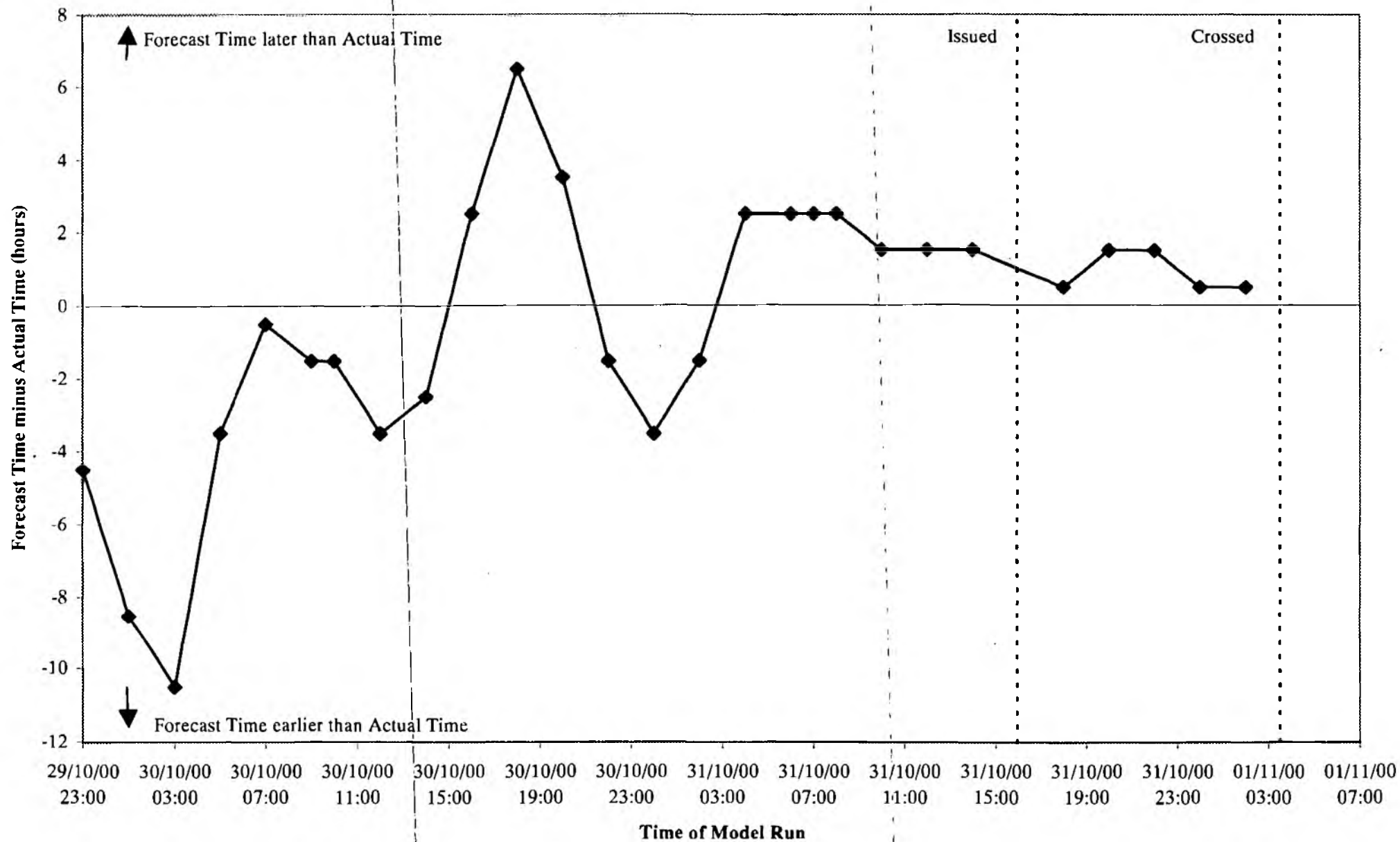


Figure 3.1f

Flow Forecasting Performance Graphs

Site: Bewdley (2001)

Severe Flood Warning Issued: 07/11/00 13:03

Severe Flood Warning Threshold Crossed: 08/11/00 04:30

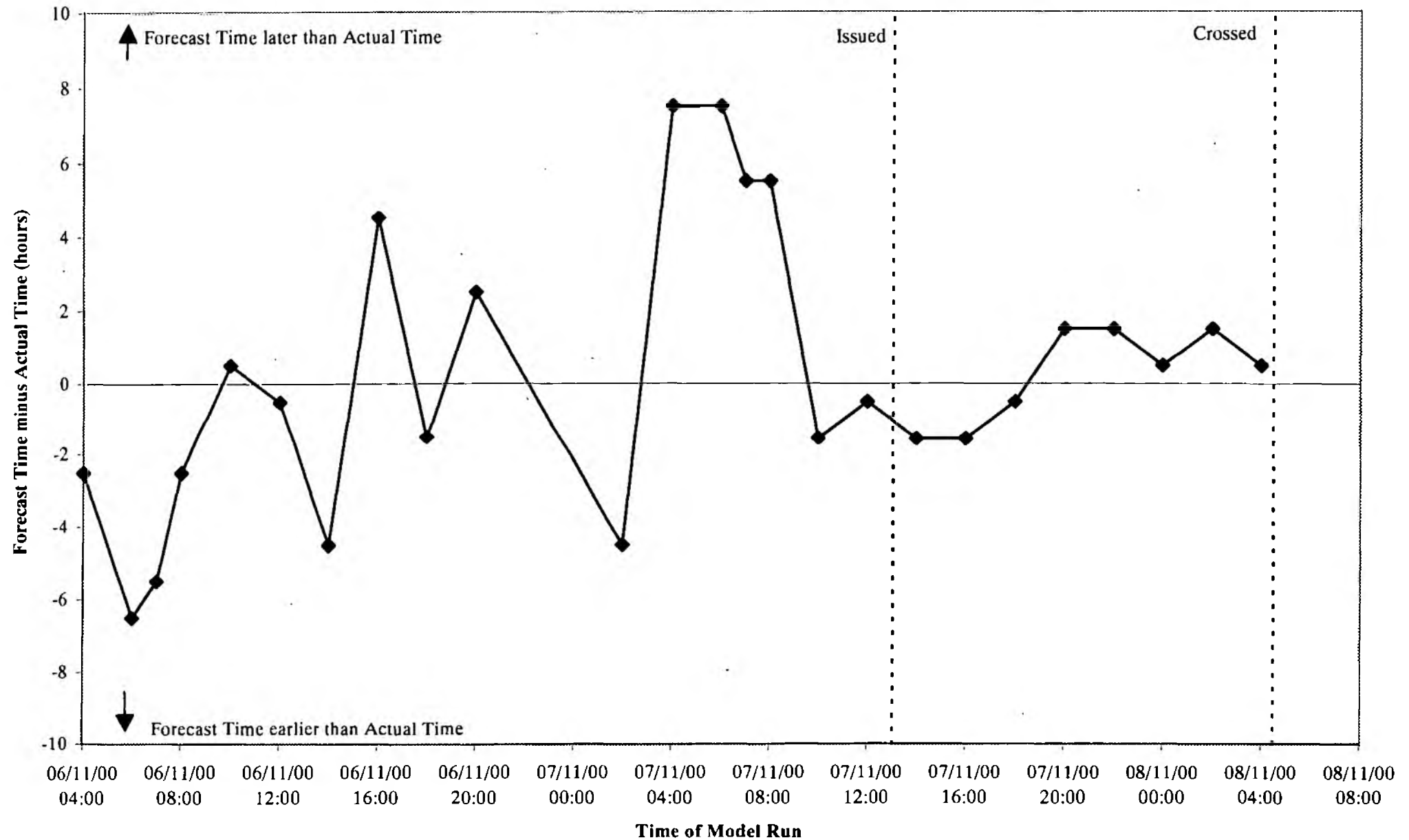


Figure 3.1g

Flow Forecasting Performance Graphs

Site: Shardlow (4007)

Severe Flood Warning Issued: 06/11/00 16:40

Severe Flood Warning Threshold Crossed: 07/11/00 04:00

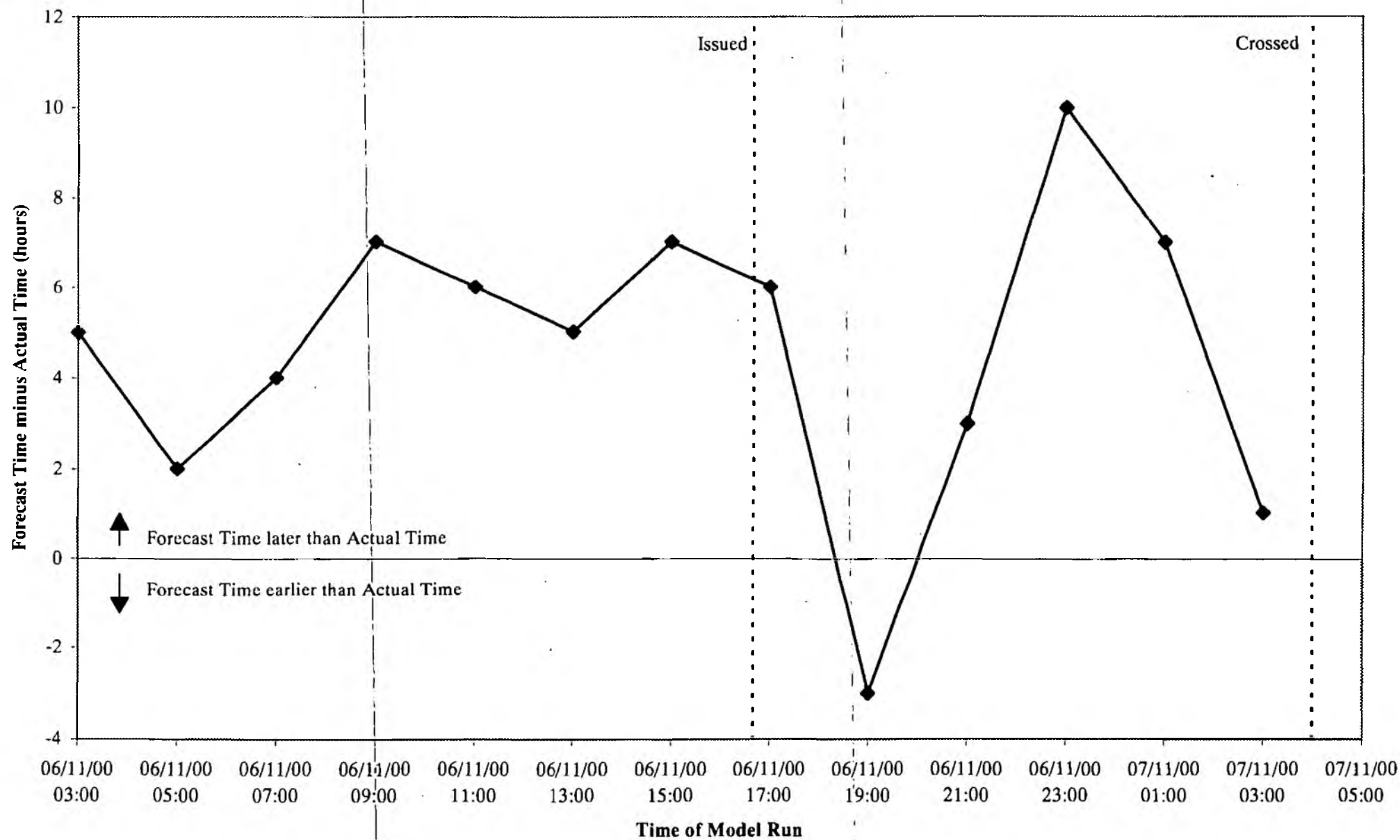
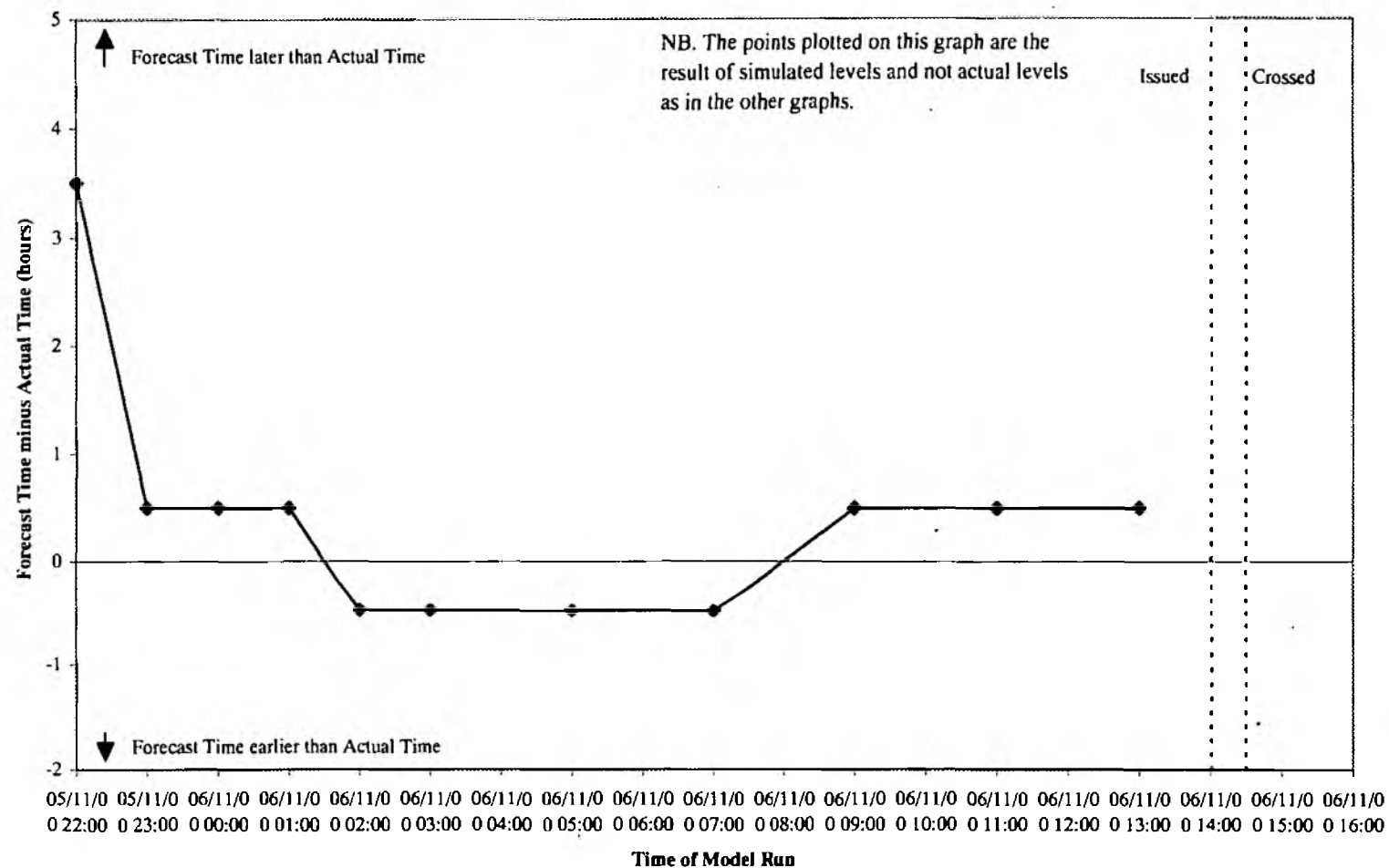


Figure 3.1h
Flow Forecasting Performance Graphs
Site: Marston (4018)

Severe Flood Warning Issued: 06/11/00 14:01

Severe Flood Warning Threshold Crossed: 06/11/00 14:30



CHAPTER 4-FLOOD WARNING

4.1 Trigger/Threshold Levels for Warnings

This was the first major test of the new Flood Warning Codes (Flood Watch, Flood Warning and Severe Flood Warning) since their introduction on September 12th 2000. The system operates as follows:

FLOOD WATCH – Issued for general areas to indicate that flooding within the specified area is possible within the next 24 hours. Flood Watches were issued across the whole Region by 5pm on Sunday 29th October in response to the daily Met office weather forecast.

FLOOD WARNINGS – Issued to indicate flooding of Homes, Businesses and Main Roads is expected within designated flood warning areas. The need to issue a flood warning is assessed by the forecast or actual crossing of a predefined threshold at a particular river level or flow measurement site. An appropriate warning is issued using the AVM to send preset Fax, voice or pager messages to partner organisations and those at risk. Flood Warnings were issued for 73 of the 76 designated Flood Warning Areas within the Region (Warnings were not issued for 3 Tidal Areas within the Severn Estuary and the Tidal Trent). A total of 297 Flood warnings were issued during the event, several more than once as river levels fell and rose again with each new band of heavy rain.

SEVERE FLOOD WARNINGS – Issued to indicate an imminent danger to life and property and issued to indicate an escalation of the impact to property and infrastructure that may be affected by the flooding within designated flood warning areas. The need to issue a Severe Flood Warning is assessed in the same manner as Flood Warnings. 36 Severe Flood Warnings were issued over the duration of the event, several more than once, particularly on the River Severn, as river levels fell and rose again with each new band of heavy rain.

All Clear – Issued to indicate that there are No Flood Watches or Warnings in Force in a general area. All Clears are issued to professional partners and the media when rivers are in-bank, levels are falling and no significant rain is forecast. 18 All Clears were issued during the period covered by this report.

4.2 Warnings Issued & Lead Times against Target Lead Times

Tables 4.1 and 4.2 show the warnings issued and lead times achieved for the Severn and Trent basins for the period 27th October to 20th November 2000. The first warnings were issued for the upper Severn and Vyrnwy on the afternoon of the 28th October, with the first warning on the Trent going out on the morning of the 29th October. The first severe warning to be issued was for the River Vyrnwy on the morning of the 30th October.

The Agency's customer charter standard is to provide a warning two hours before the onset of property flooding where this is technically possible. The lead times in tables 4.1, 4.2 and figure 4.1 are based on the time of exceedance at the River Gauge used to provide the warning. In most cases the onset of property flooding is sometime after the time of exceedance at the river gauge and will therefore give an increased warning lead-time. . An estimate of warning lead time achieved at key locations with an adjustment for the relative location of the warning gauge is given in Table 4.3 and 4.4. The table shows that good lead

times in excess of the 2 hour target lead time were achieved throughout the Region for the first property that floods in each of the major locations that were flooded. A lead time of only 1 hour 26 minutes is estimated at Leek. A 2hour lead time is not currently possible because the Regional Flow Forecasting System does not extend as far as Leek, which is at the top of the River Churnet. The warning is triggered by the exceedance of a pre-determined river level immediately downstream of Tittesworth Reservoir, approximately 2km upstream of Leek.

Figure 4.1 shows the percentage of warnings issued that achieved a two-hour lead-time at the river gauge used to provide the warning. This is indicative of how the warnings issued compare against the customer charter lead-time of two hours. 60% of warnings in the Trent basin were issued with more than two hours lead-time, and over 75% of warnings in the Severn basin were issued with more than two hours lead-time. Less than 10% of warnings in the Severn basin and less than 20% of warnings in the Trent basin were issued after the warning threshold had been exceeded. The main reason for the higher percentage of warnings issued post flood in the Trent basin is that there are many stations for which warnings are issued where no forecasts are produced. Warnings for reaches based on levels at these stations are made using observed data, they are highlighted in the tables in italics.

Table 4.5 shows the overall accuracy of warnings issued at each threshold for each area i.e. whether the warning issued achieved the level forecast. Across the region we achieved a lead-time of 6 hours or more for the majority of warnings issued. This was consistent across each area. Only 25 of the 333 warnings issued did not reach the level forecast and no levels were exceeded for which a warning should have been issued. The overall accuracy of the warnings issued was therefore 92%.

An accurate assessment of performance against the 2 hour Customer Charter Standard can only be determined by post event survey of flood victims. Post event surveys will be undertaken at several locations within the Region but results are not available at the time of writing.

TABLE 4.1: WARNING SUMMARY SHEET FOR SEVERN BASIN

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
28/10/00	15:58	V1	1	MEIFOD	2.4	17:15	1hr 17mins
	16:07	S3	1	MUNLYN	2.6	18:30	2hrs 20mins
	16:36	S1	1	CAERSWS	2.8	DNC	-
	17:31	V2	1	LLANYMYNECH	3.5	19:45	2hr 14mins
	21:39	S4	1	POOL QUAY	5.8	03:15	5hrs 36mins
29/10/00	08:26	S6	1	BUILDWAS	3.4	15:45	7hrs 19mins
	14:10	S11	1	MYTHE	2.8	23:00	8hrs 50mins
	15:51	S2	1	ABERMULE	2.8	18:15	2hrs 24mins
	15:57	V1	1	MEIFOD	2.4	17:15	1hr 18mins
	16:09	S1	1	CAERSWS	2.8	17:45	1hr 36mins
	18:02	S9	1	DIGLIS	3.2	04:45	10hrs 42mins
	18:08	A1	1	LILBOURNE	0.685	20:15	2hrs 7mins
	20:13	S5	1	WELSH BRIDGE	2.9	10:45	14hrs 30mins
	21:50	V2	2	LLANYMYNECH	4.3	02:15	4hrs 25mins
	22:17	A6	1	EATHORPE	1.5	03:45	5hrs 28mins
	22:21	A7	1	SHIPSTON	2.1	02:30	4hrs 9mins
	22:21	S10	1	SAXONS LODGE	4.0	07:45	9hrs 24mins
30/10/00	00:09	A2	1	RUGBY	1.9	10:00	9hrs 51mins
	00:12	S2	2	ABERMULE	3.5	23:45	-27mins
	00:14	A5	1	EVESHAM	1.9	03:45	3hrs 29mins
	00:14	A1	2	LILBOURNE	1.2	05:15	5hrs 1min
	00:31	S3	2	BUTTINGTON	5.1	04:00	3hrs 29mins
	01:48	S1	1	CAERSWS	2.8	17:45 (29/10/00)	8hrs 3mins
	02:58	A7	2	SHIPSTON	2.5	04:30	1hr 32mins
	02:58	S11	2	MYTHE	3.5	09:30	6hrs 32mins
	03:02	S8	1	BEWDLEY	3.3	04:45	1hr 43mins
	03:58	T1	1	TENBURY	4.5	11:00	7hrs 2mins
	05:08	S3	3	MUNLYN	3.6	04:45	-23mins
	05:08	S4	2	CREW GREEN	6.2	08:45	3hrs 37mins
	05:44	T2	1	BRANSFORD	4.4	07:30	1hr 46mins
	06:35	V2	5	LLANYMYNECH	4.5	07:15	40mins
	06:35	T1	5	TENBURY	5.0	23:30	16hrs 55mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
30/10/00	06:36	A8	1	STUDLEY	2.0	08:15	1hr 39mins
	06:59	S10	2	SAXONS LODGE	4.5	17:45	10hrs 46mins
	07:07	S5	2	WELSH BRIDGE	3.5	20:30	13hrs 23mins
	07:16	A3	1	WARWICK	2.3	00:15 (31/10/00)	16hrs 59mins
	07:16	A6	2	EATHORPE	1.9	08:30	1hr 14mins
	07:16	A5	2	EVESHAM	2.5	09:30	2hrs 14mins
	08:04	S12	1	GLOUCESTER	3.2	10:00	1hr 56mins
	08:58	S3	5	BUTTINGTON	5.4	11:30	2hrs 32mins
	09:50	A4	1	STRATFORD	1.5	18:00	8hrs 10mins
	10:45	S12T	2	GLOUCESTER	3.6	DNC	-
	11:06	S6	3	BUILDWAS	5.3	06:30 (31/10/00)	19hrs 24mins
	11:56	S7	2	BUILDWAS	4.5	16:00	4hrs 4mins
	12:02	S8	2	BEWDLEY	3.8	00:00 (31/10/00)	11hrs 58mins
	12:21	S4	5	CREW GREEN	6.35	12:30	9mins
	12:21	T2	2	BRANSFORD	5.0	21:30	9hrs 9mins
	13:46	S11	3	MYTHE	3.9	18:15	4hrs 29mins
	13:52	S5	3	WELSH BRIDGE	4.2	04:15 (31/10/00)	14hrs 23mins
	15:09	S5	5	WELSH BRIDGE	4.5	09:00 (31/10/00)	17hrs 51mins
	17:00	S12T	1	GLOUCESTER	3.2	22:30	5hrs 30mins
	17:05	S7	3	BUILDWAS	5.3	06:30	13hrs 25mins
	23:18	S9	2	DIGLIS	4.4	03:30	4hrs 12mins
31/10/00	07:23	S10	3	SAXONS LODGE	5.0	09:15	1hr 52mins
	09:52	S8	3	BEWDLEY	4.2	15:00	5hrs 8mins
	10:14	S7	4	BUILDWAS	5.9	15:30	5hrs 16mins
	15:20	S9	5	DIGLIS	4.9	06:30	15hrs 10mins
	15:50	S6	5	BUILDWAS	6.6	04:30	12hrs 40mins
	15:56	S8	5	BEWDLEY	4.8	03:30	11hrs 34mins
	15:56	S7	5	BUILDWAS	6.6	04:30	12hrs 34mins
01/11/00	19:04	S10	5	SAXONS LODGE	5.3	12:45	17hrs 41mins
02/11/00	09:41	S12	2	GLOUCESTER	3.6	05:30	19hrs 49mins
	12:53	A7	1	SHIPSTON	2.1	DNC	-
	12:53	A1	1	LILBOURNE	0.685	15:30	2hrs 37mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
02/11/00	20:02	A6	1	EATHORPE	1.5	00:00	3hrs 58mins
	13:47	A4	1	STRATFORD	1.5	DNC	-
03/11/00	02:47	S3	1	MUNLYN	2.6	01:00	-1hr 47mins
	06:37	A1	2	LILBOURNE	1.2	04:15	-2hrs 22mins
	08:58	S12	3	GLOUCESTER	3.75	08:00	-55mins
	10:07	S11	5	MYTHE	4.5	12:45	2hrs 38mins
	11:57	A6	2	EATHORPE	1.9	12:15	18mins
	14:23	S12T	5	GLOUCESTER	4.3	DNC	-
05/11/00	18:35	V2	1	LLANYMYNECH	3.5	02:45	8hrs 10mins
	18:56	A1	1	LILBOURNE	0.685	23:15	4hrs 19mins
	18:56	A7	1	SHIPSTON	2.1	01:00	6hrs 4mins
	21:15	A5	1	EVESHAM	1.9	04:15	7hrs
	21:15	A6	1	EATHORPE	1.5	05:30	8hrs 15mins
	21:15	A7	2	SHIPSTON	2.5	03:45	6hrs 30mins
	22:44	V1	1	MEIFOD	2.4	01:00	2hrs 16mins
	22:56	S3	1	MUNLYN	2.6	02:15	3hrs 19mins
06/11/00	01:11	A1	2	LILBOURNE	1.2	03:15	2hrs 4mins
	01:11	A2	1	RUGBY	1.9	08:15	7hrs 4mins
	01:48	S1	1	CAERSWS	2.8	03:30	1hr 47mins
	03:12	S8	2	BEWDLEY	3.8	04:00	48mins
	03:43	T2	1	BRANSFORD	4.4	04:15	32mins
	03:47	S4	1	POOL QUAY	5.8	07:15	3hrs 28mins
	03:47	S5	1	WELSH BRIDGE	2.9	12:15	8hrs 28mins
	03:47	S6	3	BUILDWAS	5.3	11:45	31hrs 58mins
	04:33	S2	1	ABERMULE	2.8	04:15	-18mins
	04:45	S7	2	BUILDWAS	4.5	05:00	15mins
	05:12	T1	1	TENBURY	4.5	DNC	-
	05:25	S9	2	DIGLIS	4.4	05:15	-10mins
	05:25	V2	2	LLANYMYNECH	4.3	08:00	2hrs 35mins
	06:15	S1	2	CAERSWS	3.3	DNC	-
	06:44	V1	2	MEIFOD	3.4	DNC	-
	06:52	A5	2	EVESHAM	2.5	11:00	4hrs 8mins
	06:52	A6	2	EATHORPE	1.9	09:00	2hrs 8mins
	06:59	S8	3	BEWDLEY	4.2	14:15	7hrs 16mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
06/11/00	08:02	A3	1	WARWICK	2.3	00:00	15hrs 58mins
	09:20	A4	1	STRATFORD	1.5	20:45	35hrs 25mins
	09:37	T2	2	<i>BRANSFORD</i>	5.0	20:30	10hrs 53mins
	10:30	V2	5	LLANYMYNECH	4.5	10:15	-15mins
	10:40	A2	2	RUGBY	2.6	12:15	1hr 35mins
	10:48	A1	3	LILBOURNE	1.75	DNC	-
	15:08	A2	3	RUGBY	3.1	15:00	-8mins
	15:09	S5	2	WELSH BRIDGE	3.5	05:45	14hrs 36mins
	15:58	S9	5	DIGLIS	4.9	08:15	16hrs 17mins
	16:33	A2	5	RUGBY	3.4	DNC	-
	17:13	S10	5	SAXONS LODGE	5.3	08:15	15hrs 2mins
	17:46	S5	3	WELSH BRIDGE	4.2	12:15	24hrs 54mins
	18:09	S5	5	WELSH BRIDGE	4.5	19:00	23hrs 51mins
	18:11	S3	2	BUTTINGTON	5.1	16:00	-2hrs 11mins
	18:42	S4	2	CREW GREEN	6.2	20:15	1hr 33mins
	19:40	K1	1	KIDDERMINSTER	2.2	01:15	5hrs 35mins
	20:17	S7	2	BRIDGNORTH	4.2	05:15	9hrs 2mins
07/11/00	05:01	A3	2	WARWICK	2.85	13:15	8hrs 14mins
	11:33	S7	4	BUILDWAS	5.9	20:45	9hrs 12mins
	13:03	S8	5	BEWDLEY	4.8	04:30	15hrs 27mins
	13:28	S11	5	MYTHE	4.5	22:30	9hrs 2mins
	14:38	S12T	5	GLOUCESTER	4.3	08:45	18hrs 7mins
	18:02	S6	5	BUILDWAS	6.6	DNC	-
	18:15	S7	5	BRIDGNORTH	5.5	DNC	-
08/11/00	01:11	A5	2	EVESHAM	2.5	DNC	-
11/11/00	10:48	S8	2	BEWDLEY	3.8	DNC	-
	18:21	A1	1	LILBOURNE	0.685	18:30	19mins
	23:15	S9	2	DIGLIS	4.4	20:15	-3hrs
12/11/00	16:54	S4	1	<i>POOL QUAY</i>	5.8	DNC	-
13/11/00	16:31	S12T	3	GLOUCESTER	4.0	DNC	-
14/11/00	16:59	S12T	2	GLOUCESTER	3.6	22:45	5hrs 46mins
16/11/00	10:16	A1	1	LILBOURNE	0.685	12:00	1hr 44mins
	16:47	A6	1	EATHORPE	1.5	DNC	-
19/11/00	21:47	A6	1	EATHORPE	1.5	06:45 20/11	8hrs 58mins

Italics = Warnings based on observed levels.

DNC = Did not cross threshold

TABLE 4.2: WARNING SUMMARY SHEET FOR TRENT BASIN

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
29/10/00	08:00	TR8	1	SHARDLOW	1.7	08:15	15mins
	19:58	DO2	2	BASFORD	1.9	23:15	3hrs 17mins
	20:02	DO3	2	ROCESTER	1.2	22:15	2hrs 13mins
	20:06	TR1	2	MOORLANDS	1.3	DNC	-
	20:08	TR4	2	DARLASTON	2.5	23:45	3hrs 37mins
	20:14	TR3	2	GT BRIDGFORD	1.0	30/10 03:30	7hrs 16mins
	20:14	TR2	2	PENKRIDGE	1.6	30/10 04:00	7hrs 46mins
	20:18	TR5	2	GREAT HAYWOOD	2.3	N/A	-
	21:07	DE2	1	WYE - ASHFORD	0.75	21:45	1hr 38mins
	21:11	DO4	2	DOVERIDGE	2.4	30/10 02:00	4hrs 49mins
	21:14	DO5	2	MARSTON	1.5	30/10 05:00	7hrs 46mins
	21:40	DO1	2	ROCESTER	1.2	22:15	35mins
	22:10	TR13	1	TORKSEY	4.65	30/10 09:00	10hrs 50mins
	22:20	TE1	2	UPPER TEAN	1.13	21:00	-1hr 20mins
30/10/00	00:20	SO5	1	SYSTON	28.0F	09:00	8hrs 40mins
	00:25	SO7	1	PILLINGS	40.0F	05:00	4hrs 35mins
	00:25	SO2	1	SOUTH WIGSTON	7.5F	03:30	3hrs 5mins
	00:31	TA6	2	CASTLE FARM	1.8	10:30	9hrs 59mins
	02:36	DO3	3	ROCESTER	1.55	10:15	7hrs 39mins
	02:42	TA7	2	WATER ORTON	2.2	04:00	1hr 18mins
	02:55	DE6	1	CHURCH WILNE	1.75	05:30	2hrs 35mins
	03:58	TA5	2	SWANS BARN	1.9	03:30	-28mins
	04:52	TRB2	3	SILKMORE LANE	1.4	04:15	-37mins
	05:10	TA9	2	POLESWORTH	1.3	13:15	8hrs 5mins
	05:48	DE3	1	MATLOCK	2.5	10:30	4hrs 12mins
	05:48	TR14	1	GAINSBOROUGH	5.0	31/10 09:30	27hrs 42mins
	06:03	TR6	2	YOXALL	2.0	08:30	2hrs 27mins
	06:11	SO3	2	LITTLETHORPE	14.0F	11:45	5hrs 34mins
	06:55	TA5	3	SWANS BARN	2.3	07:45	50mins
	07:07	SO4	2	BRENTINGBY	1.9	07:15	8mins
	07:52	TA6	2	CASTLE FARM	1.8	10:30	2hrs 38mins
	09:21	DE2	2	ASHFORD	1.0	15:00	5hrs 39mins
	10:22	SO4	2	BRENTINGBY	2.2	10:00	-22mins
	10:26	DO4	3	DOVERIDGE	2.4	02:00	-8hrs 26mins
	10:32	TA10	2	TAMWORTH LB	1.8	N/a	-
	10:36	DE5	1	DERBY ST MARYS	2.0	09:45	-51mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
30/10/00	10:46	SO5	2	FRISBY	2.0	17:30	6hrs 44mins
	10:58	TR10	1	COLWICK	3.6	15:45	4hrs 47mins
	10:58	TR11	1	COLWICK	3.6	15:45	4hrs 47mins
	10:58	TR12	1	COLWICK	3.6	15:45	4hrs 47mins
	11:00	TA9	3	POLESWORTH	2.0	19:15	8hrs 15mins
	11:36	TA8	2	LEA MARSTON	1.5	08:45	-2hrs 51mins
	14:00	TA11	2	HOPWAS	2.1	13:30	-30mins
	14:03	ME1	2	STONES BRIDGE	1.9	12:00	-2hrs 3mins
	16:10	DO5	3	MARSTON	2.4	18:45	2hrs 35mins
	18:59	TR3	4	GT BRIDGFORD	1.3	DNC	-
	16:23	TR9	2	SHARDLOW	2.4	15:30	-57mins
	16:23	SO7	2	PILLINGS	65.0F	31/10 02:30	10hrs 7mins
	16:23	DE6	2	CHURCH WILNE	2.26	DNC	-
	16:23	DE5	2	DERBY ST MARYS	2.19	DNC	-
	19:57	TR8	3	SHARDLOW	2.6	31/10 07:30	11hrs 33mins
	22:11	TR11	2	COLWICK	4.0	31/10 11:15	13hrs 4mins
31/10/00	10:05	TR9	3	SHARDLOW	2.7	13:30	3hrs 25mins
	10:28	TR12	2	COLWICK	4.0	11:15	48mins
	10:49	TR11	3	COLWICK	4.3	DNC	-
	20:30	TR8	4	SHARDLOW	3.15	DNC	-
	22:55	TR7	3	DRAKELOW	3.45	DNC	-
01/11/00	14:16	TR11	3	COLWICK	4.3	DNC	-
02/11/00	18:15	TA6	2	CASTLE FARM	1.8	DNC	-
05/11/00	20:52	DO2	3	BASFORD	2.4	06/11 05:15	8hrs 23mins
	20:57	DO3	4	ROCESTER	2.01	DNC	-
	21:09	TA6	3	CASTLE FARM	2.0	06/11 14:30	17hrs 21mins
	21:25	TA7	2	WATER ORTON	2.5	06/11 04:00	6hrs 35mins
	21:25	TR3	2	GT BRIDGFORD	1.0	06/11 01:45	4hrs 20mins
	21:56	DO4	2	HATTON	2.48	06/11 02:54	4hrs 58mins
	21:58	DO1	3	ROCESTER	1.55	06/11 02:15	4hrs 17mins
	21:58	DO5	2	MARSTON	1.5	06/11 05:00	7hrs 2mins
	21:58	TR2	2	PENKRIDGE	1.6	06/11 02:00	4hrs 2mins
	21:58	TR4	2	DARLASTON	2.5	06/11 01:45	3hrs 47mins
	21:58	TR6	2	YOXALL	2.0	06/11 04:30	6hrs 32mins
	22:12	DE2	1	ASHFORD	0.75	23:30	1hr 18mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
05/11/00	22:34	DO2	2	LEEK	0.95	20:45	-1hr 49mins
	22:40	SO2	1	SOUTH WIGSTON	7.5F	06/11 02:30	3hrs 50mins
	22:43	SO7	1	PILLINGS	40F	06/11 04:00	5hrs 17mins
	22:54	TE1	2	UPPER TEAN	1.13	22:45	-9mins
	23:00	TA5	2	SWANS BARN	1.9	21:45	-1hr 15mins
	23:21	TA4	2	PERRY PARK	2.0	22:30	1hr 9mins
06/11/00	00:14	DO3	3	ROCESTER	1.55	02:15	1hr 59mins
	00:46	TE1	3	UPPER TEAN	1.43	00:45	-1min
	01:49	DO2	5	LEEK	1.55	03:15	1hr 26mins
	01:59	TR1	2	STOKE	1.3	01:45	-14mins
	02:06	DE2	2	ASHFORD	1.0	05:30	3hrs 24mins
	02:06	SO5	1	SYSTON	28.0(F)	03:45	1hr 39mins
	02:06	DE6	1	CHURCH WILNE	1.75	05:00	2hrs 54mins
	02:06	DE1	1	CHATSWORTH	3.3	04:15	2hrs 9mins
	02:06	DE3	1	MATLOCK	2.5	03:15	1hr 9mins
	02:42	SO4	1	BRENTINGBY	1.9	02:45	3mins
	03:28	DO1	3	IZAACK WALTON	1.4	08:30	5hrs 2mins
	03:41	SO5	2	SYSTON	32F	08:00	4hrs 19mins
	03:55	DO3	4	ROCESTER	2.01	DNC	-
	04:00	DE3	2	MATLOCK	2.9	06:30	2hrs 30mins
	04:07	TA8	2	LEA MARSTON	1.5	04:30	-23mins
	04:27	SO4	2	BRENTINGBY	2.2	04:15	-12mins
	04:33	DO4	3	DOVERIDGE	2.7	06:15	1hr 42mins
	05:23	TA5	3	SWANS BARN	2.3	05:15	-8mins
	05:25	DE5	1	DERBY ST MARYS	2.0	05:30	5mins
	05:35	TA6	3	CHESWICK GREEN	1.5	DNC	-
	05:45	TR5	2	GREAT HAYWOOD	2.3	-	-
	05:51	TA9	2	POLESWORTH	1.3	10:45	4hrs 54mins
	06:13	TR10	1	COLWICK	3.6	10:30	4hrs 17mins
	06:13	TR12	1	COLWICK	3.6	10:30	4hrs 17mins
	06:13	TR11	1	COLWICK	3.6	10:30	4hrs 17mins
	06:13	TR13	1	TORKSEY	4.65	12:00	5hrs 47mins
	06:23	TA10	2	TAMWORTH	1.8	04:00	-2hrs 23mins
	06:28	TA1	2	SHEEPWASH	2.66	DNC	-
	06:35	DE1	3	CHATSWORTH	4.25	08:00	1hr 25mins
	06:35	TA3	2	SANDWELL	3.4	DNC	-
	06:35	TA2	5	BESCOT	3.07	DNC	-

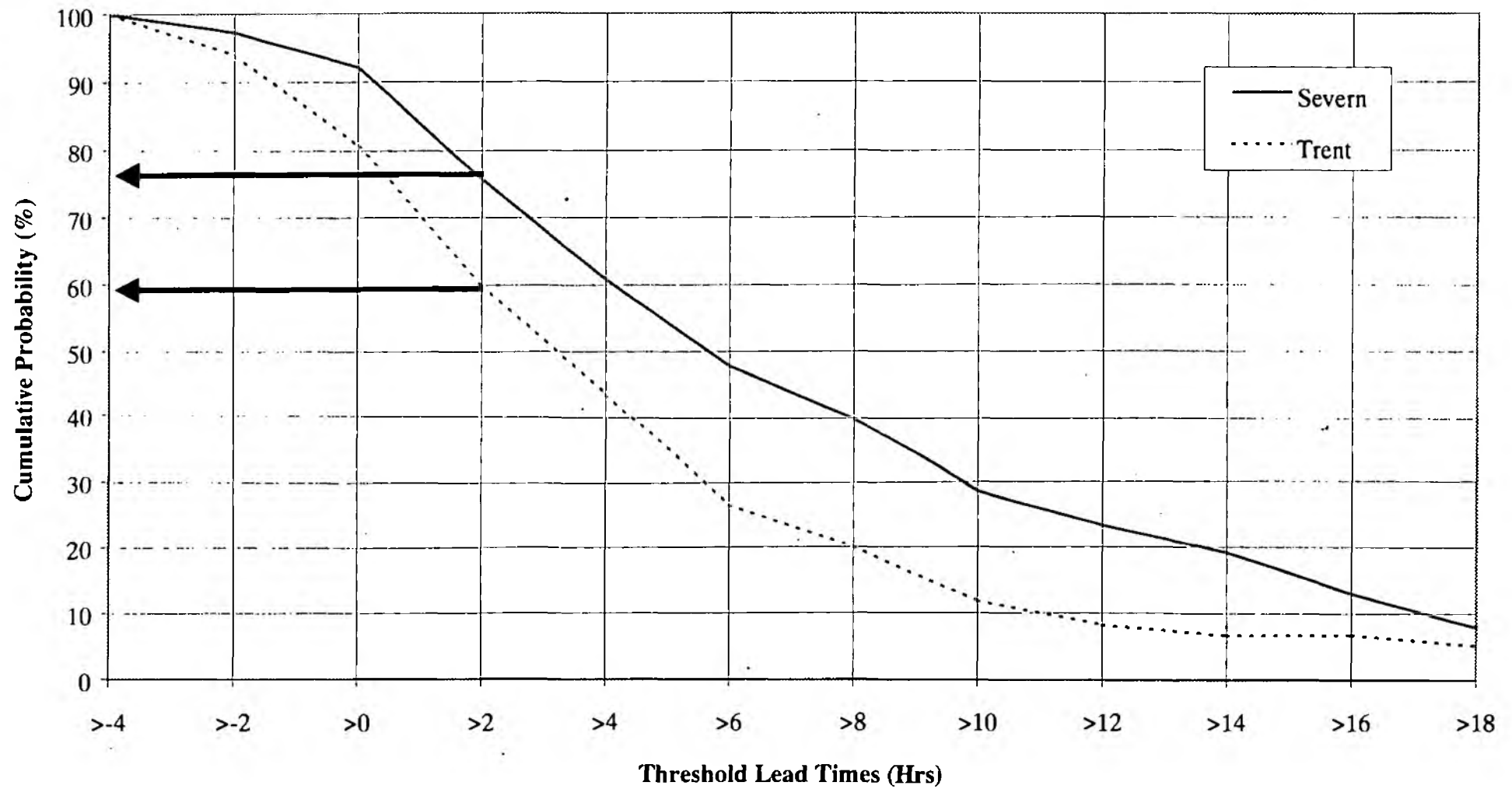
DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
06/11/00	06:44	ME1	2	STONES BRIDGE	1.9	12:00	5hrs 16mins
	07:44	TA7	3	WATER ORTON	2.5	04:00	-3hrs 44mins
	07:55	TR7	2	DRAKELOW	2.7	15:15	7hrs 20mins
	08:30	SO7	2	PILLINGS	65F	16:45	8hrs 15mins
	08:30	SO4	3	BRENTINGBY	2.5	09:00	30mins
	08:30	SO3	2	LITTLETHORPE	14.0F	09:30	1hr
	08:44	DO4	5	DOVERIDGE	3.0	DNC	-
	08:57	DE6	2	CHURCH WILNE	2.26	09:30	33mins
	08:57	TR9	2	SHARDLOW	2.4	09:15	18mins
	08:57	DE2	5	ASHFORD	1.25	11:45	2hrs 48mins
	09:33	DE1	5	CHATSWORTH	4.75	DNC	-
	09:47	DE5	5	MATLOCK	5.0	DNC	-
	09:47	SO9	2	KEGWORTH	85F	07:30	-2hrs 17mins
	09:47	DE3	5	MATLOCK	5.0	DNC	-
	10:27	DE6	5	CHURCH WILNE	2.5	07/11 03:00	16hrs 33mins
	10:27	SO8	2	KEGWORTH	85F	07:30	-2hrs 57mins
	10:27	DE5	5	DERBY ST MARYS	3.5	DNC	-
	11:02	TR11	1	COLWICK	3.8	12:45	1hr 43mins
	12:38	SO8	3	KEGWORTH	100F	07/11 01:45	13hrs 7mins
	12:38	TR9	3	SHARDLOW	2.7	17:45	5hrs 7mins
	12:38	TR8	3	SHARDLOW	2.6	13:30	52mins
	14:01	DO5	5	MARSTON	2.6	14:30	29mins
	14:01	TA9	3	POLESWORTH	2.0	16:00	1hr 59mins
	15:05	TR5	3	GT HAYWOOD	2.9	03:00	11hrs 55mins
	15:48	SO6	1	ROTHLEY	15.0F	15:30	-18mins
	16:29	TR3	5	BROADEYE BDGE	2.7	DNC	-
	16:40	TR8	5	SHARDLOW	2.95	07/11 01:45	9hrs 5mins
	16:40	TR9	4	SHARDLOW	3.10	07/11 03:30	10hrs 50mins
	16:40	TR13	1	TORKSEY	4.65	12:00	-4Hrs 40mins
	16:40	TR9	5	SHARDLOW	3.15	07/11 04:00	1hr 20mins
	17:18	TR12	2	COLWICK	4.0	15:30	-1hr 48mins
	17:34	TR11	3	COLWICK	4.3	19:45	2hrs 11mins
	17:34	TR10	3	COLWICK	4.3	19:45	2hrs 11mins
	17:34	TR11	3	COLWICK	4.3	19:45	2hrs 11mins
	18:26	TR13	2	NORTH MUSKHAM	3.45	07/11 17:00	22hrs 34mins
	18:40	TA11	2	HOPWAS	2.1	07/11 16:15	21hrs 35mins
	20:13	SO9	4	KEGWORTH	110.0F	07/11 04:15	8hrs 2mins

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	STATION	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	LEAD TIME
06/11/00	20:13	SO8	4	KEGWORTH	110.0F	07/11 04:15	8hrs 2mins
	20:13	SO7	3	PILLINGS	115.0F	07/11 05:15	9hrs 2mins
07/11/00	05:32	DO1	2	ROCESTER	1.2	05:15	-17mins
	05:48	TR7	3	DRAKELOW	3.45	10:15	4hrs 27mins
	06:05	TR11	4	COLWICK	4.8	05:30	35mins
	08:44	TR10	4	COLWICK	5.6	DNC	-
	08:44	TR12	4	COLWICK	4.8	05:30	3hrs 14mins
	12:14	TR7	5	DRAKELOW	3.8	DNC	-
	16:11	TR13	2	TORKSEY	6.4	09/11 04:15	36hrs 4mins
	19:48	TR11	4	COLWICK	5.5	DNC	-
	20:57	TR13	3	NORTH MUSKHAM	3.73	08/11 05:45	8hrs 48mins
08/11/00	05:30	SO2	1	SOUTH WIGSTON	7.5F	06:30	1hr
	10:26	TR14	1	GAINSBOROUGH	5.0	10/11 05:00	42hrs 34mins
	17:56	TR13	4	NORTH MUSKHAM	3.90	20:15	2hrs 19mins
	20:54	TR14	1	GAINSBOROUGH	5.0	9/11 18:00	21hrs 6mins
16/11/00	23:03	DE2	1	ASHFORD	0.75	17/11 03:45	4hrs 42mins
17/11/00	16:27	TR8	1	SHARDLOW	1.7	20:00	3hrs 33mins
18/11/00	01:56	DO5	3	MARSTON	2.4	DNC	-

Italics = Warning based on observed levels

DNC = Did not cross threshold.

Figure 4.1

Threshold Lead Times - Probability Distribution

**TABLE 4.3 - ESTIMATED MINIMUM WARNING LEAD TIME TO ONSET OF PROPERTY FLOODING AT KEY LOCATIONS
SEVERN CATCHMENT, 29 OCTOBER TO 3 NOVEMBER EVENT**

DATE	TIME ISSUED	WARNING AREA REFERENCE	THRESHOLD (1,2,3,4,5)	REFERENCE GAUGE	WARNING THRESHOLD (M)	TIME OF EXCEEDENCE	FLOODED LOCATION	MINIMUM WARNING LEAD TIME
29/11/00	21:50	V2	2	LLANYMYNECH	4.3	02:30	Llanymynech	4hrs 40mins
30/11/00	00:31	S3	2	BUTTINGTON	5.1	06:15	Trewern	5hrs 44mins
30/11/00	06:59	S10	2	SAXONS LODGE	4.5	17:45	Upton	10hrs 46mins
30/10/00	07:07	S5	2	WELSH BRIDGE	3.5	20:30	Shrewsbury	13hrs 23mins
30/10/00	11:52	S7	1	BUILDWAS	4.5	16:00	Ironbridge	4hrs 8mins
30/10/00	12:02	S8	2	BEWDLEY	3.8	00:00 (31/10/00)	Bewdley	11hrs 58mins
30/11/00	23:18	S9	2	DIGLIS	4.4	03:30	Worcester	4hrs 12mins
02/11/00	09:41	S12F	2	GLOUCESTER	3.6	05:30	Gloucester	19hrs 49mins
03/11/00	10:07	S11	5	MYTHE	4.5	13:15	Tewkesbury	3hrs 8mins

TABLE 4.4 ESTIMATED MINIMUM WARNING LEAD TIME TO ONSET OF PROPERTY FLOODING AT KEY LOCATIONS
TRENT CATCHMENT. 5/6 NOVEMBER EVENT

DATE	TIME ISSUED	WARNING REFERENCE	THRESHOLD (1,2,3,4,5)	REFERENCE GAUGE	WARNING THRESHOLD	TIME OF EXCEEDENCE (M)	FLOODED LOCATION	MINIMUM WARNING LEAD TIME
05/11/00	01:49	DO2	5	LEEK	1.55	03:15	Leek/Cheddleton	1hr 26mins
06/11/00	12:38	SO8	3	KEGWORTH	100F	01:45	Zouch	13hrs 7mins
06/11/00	18:26	TR13	2	NORTH MUSKHAM	3.45	07/11 17:00	Girton	22hrs 34mins
06/11/00	20:13	SO7	3	PILLINGS	115.0F	07/11 05:15	Loughborough	9hrs 2mins
06/11/00	05:48	TR7	3	DRAKELOW	3.45	10:15	Burton	4hrs 27mins
06/11/00	06:05	TR12	4	COLWICK	4.8	05:30	Newark	8hrs 35mins
06/11/00	08:44	TR11	4	COLWICK	4.8	05:30	Gunthorpe	3hrs 14mins

Table 4.5

CATCHMENT	THRESHOLD LEAD TIME ACCURACY AND TIMELINESS 28/10/00 - 08/11/00													
	WARNING	ACCURACY = $\frac{\text{No of successes}}{\text{Total of Events}}$							TIMELINESS - Threshold Lead Times (Hrs)					
		ACTUAL LEVEL					Total Warnings	Overall Accuracy %	Post Flood	<2	2 - 4	4 - 6	6+	Modal Lead Time
		FW1	FW2	FW3	FW4	SEVERE								
UPPER TRENT	FW1	0	0	0	0	0	0	-	0	0	0	0	0	-
	FW2	0	36	0	0	0	36	100	11	4	5	6	10	6+
	FW3	0	2	20	0	0	22	91	3	5	3	3	6	6+
	FW4	0	0	3	0	0	3	0	0	0	0	0	0	-
	SEVERE	0	0	0	4	2	6	33	0	2	0	0	0	<2
LOWER TRENT	FW1	34	0	0	0	0	34	100	2	9	6	12	5	4-6
	FW2	2	23	0	0	0	25	92	6	5	4	3	5	Post
	FW3	0	2	11	0	0	13	85	0	3	3	1	4	6+
	FW4	0	0	3	6	0	9	66	2	0	1	0	3	6+
	SEVERE	0	0	0	4	5	9	55	0	2	1	0	2	<2/6+
UPPER SEVERN	FW1	23	0	0	0	0	23	100	2	6	6	2	7	6+
	FW2	3	17	0	0	0	20	85	4	3	2	3	5	6+
	FW3	0	0	10	0	0	10	100	1	0	0	2	7	6+
	FW4	0	0	0	0	0	0	-	0	0	0	0	0	-
	SEVERE	0	0	0	2	13	15	87	1	2	1	0	9	6+
LOWER SEVERN	FW1	25	0	0	0	0	25	100	0	4	4	5	12	6+
	FW2	0	17	0	0	0	17	100	1	4	3	3	6	6+
	FW3	0	2	3	0	0	5	60	1	1	1	0	0	Post/<2/2-4
	FW4	0	0	0	0	0	0	-	0	0	0	0	0	-
	SEVERE	0	0	0	1	6	7	86	0	0	1	0	5	6+
SEVERN & TRENT	FW1	82	0	0	0	0	82	100	4	19	16	19	24	6+
	FW2	5	93	0	0	0	98	95	22	16	14	15	26	6+
	FW3	0	8	44	0	0	52	85	5	9	7	6	18	6+
	FW4	0	0	6	6	0	12	50	2	0	1	0	3	6+
	SEVERE	0	0	0	11	25	36	69	1	5	3	0	16	6+

4.3 Number of Properties Receiving Warnings

Tables 4.6, 4.7 and 4.8 give a summary of estimated number of properties within designated Flood Warning Areas that received or did not receive a warning and by what method. Table 4.9 gives an abbreviated summary. Of the 1195 properties that are estimated to have flooded within designated Flood Warning Areas, 1110 received a Flood Warning and/or a Severe Flood Warning directly from the Agency via the AVM, a flood warden or loud hailer.

Of the 85 that are thought not to have received a direct warning:

24 had previously not responded to the Agency's invitation to subscribe to the warning service.

25 were not thought to be at risk.

36 properties were flooded behind the defences at Burton where a direct warning service is not operated.

People at places such as Burton and Gloucester may however, have taken action as a result of the warnings issued across the media which is the preferred dissemination method for the many thousands of properties at risk behind defences.

Direct Flood Warnings or Severe Flood Warnings were issued to nearly 2300 properties that were not then subsequently flooded. This will be due to one of three reasons:

Flood levels not reaching forecast flood levels (sometimes by only a matter of millimetres)

Warnings issued well in advance to ensure that recipients have sufficient time to take appropriate action.

Warnings are issued in bands to cover the range of flood level that the river is expected to reach. i.e. the first property within a flood warning area starts to flood when the river reaches 4.5m and the last property starts to flood when it reaches 4.8m. If the river reaches a level of 4.6m then not all of the properties within that Flood Warning Area will be flooded.

In addition many properties will have received indirect warnings via the media. An attempt to quantify these has been made in the following tables using the assumption that all residents behind defences where severe flood warnings were issued received a warning via the media. This is likely to be an overestimate. These are included in the Summary Table 4.9, but not in the detailed tables which refer to Direct Warnings only. An example of a location where this was particularly relevant was Burton on Trent where levels peaked just below the defence level. A severe flood warning had been issued and it is known that many of the 7500 properties defended took action.

A further 760 properties are estimated to have flooded within the Region that are either outside of a designated Flood Warning Area or were flooded by a source not covered by the warning service e.g. Surface water or sewage flooding. Flood Watch messages however, were issued via the media for the whole of the Region aimed at raising public awareness to the possibility of flooding from ANY watercourse and in particular those outside of designated Flood Warning Areas.

Table 4.6 Summary of people receiving warnings within designated Flood Warning Areas. Severn Basin.

Warning Area Reference	Location/Flood Warning Area	For areas where a Severe Flood warning was not issued, Estimated Number of properties that were.....			For areas where a Severe Flood warning was issued, Estimated Number of properties that were.....			Warning Methods used (tick as appropriate)					Comments			
		Flooded and received a Flood Warning	Flooded and did not receive a Flood Warning	not Flooded but did receive a Flood Warning	Flooded and received a Severe Flood Warning	Flooded and did not receive a Severe Flood Warning	Not flooded but received a severe Flood Warning	AVM	Wardens	Loud Hailer	Sirens	Door knocking	Media	Other		
UPPER SEVERN																
S1	Severn - Llandinam to Glandulais		2	2	4				X					x		Groundwater flooding
S2	Severn - Glandulais to Caerhowell		9	1	16				X					x		Groundwater flooding
S3	Severn - Caerhowell to Trewern					22	0	4	X					x		
S4	Severn - Poll Quay to Crew Green					29	0	3	X					x		
V1	Vymwy - Newbridge to Llansantffraid		4	0	0				X					x		
V2	Vymwy - Llansantffraid to Shrawardine					62	0	9	X	x				x		
	Area at Confluence of Severn & Vymwy					16	0	0	X					x		
S5	Shrewsbury & Montford Bridge					230	0	184	X	x	x			x		
S6	Severn - Atcham to Buildwas		0	0	0	0	0	0	X	x	x		x	x		
S7	Ironbridge					50	?	0	X					x		
S7	Bridgnorth					30	?	46	X	x				x		
S8	Other Locations					49	0	0	X					x		
S8	Bewdley					127	13	0	X		x			x		Occupiers offered service in the past but declined
S9	Worcester					80	0	0	X	x				x		
T1	Teme - Ludlow to Bransford Bridge					0	0	218	X					x		
T2	Teme - Bransford Bridge to Powick					9	0	0	X					x		
K1	Stour - Kidderminster								X					x		
	Upper Severn Totals		15	3	20	704	13	464								
	(England totals)		0	0	0	583	13	448								
	(Wales totals)		15	0	20	121	0	16								
LOWER SEVERN																
S10	Severn Tewk to Worcs -					99		105	X					x		
S11	Severn Glos to Tewk					41		78	X	x				x		
S12	Severn Glos area					40		431	X	x				x		
A1	Avon u/s Rugby		0		15				X	x				x		
A2	Avon Rugby to Warwick		1		65				X	x				x		
A3	Avon Warwick to u/s Stratford		0		16				X	x				x		
A4	Avon Stratford to u/s Evesham		0		13				X	x				x		
A5	Avon Evesham to u/s Tewkesbury		0		42				x	x				x		
A6	River Leam		3		11				x	x				x		
A7	River Stour		4		3				x	x				x		
A8	River Arrow		0		4				x	x				x		
	Lower Severn Totals		8	0	169	180	0	554								

Table 4.7 Summary of people receiving warnings within designated Flood Warning Areas. Upper Trent Area

Warning Area Reference	Location/Flood Warning Area	For areas where a Severe Flood warning was not issued, Estimated Number of properties that were.....			For areas where a Severe Flood warning was issued, Estimated Number of properties that were.....			Warning Methods used (tick as appropriate)							Comments
		Flooded and received a Flood Warning	Flooded and did not receive a Flood Warning	not Flooded but did receive a Flood Warning	Flooded and received a Severe Flood Warning	Flooded and did not receive a Severe Flood Warning	Not flooded but received a severe Flood Warning	AVM	Wardens	Loud Hailer	Sirens	Door knocking	Media	Other	
UPPER TRENT								x						X	
DO1	Izaak Walton to Rocester			48				X							
DO2	Leek to Rocester				23	6*	60	X				x	X		* Occupiers offered service in the past but declined.
DO3	Rocester to Doveridge	2		16				x						X	
DO4	Doveridge to Marston				14		23	X	X			x	X		
DO5	Marston to Clay Mills														
TE1	Tea- Upper Tea to Uttoxeter	8		31				x						X	
TR1	Stoke to Darlaston			45				X						X	
TR2	Penk- Penkridge to Stafford	3		90				X						X	
TR3	Sow- Great Bridgeford to Great Haywood	7		39				X						X	
TR4	Darlaston to Great Haywood			17				X						X	
TR5	Great Haywood to Yoxall	3		20				X						X	
TR6	Yoxall to Drakelow	4		75				X						X	
TR7	Drakelow to Clay Mills				4		13	X				x	X		
ME1	Mease- Clifton Campville to Harlaston			16				X						X	
TA1	Great Bridge to Bescot														
TA2	Bescot to Sandwell Valley														
TA3	Sandwell Valley to Perry Barr														
TA4	Perry Barr to Water Orton														
TA5	Cole- Shard End to Coleshill			13				X						x	
TA6	Blythe- Cheswick Green to Coleshill	1		13				X						X	
TA7	Water Orton to Lea Marston														
TA8	Lea Marston to Drayton Manor														
TA9	Anker- Nuneaton to Tamworth	1		18				x						X	
TA10	Drayton Manor to Hopwas														
TA11	Hopwas to Alrewas														
	Upper Trent Totals	29	0	441	41	6	96								

Table 4.8**Summary of people receiving warnings within designated Flood Warning Areas. Lower Trent Area**

Warning Area Reference	Location/Flood Warning Area	For areas where a Severe Flood warning was not issued, Estimated Number of properties that were.....			For areas where a Severe Flood warning was issued, Estimated Number of properties that were.....			Warning Methods used (tick as appropriate)							Comments
		Flooded and received a Flood Warning	Flooded and did not receive a Flood Warning	not Flooded but did receive a Flood Warning	Flooded and received a Severe Flood Warning	Flooded and did not receive a Severe Flood Warning	Not flooded but received a severe Flood Warning	AVM	Wardens	Loud Hailer	Sirens	Door knocking	Media	Other	
LOWER TRENT															
DE1	Bamford - Rowsley				0	0	34	x					x		
DE2	Buxton - Rowsley				10	0	140	x					x		
DE3	Rowsley - Ambergate				10		20	x					x		
DE5	Ambergate - Spondon				1	0	10	x					x		
DE6	Borrowash - Church Wilne				0	0	0	x					x		
TR8	Burton - C. Don				18		0	x					x		
TR9	C. Don - L. Eaton				6	0	2	x					x		
TR10	Toton - Colwick	6		12				x					x		
TR11	Colwick - Farndon	20	5	140				x					x		
TR12	Farndon - Cromwell	20	25#	10				x					x		#not thought at risk
TR13	Cromwell - Gains	20	0	0				x					x		
TR14	Gains - W. Stock	5	5#	1				x					x		#occupiers offered service in the past but declined
TR15	W. Stock - Trentfalls	0	0	0											
SO2	Gt Glen - Blaby	0	0	0				x					x		
SO3	Litt - Wanlip			2				x					x		
SO4	Stap - Asfordby			46				x					x		
SO5	Frisby - Syston	2		5				x					x		
SO6	Rothley Bk	0	0	0				x					x		
SO7	Coss - Cotes			9				x					x		
SO8	Cotes - Kegworth	15		13				x					x		
SO9	Kegworth - R. Trent	0	0	0				x					x		
	Lower Trent Totals	88	35	238	45	0	206								
	Totals for Midlands Region	140	38	868	925	19	1425								

Table 4.9 Flood Warning Summary of Performance

	Upper Severn	Lower Severn	Upper Trent	Lower Trent	Total
Number of properties flooded following a Flood Warning	15	8	29	88	140
Number of properties flooded without a Flood Warning	3	0	0	35	38
Number of properties not flooded but received a Flood Warning	20	169	441	238	868
Number of properties flooded following a Severe Flood Warning	704	180	41	45	970
Number of properties flooded without a Severe Flood Warning	13	0	6	0	19
Number of properties not flooded but received a Severe Flood Warning	2568	2833	7776	1562	14739

Table 4.10 - Use, effectiveness and reliability of AVM

AVM location	Number of recipients called	Total messages	Calls answered	Call No answer	Call busy	Number unobtainable	Other call failures	Calls answered (%)	Successful contacts (%)	Number of system breakdowns	Hours out of commission	Availability (% of event duration)
Shrewsbury	923	24430	10589	7388	1312	1526	1903	43%	87%	2	3	99
Tewkesbury	999	15198	7381	3587	681	1544	2005	49%	82%	0	0	100
Lichfield	550	5679	3557	1061	508	463	90	63%	89%*	1	2	99%
Nottingham	749	11906	7484	1812	943	428	1239	63%	91%	2	0.5	99.90%
Solihull	450	788	468	77	76	83	84	59%	98%	0	0	100
TOTAL	3671	58001	29479	13925	3520	4044	5321	51%	N/A	5	5.5	99%

*estimated

4.4 Effectiveness of Flood Warning Dissemination Methods

Flood Warnings were disseminated using a number of different methods during the event. The Automatic Voice Messaging (AVM) system is the primary method of dissemination in most locations and is also used to contact Flood Wardens for onward dissemination of the warnings in a number of locations. Multiple dissemination methods were employed wherever possible in order to maximise the number of people who heard or received warnings. For example, in Shrewsbury the first warnings were issued by the AVM to activate the Flood Warden Scheme and then Loudhailer vans were deployed to tour the streets at risk from flooding. The extent and severity of the flooding attracted a great deal of media coverage which also helped to alert those at risk and then provide regular updates.

In addition to members of the public, the AVM is also used to disseminate warnings to the Emergency Services, Local Authorities, Media and utility companies. There have been no reports of warnings not being received or these organisations not being aware of the situation in their Area. Comments have been received from professional partners (appendix F) about the content and advice contained on the Faxed warnings, in particular the advice of Flood Warnings to activate emergency procedures where such an action would be inappropriate or no procedures exist. A couple of Authorities have requested that Flood Warning updates are numbered sequentially so that it is immediately apparent at what stage the flood is at within the overall escalation of the event.

4.4.1 AVM

There are 5 AVM's in the Region, one in each area office and one at the Regional office. The Regional office AVM is used as a backup to the Area AVMs should they fail. Table 4.10 shows the use and reliability of the 5 AVMs used in the Region. 3671 people or organisations were contacted using AVM during the event. The majority of these recipients were contacted with voice, fax and/or pager messages for several warnings of varying severity. Consequently, almost 58,000 calls were made by the Region's AVMs, of which nearly 30,000 were answered. Although this suggests a success rate of only 50%, because most recipients have more than one contact number, the important statistic is the percentage of successful contacts—i.e. the proportion of recipients who actually received the warning through at least one number. Between 82% and 98% of recipients were successfully contacted using the AVM alone.

The reliability of the AVM system software and hardware is indicated by the “number of system breakdowns” and “hours out of commission” experienced during the event. 5 breakdowns were experienced resulting in 5.5 hours out of commission. The problems were reported and rectified by simply re-booting the machines. The regional backup machine was used whilst the area machine was out of commission.

4.4.2 Floodline and RMS

With the introduction of the new warning codes on September 12th, the Floodcall system operated by Cable and Wireless was replaced by RMS operated by BT in conjunction with the Floodline call centre. Both Floodline and RMS were inundated

with calls during the event and stood up well with no system breakdowns. Nationally, from 1st November to 20th November, 370,000 calls were made to Floodline, 300,000 of these requested the RMS service, 8,000 were put through to the Agency, 58,000 spoke with a Floodline operator and 4,000 ordered an information pack or listened to road information.

New RMS scripts conforming to the national template were used to record 2200 RMS messages on the system. Each message takes 5 to 10 minutes to write, record and check and so this took approximately 200 man hours of work within the Region during the event. This was clearly time well spent given the number of calls made to RMS, although the number of public calls made to each message box or to each Region is not currently recorded by the system.

A number of complaints were made by the public about RMS saying that messages were out of date. Messages were updated regularly by staff and revised whenever a new warning was issued. Early on in the event, however, it was taking in excess of 20 minutes for a message to be accessible by the public after it had been recorded. This was because messages could only be downloaded one at a time leading to queuing of messages particularly at busy times. BT added more portals later in the event so that more than one message could be downloaded at any one time. Some members of the public also complained that the messages were too long, alarmist and some times contradictory. The main reason for this claim is thought to be that the Flood Watch message for a general area is played after a flood warning or severe flood warning for a specific area. Consequently, the listener hears the detailed message and information for the specific location that they are interested in then hears a more general message covering a wider area. Often the two messages have been recorded at different times and therefore the caller hears a single message apparently recorded at different times.

As a result of comments made by the public during the event, the Floodline introductory message was modified to speed up and make access more reliable to the RMS service. This greatly reduced the number of problems reported with the service.

4.4.3 Other Methods

In addition to AVM and Floodline/RMS, Flood Warnings were disseminated using Flood Wardens, Loudhailers mounted on Agency Vans, door knocking, TV and Radio. The success of each of these methods individually and in combination can only be fully assessed using detailed Post Event Surveys that are not yet available. By using all of these methods in combination in designated Flood Warning Areas, the Agency has successfully alerted the at risk population, the general public and our professional partners prior to the onset of flooding.

Flood Warden Schemes continue to be a successful method of disseminating warnings in several locations, particularly along the River Severn. Relying on a Flood Warden to pass on Agency warnings does however, involve an element of risk as was experienced in one area of Shrewsbury. Both the Flood Warden and deputy were not in the area when the warning was issued and consequently the warning was not cascaded directly to the community. The success of the combination of indirect methods used to issue the warnings in the town ensured that the community was aware of the approaching flood.

A direct warning service (AVM, Flood Warden etc.) is not provided to homes and businesses in large urban areas that are at risk from flooding but protected by flood defences, such as Burton Upon Trent and Nottingham. When the flood defences may be overtopped or breached and a Severe Flood Warning is issued then the lead times available allow the warnings to be disseminated using Loudhailer vans, TV, Radio and door knocking by Agency staff or, by local agreement, the Police. This was the case at Burton Upon Trent where the River Trent came very close to overtopping the 100 year defences that protect 6000 properties. The issue of the Severe Flood Warning triggered the activation of the Burton Major Flood Incident Plan that led to an all agency response to alert the town to the approaching flood. Local TV and Radio bulletins alerted the town in general to the risk and door knocking and loud hailer vans were used to warn those people and properties that were at most risk. The town centre was evacuated and shops and businesses closed early. There were reports of householders moving valuables upstairs and sandbagging of properties most at risk. The action that was taken by the people of the town suggests that the warning was disseminated and received effectively and that therefore an AVM or Flood Warden Scheme is not appropriate in these circumstances. Post Event Surveys are again necessary to confirm this assumption.

4.5 Issues Arising

- Warning lead times and accuracy
- Flooded properties within flood warning areas not receiving warnings
- Effectiveness of Flood Watch message for flooded properties outside of flood warning areas
- Effectiveness of various flood warning dissemination techniques and content of fax messages.
- Reliability of AVM system
- RMS scripts and updating messages

4.6 Recommendations

- Investigate sites with poor lead time or accuracy and identify forecasting and/or warning improvements. Identify sites where the 2-hour lead time is not technically possible and set an appropriate target lead time.
- Offer warning service to properties that were flooded but did not receive a warning within Flood Warning Areas.
- For locations that were flooded outside of designated flood warning areas, identify where a prior warning is feasible and include in the Regional programme of Flood Warning Improvements. Use the results of Post Event Surveys to assess the effectiveness of the "Flood Watch only" service outside of designated flood warning areas.
- Use the results of Post Event Surveys to assess the effectiveness of the various warning dissemination methods particularly for large urban areas behind defences. Continue to use multiple dissemination methods for maximum benefit.
- Review content and advice given on faxed flood warnings to partner organisations.

- Reliability of AVM hardware and software is still in question. System suppliers (Kingston Voiceware) to rectify problems encountered during event and replace Shrewsbury AVM, which continues to suffer from frequent breakdowns.
- National RMS script to be revised to reduce overall message length and to make content less alarmist. Messages need to be downloaded onto the system quicker. Regional breakdown of call statistics is required so effort can be targeted to message boxes with the greatest demand.

CHAPTER 5-EVENT IMPACT

5.1 Introduction

- 5.1.1 This event was notable for both its severity and the fact that it impacted not only on most of Midlands Region but also other parts of the country including the South West, the South Coast and also parts of Yorkshire and Wales.
- 5.1.2 The consequence of the relatively prolonged and widespread nature and of this event was severe disruption to road and rail communications as well as the direct flooding impact on very many homes, businesses and communities.
- 5.1.3 All four Areas of Midlands Region were affected.

5.2 Event Hydrology

5.2.1 Rainfall

The rainfall totals for each raingauge across the region can be found in Table 5.1

Figure 5.1 is an isohyet map showing the amount of rainfall that fell across the region for the period 28th October to 11th November 2000. Very high totals were recorded in the Welsh Mountains and the headwaters of the River Derwent.

Table 5.2 shows rainfall return periods during the event. Rainfall totals over the period 28th October to 5th November in the Peak District reached a maximum of 1 in 70 years and those in the Welsh Mountains a maximum of 1 in 60 years.

Over the extended period 28th October to 11th November, rainfall totals reached a maximum in the Peak District of 1 in 70 years and in the Welsh Mountains a maximum of 1 in 100 years.

The highest rainfall totals in the Welsh Mountains over one day fell at Dolydd, which received 79.5mm. In the Peak District the highest one-day total was 68.5mm at Derwent Dam.

Table 5.1

Welsh Mountains

	28-Oct	29-Oct	30-Oct	31-Oct	01-Nov	02-Nov	03-Nov	04-Nov	05-Nov	06-Nov	07-Nov	TOTALS
Llangynog	37.0	60.5	19.5	11.0	5.0	12.0	4.5	1.0	62.5	3.5	14.5	231.0
Vyrnwy	32.0	59.0	25.5	11.5	3.5	8.5	9.0	0.5	46.5	2.5	4.5	203.0
Llanfyllin	19.5	56.0	20.0	12.0	2.0	9.5	2.5	0.0	43.0	2.0	5.5	172.0
Pen-y-Coed	32.5	66.5	34.5	20.0	6.0	7.5	11.0	2.0	51.0	1.5	3.5	236.0
Cefn Coch	16.5	56.5	1.0	1.0	6.0	13.5	11.5	0.5	33.5	1.5	6.5	148.0
Caersws	18.0	43.5	22.0	7.0	4.0	10.0	6.5	0.0	22.0	4.0	3.0	140.0
Dolydd	33.0	79.5	47.0	21.5	15.0	15.0	11.5	3.5	36.0	1.0	1.5	264.5
Nantgwyn	31.0	46.0	19.0	8.5	7.0	15.0	8.0	1.0	27.5	4.0	3.5	170.5
Cyninon	20.5	45.0	16.0	5.0	3.0	10.5	1.5	0.0	42.0	7.0	10.5	161.0
Sarn	24.0	44.0	17.5	3.5	1.5	9.5	3.0	0.0	30.0	7.5	1.5	142.0
TOTALS	264.0	556.5	222.0	101.0	53.0	111.0	69.0	8.5	394.0	34.5	54.5	

Welsh and Shropshire Hills

	28-Oct	29-Oct	30-Oct	31-Oct	01-Nov	02-Nov	03-Nov	04-Nov	05-Nov	06-Nov	07-Nov	TOTALS
Bagley	10.5	42.5	12.0	5.5	0.5	3.5	1.0	0.5	39.0	6.5	4.0	125.5
Monkmoor	8.0	33.5	10.0	3.0	0.5	3.0	1.0	0.5	28.5	8.5	1.0	97.5
Welshpool	13.5	44.5	15.5	10.5	3.0	5.5	1.5	0.0	27.0	8.0	1.0	130.0
Rorrington	16.5	30.5	16.0	6.5	3.0	5.5	1.5	0.0	27.0	11.5	1.0	119.0
Walkmills	19.0	51.0	20.0	2.5	4.5	8.0	2.0	0.0	30.0	16.5	1.0	154.5
Bishops Castle	21.0	47.0	11.0	3.0	3.0	7.0	0.5	0.0	37.0	11.5	2.0	143.0
Bettws-y-Crywn	26.5	50.0	15.5	5.5	4.5	10.0	3.0	0.5	33.0	12.0	4.0	164.5
Wiley	13.5	33.5	13.0	0.5	2.0	5.5	0.5	0.0	36.0	12.0	4.0	120.5
Trimpley	10.0	32.5	2.5	0.5	0.5	9.0	0.0	0.0	30.0	9.0	7.5	101.5
Rhos-y-Meirch	19.5	46.5	10.5	6.0	2.5	9.0	2.5	0.0	43.0	13.5	2.0	155.0
TOTALS	158.0	411.5	126.0	43.5	24.0	66.0	13.5	1.5	330.5	109.0	27.5	

Severn Lowlands

	28-Oct	29-Oct	30-Oct	31-Oct	01-Nov	02-Nov	03-Nov	04-Nov	05-Nov	06-Nov	07-Nov	TOTALS
Prees	9.0	35.0	9.0	2.5	1.5	5.0	4.5	0.5	33.0	6.5	4.5	111.0
Ercall	6.0	31.5	6.5	2.0	0.5	4.5	4.0	0.5	33.0	8.5	2.0	99.0
Rushmoor	7.5	31.5	7.5	2.5	1.0	4.0	1.5	0.5	40.0	9.0	1.0	106.0
Cosford	15.5	29.5	9.0	0.0	0.5	10.5	0.0	0.5	39.5	10.0	7.0	122.0
Bratch	10.5	29.5	5.0	0.5	2.0	10.5	0.0	0.0	40.5	10.5	0.0	109.0
Lye	11.0	31.5	1.5	0.0	1.0	11.0	0.5	0.0	38.5	0.0	4.5	99.5
Hartlebury	9.0	32.0	3.0	1.0	0.5	10.5	0.0	0.0	28.5	4.0	4.0	92.5
Langley	14.5	29.5	6.5	5.0	0.0	11.5	0.0	0.5	19.5	6.5	2.5	96.0
Dowdeswell	20.0	42.5	4.0	3.5	0.5	22.0	0.0	0.0	31.5	8.5	4.5	137.0
Kingswood	19.5	48.5	8.0	11.5	3.0	26.5	0.0	0.0	21.0	6.0	2.0	146.0
Milcote	8.5	28.0	3.5	1.0	0.5	15.5	0.0	0.0	15.5	2.5	1.0	76.0
Bickley	14.0	34.5	2.5	1.5	1.0	4.0	0.5	0.0	38.0	12.5	4.0	112.5
Ditton Priors	18.0	38.0	3.0	0.5	4.0	6.5	0.5	0.0	35.5	14.5	3.0	123.5
Ledbury	11.0	42.5	9.5	1.5	0.0	7.0	0.5	0.0	28.5	6.0	2.0	108.5
Crowle	9.0	39.5	5.0	1.0	0.0	16.5	1.0	0.0	22.0	2.5	1.5	98.0
Alvechurch	10.0	32.0	3.0	0.0	1.0	20.0	0.5	0.5	27.5	5.0	2.5	102.0
Henley	9.0	30.5	2.5	0.0	0.5	17.5	0.0	0.0	23.0	1.5	2.5	87.0
Sheriffs Lench	14.5	36.0	7.0	0.5	1.5	12.5	0.5	0.0	15.0	2.5	1.0	91.0
Miserden	21.5	51.0	5.0	11.5	1.0	30.5	1.0	0.0	33.0	6.0	6.0	166.5
Longford	14.5	37.5	10.0	4.5	0.5	11.5	0.0	0.0	25.5	4.0	0.5	108.5
TOTALS	252.5	710.5	111.0	50.5	20.5	257.5	15.0	3.0	588.5	126.5	56.0	

Avon and Soar Headwaters

	28-Oct	29-Oct	30-Oct	31-Oct	01-Nov	02-Nov	03-Nov	04-Nov	05-Nov	06-Nov	07-Nov	TOTALS
Shipston	10.5	31.0	1.5	2.5	0.0	10.0	0.0	0.0	18.5	3.5	1.5	79.0
Wellesbourne	6.5	25.0	2.5	2.5	1.0	12.5	0.5	0.0	14.0	3.5	1.5	69.5

Figure 5.1

RAINFALL TOTALS OVER THE PERIOD 28/10/00 - 11/11/00 (09:00)

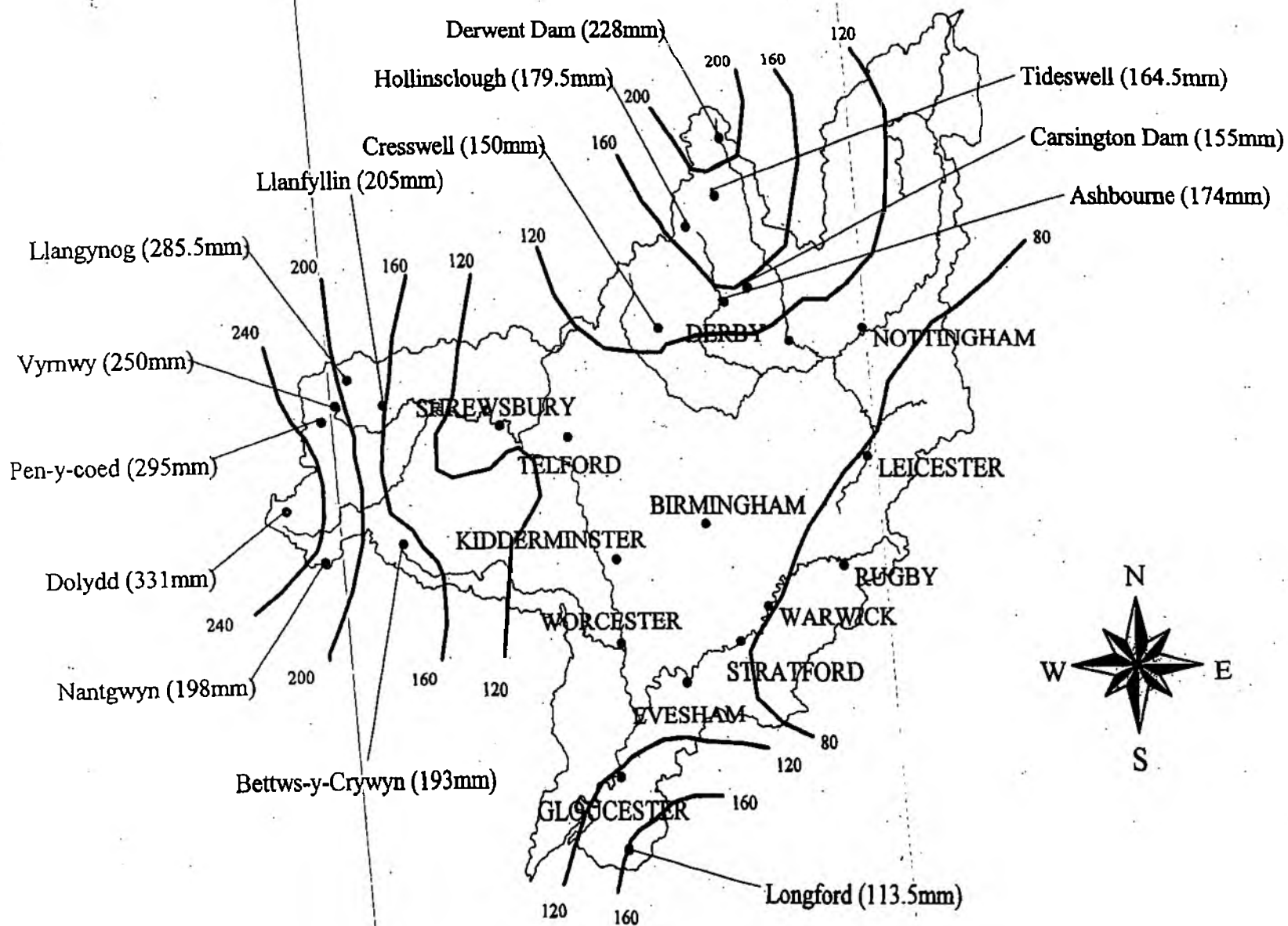


Table 5.2

**RETURN PERIODS FOR SELECTED RAINGAUGES
FOR THE 9-DAY RAINFALL 28/10/00 - 05/11/00**

RAINGAUGE	RAINFALL (mm)	RETURN PERIOD
Dolydd	260	1:29
Nantgwyn	167	1:36
Vyrnwy	196.5	1:13
Pen-y-coed	232	1:49
Llanfyllin	165	1:63
Llangynog	215.5	1:17
Derwent Dam	160	1:16
Tideswell	123	1:10
Longford	104	1:25
Bettws-y-Crywyn	148	1:43
Cresswell	130.5	1:65
Carsington Dam	120	1:24
Hollinsclough	158	1:30
Ashbourne	136.5	1:31

**RETURN PERIODS FOR SELECTED RAINGAUGES
FOR THE 15-DAY RAINFALL 28/10/00 - 11/11/00**

RAINGAUGE	RAINFALL (mm)	RETURN PERIOD
Dolydd	331	1:55
Nantgwyn	198	1:42
Vyrnwy	250	1:21
Pen-y-coed	295	1:106
Llanfyllin	205	1:106
Llangynog	285.5	1:40
Derwent Dam	228	1:70
Tideswell	164.5	1:23
Longford	113.5	1:25
Bettws-y-Crywyn	193	1:105
Cresswell	150	1:71
Carsington Dam	155	1:57
Hollinsclough	179.5	1:29
Ashbourne	174	1:61

5.2.2 River Flows

Table 5.3 shows the estimated return periods for levels reached in the Severn and Trent basins. At the top of the Rivers Severn and Vyrnwy the return periods are unexceptional, however nearer to the Vyrnwy confluence, return periods rise dramatically to estimates of between 35 and 90 years. Downstream of the confluence, Montford return periods are estimated as exceeding 1 in 100 years. Along the Middle Severn return periods ranged from 25 to 100 years. Lower Severn levels were estimated as 1 in 20-55 years. Levels at Gloucester were estimated as having a return period of 1 in 5-15 years. Levels on the Leam and the Avon were unexceptional with return periods estimated as 1 in 2-5 years. Return periods on the Teme at Tenbury were between 10-20 years.

In the Trent Basin the highest return periods are estimated on the River Derwent at Church Wilne and Derby St Mary's. High return periods are also estimated for the River Trent at Shardlow and Drakelow and the River Blythe at Castle Farm. The head of the River Dove recorded levels estimated as 1 in 20 years as a maximum, whilst further downstream near the Dove confluence levels are estimated as 1 in 30-40 years. The head of the River Derwent return periods are estimated as 1 in 45 years as a maximum; whilst further downstream near the Derwent confluence return periods are estimated as 1 in 80 to in excess of 100 years. Levels on the Soar and Manifold were unexceptional. In the lower reaches of the Trent the return period is estimated to be 1 in 55-65 years. Levels on the River Sow are estimated to be between 1 in 15-25 years.

Ranges in the return periods quoted vary in size because of differences in length of record. Stations like Bewdley and Gloucester have a very long record, whereas records for Bridgnorth and Derby St Mary's have a relatively short record. A short record leads to poor distribution and fitting of the flood frequency curve at high levels which means that there is more uncertainty involved when estimating the return periods.

Tidal surge predictions for Avonmouth and Immingham are summarised in Table 5.4

Table 5.3

**RETURN PERIODS FOR SEVERN AND TRENT BASIN
OCTOBER/NOVEMBER 2000**

RIVER	STATION	PEAK LEVEL	PEAK FLOW	DATE	TIME	RETURN PERIOD	HIGHEST SINCE
CLYWEDOG	BRYNTAIL	0.929	-	05-Nov	06:45	<MAF	02-Mar-99
SEVERN	CAERSWS	3.452	-	30-Oct	07:30	2 - 5	01-Mar-99
SEVERN	ABERMULE	3.976	-	30-Oct	07:45	5 - 10	01-Mar-99
SEVERN	BUTTINGTON	5.496	-	30-Oct	15:45	35 - 45	HOR (1981)
VYRNWY	VYRNWY WEIR	1.593	-	29-Oct	06:00	5 - 10	25-Jan-90
VYRNWY	MEIFOD	3.483	-	29-Oct	08:00	4 - 6	31-Jan-83
VYRNWY	LLANYMYNECH	4.884	-	30-Oct	13:45	75 - 85	HOR (1970)
SEVERN	CREW GREEN	6.566	-	31-Oct	21:15	80 - 90	HOR (1984)
SEVERN	MONTFORD	6.96	475	01-Nov	01:15	>1 in 100	HOR (1954)
SEVERN	WELSH BRIDGE	5.252	-	01-Nov	10:15	55 - 65	21-Mar-47
SEVERN	BUILDWAS	7.019	-	01-Nov	22:15	25 - 35	HOR (1986)
SEVERN	BRIDGNORTH	5.259	-	02-Nov	02:00	80 - 100	HOR (1986)
SEVERN	BEWDLEY	5.563	-	02-Nov	11:00	50 - 70	21-Mar-47
SEVERN	DIGLIS	5.06	-	03-Nov	08:15	25 - 35	25-Jan-60
SEVERN	SAXONS LODGE	5.391	506.94	03-Nov	09:45	45 - 55	HOR (1972)
SEVERN	HAW BRIDGE	5.479	-	09-Nov	13:15	20 - 30	01-Jan-47
SEVERN	MYTHE	4.578	-	08-Nov	05:15	20 - 30	HOR (1972)
SEVERN	GLOUCESTER	4.408	-	09-Nov	20:15	5 - 15	21-Mar-47
AVON	RUGBY	3.313	73.6	06-Nov	17:15	2 - 5	10-Jan-98
LEAM	EATHORPE	2.489	40.56	30-Oct	23:00	2 - 5	10-Apr-98
TEME	TENBURY	5.077	-	30-Oct	03:45	10 - 20	28-Jan-90

RIVER	STATION	PEAK LEVEL	PEAK FLOW	DATE	TIME	RETURN PERIOD	HIGHEST SINCE
BLYTHE	CASTLE FARM	2.202	-	30-Oct	21:15	70 - 80	HOR (1987)
DOVE	IZAAK WALTON	1.457	-	06-Nov	09:45	15 - 20	23-Oct-98
MANIFOLD	ILAM	1.995	-	06-Nov	09:15	5 - 10	23-Oct-98
DOVE	ROCESTER	1.991	-	06-Nov	12:15	15 - 20	25-Jan-95
CHURNET	BASFORD BR.	2.588	-	06-Nov	11:15	25 - 35	23-Aug-87
DOVE	DOVERIDGE	2.913	-	06-Nov	13:45	15 - 20	1965
DOVE	MARSTON	2.698	-	06-Nov	18:15	30 - 40	HOR (1969)
TRENT	SHARDLOW	3.455	591	07-Nov	12:30	80 - 90	HOR (1959)
DERWENT	CHATSWORTH	4.703	-	06-Nov	13:30	30 - 40	1965
TRENT	DRAKELOW	3.791	-	07-Nov	19:30	60 - 80	HOR (1960)
WYE	ASHFORD	1.267	-	06-Nov	12:15	10 - 20	27-Oct-98
DERWENT	MATLOCK	4.62	346	06-Nov	19:00	35 - 45	1965
DERWENT	CHURCH WILNE	2.515	-	07-Nov	07:15	> 1 in 100	HOR (1974)
DERWENT	DERBY ST MARY	3.213	294	07-Nov	05:15	80 - 100	HOR (1983)
SOAR	LITTLETHORPE	2.506	30	06-Nov	22:30	5 - 10	30-Dec-81

TABLE 5.4 - TIDE AND SURGE FORECASTS

Date 24 hrs from 00:01 to 24:00 GMT on	AVONMOUTH Predicted High mAOD	HT Surge Forecast mAPT	AVONMOUTH Actual High mAOD	SHARPNESS Predicted High mAOD	IMMINGHAM Predicted High mAOD	HT Surge Forecast mAPT	KEADBY Predicted High mAOD
28/10/00	13.8	0.03	13.55	9.4	3.6	0.16	4.7
28/10/00	13.8	0.64	14.09	9.4	3.4	Neg	4.4
29/10/00	13.5	0.48	13.62	9.1	3.6	Neg	4.6
29/10/00	13.4	0.42	13.29	9.0	3.4	Neg	4.4
30/10/00	13.1	0.45	12.99	8.7	3.4	0.47	4.4
30/10/00	12.8	0.36	0.11	8.4	3.2	Neg	4.2
31/10/00	12.5	0.19	0.45	8.0	3.1	0.23	4.1
31/10/00	12.1	0.48	12.63	7.6	3.0	Neg	3.9
01/11/00	11.8	0.42	12.33	7.3	2.7	Neg	3.6
01/11/00	11.4	0.31	11.67	6.8	2.7	Neg	3.6
02/11/00	11.1	0.39	11.8	6.5	2.3	0.19	3.1
02/11/00	10.7	0.45	11.05	6.1	2.4	Neg	3.2
03/11/00	10.4	0.17	10.53	5.7	1.9	0.09	2.6
03/11/00	10.0	0.23	10.00	5.3	2.0	0.14	2.8

Date 24 hrs from 00:01 to 24:00 GMT on	AVONMOUTH Predicted High mAOD	HT Surge Forecast MAPT	AVONMOUTH Actual High mAOD	SHARPNESS Predicted High mAOD	IMMINGHAM Predicted High mAOD	HT Surge Forecast MAPT	KEADBY Predicted High mAOD
04/11/00	9.7	0.11	9.81	5.0	1.6	0.00	
04/11/00	9.2	0.05	9.36		1.8	Neg	2.2
05/11/00	9.1	0.06	0.05	4.4		0.03	2.4
05/11/00		0.17	9.38	4.3	1.5	0.3	2.1
06/11/00	9.0	0.33	9.61	4.2	1.7	0.27	2.4
06/11/00	9.5	0.00	9.65	4.8	1.7	Neg	2.3
07/11/00	9.7	0.20	10.06	5.0	1.9	0.09	2.6
07/11/00	10.4	0.25	10.96	5.7	2.0	Neg	2.8
08/11/00	10.7	0.25	11.41	6.1	2.3	Neg	3.1
08/11/00	11.4	0.31	11.97	6.8	2.4	Neg	3.2
09/11/00	11.7	0.17	12.12	7.2	2.7	Neg	3.6
09/11/00	12.2	0.11	12.63	7.7	2.8	Neg	3.6
10/11/00	12.5	0.02	12.59	8.0	3.0	Neg	4.0
10/11/00	12.8	0.16	13.21	8.4	3.0	Neg	4.0

Date 24 hrs from 00:01 to 24:00 GMT on	AVONMOUTH Predicted High mAOD		HT Surge Forecast MAPT	AVONMOUTH Actual High mAOD	SHARPNESS Predicted High mAOD	IMMINGHAM Predicted High mAOD	HT Surge Forecast MAPT	KEADBY Predicted High mAOD
11/11/00	13.0		0.27	13.27	8.6	3.3	Neg	4.3
11/11/00	13.2		0.28	13.64	8.8	3.3	Neg	4.2
12/10/00	13.4		0.25	13.66	9.0	3.5	Neg	4.5
12/11/00	13.5		0.25	13.92	9.1	3.4	Neg	4.4
13/11/00	13.5		0.17	13.89	9.1	3.6	Neg	4.7
13/11/00	13.5		0.17	13.91	9.1	3.5	Neg	4.5
14/11/00	13.5		0.09	13.70	9.1	3.6	Neg	4.7
14/11/00	13.3		0.05	13.53	8.9	3.4	Neg	4.4
15/11/00	13.2		0.05	13.92	8.8	3.5	Neg	4.5
15/11/00	12.9		0.28	13.25	8.5	3.2	Neg	4.2

5.3 Properties & Infrastructure Affected by Flooding

5.3.1 Details of property and infrastructure flooding in each of the four Areas of Midlands Region are included in the attached tables.

5.3.2 In Upper Severn Area all the major watercourses were affected resulting in flooding to many undefended communities. An earth bank failed on the River Roden upstream of Wem and will need to be repaired. The 1 in 100 year defences at Newtown (Powys) performed appropriately and no problems were reported for the town. None of the other riverside communities on the Rivers Severn and Vyrnwy in the Area have formal flood defences except for the 1 in 5 year argaes in the confluence area

In particular, the following currently undefended towns were affected in Upper Severn area:

Shrewsbury – a possible flood defence scheme is being resurrected involving the use of demountable defences.

Ironbridge – feasibility work will be undertaken but an economically viable scheme is unlikely

Bridgnorth – Feasibility work will be undertaken

Bewdley – A flood defence scheme involving the use of demountable defences is being prepared.

Worcester – feasibility work will be undertaken.

Kidderminster – A scheme involving upstream balancing of flows is well advanced.

5.3.3 In Lower Severn Area the flooding was essentially fluvial and mainly affected the River Severn between Gloucester and the River Teme confluence (Lower Severn Area boundary). There was some tidal influence on flood levels near to Gloucester. The event was not particularly significant in the River Avon catchment.

None of the towns and villages between Worcester and Gloucester have any major formal raised defences although minor 1 in 5-year banks do exist to reduce the frequency of flooding at many locations.

In particular, the following currently undefended towns were affected in Lower Severn area:

Gloucester - A feasibility study is planned.

Tewkesbury - Flood defences are not viable but control of flood plain development is essential so that flood storage is not reduced.

Kempsey - A feasibility study is in progress.

Upton on Severn - Flood defences are not viable, a feasibility study was completed in 1995.

5.3.4 In Upper Trent Area the worst affected areas were Stafford (Rivers Sow and Penk), Burton on Trent, Uttoxeter (River Tean), Leek (River Churnet) and villages in the River Dove valley. Agency defences were just overtopped at Burton upon Trent although only a relative small number of the 7,400 potentially at risk properties were actually affected. At Leek the flood relief channel was insufficient to prevent flooding to properties. In the Dove valley, the defences along Foston Brook were overtopped resulting in flooding to properties at Hatton and Scropton.

5.3.5 In Lower Trent Area the worst affected areas were the River Derwent valley, the River Erewash (eg Ilkeston), the lower reaches of the River Soar (eg Zouch), the middle reaches of the River Trent from upstream of Nottingham down to Newark (eg Gunthorpe, and Newark) and in the tidal reaches down to Gainsborough (eg Gorton). Flooding was prevented at Torksey Lock by emergency raising of the defences with sandbags.

Agency defences failed or were exceeded at five locations in Lower Trent Area as follows:

River Soar at Quorn – leaking flood defence wall. Remedial works are programmed.

River Trent at Attenborough – 50 year Defences were overtopped.

River Trent at Farndon – 50 year Defences were overtopped.

River Derwent at Matlock – Wall partially collapsed due to flood flows undermining foundations. Emergency repairs instigated.

River Derwent at Langley Mill -

5.4 Issues and Recommendations

5.4.1 In the Severn valley, flooding over the last few years seems to residents to have become a much more frequent and devastating experience than it was in the past. Whereas they were resigned to occasional flood events the current trend of almost regular annual events has become unacceptable. There is considerable pressure upon the Agency and the Government to progress Flood Defence works. There is growing concern amongst those affected that the methods of economic appraisal of the benefits of flood defences are flawed and that either changes are needed to these methods or there needs to be a modification of Treasury rules to enable schemes to progress. Under the current rules, the urgently needed schemes at Bewdley and Shrewsbury may not progress if sufficient benefits can not be identified to offset the costs.

5.4.2 In feasibility studies for schemes there is a need to include benefits relating to the human impact of floods and to look at the economic effects on the local community and not just on the country.

5.4.3 In many parts of the River Severn valley, the impact on the local agricultural community was large and this flood is likely to have severe adverse effects on the local economy and affect employment in an area that still relies heavily on agriculture.

- 5.4.4 Businesses in the riverside towns and villages in the River Severn valley rely on tourism and may not be back in business in time to benefit from visitors in the first part of the year 2000.
- 5.4.5 In the Stroud valleys there was some property flooding along most of the tributaries of the River Frome and on the main river itself. There is currently no targeted flood warning scheme for the Frome, as its response rate is very quick. Some of the flooding may have been exacerbated by the operation (or in some cases non-operation) of sluices by their third party owners. The Agency has no responsibility for these sluices but is working with the Local Authority to raise the issue with the sluice owners. There are well over 100 former mill sites in the valley so it is a significant local problem.
- 5.4.6 At Berkeley road flooding cut off the egress from the nuclear power station causing 650 staff to be unable to get home overnight.
- 5.4.7 At Burton on Trent, the defences were generally sufficient but investigation will be needed to assess whether further enhancements are appropriate.
- 5.4.8 Investigations will be needed into the precise sequence of events in the Dove Valley where Agency defences were overtopped. Capital improvements may be necessary if the standard of protection is less than previously thought.
- 5.4.9 In Lower Trent Area, the Agency's flood defences generally performed well and prevented even more serious flooding from occurring. Nevertheless the possibility of a need to improve the tidal defences as well as to construct new defences to protect undefended communities should be investigated.

5.5 **Tables**
See next pages

Location of Flooding	Source of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
LOWER SEVERN AREA										
RIVER SEVERN										
S10 D/S Worcester	M	3	99	0	0	0	0	0	0	B4211, Hanley Rd
to U/S Tewkesbury										A38
Total includes:										A4104 Upton
Callow End			3							
Clifton/Severn Stoke			8							
Kempsey			20							
Upton			50							
Ripple			3							
Bushley			2							
Pixham			3							
Cleavelode			2							
Hanley Castle			4							
Uckinghall			3							
Rhydd			1							
S11 U/S Tewkesbury	M	10	41	15	0	0	0	0	0	A38, B4123
to U/S Ashleworth										
Total includes:										
Tewkesbury			10							
Deerhurst			2							
Ashleworth Quay & Ashleworth			8							
Apperley			6							

[illegible]

SEVERN TRIBS											
Frome	M	2	6								
Slad/Painswick/Nailsworth	OWC	4	20								
Little Avon - Berkeley & Charfield	M		7								Berkeley PS access
Lyd			9								
Leadon			1								
Cam/Wicksters			2								
Thornbury			2								
Oldbury on Severn			6								
Slimbridge			3								
Blakeney	OWC		4								
Bream	OWC		1								
Churcham	OWC		1								
Cinderford	OWC		1								
Drybrook	OWC		15								
Pendock	OWC		1								
Redmarley	OWC		3								
Staunton	OWC		6								
Yorkley	OWC		1								
Awre	OWC		1								

NOTES:

1) * Estimate of properties which did not flood but would have done without the defences
2) Return period of River Avon flood was not as great as River Severn flood, and was considerably less than Easter 1998 event

Location of Flooding	Source of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
UPPER SEVERN AREA (Welsh locations)										
RIVER SEVERN										
S1 Llandinam to Glandulais	M	4	4	80	0	0	0	0	0	A489
S2 Glandulais to Caerhowel	M	4	10	200						A488
S3 Caerhowel to Trewern	M	4	22				1		1	Railway, A483
S4 Pool Quay to Crew Green	M	4	29				1		1	
RIVER VYRNWY										
V1 New Bridge to Llansantffraid	M	4	4	135			1		1	
V2 Llansantffraid to Llanymynech	M	4	6							
V2/S4 Llandrinio	M	5	16							
Pont Llogel to Pontrobert	M	3	2							
Afon Cain - Llanfyllin	M	3	17							
Afon Cain - Llanfechain	M	2	9							
River Tanat – Llangynog to Llanyblodwel	M	2	13	20						
The Mule – Kerry	N	1	12							
River Camlad – Churchstoke	M	1	2							
River Lledan - Welshpool	N	1	7							

Location of Flooding UPPER SEVERN AREA (English Locations)	Source of Flooding Main/Non Main/Sea	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
River Vyrnwy										
V2 Llanymynech to Shrawardine	M	5	62				1		1	
River Severn										
S5 Shrawardine to Atcham	M	10	234							
Total includes:										
Montford Bridge	M	10	4							B4380
Shrewsbury	M	10	230							All access routes to town centre except
S6 Atcham to Buildwas	M	>50								B4380 @ Atcham & Cressage
S7 Buildwas to Highley	M	11	90							
Total includes:										
Ironbridge	M	11	50							B4380 @ Buildwas, A4169 @ Ironbridge
Bridgnorth	M	4	30							A442 @ Fort Pendlestone
Others	M	11	10							
S8 Upper Arley to Bevere	M	10	190							
Total includes:										
Bewdley	M	10	140							B4195 Bewdley, B4194 Ribbesford
Others	M	10	50							B4196 Louchford
S9 Worcester	M	9	80							A443, A449 & A44

UPPER SEVERN AREA (Welsh Locations) Cont'd										
River Temc - Knighton	N	1	5							
Bechan Brook - Bettws	N	3	4							
Welshpool	Surface Water	1	7							

Location of Flooding UPPER SEVERN AREA (English Locations) Cont'd	Source of Flooding Main/Non Main/Sea	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
River Teme										
T1 Ludlow to Bransford	M	2	2							
T2 Bransford to Powick	M	6	9							A4103 Bransford Br
River Morda	M & N	2	5							
River Perry	M	2	3							
Rea Brook	M	1	2							
Pontesbury	Surface Water	1	4							
Westbury	N	1	5							
Yockleton	N	1	1							
Lakemoor Brook	N	1	1							
Shawbury	Surface Water	1	1							
Wesley Brook - Shifnal	N	1	2							
Meir Brook	N	1	1							
Smestow Brook - Wombourne, Smestow	N	5	4							
River Stour - Various Locations	N	2	6							
Bromsgrove	N	1	1							
River Clun - Various Locations	N	8	17							A488 at Clun
River Kemp	N	2	10							
River Onny - Horderley	N	2	1							
River Corve	N	1	1							
River Teme - Leintwardine	N	1	1							A4113,A4110

Location of Flooding UPPER SEVERN AREA (Caravans & Chalets)	Source of Flooding Main/Non Main/Sea	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
Wales										
R Severn - Abermule	M		6							
- Garthmyl	M		8							
- Cilcewydd	M		6							
R. Banwy - Foel	M		5							
- Cyfronwydd	M		5							
R. Tanat - Llangynog	M		6							
- Bryn Tanat	M		7							
R. Vyrnwy - Trederwen	M		13							
England										
R. Severn - Coalport	M		4							
- Bridgnorth	M		200							
- Quayford (2 sites)	M		69							
- Hampton Loade	M		5							
- Bewdley	M		4							
- Lickhill	M		22							
- Stourport (4 sites)	M		505							
- Larford Farm	M		30							
-Astley	M		5							
- Lenchford	M		30							
- Holt	M		43							
- Hawford	M		20							
- Beverc	M		4							
R. Teme - Stanford Bridge	M		10							

Location of Flooding	Source of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
LOWER TRENT AREA										
LEICESTERSHIRE										
Cossington	N		2							
Reasby	N		3							
Syston	N		4							
Anstey	M		1							
Mountsorrel	M		1							
Quorn	M				4					
Shepshed	N		1							
Loughborough	M		5							
Loughborough	N		15							
Zouch	M		26							
Asfordby	M		1							
Hathern	N									A6 Closed
NOTTINGHAMSHIRE										
Stoke Bardolph	M		1							
Burton Joice	N		6							
Wakeringham	M		2							
Beckingham	M		4							
Littleborough	M		2							
Church Lancham	M		2							
Lancham	M		3							
High Marnham	M		1							
Mansfield	M		1							
Bleasby	M		3+12Caravans							

[illegible]

[illegible]

Location of Flooding	Source of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
LOWER TRENT AREA										
Little Eaton	M		1							
Breadsall	N		3							
Draycott	M									Derby - Notts Railway closed
Darley Abbey	M		3							
Rowsley	M		2							
Matlock	M				4					
Darley Bridge	M		4							
Derby	Surface		56							
Shardlow	Surface		2							
Ambaston	M		2							
Buxworth	Buxworth		2							
Pinxton Wharf	M		1							
Langley Mill	M				5					

Location of Flooding	Source Of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
UPPER TRENT AREA										
River Dove										
Marchington -										
Dog & Partridge Area	M		10							
Scropton -										
Brookside Farm	M					1				
Watery Lane, Scropton	M					12				
Riding Stable Area	M					10				
Brandon's Turkey Farm	M					4				
Hatton -										
LHS Scropton Lane to Hearhfield Avenue area	M					62				
Yew Tree avenue	M					80				
Salt Box Café	M					1				
Nestle Factory	M					1				
Hatton / Turbury -										
Castle Hotel	M					1				
Old Scropton Lane	M					5				
Old Marston Lane	M					20				
Tutbury Mill Fleam	M					1				

Location of Flooding	Source Of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
UPPER TRENT AREA										
River Churnet										
Leek -										
Abbey Green Road	M					3				
Acordis	M					1				
Leek Dying & Finishing	M					1				
White Horse PH	M					1				
Shell Garage	M					1				
Leek Town FC	M					1				
Macclesfield Road	M					7				
Cheddleton -										
Flint Mill	M		1							
Churnetside Business Park	M		5							
Bolton's Factory	M		1							
Oakmoor Island	M		?							
Balls Farm	M		1							
Bridge Hs Alton Road	M		1							
Harry Deacons	M		1							
JCB Rocester	M		1							
Ipstones -										
Park Lane	N		2							

[illegible]

Location of Flooding	Source Of Flooding	Number Times Location Flooded 1990 to 2000	Number Properties Flooded Un - Defended Nov-00	Number Properties Defended (Agency Defences)	Number Properties Flooded Failure Agency Defences	Number Properties Flooded Agency Defences Exceeded	Number Properties Defended (Private Defences)	Number Properties Flooded Failure Private Defences	Number Properties Flooded Private Defences Exceeded	Details of Road, Rail and Other Flooding,
UPPER TRENT AREA	Main/Non Main/Sea									
HILTON BROOK										
Hilton -										
Blue Circle & cottages	M		5							
School & Houses	M		5							
Longford	N		7							
Rolleston Brook										
Rolleston -										
Brookside	M		10							
Station Road	M		10							
Blithe										
Lower Leigh	M		?							
River Trent										
Burton-										
Newton Road	M					20				
Thurco	M					1				
LH Plant	M					1				
Boot Horse PH	M					1				
Leonden Club	M					1				
Riverside Hotel, Branston	M					1				
Sherrats Farm	M					1				
A38 Tatenhall Bridge	M					12				
Meadow Road	M			6500		2				

Tame View Estate	M		?	2500						
River Anker										
Polesworth										
Bridge Street	M		1							

CHAPTER 6 - EMERGENCY RESPONSE

6.1 Major Incident Plans

Table 6.1 below shows details of major emergency plans activated and Agency involvement with Gold and Silver Controls.

COUNTY	MAJOR EMERGENCY PLAN ACTIVATED	GOLD/SILVER OPEN	AGENCY ATTENDANCE
UPPER SEVERN			
Powys	No	-	
Shropshire	Yes	Silver	Yes
Worcestershire	Yes	Silver – Worcester & Kidderminster	Yes – Worcester
LOWER SEVERN			
Worcestershire	Yes	Silver	Yes
Gloucestershire	Yes	Silver & Gold	Yes
Warwickshire	No	-	-
UPPER TRENT			
West Midlands	No	-	-
Staffordshire	Yes	Silver – Burton on Trent (Control set up in Lichfield)	Yes
		Gold – Stafford	Yes
LOWER TRENT			
Derbyshire	No	-	-
Nottinghamshire	No	Gold & Silver	Yes
Leicestershire	No	-	-
Lincolnshire	Yes	Silver	Links were established and contact was made every hour, but no physical attendance

6.2 Direct Works Resources Used

Labour

During the course of the event a total of 227 men were used. This involved a maximum of 175nr emergency workforce operatives and support during daylight hours and a maximum of 52nr overnight. 12 men from Anglian Region were used in Lower Trent North for one night shift. 12 Environmental Protection staff and 2 FER staff supported the normal emergency workforce at various periods during the event. Men were also transferred around the region away from their normal operating areas as necessary.

Table 6.2 – Summary of Direct Works Personnel used

Number of people involved – Workforce	227
Number of people involved – Staff	21
Number of shifts worked	1963
Number of hours worked	21175

Materials

Approximately 15,000 sand bags were deployed during the event of which 3000 were imported, filled, from Anglian Region. 120 one tonne bags were acquired for the Nottingham Area and a further 135 were used to temporarily repair damaged defences in Wem and 290 at Hatton.

Plant

Overall 30nr pumps were deployed across the region. 9 of these were Agency owned and the remaining 21 hired at short notice from SLD/Sykes and British Waterways.

Key locations for pumps were:

Table 6.3 – Pump Deployment

Location	Number Deployed
Shardlow/Wilne	9
Darley Bridge	1
Laneham Beck	4
Burton upon Trent	3
Standby for Gloucester/Tewkesbury	4
Nottingham	7
Ratcliffe/Quorn	2

7. PUBLIC RELATIONS

Media interest was exceptionally high between Monday 30 October and Tuesday 14 November 2000. 1065 media enquiries were handled; 357 from the print media, 332 from television and 376 from radio.

58 television and 164 radio interviews were undertaken. This total included participation in a number of in-depth, documentary -type "flood specials" with both Independent TV and BBC.

Largely positive coverage was achieved in media ranging from the Sunday Sport to the Financial Times. Besides the expected messages about current flooding in specific areas, a range of positive messages was disseminated such as the issues surrounding building on flood plains; the "can't prevent it, but can prepare for it" message; why dredging the rivers is not a panacea against flooding and the Agency's recent and proposed work in flood warning and defence.

The PR department staff worked to a rota providing 24-hour/seven day coverage throughout the event. External freelance help amounting to 5 man-days was brought in and help was also gratefully accepted from a number of non-PR Midlands staff. We propose to design a short training course for non-PR Midlands staff so that we shall have a number of well-prepared prospective helpers for future events.

Inter-departmental co-operation both at Regional level and with the Areas was extremely high and fruitful. It was, however sometimes difficult to contact Area Flood Rooms due to pressure on phone lines.

The use of briefing notes, updated as a result of video conferences with Area and Regional staff at 07.00, 10.00 and at 15.00, proved a useful innovation during this event ensuring that all those speaking to the media were conveying consistent messages. It would be helpful if during a future event the afternoon video conferences could be brought forward by an hour to ensure that information was up to date for the important "drive-time" media enquiries.

The event allowed us to build on and cement the relationships with local journalists, which we have worked on over recent months. It became apparent however that some inconsistencies between the Region's borders and the areas covered by some radio and TV stations meant that providing a full picture of the situation was sometimes a problem. We shall work towards a system of co-operation with other regions to ease efficient inter-regional exchange of information.

CHAPTER 8 - INCIDENT SPECIFIC

8.1 Introduction

This chapter considers the views of the event by other professional partners. A standard letter was sent to all such bodies and their full responses are reproduced in Appendix F. Professional partners were defined as those who got involved in the flood events by nature of their roles and responsibilities in dealing with emergencies. These were the County and District Councils, the Emergency Planning authorities, the Police and Fire Services and the utilities. Many are still involved in ongoing support to those flooded and many have yet to complete their own debriefs. However, most of those asked responded to the letter asking for their views on:

- Impact of the floods
- Agency performance
- Partner performance and relationship with the Agency
- Lessons learned that should be applied for the future

This Appendix summarises the responses and brings out recommendations to follow up. Individual responses have been copied to the relevant Agency Area to follow up any local points.

8.2 The Event

The events in the Midlands were characterised by three main features:

- The main River Severn had three successive peaks of flow that initiated Severe Flood Warnings and caused property flooding and major disruption along the whole basin over a three-week period. There were coincident high tides in the Severn Estuary for part of the events.
- During the same three-week period there were Flood Watches and Flood Warnings in the Trent catchment with Severe Flood Warnings and property flooding and disruption along the Trent itself and some of its tributaries in the third week.
- Some parts of the Region were not subject to Severe Flood Warnings but still had local flooding from minor watercourses, surface water sewers or land run off.

The severity was such that for most places it was the worst event in terms of depth of flooding and impact for over fifty years. It was also unusual in affecting such a wide area for such a prolonged period.

The responses from the Professional Partners reflected these characteristics. Some had been on some stages of alert for over a month whereas others had been relatively unaffected. Many reflected the cost to their organisations, much of which could not be recovered under the Bellwin Scheme. There was also concern about the cost to the local economies, particularly to local shops. (For example, just two chain stores in Shrewsbury had lost over £1M of business in the busy run up to Christmas).

The duration had also caused concern that public tolerance to such events was decreasing. There were problems in sourcing sufficient sandbags.

8.3 Agency warnings

Generally Professional Partners received timely warnings with reasonable to good accuracy on peak times and heights. There were a few instances where there was insufficient lead time but these were generally at the heads of catchments where current technology cannot offer much improvement. Predictions of peak times and heights along the Severn were good. There was some criticism of accuracy in the Trent catchment. This is mainly because in both cases the models used were at the extremes of their previous calibration. On the Severn there have been several recent big events which have enabled the accuracy of predictions to be improved. Predictions of peaks were within 1 or 2 cm in 3m of flood. This event will enable improved calibration of the Trent model.

There was a plea to get warnings out before 1600 hours where possible, as after that time it can be difficult to mobilise a response.

Some recipients of warnings could not relate the predicted water levels and rates of rise to risk (e.g. to heights of defences). This is a problem recognised within the Agency at some locations and steps are in hand to develop diagrammatic tools which could be shared with external partners.

The value of the Flood Plain CD roms was noted in helping identify areas at risk. There were requests for updates and the opportunity to discuss the flood plain outlines.

With multiple warnings issued for many stretches of river, it was suggested that they be numbered sequentially for each stretch.

8.4 Flood warning codes

There is still some criticism of aspects of the new codes. The use of terminology "Flood Warning Codes" which incorporates "Flood Warning" as one of the codes has the potential to cause confusion. There were virtually universal Flood Watches and Flood Warnings at times. The latter include the advice to Local Authorities to activate emergency plans as appropriate. In practice most do little until Severe Flood warnings are issued. Better information about flood heights and times would also help as the cost of mobilisation is high. This is at odds with the Agency approach which is to respond and scale back as appropriate.

Some recipients see the issue of Flood Watches as being too indiscriminate. They cover too wide an area and there is little specific action that can be taken. Some felt that the Agency was issuing these to cover its back and there was a risk of "crying wolf".

A comment was also made that the advice to "Act Now" included with Flood Warnings was too severe, causing unnecessary alarm to old people.

One response recorded that some farmers, especially those that did not live on their farms, did not move stock to higher ground as recommended.

The use of wardens was recommended. Those that had kept some form of warden service found it invaluable to get messages to local residents at risk, for example on predicted peaks and times. At least one Local Authority is considering reintroducing a warden service. This

was prompted in part by the difficulties with Floodline – both in getting through and the delay in updating information.

8.5 Emergency response

The availability of Flood Plans in many authorities proved useful. Gold and Silver controls were set up at most of the worst affected areas and an Agency presence was much appreciated. This was seen as providing a direct link to the Agency control rooms and help with interpretation and determining local action. The presence of known local Agency officers was particularly welcomed, especially where the same people had been involved in joint exercises. The Agency had problems in resourcing some of the demands for attendance at Gold and Silver controls and used some staff who had not previously been involved.

Provision of up to date advice on where was flooded and which roads were closed caused some difficulties. One commented that the Agency was seen as the “Flooding Authority” but did not directly help the public. The biggest problem faced revolved around finding and delivering sandbags. In all of these areas the Agency could work with the other agencies to improve public understanding of roles and availability of information.

There is interest in alternatives to sand bags for defending small locations and individual properties. The Agency needs to keep others informed of the work it is doing in this area.

8.6 Communications and media

There were difficulties in contacting Agency offices at times. Some of these were overcome by identifying dedicated lines for other agencies or Gold Controls.

The use of newer technologies was suggested. Dedicated web pages could be used for updating information which could reduce reliance on direct telephone contact. This could be coupled with the use of video footage and GIS to give better information on the impact.

One Gold Control used video conferencing for the first time and found it valuable enough to become a permanent feature. The Agency has VC facilities at all major offices and could explore the extended use.

There was some miscommunication through local radio media. In a couple of instances wrong information was given out about road and bridge closures which added to the traffic disruption. There was also concern about the impression given that some towns were effectively isolated. This damaged local trade unnecessarily. In contrast, little information was given about the more local events when most media attention was focussed on the bigger impacts.

8.7 Other issues raised

1. There needs to be better information about responsibilities for maintenance of watercourses, drains and sewers among the local authorities, highway authorities, riparian landowners, water companies, etc. The Agency could help here by offering a training package modelled on the in house one.
2. Most local authorities have lost drainage staff following the transfer of sewerage agencies to the water companies. This has resulted in a declining knowledge base about flooding.

3. There is a problem in cost-benefit justifying local schemes on non-main river. There was a request as to the availability of the Government's £51M extra funding.
4. Several comments about the need to promote Sustainable Urban Drainage (SUDS) and applying it to existing developments.
5. The suggestion to seek grants to flood proof buildings.
6. Problems with enforcing road closures and stopping vehicles speeding through flood water.
7. Some local problems with foul flooding from sewers – in getting the water company to respond and in responsibility for cleaning up.
8. The suggestion of a national leaflet of health and safety advice particularly in what to do after a flood.
9. The vulnerability of utilities, e.g. electricity sub-stations in flood risk areas.
10. Concern about health and safety of the public walking in floodwater and the provision of walkways.

8.8 Recommendations for action by the Environment Agency

1. Joint exercises need to continue, involving Agency staff likely to be called in to help with a major event.
2. The Agency to attend all Gold Controls and Silver Controls where possible.
3. Communications between Agency and Professional Partner organisations need reinforcing with dedicated telephone lines.
4. The use of the Internet to share information should be explored. This could include real time data about flood predictions as well as reference information such as sources of sandbags.
5. Diagrams linking flood warnings and levels to physical features need to be improved and shared.
6. Sequential warning faxes for the same river stretch should be numbered.
7. Comments about the interpretation of warning messages should be fed into the national review.
8. Publicity about the flood warning codes and the action to take needs to be continued.
9. The Agency should consider offering training courses for external partners on land drainage and flood legislation.
10. The Agency to keep interested parties apprised of its work on alternatives to sand bags and conventional defences, possibly via the Internet
11. The Agency to work with local authorities to develop flood warden schemes where these are seen as beneficial.
12. Comments about Floodline to be fed in to national review.
13. Local discussions to take place to consider timing of warnings relative to partner staff availability and out of hours contact.
14. The Agency to support the provision of national leaflets covering health and safety in flood situations.
15. There is common interest in impacts such as road closures and access difficulties. Ways need to be explored to improve the quality and availability of such information for both the agencies involved and the public.
16. The use of video conferencing between the Agency and external partners merits investigation.

APPENDIX A – DEVELOPMENT IN THE FLOODPLAIN

Age of Properties Flooded	Upper Severn	Lower Severn	Upper Trent	Lower Trent	Total
0 – 5 years		2	1	22	25
6 – 10 years	21	3	10	19	53
11 – 20 years		0	23	11	34
20+ years	885	274	370	314	1843
Totals	906	279	404	366	1955

(Note: Upper Severn figure is 21 properties less than 20 years old, more detailed split unavailable)

Number of properties flooded built against Agency advice – 16

Number of properties flooded not shown at risk on S105 maps – nil

Land allocated for development that flooded or had severe flood warnings issued:

Upper Severn –	Land adjacent Telephone Exchange, Shrewsbury TA Centre, Shrewsbury
Lower Severn –	Redrow Homes site, Avonmouth
Upper Trent –	Employment Estate, Whites Bridge, Leek
Lower Trent –	Tolney Lane, Newark

APPENDIX B – PUBLIC RESPONSE

Detailed post event surveys are to be undertaken in the near future which will give a better indication of the proportion of owners of flooded properties who took effective action as a result of the warnings that were issued. The timely warnings with, in many cases, lead times in excess of 12 hours, will mean that a considerable amount of damage will have been prevented by the actions of individuals and the various organisations who respond to flood emergencies. In the absence of survey results there follows anecdotal evidence of the actions that were taken:

- Landlord in Shrewsbury who loaded furniture and valuables into a van and stored them in safety away from the town.
- Resident of Upton who spent seven days and nights sandbagging, pumping and baling successfully protect two classic cars from the flood.
- Burton Upon Trent town centre was evacuated and shops and businesses closed early. There were reports of householders moving valuables upstairs and sandbagging of properties most at risk.
- A resident of Bewdley installed floodgates across his doorways. Unfortunately the river level exceeded the height of the gate and his home was flooded.
- A resident held the flood waters at bay at Little Carlton near Newark by hiring an old fire engine and pumping continuously to prevent his home from flooding.
- The following is a personal account by Louise Edginton, Bewdley Town Councillor

My Week

Louise Edginton
Bewdley Town Councillor

Monday

We are expecting to be flooded. Me and my husband Benjamin, who is 73, have seen the news, and we know that the river is rising at Shrewsbury; and that we've only got 48 hours for it to get down to us. We were flooded two years ago, but up until then we hadn't been flooded for 33 years. We've lived here 43 years, the house is 400 years old and it's on the quay-side. It wasn't as bad in 1998 as this week - we could leave the house then. We get in some tinned food, bread, butter, bananas and lots of cheese, and start moving a few things upstairs.

Tuesday

We move all of the books out of the bookshelves. We've got over 300, and trundle them upstairs. It takes about three hours because we have to move other things out to put them in and stack everything up. We're feeling very philosophical about it really. We know it's coming and there is nothing we can do about it. My son-in-law comes round in the evening and we put the furniture up on to pallets about 4ft 6ins high. We can't save the carpets, because they're fitted. We take everything else - the radios and televisions - upstairs. I go to bed hoping it won't come. Perhaps they're wrong.

Wednesday

At 4.45am our next door neighbours start their pump, which wakes us up. I go down stairs to take a look out of the window because my grandson wants me to phone him to tell him how high the water is. I get my feet wet in the lounge - the water's already coming in. I feel a bit grim about it, but these things happen. I tell my husband. We go into the kitchen and put our fridge/freezer up on bricks, and move everything else out of the downstairs rooms. We put the

paperwork from the back room right up into the attic. It takes about five hours. My son-in-law comes round and puts breeze blocks and planks down so we can walk around downstairs. We retire upstairs and decide: "That's it, we can't move again!" The water has risen right over the breeze blocks and the planks, and we're stuck. It's about 2ft 6ins deep. The furniture on the pallets is still dry though. I go to bed hoping that the cooker, washing machine and fridge are safe, and that the water won't get to the furniture.

Thursday

I wake up to find the fridge on its side, and the washing machine and cooker both half full of water. The water is now 3ft deep in the lounge and kitchen, and 2ft 6ins in the back room. Our two gas fires are also underwater. I'm not very happy. We spend the day upstairs trying to read books. I usually read a lot, but I don't seem to read anything. I just can't settle down to it. I keep going to the top of the stairs and look down to see where the water is. We have cheese sandwiches and rice pudding. We've got the microwave upstairs, so at least the rice pudding is warm. We sit and talk about the flood. We don't normally watch television a lot, but we watch all the news to find out more information. We see our house on it. I go to bed hoping it will end tomorrow. The peak has come so we are hopeful.

Friday

We wake up at 7am and peer downstairs. I can see the water's going down slightly. I get dressed and have breakfast - cheese rolls again. We have rice pudding for lunch. I'd been hoping the water would run off quickly, but it doesn't seem to be. I don't know what is happening to the phone. It was working for a time, but not today. But we have got a mobile. The water has dropped by about 18ins and I manage to get out of the house. I report that the phone is not working and get some more rolls, a newspaper and boiled ham. We spend the day upstairs. Tomorrow hopefully we will go downstairs and hose it all out. After the flood of '98 we had a new kitchen - the cupboards are full of mud. But I always look on the bright side. I might think "I could have done without this," but we love the house, and the view; and we are very happy here. We shan't move. Hopefully we are insured. My husband just said to me not long ago:

"Did you pay the insurance this year?" I said: "I'm pretty sure I did". I just hope I didn't make a mistake. I'll be scrabbling around, looking for the paperwork.

APPENDIX C – ORGANISATIONAL ISSUES

Impact of Changing Needs in Flood Defence Review on ability of Agency to respond to the event:

STRENGTHS

- Few significant changes were required by Midlands Region in order to implement Changing Needs in Flood Defence but more clearly defined emergency roles and responsibilities assisted the Agency's response to the event.
- Consistency in the structure of Flood Warning teams nationally paid dividends; similarly the consistency of documentation such as faxes, reports etc was equally beneficial.

WEAKNESSES

- Moving Development Control staff outside of Flood Defence to work more closely with planning liaison within Customer Services is bringing significant advantages to the Agency's influence over the Town & Country Planning regime. However it has reduced the size of the fully skilled Flood Defence team.

OPPORTUNITIES

- More easily facilitated opportunities for using inter-functional and inter-regional teams made a huge difference, particularly in the latter stages of the long-running event

Comment on any "structure of government" questions thought to be germane to impacts of the event:

- Clearly, many departments of national government are involved in dealing with a flood emergency – MAFF, DETR, Home Office, DSS, Treasury. It would be impractical to have a single department responsible but this means that effective and timely communications are key to successful management of the event. In this instance, the overriding concern has been the slowness of response from Government departments regarding funding. This is despite interest at the highest level from senior Ministers.
- Local Authorities differ in their procedures for handling Flood emergencies, such as the setting up of Silver and Gold Controls. This can create problems when the Agency is dealing with political cross boundaries.

APPENDIX D – ECONOMIC IMPACTS

NB All costs quoted in this appendix are approximate only at this stage

D1.1 Cost of Emergency Response - Agency

	Costs
Regional Office:–	
Regional Flood Defence	20000.00
Water Resources - Forecasting	21000.00
Public Relations – Staff	17000.00
“ “ - Media monitoring	25000.00
NCPM	8000.00
RCC – (Extra over normal costs)	1000.00
Others – Senior management etc	5000.00
Lower Severn	45000.00
Upper Severn	50000.00
Upper Trent	26000.00
Lower Trent	50000.00
Direct Works	
Lower Trent North	123000.00
Lower Trent South	110000.00
Upper Trent	60000.00
Upper Severn	55000.00
Lower Severn	60000.00
Other Costs identified to date:	
Additional Floodline charges	41000.00
Data collection costs	100000.00
Other costs - unidentified	308000.00
Total	1125000.00

D1.2 Cost of Emergency Response – Other Organisations

Full details of the impact of the event on other organisations are as yet unavailable. The following are quoted as examples of Local Authorities and IDBs from Lower Severn Area.

Gloucester City Council	22000.00
Warwick District Council	2000.00
Rugby Borough Council	5000.00
Stroud District Council	6000.00
Wychavon District Council	4000.00
Forest of Dean District Council	4000.00
South Gloucestershire IDB	1500.00

Other figures quoted have been £120k from Shrewsbury & Atcham and £400k from Derbyshire County Council, although this last figure includes the costs of repairs to bridges and culverts.

D2.1 Costs of Emergency Repairs – Agency

The following is an indication of anticipated costs by Area to carry out essential repairs to flood defences throughout the Midlands Region which were either damaged or identified as inadequate during the event.

UPPER TRENT AREA

Burton on Trent – River Trent

Flood bank/wall repairs – Blackpool St	£20000
Flood wall repairs – Trent Bridge	£40000
Penstock repairs – College	£2000

Hatton – River Dove

Flood wall re-construction	<u>£40000</u>
Sub total	£102000

LOWER TRENT AREA

Borrowash – River Derwent

200m channel protection	£70000
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Rolleston – River Trent

Flood bank repairs	£10000
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Farndon – River Trent

Flood bank repairs	£5000
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Fiskerton – River Trent

Flood wall repairs	£10000 awaiting further inspection
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Little Carlton – River Trent

Floodwall repairs	£4000
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Langley Mill – River Erewash

Flood bank/wall repairs	£30000 awaiting further inspection
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Colwick – River Trent

Floodwall repairs	£4000
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Ilkeston – River Erewash

Flood bank/wall repairs	£20000 awaiting further inspection
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Beeston Rylands – River Trent

Flood wall repairs	£50000 awaiting further inspection
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Clifton – River Trent

New sluice	£60000
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Morton Corner – River Trent

Repairs to leaking flood wall	£25000
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North Soak Drain

Repairs to leaking flood bank	£100000
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Misterton – River Idle

De-watering weed grate	£100000
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Gainsborough, Bowling Green Lane – River Trent

Repairs to leaking flood bank	£10000
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Walkerith Ferry – River Trent	
Repairs to leaking flood bank	£10000
Amcotts to Mere Dyke – River Trent	
Repairs to leaking flood bank	£25000
Hale – Bottesford Beck	
	£80000
South Soak Drain	
Repairs to leaking wingwalls to structure	£20000
Nottingham area – River Trent	
Penstock-repairs	<u>£10000</u>
Sub total	£643000

LOWER SEVERN AREA

Alcester – River Arrow	
FAS repairs	£60,000
Barton – River Avon	
FAS repairs	£20,000
Minsterworth – River Severn	
Flood bank repairs	£120,000
Longney/Elmore – River Severn	
Flood bank repairs	£100,000
Sandhurst – River Severn	
Defence repairs	£10,000
Gloucester – River Severn	
Flood bank repairs at Sudmeadow	£15,000
Deerhurst – River Severn	
Defence repairs	£10,000
Wellesbourne – River Dene	
FAS repairs	<u>£30,000</u>
Sub total	£365,000

UPPER SEVERN AREA (Note: (w) indicates Welsh location)

Dyffed area – River Vyrnwy	
Flood bank repairs	£5,000
Welshpool – River Severn (w)	
Flood bank repairs	£15,000
Buckley Farm – River Severn	
Flood bank repairs	£50,000
Stone Argae – River Severn (w)	
Flood bank repairs /re-construction	£90,000
The Haim – River Severn	
Flood bank repairs	£50,000
Haimwood By Take – River Vyrnwy	
Major erosion repairs	£70,000
Fishermans Reach – River Vyrnwy	
Flood bank repair	£5,000
Meifod – River Vyrnwy (w)	
Flood bank repair	£5,000

Llanfyllin Town – Afon Cain (w)	
Urgent scheme	£30,000
Llanfechain – Afon Cain (w)	
Urgent scheme	£20,000
River Trannon (w)	
Flood bank repairs	£10,000
River Tern	
Re-construction of Walcot sluice	£50,000
River Roden	
Commonwood embankment re-construction	<u>£250,000</u>
Sub total	£650,000

EMERGENCY REPAIRS -REGIONAL TOTAL £1,760,000

APPENDIX E – HISTORY OF FLOODING

JULY 1998

Following on from a wetter than average June, July commenced with relatively dry weather. This continued throughout the month, although there were localised heavy showers throughout the Region. On the evening of 31st July, 32mm of rainfall was recorded in one hour at Colwick (Nottingham). This has been estimated as a 1 in 50 year's rainfall event. Overall, Regional rainfall totals for the month were only 46% of the long-term average.

Flooding: On 31st July, the carrying capacity of a culvert was exceeded on the Day Brook in Nottingham resulting in property flooding.

Flood Warnings Issued: None - Area not covered by flood warning system.

Properties flooded: 2 plus several gardens.

Action taken: The hydraulic capacity of the culverts was assessed using mathematical modelling techniques. Minor flood defence works are planned.

SEPTEMBER 1998

The unsettled weather continued into September. On the 10th, 31mm of rainfall was recorded in 24 hours at Dolydd in the Welsh uplands and on the 12th, 28mm was recorded at both Prees in the Tern catchment and at Barnhurst in the Sow catchment.

Drier, more settled conditions during the middle of the month were followed by localised intense thunderstorms on the 26th. Up to 40mm of rainfall was recorded in 24 hours in some parts of the upper Trent catchment. However, due to the increased soil moisture deficits during the middle of the month, this rainfall did not raise river levels sufficiently to cause out of bank conditions. Regional rainfall totals for the month were 123% of the long-term average.

Flooding: A Yellow warning was issued on the 5th for the River Soar between Cossington and Cotes. A Yellow warning was issued on the 13th for the River Tame from Perry Barr to Water Orton. On the 26th the thunderstorms in the upper Trent catchment resulted in some surface water flooding.

Flood warnings issued:	Yellow	2
	Amber	0
	Red	0
	Total	2

Properties affected: None.

OCTOBER/NOVEMBER 1998

Heavy rain in the last ten days of October, including two very intense spells, resulted in a double peaked event in catchment headwaters and a prolonged period of flooding in many middle and lower reaches of the Region's rivers, especially the River Severn.

Flooding: Between 22nd October and 8th November, approximately 800 properties were flooded (excluding caravans). River level return periods were estimated to be up to 1 in 40 years in the Severn catchment and in excess of 1 in 50 years in parts of the Derwent catchment. Flood warnings were issued in 55 of the Region's 78 reaches, a length of 1,300km. Red warnings were issued in 11 reaches covering a length of 295km.

Flood Warnings Issued:	Yellow	85
	Amber	46
	Red	20
	Total	155

Properties flooded: [*Those in italics are ordinary watercourses*]

River Severn	Caersws to Tewkesbury	365
<i>River Clun</i>	<i>Clun</i>	6
<i>Un-named</i>	<i>Woore</i>	3
River Dove	Doveridge	2
River Churnet	Various locations	38
R Blithe/Forsbrook (Staffs)	Blythe Bridge/Forsbrook	8
River Tean	Upper Tean	2
River Blythe (Warks)	Blythe/Henwood Mills	2
Lyme Brook	Newcastle under Lyme	20
<i>River Hamps</i>	<i>Waterhouses</i>	2
<i>River Trent</i>	<i>Norton Green</i>	17
<i>Leek Brook</i>	<i>Leek</i>	6
Rivers Derwent/Wye	Buxton (mostly ordinary watercourses or surface water)	200
	Bakewell	50
	Wyedale	4
	Ashford in the Water	30
	Rowsley	20
	Darley Bridge	2
River Trent	Cavendish Bridge	2
)	<i>Tideswell</i>	15
<i>Minor watercourses</i>)	<i>Stoney Middleton</i>	10
<i>and surface water</i>)	<i>Curbur</i>	6
)	<i>Eyam</i>	10
<i>River Noe</i>	<i>Castleton</i>	10
<i>Bradwell Brook</i>	<i>Bradwell</i>	8
	Total	838

Action taken: Options for flood alleviation for the River Wye in Bakewell and Ashford have been investigated and a scheme has been included in the capital programme.

Consultants were appointed to undertake a hydrology study for the River Churnet at Leek to establish the likely frequency of future flooding. This study was completed in October 2000.

At Bewdley and Shrewsbury, public meetings were held to discuss possible options for flood alleviation. In October 1999, a trial removable defence system was demonstrated at Bewdley. Since then a number of options for removable barriers have been investigated and support in principle obtained from various local bodies. Site investigation works were due to commence at the end of October 2000 but were delayed by flooding.

For Norton Green on the River Trent (Ordinary watercourse), the Agency has produced a preliminary report outlining some possible solutions. The Agency has recommended that Stoke on Trent City Council, as the Drainage Authority, should undertake a full feasibility study. The Agency has agreed to support and advise where necessary.

DECEMBER 1998/JANUARY 1999

Intermittent rainfall during December resulted in all catchments nearing saturation by the middle of the month. Heavy rain on 10-12th December led to extensive washland flooding along the whole of the Severn valley. On the 17th further rainfall resulted in high flows in the middle reaches of the Severn.

Flooding:

On Christmas Eve there were periods of intense local rainfall over the Wreake, Soar, Tame and Avon catchments. Continued rainfall throughout the evening and into Christmas Day resulted in levels rising again on the River Severn. Red warnings were issued for Gloucester as a result of high tidal surges (up to 1 metre).

There were reports of one fatality when a person was washed away in the River Avon catchment.

Flood warnings issued:	Yellow	23
	Amber	13
	Red	6
	Total	42

Properties flooded:

River Severn	Worcester	5
	Minsterworth	19
	Elmore Back	5
	Bow Lane/Waterend	9
	Longney	8
	Total	59

JANUARY 1999

The unsettled weather continued into the New Year and rainfall on 2nd/3rd January resulted in renewed rises in river levels and widespread minor flooding. In the first thirteen days of the month 68% of the January average rain fell resulting in soil moisture deficits remaining at field capacity. 39 Yellow warnings, 8 Amber warnings and one Red warning were issued in the first two weeks of 1999. By the 13th, river flows were generally at or slightly above 100% of average for the month. The 15th January saw the start of six days of continued rainfall resulted in further flooding.

Flooding:

A complex low-pressure system settled over the Midlands Region on the 15th January. Between 15th and 25th January, 47 Yellow warnings, 16 Amber warnings and 5 Red warnings were issued across the Region. Neither rainfall nor river levels achieved were exceptional, but the event was characterised by modest daily rainfall totals causing widespread flooding in an already saturated catchment. Flooding was most severe in the Lower Trent and Upper Severn Areas where all of the Red warnings were issued. The majority of warnings were issued within 36 hours, driven by the heavy rainfall on the 15th. In general, the flooding was estimated to have been a 1 in 5-year event although at certain locations in the Trent basin river levels were higher than this average, eg. River Blythe in Warwickshire 1 in 5-10 years and River Anker in Warwickshire 1 in 5-7 years.

Flood warnings issued:	Yellow	86
	Amber	24
	Red	6
	Total	116

Properties affected:

River Soar	Zouch	3
Ordinary watercourses	Lower Trent Area	12
River Severn	No data available	

MARCH 1999

Towards the end of February, soil moisture conditions were at field capacity across much of the Region. Most of the Region's rivers were flowing between 80-100% of the February average, although the headwaters of the River Severn were in excess of 100% average. Moderate rainfall over the 26th and 27th February primed the catchment for the falls that were to follow.

Flooding:

Heavy rain affected the Welsh mountains on the 28th February giving maximum totals of 90mm in 24 hours. This resulted in rapid rises occurring in the headwaters of the Severn and Vyrnwy on 1st March, and the issue of Yellow and Amber warnings throughout the catchment. Another 65mm of rain fell over the same area in the following 48 hours leading to the issue of Red warnings for the Severn-Vyrnwy confluence area and

Shrewsbury. In the Trent catchment heavy rainfall led to the issue of Yellow and Amber warnings.

Flood warnings issued:	Yellow	60
	Amber	14
	Red	5
	Total	79

Properties affected:

Upper Trent Area	Various locations	2
River Severn	Upton on Severn	10

APRIL 1999

The pattern of rainfall throughout the month was mixed. The first three weeks were generally showery with no associated flooding. The only significant rainfall was on the 11th when up to 31mm fell. The last ten days of the month saw three separate rainfall events, which resulted in Yellow flood warnings being issued.

Flooding:

On the 20th/21st, 2 Yellow warnings were issued for the River Soar due to localised rain. On the 23rd an event across the Avon, Tame and Soar catchments led to the issuing of 6 Yellow warnings, although no property was affected. More significant flooding occurred in the Northfield area of Birmingham from the River Rea (ordinary watercourse) where around 200 properties were affected. Finally in April, another rainfall event necessitated the issue of 2 Yellow warnings on the River Blythe and River Avon.

Flood warnings issued:	Yellow	10
	Amber	0
	Red	0
	Total	10

The River Rea is not covered by the Agency's flood warning system.

Properties flooded:

River Rea, Northfield (Ordinary watercourse)	200
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Action taken: See below

JUNE 1999

The start of the month saw a very intense rainfall event on the 2nd, which was centred on the Tame catchment in Birmingham and the Avon/Stour catchments in Warwickshire. The highest rainfall recorded was 47.5mm in 24 hours at Wellesbourne in Warwickshire. However, the worst affected place was Birmingham where 30-35mm of rainfall was recorded in 24 hours. The rest of the month saw only occasional scattered showers with rainfall totals below the average for the time of year.

Flooding:

The event saw the issue of 7 Yellow warnings in the Avon, Tame and Soar catchments and 3 Amber warnings in the Avon, Leam and Warwickshire Stour catchments. On 2nd June properties were flooded in the Northfield area of Birmingham. The flooding was due to a combination of surface water runoff from highways/open spaces, blocked gullies and the effects of the River Rea, an ordinary watercourse.

There was one fatality when a six-year-old boy was swept away by the River Stour at Cradley in the West Midlands. Another boy was rescued in the same incident.

Flood warnings issued:	Yellow	7
	Amber	3
	Red	0
	Total	10

The River Rea is not covered by the Agency's flood warning system.

Properties flooded:

River Rea, Northfield (Ordinary watercourse) 200

Action taken:

Richard Burden, MP for Northfield, held a flooding summit meeting involving the Environment Agency, Birmingham City Council (officers and councillors) and Severn Trent Water. The outcome of this was that two action groups were formed – a technical group looking at possible remedial works and a constituency task force looking at better arrangements for flood warning and local response. The Agency is a participant in both groups. Birmingham City Council have carried out a detailed flooding survey at 40 separate locations where flooding is an issue. A £1.5 million scheme has been promised over the next five years. The City Council has approached Central Government regarding extra funding. In September 2000, residents of Northfield were invited to join the Agency's flood warning system. The Agency is continuing to work with the council to establish flood alleviation measures that can be adopted.

AUGUST 1999

Following convective storms circulating over the Birmingham area between the 8th and the 12th, very high, localised rainfall (in excess of 40mm) fell over a period of 6/7 hours affecting the River Tame and upper Trent catchments. Reports were received of 75mm falling in 24 hours. The estimated return period was a 1 in 20 year's event.

Flooding:

Levels recorded on the River Tame were the highest on record (40 years). Four balancing areas were in operation simultaneously during the event, for the first time since construction in the 1970's and an estimated 2,000 properties

were protected by the alleviation scheme. Flood defences in the Brookvale Road area of Witton were overtopped causing considerable traffic disruption in the area and flooding to one property. In Warwickshire, many industrial and commercial premises in the Station Road area of Coleshill were flooded from the River Cole. The return period here has been estimated as between 50-70 years. The River Blythe caused flooding at Blythe Mill near Coleshill and 30 other homes had to be evacuated in the Balsall Common area.

High levels on the Rivers Sow and Penk in the Stafford area flooded two commercial properties in the Silkmore area of the town overnight on the 9th and 10th.

Flood warnings issued:	Yellow	12
	Amber	4
	Red	1
	Total	17

Property flooded:

R Tame	Brookvale Road, Witton	1
Railway lines - Bescot & Castle Bromwich		2
R Cole	Coleshill	Industrial premises
R Blythe	Blythe Mill	1
Canley Brook	Coventry	13

Action taken: The River Tame alleviation scheme through Birmingham and the Black Country provides a 1 in 50 year flood protection. This does not meet the MAFF indicative standard of 1 in 100 years for an urban area. The overtopping of some defences highlighted the need to review the level of flood protection. This review is being carried out along with the River Tame Asset Survey. If a justifiable option to increase the level of protection is available or if any significant work is identified in the Asset Survey, it will be integrated into the capital works programme.

OCTOBER 1999

October started with heavy storms over the Midlands producing twenty-four hour rainfall totals of up to 57mm in the Welsh uplands and 42mm in the Peak District. Between the 21st and 24th there was further heavy rainfall across the Region with 30mm being recorded in 24 hours in the North Shropshire and Stafford areas. Almost 50% of the average rainfall for October fell in the first week of the month. Overall rainfall across the Region was above average during October leading to reductions in all soil moisture deficits.

Flooding: As a result of the heavy rainfall on the 1st, 33 Yellow flood warnings were issued on the Rivers Soar, Tame, Dove and Trent and Severn. 6 Amber warnings were issued for the Tame catchment, River Leam and lower reaches of the Severn.

On the 25th and 26th, 9 Yellow warnings were issued for the Rivers Dove, Sow, Trent, Soar, Leam and Severn. An Amber warning was issued for the River Severn at Gloucester due to a predicted high spring tide.

Flood warnings issued:	Yellow	42
	Amber	1
	Red	0
	Total	43

Properties affected: None.

DECEMBER 1999

During the first week of the month there was unsettled weather over much of the Region. However, the only rainfall event that was severe enough to warrant the issue of warnings, was on the 3rd when a localised storm over north Shropshire affected the River Vyrnwy. On the 10th a concentrated front of rainfall brought 50-60mm of rain in 24 hours at the top of the Severn and Vyrnwy catchments, with lesser amounts across the rest of the Region.

Flooding: On the 3rd, 2 Yellow warnings were issued for the River Vyrnwy. On the 11th and 12th, 23 Yellow warnings were issued across much of the Region including the Rivers Avon, Soar, Teme, Dove, Wye Vyrnwy, Sow and Trent. 7 Amber warnings were issued for the River Severn between Shrewsbury and Tewkesbury and the River Leam and a Red warning was issued for the reach of the River Severn including Ironbridge and Bridgnorth.

Flood warnings issued:	Yellow	25
	Amber	7
	Red	1
	Total	33

Property flooded: 10-20

DECEMBER 1999/JANUARY 2000

Following a few days respite, the bad weather returned to the Region just before Christmas. All catchments were still saturated following the rainfall during the first three weeks of the month. The highest tides of the year were predicted for both the Severn and Trent over the Christmas period. A front passed over the Region on the 23rd/24th bringing heavy rainfall everywhere. The worst affected were the lower Severn and Avon catchments where 15-27mm fell. This was followed by successive fronts crossing the Region bringing sporadic showers and heavier periods of rain over the next few days.

Flooding: Between the 24th and 30th a total of 43 Yellow, 14 Amber and 6 Red warnings were issued, with most catchments being affected. The Red warnings affected the River Severn from

upstream of Worcester down to Tewkesbury and the tidal reaches at Gloucester and Severn Beach.

Flood warnings issued:	Yellow	43
	Amber	14
	Red	6
	Total	63

Properties affected:	Upton on Severn	20
	Severn tidal reaches	30
	Total	50

FEBRUARY 2000

Rainfall totals for February exceeded the monthly long term average by 40%. Two periods of flooding were recorded during the month.

Flooding: Snowfall on the 16th produced up to 20mm water equivalent of snow on the Pennines and upper Soar catchments. A band of rain on the 17th caused melting and triggered a number of Yellow flood warnings on the Rivers Wye, Dove, Trent and Soar.

Towards the end of the month, heavy and prolonged rainfall fell over the Welsh mountains and the Peak District. Between the 28th February and 1st March, 15 Yellow warnings were issued in the Trent basin (mainly the Rivers Dove and Derwent), and 6 in the Severn basin. 6 Amber warnings were also issued for the upper Avon, Leam, Soar and the Rising Brook in Stafford.

Flood warnings issued:	Yellow	27
	Amber	6
	Red	0
	Total	33

Properties affected:	Caravan site and commercial properties adjacent to the Rising Brook in Stafford.
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MARCH 2000

The unsettled weather continued into March with heavy rainfall over the Welsh mountains and the Peak District.

Flooding: Following heavy rainfall at the end of February 10 Yellow warnings were issued in both the Severn and Trent basins on the 2nd March. An Amber warning was issued for the River Wye at Ashford.

Flood warnings issued:	Yellow	10
	Amber	1

Red	0
Total	11

Properties affected: None

APRIL 2000

April was an exceptionally wet month, with the Region receiving over twice the average monthly rainfall. For England and Wales as a whole, this was the wettest April since records began in 1766.

Flooding: Heavy rainfall and snowfall on the 2nd and 3rd caused some flooding of low-lying land and roads in the Lower Severn and Lower Trent Areas. A total of 14 Yellow and 6 Amber warnings were issued. The Rivers Avon and Stour were the worst affected with the lower reaches of the Severn also subject to warnings owing to the high flows occurring at the same time as the spring tide cycle. Further heavy rainfall, combined with high tides in the Severn Estuary, on the 18th and 19th resulted in 18 Yellow and 3 Amber warnings being issued. Bands of showers, often prolonged and heavy, affected most of the Region towards the end of the month and caused some localised flooding of roads and farmland. A further 14 Yellow and 2 Amber warnings were issued during this period.

Flood warnings issued:	Yellow	51
	Amber	11
	Red	0
	Total	62

Properties affected: <10

MAY 2000

Heavy showers crossed the Region over the Bank Holiday weekend.

Flooding: The rainfall resulted in some localised flooding of low-lying land and necessitated the issue of Yellow and Amber warnings, mostly in the Avon and Soar catchments.

Flood warnings issued:	Yellow	7
	Amber	3
	Red	0
	Total	10

Properties affected: None

JULY 2000

On the evening of 6th July there was a period of intense rainfall over the Northfield area of Birmingham. Records from the nearest Agency gauge at Frankley showed 29mm of rain fell in 2½ hours. This has been estimated as a 1 in 10 year's rainfall event.

Flooding: Serious flooding of the River Rea, an ordinary watercourse, occurred.

Flood warnings issued: Area not covered by flood warning service. ---

Properties affected: 200

Action taken: See earlier report

APPENDIX F – VIEWS OF PROFESSIONAL PARTNERS

As detailed in Chapter 8 letters were sent to all our Professional Partners seeking their views. Replies were received from the following bodies and can be viewed at our local Agency office:

Birmingham City Council

- Department of Planning & Architecture
- Transportation Department

Blaby District Council
The District of Bolsover
Broxtowe Borough Council
Borough of Charnwood
Cheltenham Borough Council
Cherwell District Council
Daventry District Council
Gedling Borough Council
Gloucestershire Constabulary
Shropshire County Council
East Staffordshire Borough Council
Gloucestershire County Council
Hertfordshire Council
Newark & Sherwood District Council
City of Nottingham -Development & Environmental Services
Nottinghamshire Police
Nottinghamshire Fire & Rescue Services
Nottinghamshire Community Response
Borough of Nuneaton & Bedworth
Shrewsbury & Atcham Borough Council
Shropshire County Council
South Derbyshire District Council
Stafford Borough Council
Staffordshire County Council
Staffordshire Fire & Rescue Service
City of Stoke on Trent
West Mercia Constabulary
Warwickshire Constabulary
Warwickshire Fire & Rescue Service
Wolverhampton Metropolitan Borough Council
Hereford & Worcestershire Emergency Planning
City of Worcester

CONTACTS:

THE ENVIRONMENT AGENCY HEAD OFFICE

Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD.
Tel: 01454 624 400 Fax: 01454 624 409

www.environment-agency.gov.uk

www.environment-agency.wales.gov.uk

ENVIRONMENT AGENCY REGIONAL OFFICES

ANGLIAN

Kingfisher House
Goldhay Way
Orton Goldhay
Peterborough PE2 5ZR
Tel: 01733 371 811
Fax: 01733 231 840

SOUTHERN

Guildbourne House
Chatsworth Road
Worthing
West Sussex BN11 1LD
Tel: 01903 832 000
Fax: 01903 821 832

MIDLANDS

Sapphire East
550 Streetsbrook Road
Solihull B91 1QT
Tel: 0121 711 2324
Fax: 0121 711 5824

SOUTH WEST

Manley House
Kestrel Way
Exeter EX2 7LQ
Tel: 01392 444 000
Fax: 01392 444 238

NORTH EAST

Rivers House
21 Park Square South
Leeds LS1 2QG
Tel: 0113 244 0191
Fax: 0113 246 1889

THAMES

Kings Meadow House
Kings Meadow Road
Reading RG1 8DQ
Tel: 0118 953 5000
Fax: 0118 950 0388

NORTH WEST

Richard Fairclough House
Knutsford Road
Warrington WA4 1HG
Tel: 01925 653 999
Fax: 01925 415 961

WALES

Rivers House/Plas-yr-Afon
St Mellons Business Park
St Mellons
Cardiff CF3 0EY
Tel: 029 2077 0088
Fax: 029 2079 8555



ENVIRONMENT AGENCY GENERAL ENQUIRY LINE

0845 933 3111

ENVIRONMENT AGENCY FLOOD LINE

0845 988 1188

ENVIRONMENT AGENCY EMERGENCY HOTLINE

0800 80 70 60



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