Monmouthshire County Council

Flood and Water Management Act 2010

Section 19 Flood Investigation Report

Forge Road, Monmouth

Persistent Wet Weather
October 2019

Version: FINAL

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Contents

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1. Executive Summary

In accordance with Section 19 of the Flood and Water Management Act 2010 (FWMA), Monmouthshire County Council (MCC) has a duty as Lead Local Flood Authority (LLFA) to investigate flooding within its area, insofar as it considers it necessary and appropriate. This report meets the requirements of Section 19 of the Act and provides a factual account of the flood event that occurred on 26 October 2019 at Forge Road, Monmouth due to intense rainfall from the Met Office named weather event Persistent Wet Weather 25 and 26 October 2019.

From anecdotal reports the primary source of flooding at Forge Road was fluvial from the River Monnow.

On 26 October 2019, river levels on the Monnow increased and the river overtopped causing flooding to residential properties on Forge Road and Osbaston Road. High levels on the Monnow also prevented an ordinary watercourse from discharging to the Monnow, the watercourse backed up and further contributed to flooding at Forge Road.

Once flood waters entered one property, within 2 to 3 hours flood depths were 0.61m. After the Monnow overtopped at Forge Weir there was a very rapid rise in flood depths from 0.46 to 0.91m. The flooding continued overnight on 26 October and into the morning of 27 October.

Following the flood event officers from MCC visited the residents and properties affected to collect information on the event. At the time of preparing this report 12 residential properties are reported to have flooded during the event.

Data in relation to the flood event resulting from the Met Office named Storm Dennis, which occurred less than 4 months after that in October 2019, has been included in the report. Inclusion of the data on Storm Dennis allows comparison of different characteristics of the flood events, and aids understanding of flood mechanisms. This report will however focus primarily on flooding which occurred as a result of Persistent Wet Weather October 2019.

Information has been shared between MCC, and Natural Resources Wales (NRW) as the Risk Management Authorities (RMA). Supporting information on weather patterns and rainfall at the time of the event has been gathered from the Met Office.

2. Introduction

2.1 Purpose of the Section 19 Flood Investigation

On 25 and 26 October 2019, Monmouthshire was impacted by a significant weather event which resulted in heavy and prolonged rainfall in the northern parts of the county and upper catchments of many ordinary watercourses and main rivers, including the River Monnow.

As a result, many areas across Monmouthshire flooded particularly in the north.

This report will focus on flooding at Forge Road and Osbaston Road, collectively referred to in the report as Forge Road.

The report has been prepared by MCC in response to the duties of the LLFA in Section 19 of the FWMA, which states:

(1) On becoming aware of a flood in its area, a Lead Local Flood Authority must, to the extent that it considers it necessary or appropriate, investigate:

(a) Which risk management authorities have relevant flood risk management functions, and

(b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must:

(a) Publish the results of its investigation, and

(b) Notify any relevant risk management authorities.

2.2 Site Location

Forge Road is a no through road accessed from Osbaston Road in Monmouth's northern suburb Osbaston. From Osbaston Road, Forge Road runs parallel to the left bank of the River Monnow and is approximately 2.6km upstream of the Monnow's confluence with the River Wye. Downstream of Forge Road there are 2 residential properties on Osbaston Road which sit on low lying land that is susceptible to flooding. The area has an industrial past, historically a large weir to the west of Forge Road provided power to an iron forge. The weir now has 2 Archimedes Screw turbines and is a private hydro-electric power station.

Upstream of Forge Road the River Monnow has a catchment of approximately 430km² and is predominately rural in nature. The blue line in Figure 2-1 shows the Flood Estimation Handbook catchment for the River Monnow at Forge Road. The main tributaries of the River Monnow are the Norton Brook, Escley Brook, River Honddu and the River Dore. Along the south western edge of the Monnow's catchment is the River Trothy, and to the south eastern edge of the Monnow's catchment is the Garren Brook. The Black Mountains are along the north western boundary of the Monnow's catchment.

The River Monnow is a designated main river that falls within the Lower Wye Internal Drainage District (IDD) managed by Natural Resources Wales (NRW), see Figure 5-1 and Figure 5-2 for the IDD boundary.

Figure 2-2 is a plan of the flood investigations area.

Figure 2-1. River Monnow Catchment at Forge Road produced from FEH catchment data.

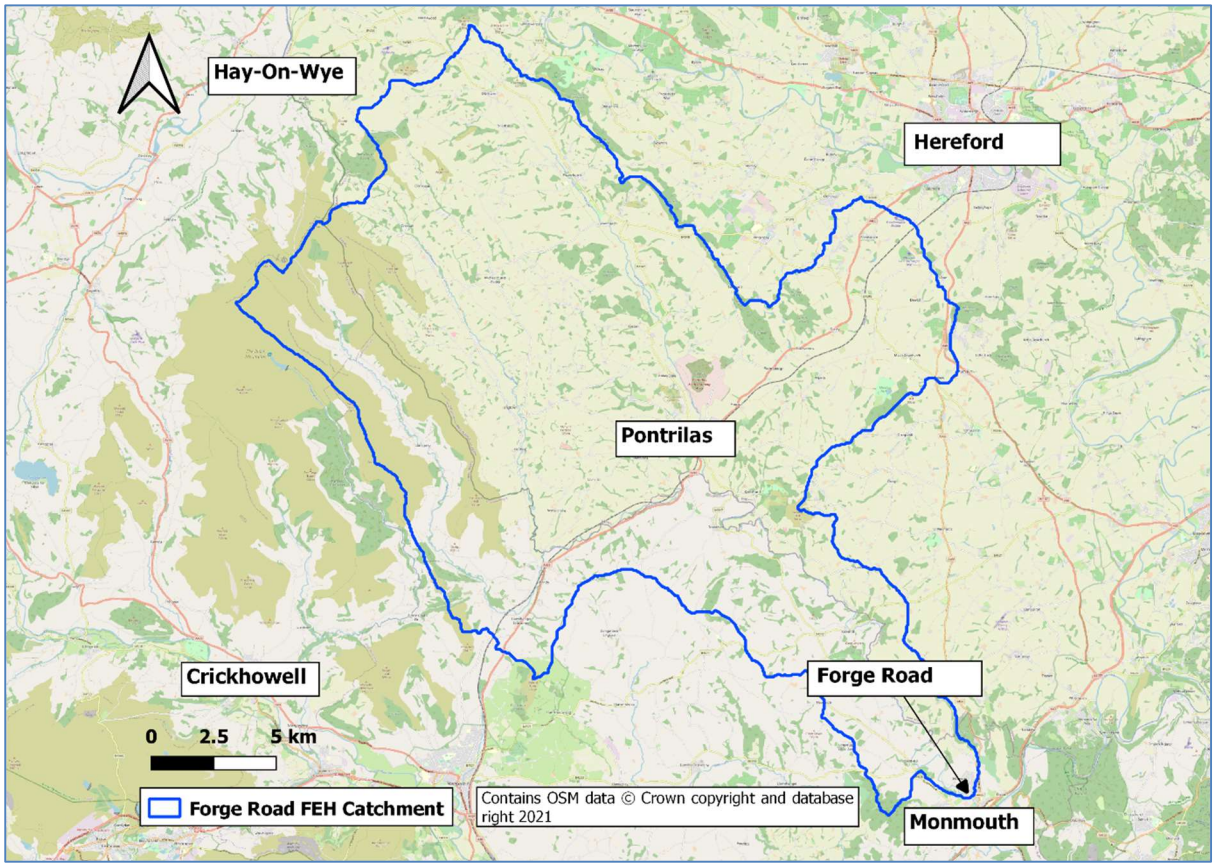


Figure 2-2. Flood Investigation Area location plan

NRW flood maps show Forge Road is at high risk of flooding from the River Monnow, and at some low surface water flood risk as shown in Figure 2-3 and Figure 2-4.

Figure 2-3. Extract from Natural Resources Wales, Risk of Flooding from Rivers

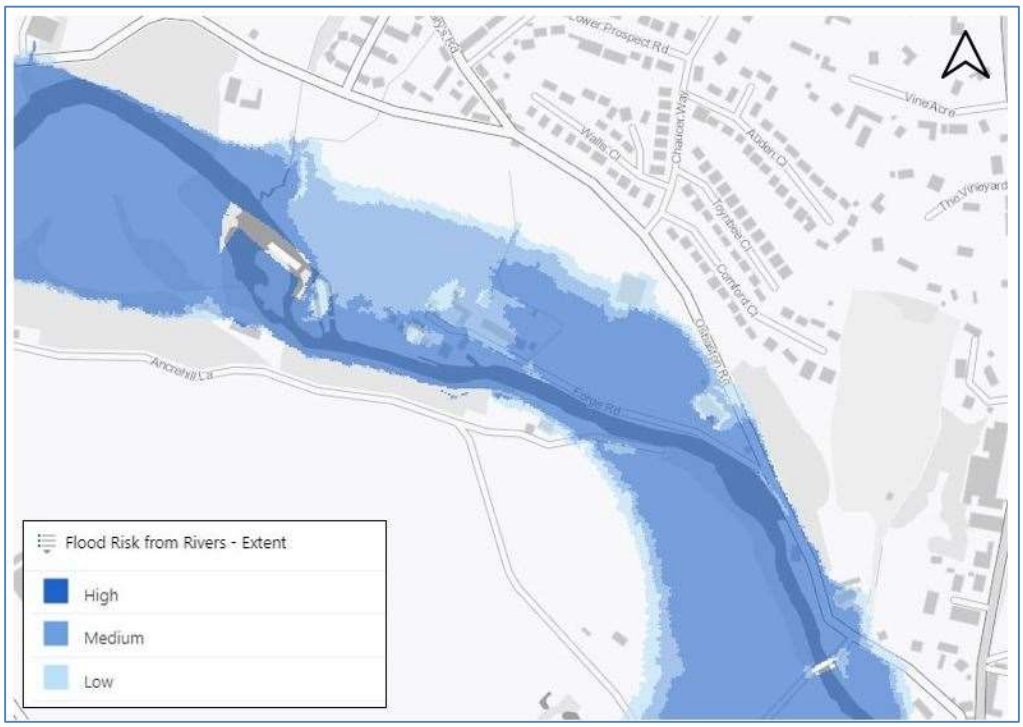


Figure 2-4. Extract from Natural Resources Wales, Risk of Flooding from Surface Water

2.3 Investigation Evidence and Data

To support the investigation the following list of qualitative and quantitative evidence has been gathered:

- Residents' photos, statements, written correspondence, and recorded verbal correspondence.
- Site inspections and photos.
- Met Office Data – Storm report and weather warnings.
- Natural Resources Wales – hydrometric data, report entitled: *February 2020 Floods in Wales: Flood Event Data Summary.*
- Environment Agency – hydrometric data.
- Monmouthshire County Council – hydrometric data, asset database, Flood Risk Management Plan, Preliminary Flood Risk Assessment.
- Historic reports relating to flooding at Forge Road:
  - *1998 Easter Floods Final Assessment by the Independent Review Team – Volume 2*, prepared by the Environment Agency on behalf of the Easter Flood Review Team September 1998. Product code GEHO0807BNAZ-E-E. The document will be referred to in this report as the *EA Easter Floods Report 1998.*

2.4 Anecdotal Evidence

Table 2-1 presents anecdotal evidence collected at a community meeting on 12 March 2020 at Osbaston Primary School and via telephone interview in May and June 2021, that compares flooding on 26 and 27 October 2019 with flooding on 16 February 2020 from Storm Dennis.

The table provides a reference to address points of local individuals consulted; a full table with a list of references and addresses can be found in Appendix A, however the appendix will be redacted prior to report publication due to General Data Protection Regulations. For some properties within the table there are only reports of flooding during one event, however it is believed that the same properties flooded during both events.

Table 2-1. Anecdotal evidence

Address reference	Notes
FR2020/01	February 2020 flood event: • Water came up through floor. • Water entered the house at approximately 08:00hrs on 16 February 2020 and receded in the night. Flooding lasted much longer than in previous events which typically last approximately 3hrs.
	October 2019 flood event: • Internal ground floor flooding to depth of 0.76m. • Water came up through the floorboards.
FR2020/02	February 2020 flood event: • Still recovering from October 2019 flood event, had not returned to the property. • Water has nearly always come in through the back of the property.
	October 2019 flood event: • Internal property flooding to the ground floor depth approximately 0.7m.
FR2020/03	February 2020 flood event: • Internal flooding. • February 2020 flood was higher than the October 2019 flood.
	October 2019 flood event: • Internal ground floor flooding to depth of 0.76m.

	• February 2020 flood was higher than the October 2019 flood.
FR2020/04	February 2020 flood event: • Internal flooding.
	October 2019 flood event: • Internal ground floor property flooding up to 0.76m.
FR2020/05	February 2020 flood event: • Internal flooding. • The February 2020 flood was worse than the October 2019 flood.
	October 2019 flood event: • Internal flooding to same depth as neighbours. • The February 2020 flood was worse than the October 2019 flood.
FR2020/06	February 2020 flood event: • Internal ground floor property flooding, depth 0.5 to 0.6m.
	October 2019 flood event: • Internal ground floor property flooding.
FR2020/07	February 2020 flood event: • Flood water came towards the property at high speed from the hydroelectric turbine. The force of the flooding caused erosion to the property.
	October 2019 flood event: No record
FR2020/09	February 2020 flood event: No record
	October 2019 flood event: • Internal flood depth 0.4m. • Water came up through floor.
FR2020/10	February 2020 flood event: No record
	October 2019 flood event: • Internal property flooding to a depth of 0.13m. • Water came in through the front of the property and then worked its way round the back.
FR2020/11	February 2020 flood event: No record
	October 2019 flood event: • Garage flooded.
FR2020/13	February 2020 flood event: • Peak of the flood was approximately 11:30hrs to 12:00hrs on 16 February 2020.
	October 2019 flood event: No record.
FR2020/14	February 2020 flood event: No record
	October 2019 flood event: • Internal flood depth 0.76m. • Water came up through floor.
FR2020/15	February 2020 flood event: No record
	October 2019 flood event: • Internal flooding to same depth as neighbours.

Table 2-2 provides flood event milestones from anecdotal reports.

Table 2-2. Flood event milestones from anecdotal reports

Milestones	Time and date
Peak of flooding	23:30 to 24:00, 26 Oct

3. Flooding

3.1 Previous Flood Incidents

Table 3-1 provides details of historical flooding at Forge Road. The information on flooding prior to October 2019 is taken from the *EA Easter Floods Report 1998*, and it has been assumed that flood depth in the report refers to the maximum internal property flooding. Information in the table relating to Storm Dennis and Persistent Wet Weather October 2019 is from anecdotal reporting to MCC.

Table 3-1. Recorded historic flood events

Date	No. properties flooded	Flood depth (m)
16 February 2020	12	0.60
26 October 2019	12	0.91
10 April 1998	10	0.25
1979	Unknown	0.75
1960	Unknown	0.90
1947	Estimated 10 properties	1.25

3.2 Flood Incident

At 10:35am on Friday 25 October 2019, the Met Office issued an Amber weather warning for South Wales including Monmouth. See section 3.7 for further details on the Met Office weather warning.

Heavy and persistent rain fell across Monmouthshire during Friday 25 October, and overnight into Saturday 26 October.

Due to the persistent heavy rainfall, levels on the Monnow rose during the day on Friday 25 October, levels proceeded to increase significantly during the day on 26 October.

MCC has anecdotal reports that the primary source of flooding was the River Monnow.

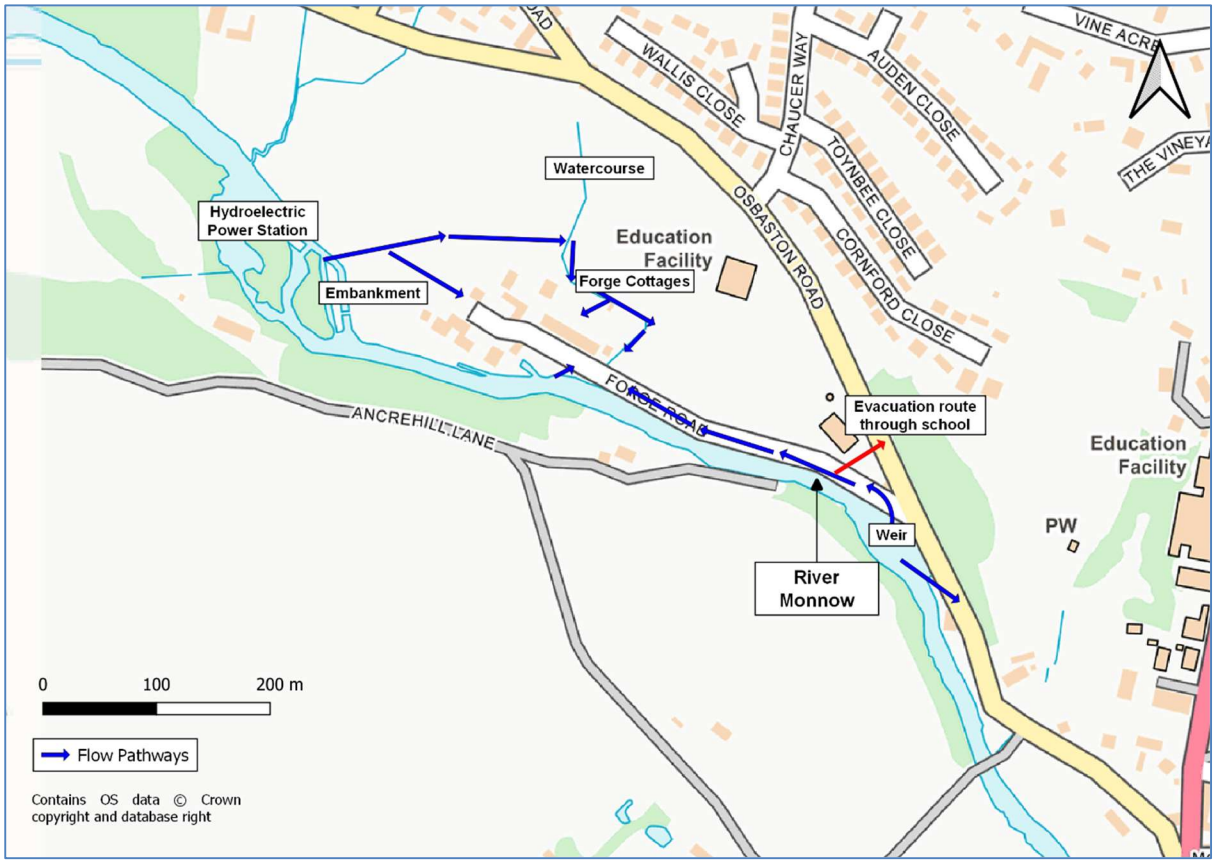
On 26 October 2019 river levels on the Monnow increased, and the river came out of bank at the junction of Forge Road and Osbaston Road, and at Forge Weir, and flooded properties on Forge Road and Osbaston Road, Figure 3-1 shows flow paths.

Residents stated that once flood waters entered one property, within 2 to 3 hours flood depths were 0.61m. After the Monnow overtopped at Forge Weir there was a very rapid rise in flood depths from 0.46 to 0.91m. The flooding continued overnight and into the morning on 26 and 27 October.

Historically in response to flood warnings, residents of Forge Road have moved cars north up to Osbaston Road; when the junction of Forge Road and Osbaston Road is flooded, they drive through the school grounds at the junction subject to access.

On 26 October 2019, 12 properties were flooded within the Forge Road flood investigation area.

Figure 3-1 Forge Road flood flow paths from anecdotal evidence



3.3 Gauging Stations

The location of nearby NRW and EA river, rainfall, and tidal gauges are shown in Figure 3-2.

All gauges are NRW except Vowchurch rain gauge, Ross on Wye river gauge, and Avonmouth Portbury tidal gauge which are EA. All the listed river and tidal gauges are telemetered. Rain gauges are a mixture of telemetered and logger.

Figure 3-2. Local rain and river gauges[1][2]

3.4 Gauge Monitoring

Table 3-2 provides a list of hydrometric data from NRW and the EA which has been assessed in the investigation. Gauges selected are telemetered as these provide readings at consistent 15-minute time intervals. Some gauge data has been excluded from the assessment due to known data accuracy issues.

The assessment has been carried out for 2 comparable storms which caused flooding in South Wales, these were the Met Office named events Persistent Wet Weather October 2019, and Storm Dennis 15 and 16 February 2020. The hydrographs later in the section are for the following 2 periods covering these storms:

[1] Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.
[2] this uses Environment Agency rainfall data from the real-time data API (Beta).

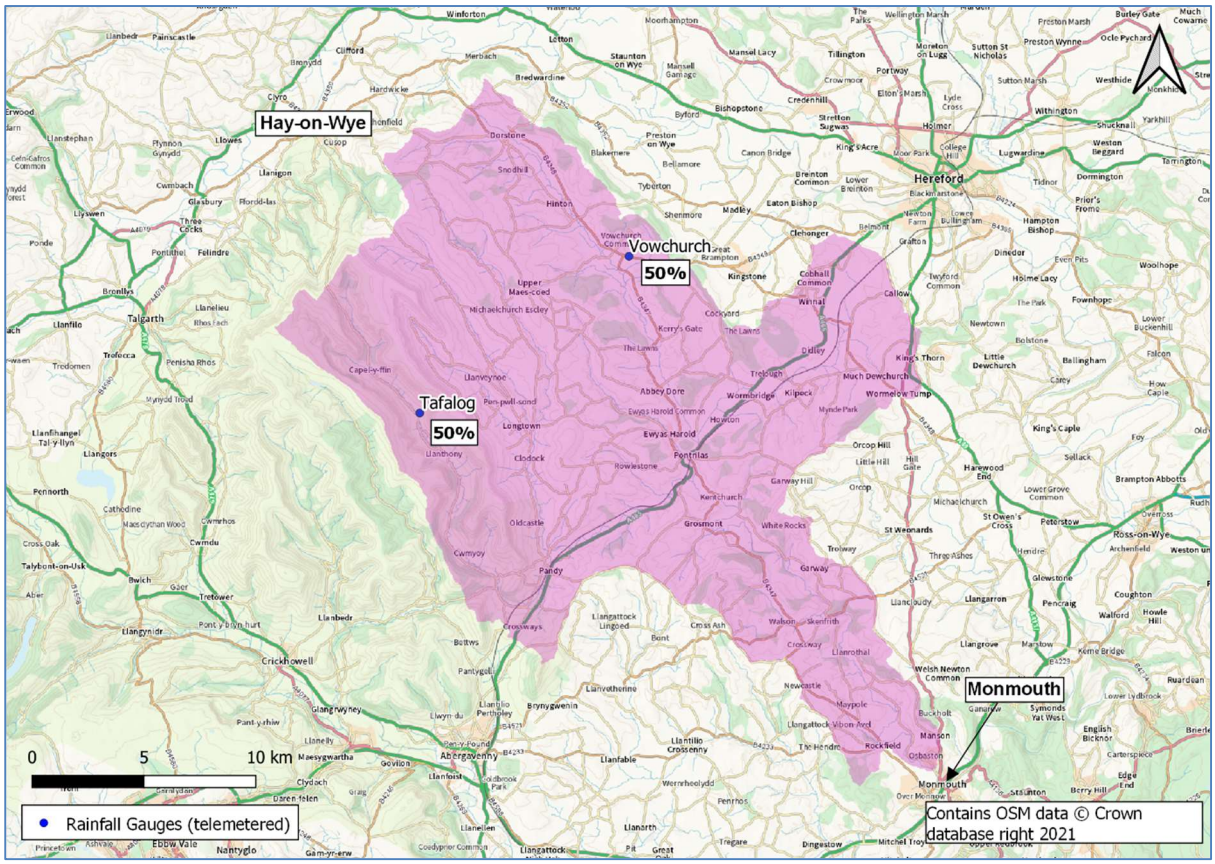
- 15-day period 00:00 on 17 October 2019 to 23:45 on 31 October 2019.
- 15-day period 00:00 on 7 February 2020 to 23:45 on 21 February 2020.

Table 3-2. Hydrometric gauges included in the assessment

Data	Gauge name	Source
River Monnow	Grosmont	NRW
River Monnow	Skenfrith	NRW
River Monnow	Monnow Gate	NRW
River Wye	Ross on Wye	EA
River Wye	Monmouth	NRW
River Wye	Redbrook	NRW
River Trothy	Michael Troy	NRW
Rainfall	Tafalog	NRW
Rainfall	Vowchurch	EA

Within the Monnow's catchment upstream of Forge Road there are 2 telemetered rain gauges. Thiessen Polygon analysis requires a minimum of 3 gauges and so cannot be carried out. The rain gauges are spread evenly over the catchment and have been assigned equal weighting, see Figure 3-4.

Figure 3-3. Rain gauge weightings



Residential properties in the Forge Road flood investigation area are approximately 2.6km upstream of the Monnow's confluence with the Wye.

For the gauges on the Monnow and Wye included in the assessment, Table 3-3 describes their approximate distance upstream and downstream from the Monnow's confluence with the Wye.

Table 3-3. River gauge approximate upstream and downstream distance from the Monnow's confluence with the Wye.

River Gauge	Gauge proximity to the Monnow's confluence with the Wye (km)
Monnow at Grosmont	26.8 upstream
Monnow at Skenfrith	16.1 upstream
Monnow at Monnow Gate	0.8 upstream
Wye at Ross on Wye	33.1 upstream
Wye at Monmouth	1.3 upstream
Wye at Redbrook	2.3 downstream
Wye at Tintern Abbey	16.7 downstream

The following hydrographs in Figure 3-4 to Figure 3-10 present river stage data for the Monnow and Wye, alongside rainfall data for Persistent Wet Weather October 2019. The remainder of the hydrographs included in the assessment are in Appendix B. The same rainfall data from Vowchurch has been used for ease of cross referencing between them. There is a time lag between rainfall on the catchment based on data from Vowchurch, and the response in levels on the Monnow, this is referred to as the time to peak.

Figure 3-4. Persistent Wet Weather October 2019 - Rainfall and river levels for the Monnow at Grosmont for the 15-day period 17 to 31 October 2019

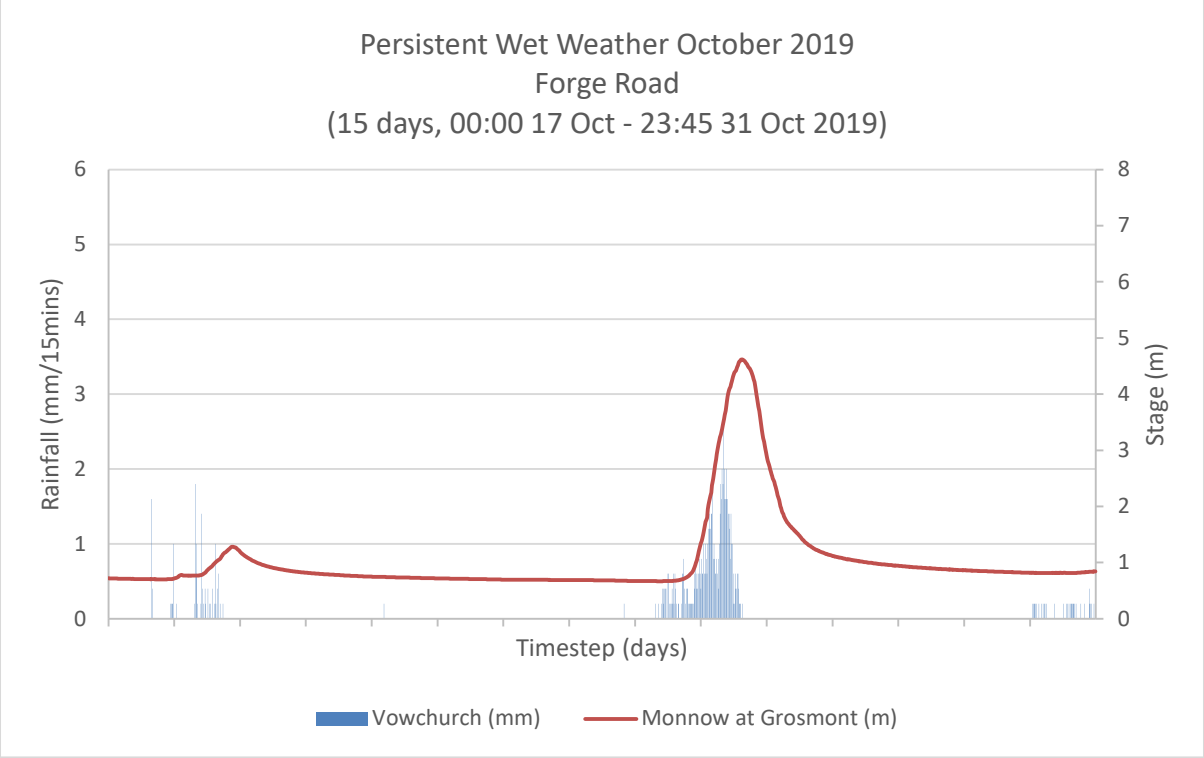


Figure 3-5. Persistent Wet Weather October 2019- Rainfall and river levels for the Monnow at Skenfrith for the 15-day period 17 to 31 October 2019

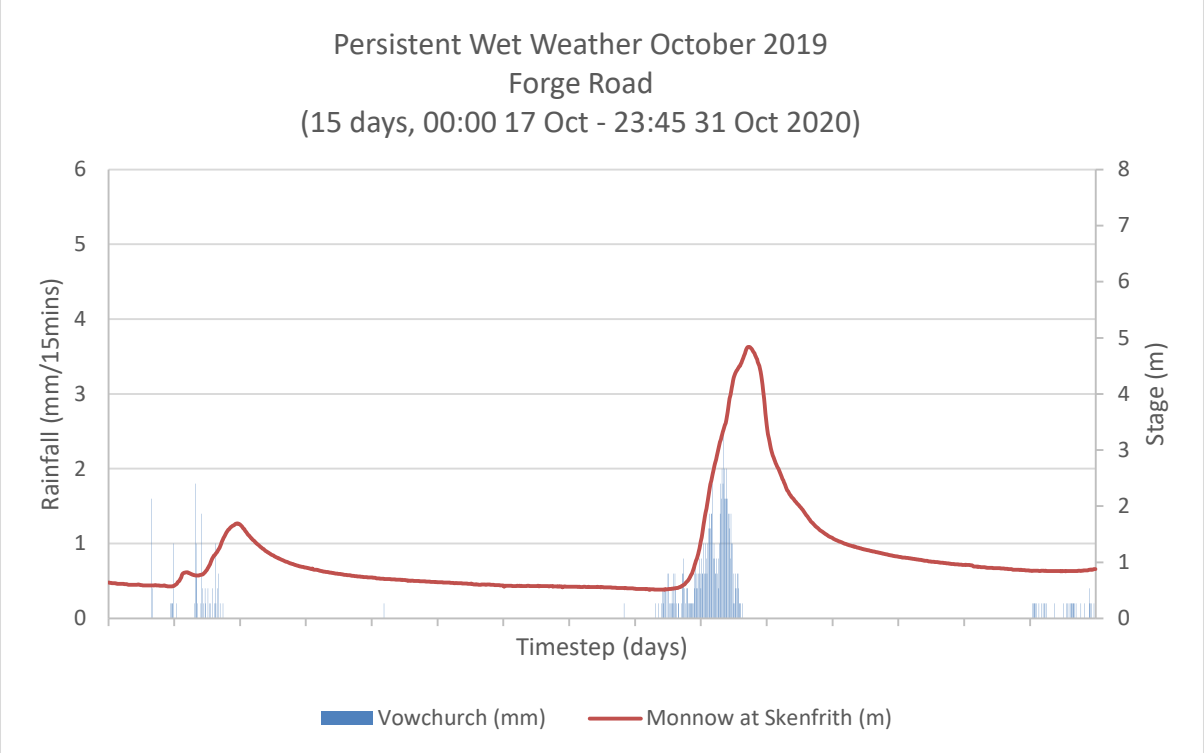


Figure 3-6. Persistent Wet Weather October 2019 - Rainfall and river levels for the Monnow at Monnow Gate for the 15-day period 17 to 31 October 2019

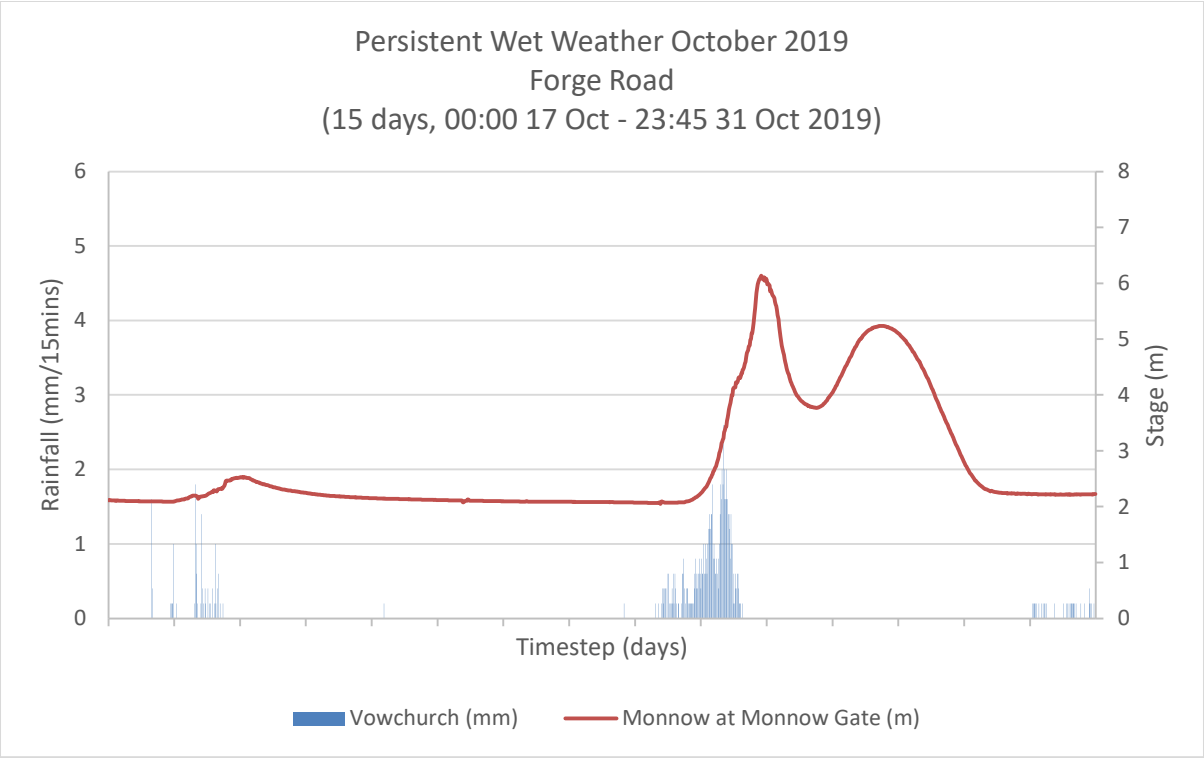


Figure 3-7. Persistent Wet Weather October 2019 - Rainfall and river levels for the Wye at Ross on Wye for the 15-day period 17 to 31 October 2019

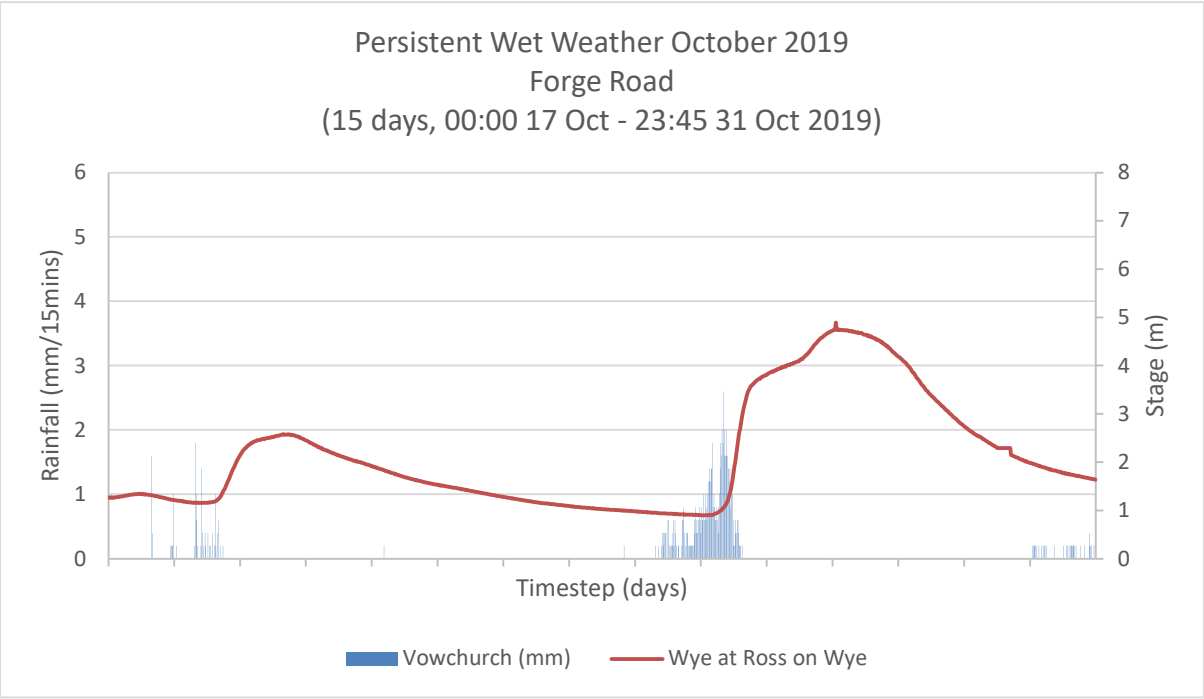


Figure 3-8. Persistent Wet Weather October 2019 - River levels for the Wye at Monmouth for the 15-day period 17 to 31 October 2019

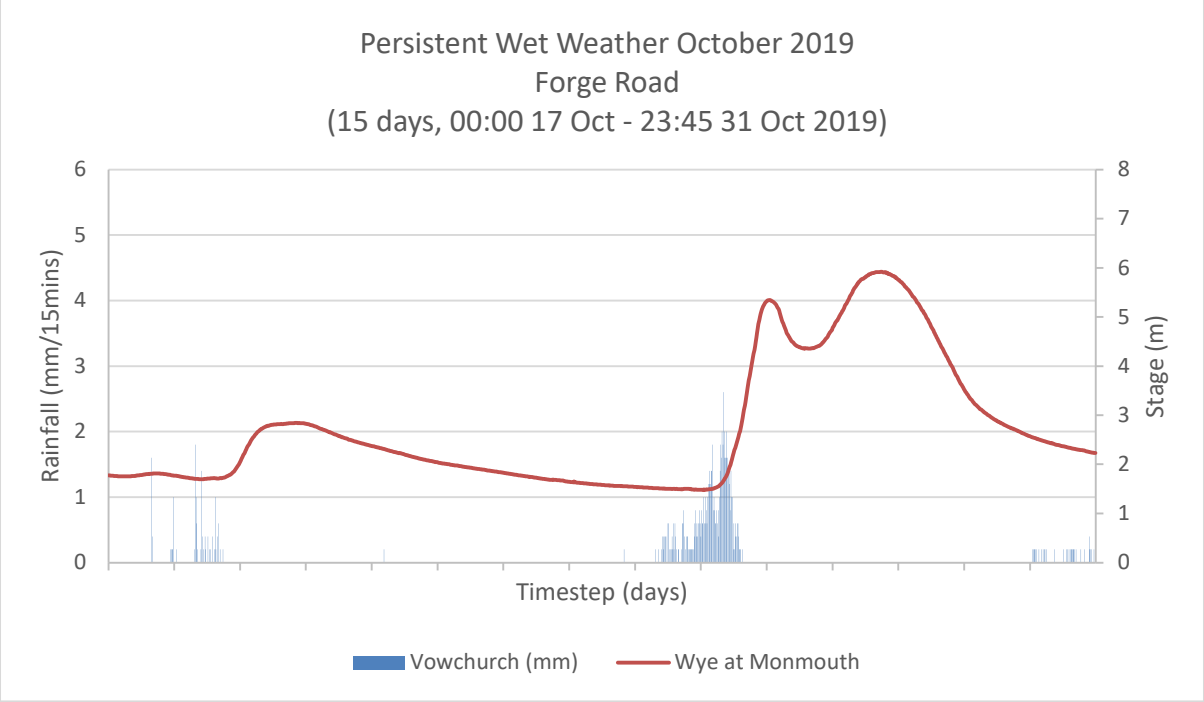


Figure 3-9. Persistent Wet Weather October 2019 - River levels for the Wye at Redbrook for the 15-day period 17 to 31 October 2019

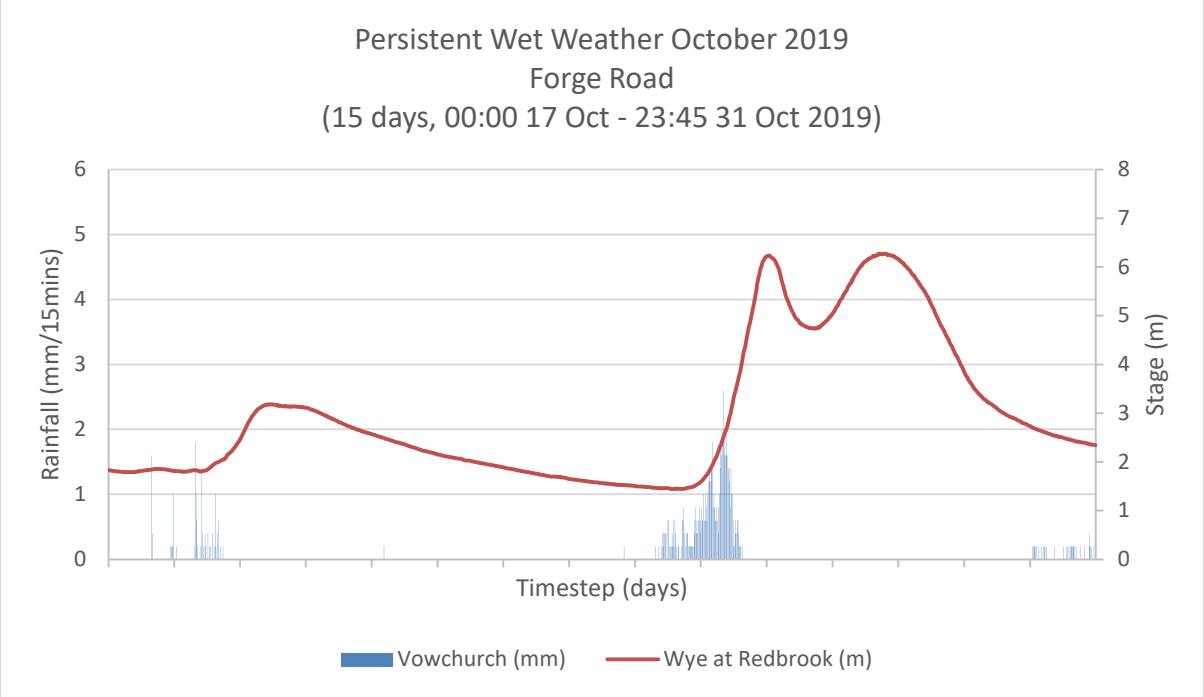
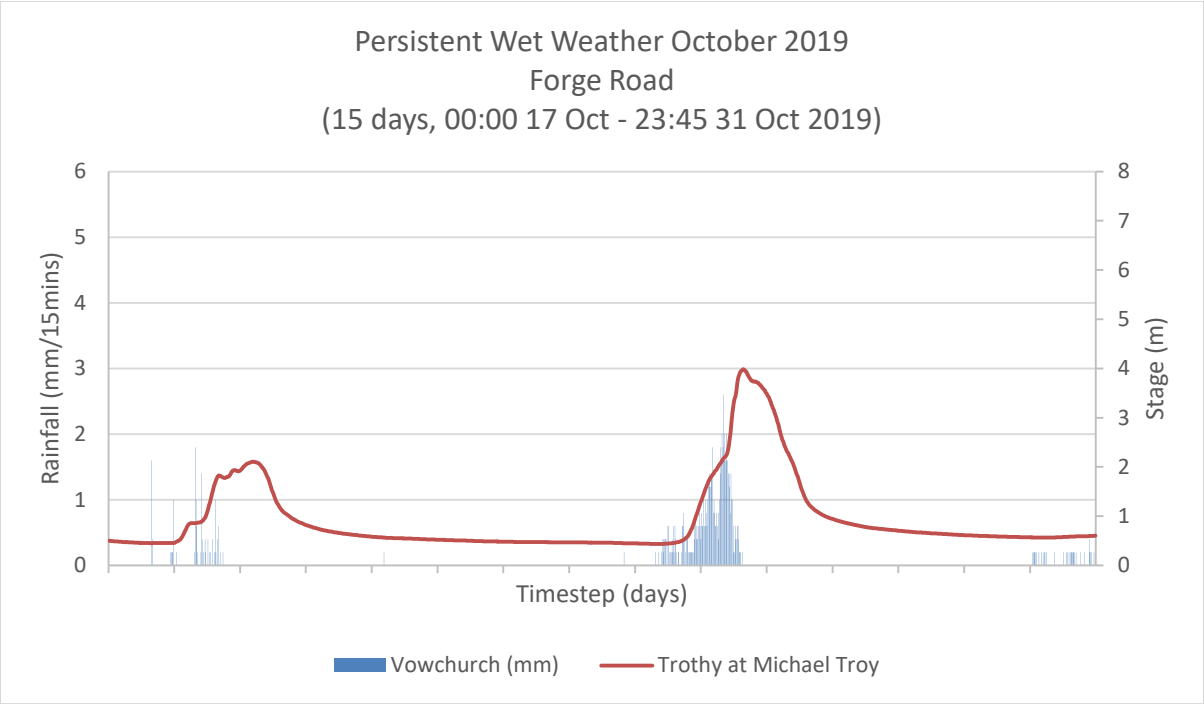


Figure 3-10. Persistent Wet Weather October 2019 - River levels for the Trothy at Michael Troy for the 15-day period 17 to 31 October 2019



The peaks in the hydrographs on the Monnow and the Wye are used by flood risk authorities as triggers for flood warnings, and to action emergency flood responses. Lead times are important in emergency flood situations; the earlier the warning, the longer property owners have to evacuate and protect their property, and the longer emergency services have to respond.

Table 3-4 and Table 3-5 present river level peaks in chronological order from the hydrographs included in the assessment.

Table 3-4. Persistent Wet Weather 25 and 26 October 2019 - Hydrograph river peaks for the period 17 to 31 October 2019, in chronological order

River and gauge	Level (m)	Time (GMT, hrs), Date
Peak on the Monnow at Grosmont	4.622	14:45, 26 Oct, 2019
Peak on the Trothy at Michael Troy	3.988	15:30, 26 Oct, 2019
Peak on the Monnow at Skenfrith	4.841	17:15, 26 Oct, 2019
1st peak on the Monnow at Monnow Gate	6.138	22:00, 26 Oct, 2019
1st peak on the Wye at Redbrook	6.235	00:45, 27 Oct, 2019
1st peak on the Wye at Monmouth	5.345	01:00, 27 Oct, 2019
Peak on the Wye at Ross on Wye	4.895	01:15, 28 Oct, 2019
2nd peak on the Wye at Redbrook	6.277	17:00, 28 Oct, 2019
2nd peak on the Monnow at Monnow Gate	5.237	17:15, 28 Oct, 2019
2nd peak on the Wye at Monmouth	5.920	17:30, 28 Oct, 2019

Table 3-5. Storm Dennis - Hydrograph river peaks for the period 7 February to 21 February 2020, in chronological order

River and gauge	Level (m)	Time (GMT, hrs), Date
Peak on the Monnow at Grosmont	4.630	07:00, 16 Feb, 2020
Peak on the Trothy at Michael Troy	4.304	07:30, 16 Feb, 2020
Peak on the Monnow at Skenfrith	4.762	09:15, 16 Feb, 2020
1st peak on the Monnow at Monnow Gate	6.385	12:15, 16 Feb, 2020
1st peak on the Wye at Redbrook	6.888	14:30, 16 Feb, 2020
1st peak on the Wye at Monmouth	5.907	14:30, 16 Feb, 2020
Peak on the Wye at Ross on Wye	5.065	21:30, 17 Feb, 2020
2nd peak on the Wye at Monmouth	7.146	08:30, 18 Feb, 2020
2nd peak on the Wye at Redbrook	7.681	08:45, 18 Feb, 2020
2nd peak on the Monnow at Monnow Gate	6.579	09:45, 18 Feb, 2020

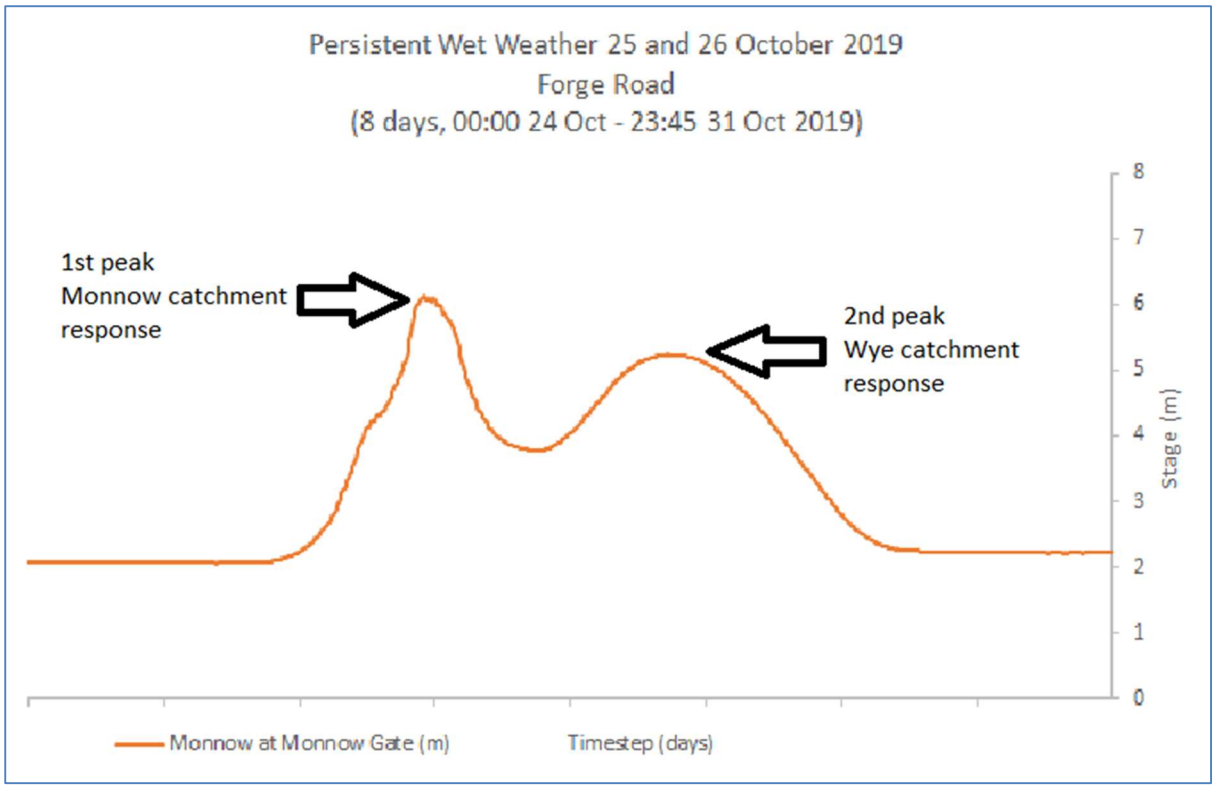
The following observations have been made on the hydrographs included in the assessment and the 2 tables above:

- From Table 2-2 there are anecdotal reports that the peak of the flooding at Forge Road occurred between approximately 23:30 and 24:00hrs on 26 October 2019. This is almost consistent with the hydrograph peak on the Monnow at Monnow Gate which occurred at 22:00 on 26 October 2019.
- For both flood events a single peak is recorded on the Monnow at Grosmont and Skenfrith, and for the Wye at Ross on Wye.
- For both flood events a double peak is recorded on the Monnow at Monnow Gate, and on the Wye at Monmouth and Redbrook. The Monnow has a peakier hydrograph than the Wye. This can be due to differing catchment characteristics including size, antecedent soil conditions, steepness and topography, land cover, and aspect. It can

also be due to differing spatial rainfall intensity. See Figure 3-11 for a diagram indicating the double peak on the Monnow at Monnow Gate, and the catchments the peaks are generated by.

- For Persistent Wet Weather 25 and 26 October 2019 the 2nd peak on the Monnow at Monnow Gate occurs 1 day 19 hours and 15 minutes after the 1st peak. For Storm Dennis the 2nd peak on the Monnow at Monnow Gate occurs 1 day 21 hours and 30 minutes after the 1st peak.
- It's noted that the Trothy's confluence with the Wye is downstream of the Monnow's confluence with the Wye, and upstream of Redbrook. Discharge from the Trothy to the Wye contributes to levels on the hydrographs at Redbrook, and this in turn contributes to the Wye backing up from Redbrook to Monmouth during the 1st peaks. Watershed analysis in GIS calculates the Trothy's catchment to be 140.72km^2.
- In the Persistent Wet Weather 25 and 26 October 2019 flood event, the 1st peaks for the Monnow at Monnow Gate and the Wye at Redbrook, are the Monnow's catchment's response to direct rainfall. In these 1st peaks, flows travel downstream on the Monnow and then the Wye to Redbrook, then the Wye backs up to Monmouth.
- In the Persistent Wet Weather 25 and 26 October 2019 flood event, the 1st peak at Ross on Wye is the Wye's response to direct rainfall on its catchment. The 1st peak at Ross on Wye moves downstream generating a 2nd peak at Redbrook, then the Wye backs up to generate a 2nd peak at Monnow gate 15 minutes later, and a 2nd peak at Monmouth 15 minutes after that.
- In the Storm Dennis flood event, the 1st peaks for the Monnow at Monnow Gate and the Wye at Redbrook, are the Monnow's response to direct rainfall on its catchment. In these 1st peaks, flows travel downstream on the Monnow and then the Wye to Redbrook, then the Wye backs up to generate the 1st peak at Monmouth. This is the same mechanism as in Persistent Wet Weather 25 and 26 October 2019.
- In the Storm Dennis flood event, the 1st peak at Ross on Wye is the Wye's response to direct rainfall on its catchment. The first 1st peak at Ross on Wye moves downstream generating a 2nd peak at Monmouth and then Redbrook, then the Wye backs up to generate a 2nd peak at Monnow Gate, but does not reach Monmouth to generate a 3rd peak there. This is a different mechanism to Persistent Wet Weather 25 and 26 October 2019, likely as a result of different storm intensities and antecedent catchment and river conditions.
- The more saturated a catchment is the greater the speed of runoff. The catchments were saturated at the onset of Storm Dennis generating very fast runoff.
- At the onset of Storm Dennis at Vowchurch, river levels were 2.706m at Monmouth, 3.078m at Redbrook, and 2.363m at Monnow Gate. At the onset of Persistent Wet Weather 25 and 26 October 2019 at Vowchurch, levels were relatively much lower than they were for Storm Dennis with 1.505m at Monmouth, 1.455m at Redbrook, and 2.088m at Monnow Gate.
- At Monnow Gate the 1st peak was 0.247m higher during Storm Dennis than Persistent Wet Weather 25 and 26 October 2019, the 2nd peak was 1.342m higher during Storm Dennis. All 2nd peaks in Storm Dennis were notably higher than in Persistent Wet Weather 25 and 26 October 2019.
- Peak levels during Storm Dennis for Grosmont, Monmouth and Redbrook were new record highs at these gauges. This is recorded in Table 5 of the NRW report entitled *February 2020 Floods in Wales: Flood Event Data Summary.*

Figure 3-11. Persistent Wet Weather 25 and 26 October 2019 - Hydrograph peaks - River levels for the Monnow at Monnow Gate for the 15-day period 7 to 21 February 2020



Graphs in Figure 3-12 to Figure 3-17 show cumulative rainfall totals for the 4-day period with the storms beginning on day 2, for Tafalog and Vowchurch rain gauges, and for their average rainfall, the cumulative totals are presented in Table 3-6.

Table 3-6. Cumulative rainfall totals

Rainfall gauge	Persistent Wet Weather (mm)	Storm Dennis (mm)
Tafalog	94.4	93.0
Vowchurch	78.8	62.0
Tafalog Vowchurch average	86.6	77.5

Despite Persistent Wet Weather 25 and 26 October 2019 having a greater cumulative rainfall for the 4-day period, peaks on the Monnow at Monnow Gate were notably higher for the Storm Dennis flood event due to the antecedent conditions on the catchment and the river.

Figure 3-12. Persistent Wet Weather October 2019 - Rainfall totals Tafalog (mm/15mins), and cumulative rainfall (mm) for the 4-day period 24 to 27 October 2019

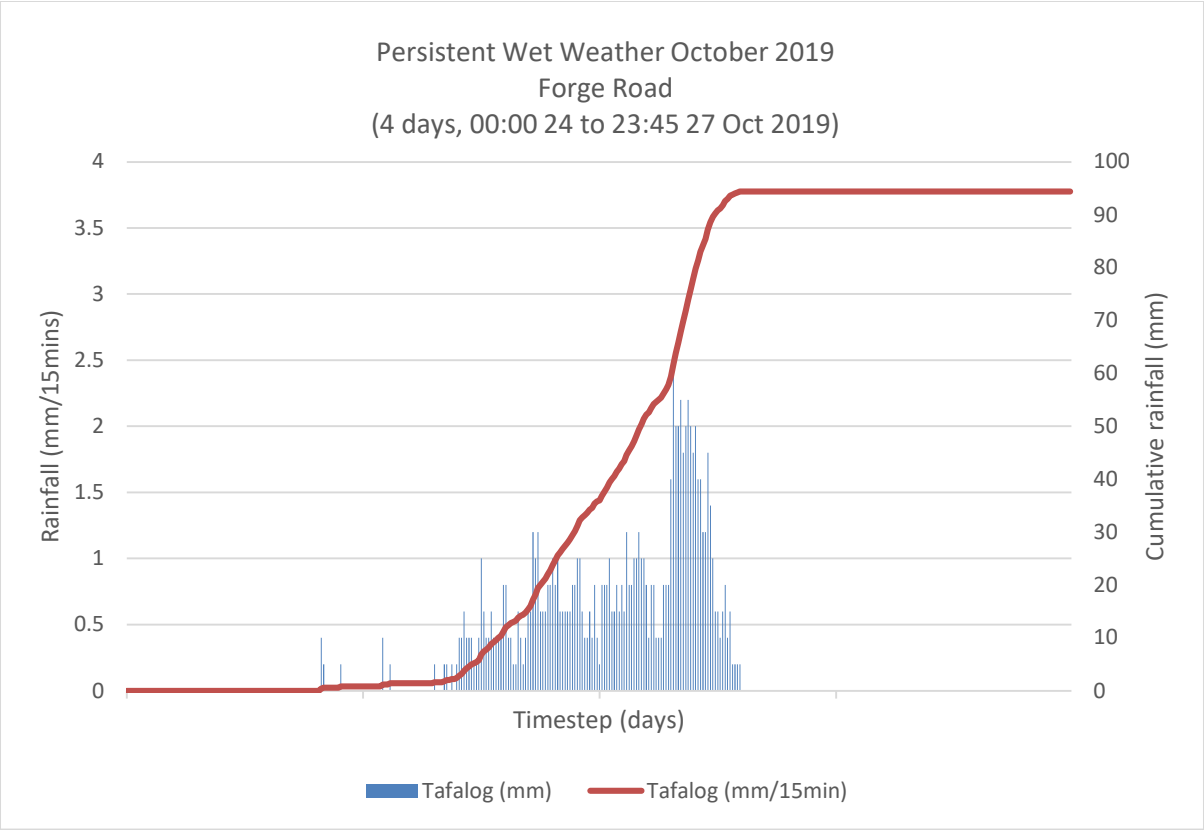


Figure 3-13. Storm Dennis - Rainfall totals Tafalog (mm/15mins), and cumulative rainfall (mm) for the 4-day period 14 to 17 February 2020

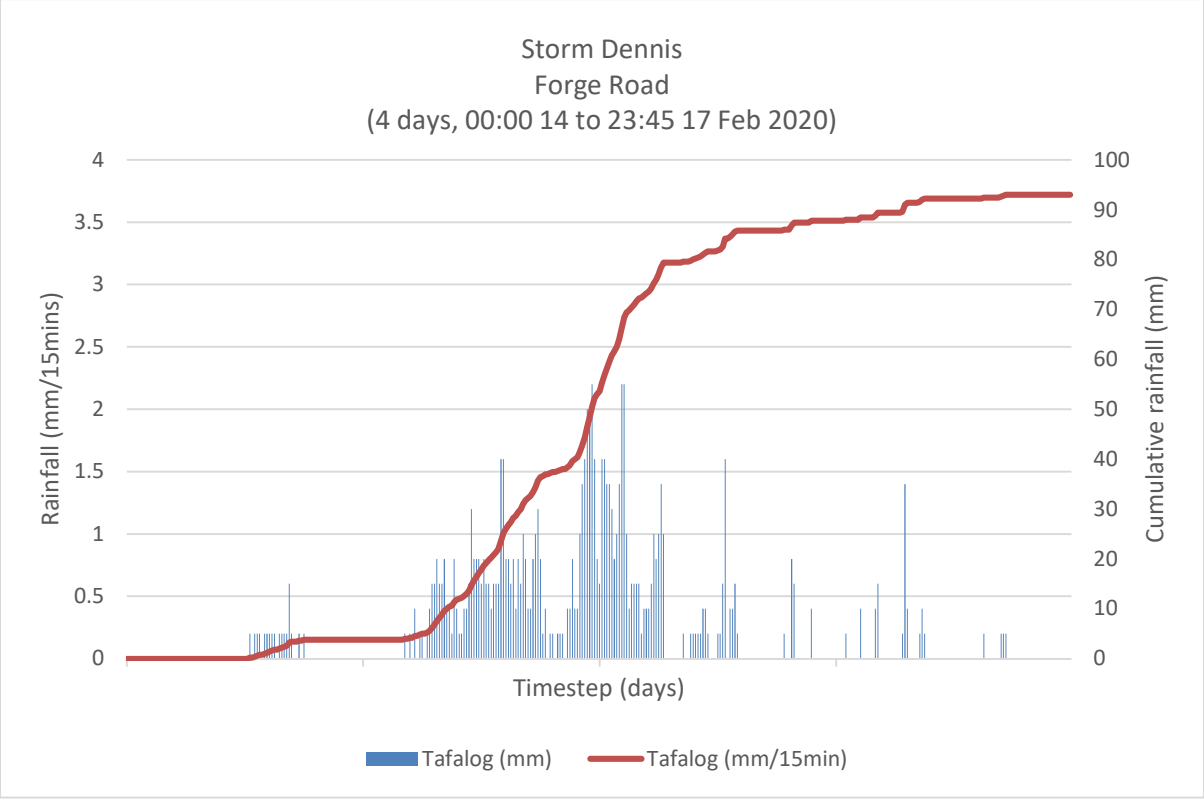


Figure 3-14. Persistent Wet Weather October - Rainfall totals Vowchurch (mm/15mins), and cumulative rainfall (mm) for the 4-day period 24 to 27 October 2019

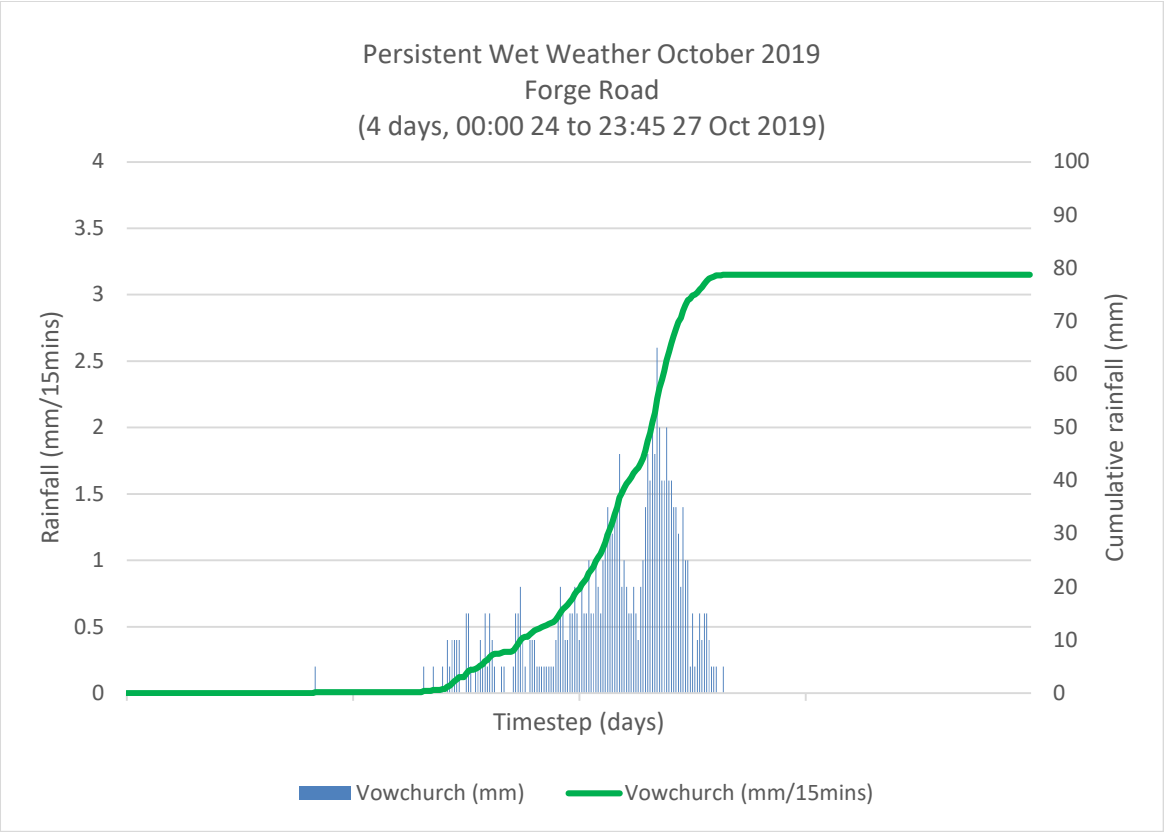


Figure 3-15. Storm Dennis - Rainfall totals Vowchurch (mm/15mins), and cumulative rainfall (mm) for the 4-day period 14 to 17 February 2020

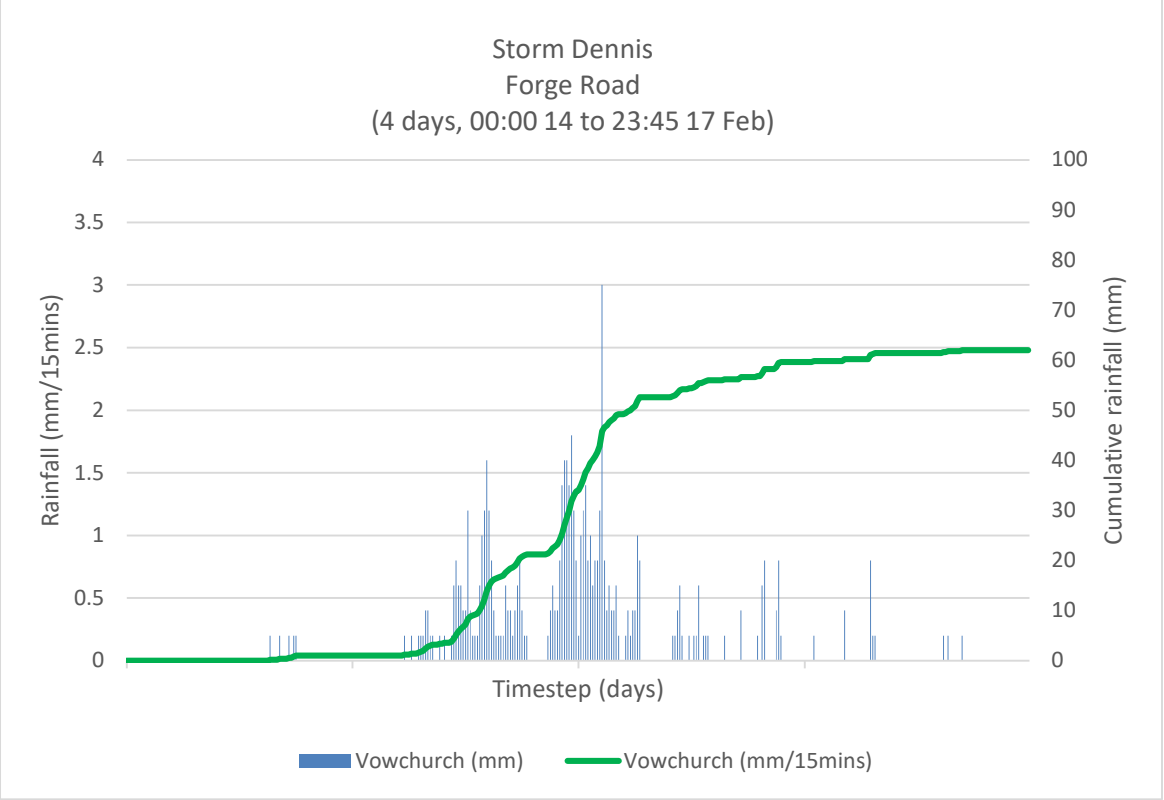


Figure 3-16. Persistent Wet Weather October 2019 - Rainfall totals Tafalog Vowchurch average (mm/15mins), and cumulative rainfall (mm) for the 4-day period 24 to 27 October 2019

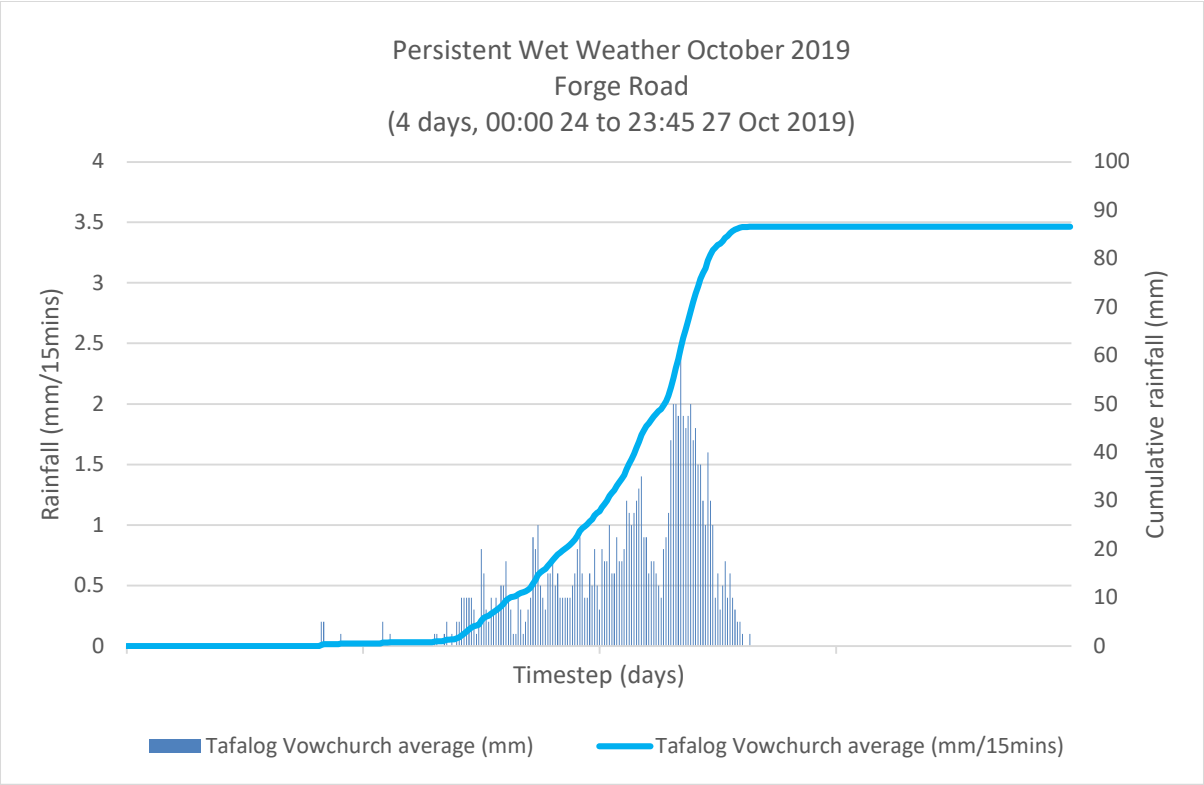
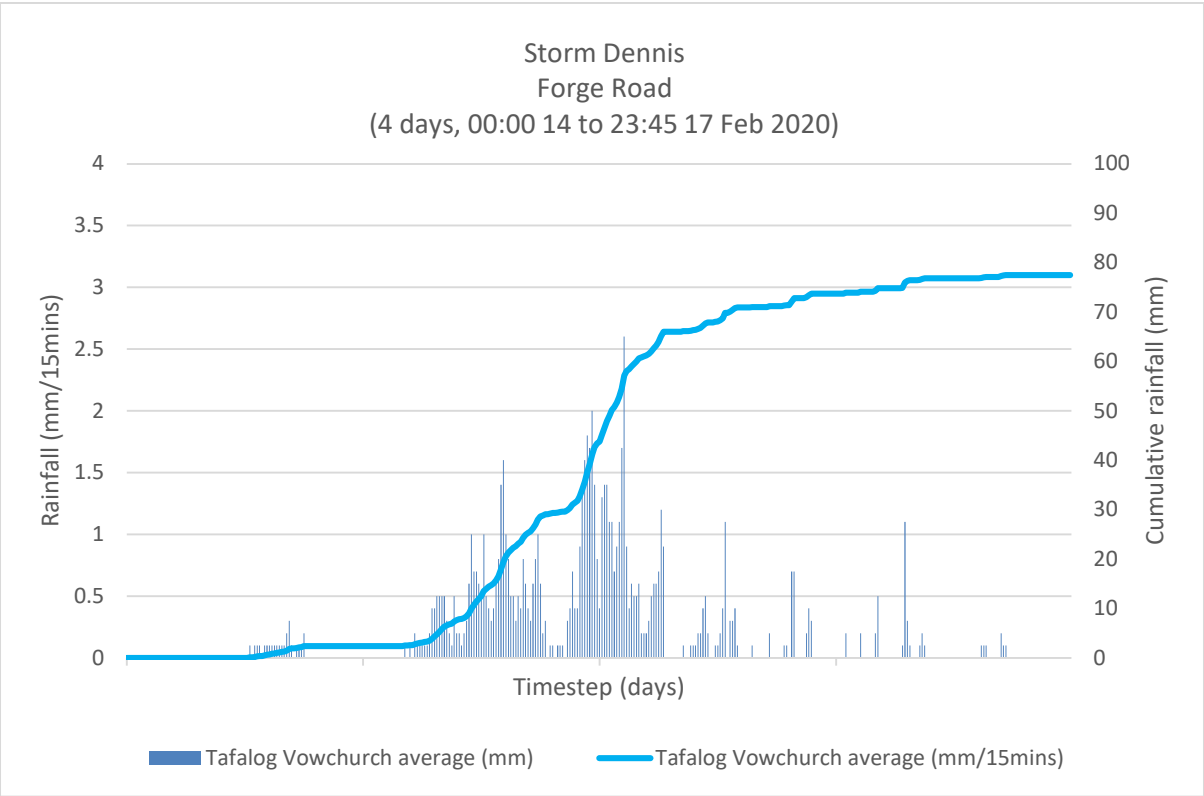


Figure 3-17. Storm Dennis - Rainfall totals Tafalog Vowchurch average (mm/15mins), and cumulative rainfall (mm) for the 4-day period 14 to 17 February 2020



3.5 Return Period

3.5.1 Rainfall

The rainfall return period is the average interval a storm of at least a specified magnitude will occur on a catchment. The higher the return period the greater the storm.

The rainfall return period has been calculated for the Monnow's catchment at Forge Road using Flood Estimation Handbook (FEH), at point 350650, 213600, see Table 3-8. Average rainfall depth and duration data was used from Tafalog and Vowchurch rain gauges. The rain gauge depth and duration data used is presented in Table 3-7, and shows how rainfall varied between the 2 gauges.

Table 3-7. Rainfall depth and duration data.

Rain Gauge	Storm	Period	Duration (hrs)	Rainfall Depth (mm)
Tafalog	Persistent Wet Weather Oct 2019	09:30hrs 25 Oct to 14:15hrs 26 Oct	28.75	92.2
Tafalog	Storm Dennis	06:30hrs 15 Feb to 06:30hrs 16 Feb	24	74.4
Vowchurch	Persistent Wet Weather Oct 2019	10:00hrs 25 Oct to 14:30hrs 26 Oct	28.5	77.8
Vowchurch	Storm Dennis	07:00hrs 15 Feb to 06:30hrs 16 Feb	23.5	51.2

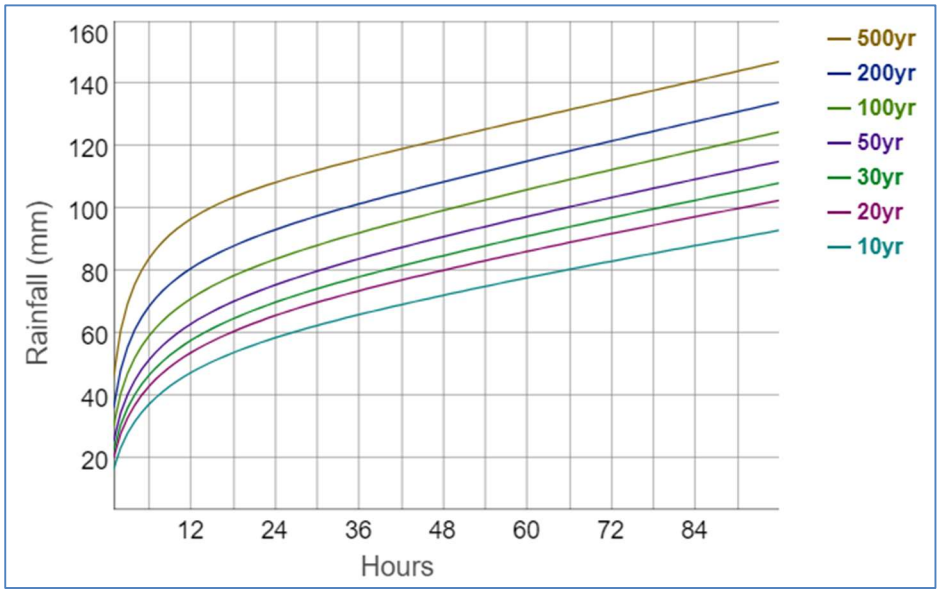
Table 3-8. FEH return period in years.

Storm	Duration (hrs)	Rainfall Depth (mm)	Return Period in Years
Persistent Wet Weather October 2019	28.63	85	84
Storm Dennis	23.75	62.8	15

Persistent Wet Weather October 2019 has the higher FEH return period. The difference in return period between the 2 storms is primarily due to Persistent Wet Weather 2019 having a 26%, or 22mm higher rainfall depth. Persistent Wet Weather October 2019 also had a longer storm duration than Storm Dennis by 17%, or 5 hours.

The Depth Duration Frequency curves in Figure 3-18 show the relationship between rainfall depth and storm duration for set return periods for the Monnow's catchment at point 350650, 213600. Between 0 and approximately 24-hours, rainfall depths increase at a decreasing rate, and for storms of approximately 24-hour duration and greater, the relationship between storm duration and rainfall depth is linear.

Figure 3-18. FEH Depth Duration Frequency, Monnow catchment, point 350650, 213600.



3.5.2 River

River flow data is required for the catchment to calculate the river flow return period. This data is not currently available for the Monnow at Forge Road or at the Monnow Gate gauging station.

3.5.3 Tidal

This section is not applicable to this report, it is retained for consistency with other FWMA Section 19 reports.

There is no tidal influence on the Wye or Monnow at Forge Road or Monmouth.

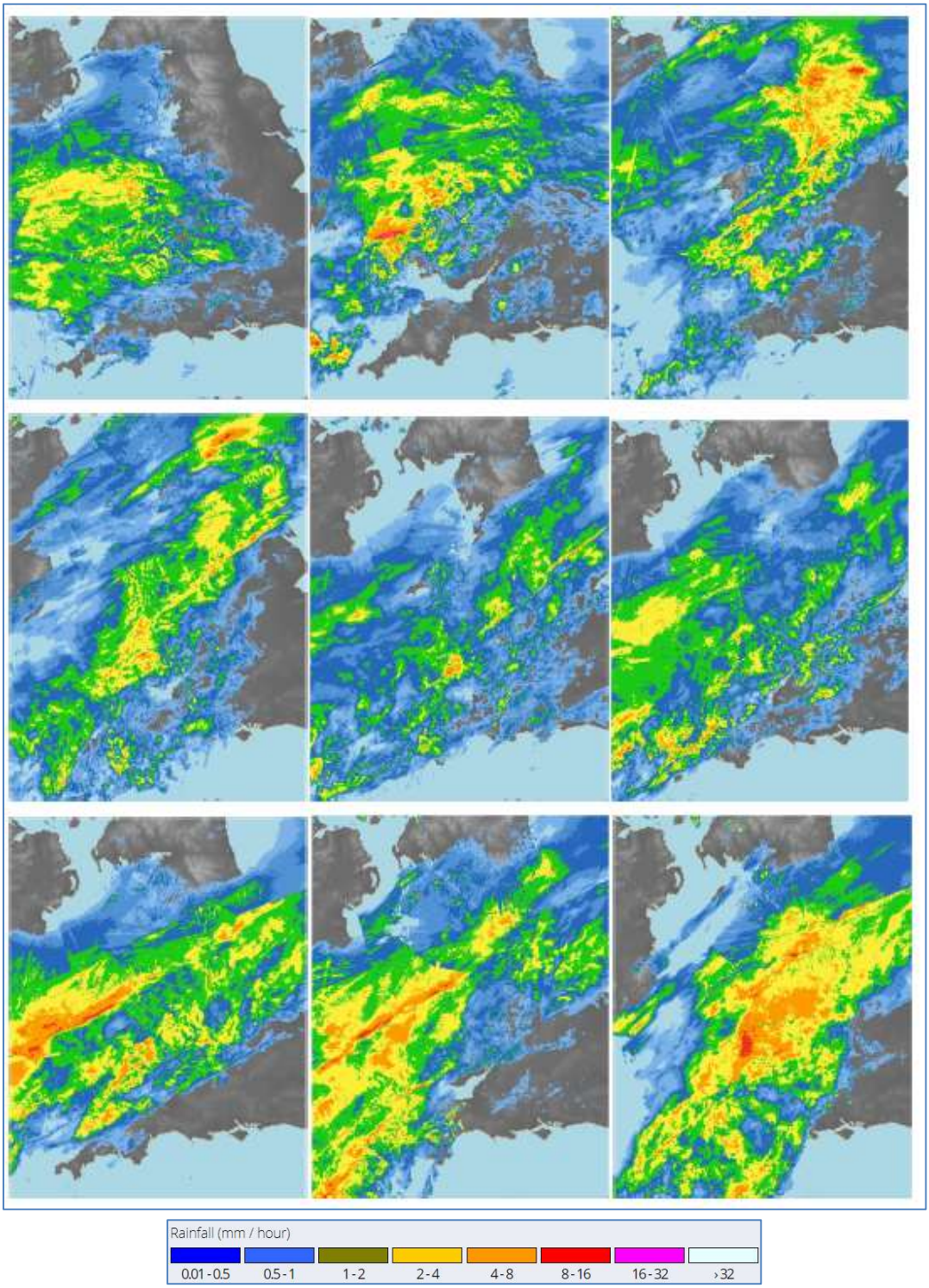
3.6 Persistent Rainfall Event 25 and 26 October 2019

South Wales has an oceanic climate and experiences low pressure weather systems moving eastwards from the Atlantic with the polar jet stream. It is also characterised by mountainous terrain. Rivers drain radially from the Brecon Beacons to the coast via main rivers.

Orographic uplift rainfall occurs when air is forced from a low elevation to a higher elevation as it moves across rising terrain. The combination of weather systems arriving from the Atlantic and the orographic lift over the extensive mountainous ranges in South Wales leads to notable storm events. The Met office document *Wales: Climate, Updated 10 October 2016* reported that most parts of Wales experiences daily totals greater than or equal to 50mm at least once every 2 years.

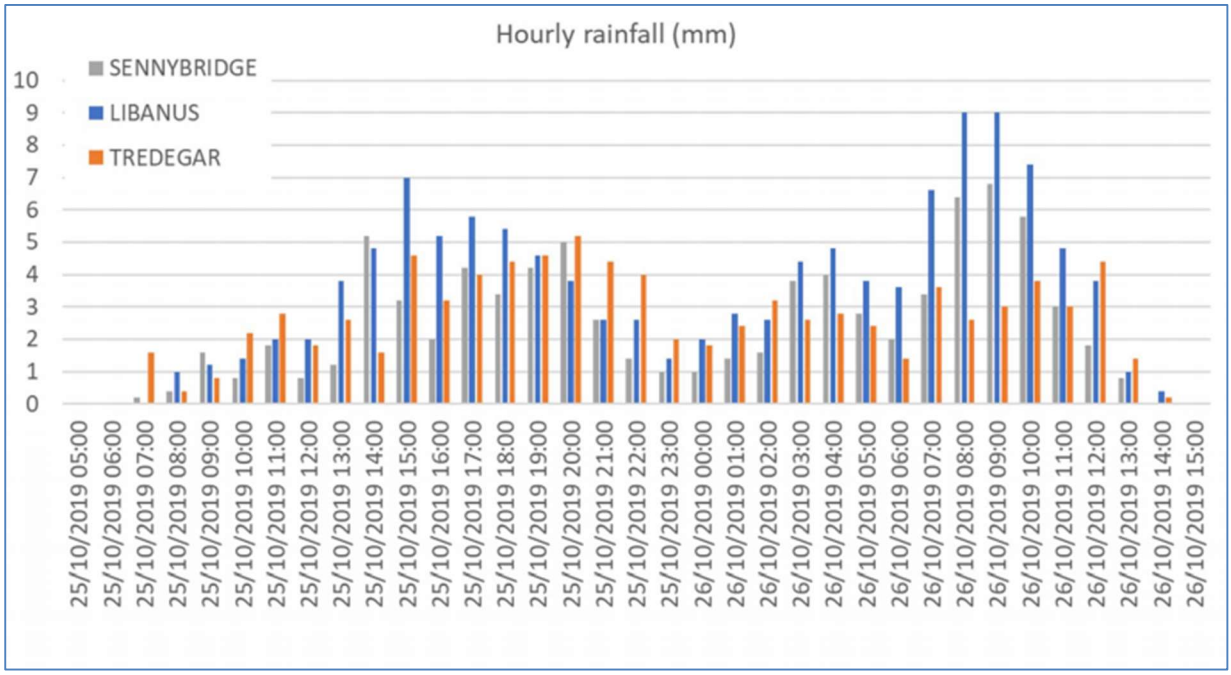
A Met Office review of the persistent heavy rainfall across Wales and England on 25 and 26 October 2019 (see section 10) reported a slow-moving weather front, see Figure 3-19. The wettest areas in Wales were over high ground in the south where over 100mm of rain fell over the 2 days. Some locations in Wales received over 75% of 1 month's average rainfall. This rain fell on already very wet ground causing river levels to rise rapidly. The weather front associated with this rainfall stretched from South Wales to Lincolnshire and was associated with a large temperature gradient of approximately 7°C in Birmingham and 17°C in London (daily maximum temperatures).

Figure 3-19. Met Office report on persistent rainfall 25 and 26 October 2019. Rain radar images indicating persistent heavy rainfall over South Wales (3-hour intervals over the 24-hour period: 0900 UTC 25 October 2019 and 0900 UTC 26 October 2019)



The chart below in Figure 3-20 shows hourly rainfall totals for 3 locations, Libanus and Sennybridge in Powys, and Tredegar in Blaenau Gwent. The rainfall was not particularly intense, but it was persistent: in 32 hours Libanus recorded 120.6mm of rainfall, both Tredegar and Sennybridge both recorded over 80mm.

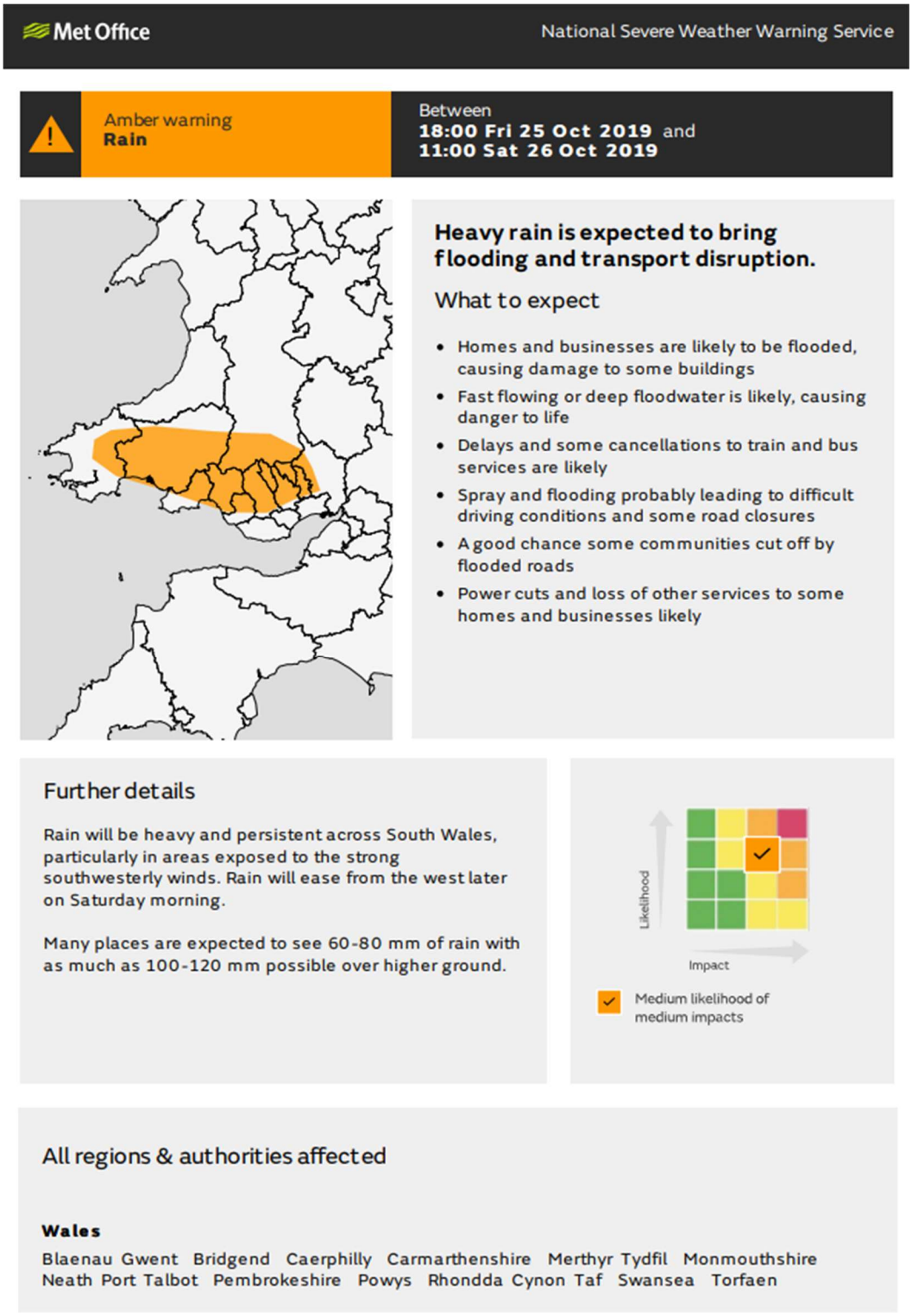
Figure 3-20. Met Office report on persistent rainfall 25 and 26 October 2019, rainfall totals recorded at Libanus, Sennybridge and Tredegar between 05:00 on 25 October and 15:00 on 26 October 2019.



3.7 Met Office Weather and Flood Warning

At 10:35hrs on Friday 25 October 2019, the Met Office issued an Amber weather warning for rain in South Wales including Monmouth as shown in Figure 3-21.

Figure 3-21. Met Office weather warning for South Wales issued 10:35hrs Friday 25 October 2019.



4. Sources of Flooding

4.1 Fluvial Flooding

It's been established from anecdotal reports that the primary source of flooding was the River Monnow.

On 26 October 2019, river levels on the Monnow increased, the river came out of bank at the junction of Forge Road and Osbaston Road, flowed down Forge Road, and flooded the residential properties there. Water also began to emerge from the ground in front of the properties due to the high levels on the Monnow. Levels on the Monnow continued to rise, and the river later overtopped the embankment at Forge Weir and the hydroelectric turbine west of Forge Road, the water then flowed eastwards over a field to the properties and entered an ordinary watercourse that flows eastwards to the north of the properties, and then south around the properties to discharge to the Monnow via a culvert under Forge Road. High levels on the Monnow prevented the watercourse discharging, the watercourse then backed up and further contributed to flooding of the properties. The Monnow also flooded property downstream of Forge Road that is low lying and close to the river. Figure 4-1, Figure 4-2 and Figure 4-4 are photos and an information board on Forge Weir, the hydroelectric turbine and a fish pass constructed by the weir. To monitor flood levels at Forge Road residents have installed a makeshift gauge pole at the culvert inlet on the ordinary watercourse which they use to monitor flows, see Figure 4-3. For a map showing flow paths please see Figure 3-1.

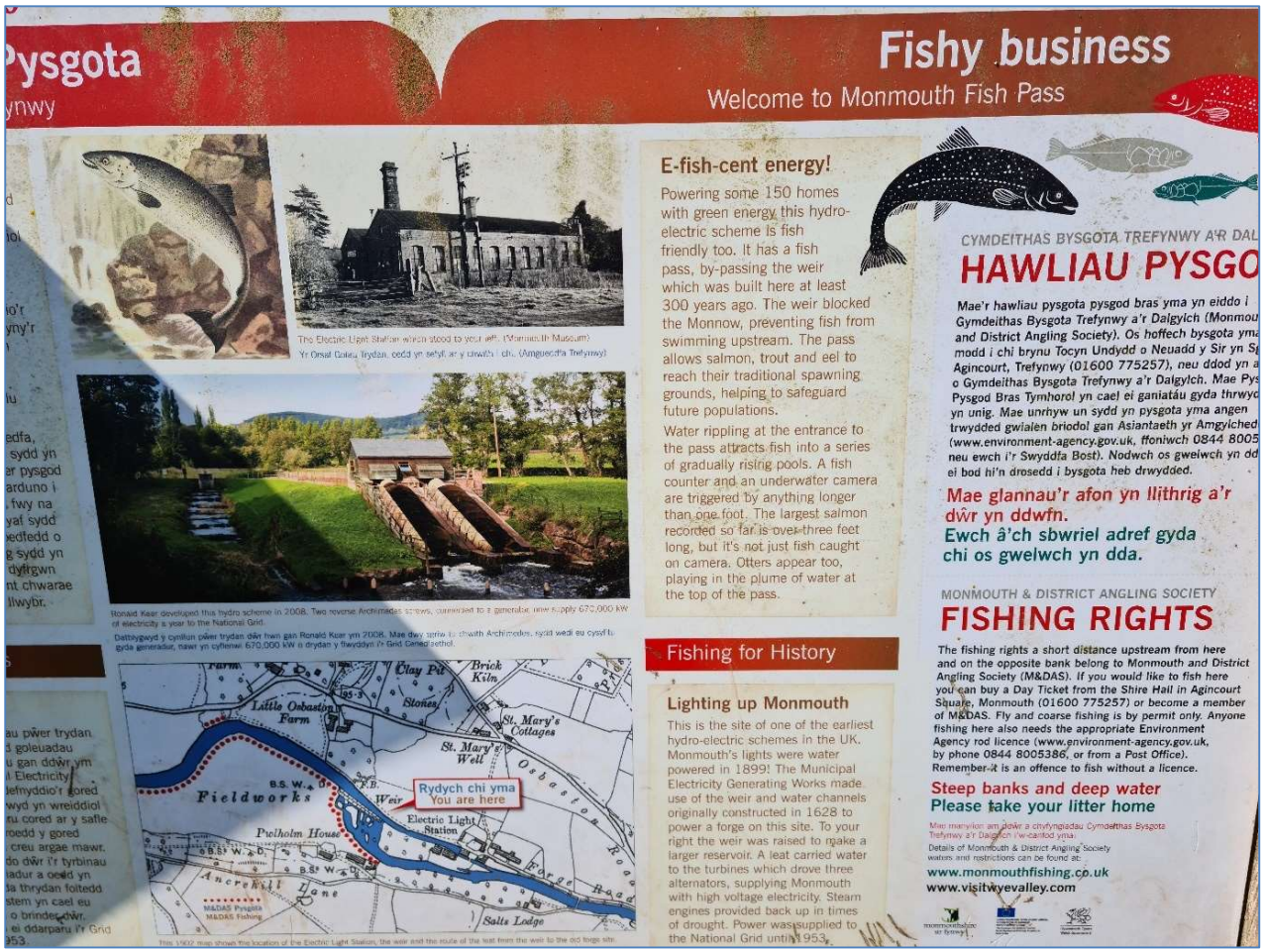
Anecdotal reports state that from the onset of internal property flooding, within 2 to 3 hours internal flood depths were 0.61m. After the Monnow overtopped at Forge Weir there was a very rapid rise in flood depths from 0.46 to 0.91m. The flooding occurred from the evening of 25 October into the morning of 26 October 2019.

Figure 4-1. Forge Weir, site visit May 2021

Figure 4-2. Flood embankment adjacent to Forge Weir on the left bank of the Monnow, site visit May 2021

Figure 4-3. Resident's gauging pole on the ordinary watercourse adjacent to Forge Road. Photo taken during February 2020 flood event

Figure 4-4. Photo of an information board adjacent to Forge Weir showing historical map of the Monnow's river structures at Forge Road in 1902. Photo taken during site visit May 2021



4.2 Groundwater

As outlined in section 4.1 water emerged up through the ground in front of properties on Forge Road and came up through the floorboards within properties; this was due to high levels on the Monnow.

4.3 Tidal

This section is not applicable to this report, it is retained for consistency with other FWMA Section 19 reports.

There is no tidal influence on the Wye or Monnow at Forge Road or Monmouth.

4.4 Land Drainage

There is an ordinary watercourse north of Forge Road that channels overland flows from the fields there, it flows parallel to the Monnow, and then at the north east point of Forge Road it channels south until it enters a culvert under Forge Road and discharges to the Monnow.

4.5 Surface Water Drainage

Forge Road was inundated with flows from the Monnow. There are no surface water drains on Forge Road with surface water draining to the Monnow directly adjacent to the road, see Figure 4-5.

Surface water drains along Osbaston Road approximately 470m south of Forge Road have been reported to backup just before the river overtops its banks at that location.

Figure 4-5. Picture looking northwest along Forge Road, the River Monnow runs parallel to left of Forge Road in this image. Photo taken site visit May 2021

5. Rights and Responsibilities of Risk Management Authorities

5.1 Lead Local Flood Authority

Under the FWMA 2010, MCC has been established as the Lead Local Flood Risk Authority (LLFA) for its administrative area. NRW are the RMA for the main river Monnow.

In its role as LLFA, MCC held a community meeting to discuss the flood event on 16 February 2020 with residents, the meeting was held at Osbaston Primary School on 12 March 2020 and was attended by NRW as RMA for the River Monnow.

As defined in the Act, MCC is responsible for 'Managing' what is termed, its 'local flood risk'. This includes the risk of flooding from ordinary watercourses, surface runoff and groundwater.

Local Authorities have always had certain responsibilities in relation to ordinary watercourses, and in practice most Local Authorities take the lead in dealing with surface water flooding incidents prior to the changes contained within the Act.

The Act places statutory duties on Local Authorities in their new role as LLFAs including:

- The preparation of local flood risk management strategies;
- A duty to comply with the national strategy;
- To co-operate with other authorities, including sharing data;
- A duty to investigate all flooding within its area, insofar as the LLFA consider it necessary or appropriate;
- A duty to maintain a register of structures and features likely to affect flood risk;
- A duty to contribute to sustainable development; and
- Consenting powers on ordinary watercourses.

In addition to these, each LLFA has a number of permissive powers. These are powers that allow them to undertake certain activities to manage flood risk, they are discretionary and include:

- Powers to request information;
- Powers to designate certain structures or features that affect flood or coastal erosion risk;
- The expansion of powers to undertake works to include broader risk management actions; and
- The ability to cause flooding or coastal erosion under certain conditions.

LLFA's in Wales have also taken on the role of the Sustainable Drainage Systems (SuDS) Adopting and Approving Body in relation to sustainable drainage systems as of 7 January 2019. In this role they are responsible for both approving the original design of the SuDS and adopting and maintaining the finished system in accordance with Welsh Government's National Standards for Sustainable Drainage.

The function of the LLFA during and after the flooding at Forge Road included a range of Response and Recovery functions:

- Officers investigated the flooding and have produced this report in line with Section 19 of the FWMA 2010.
- Officers contacted residents affected by flooding to offer support and advice to assist in the recovery following the event.

- Officers coordinated the response to the flooding with Emergency Services

Asset information collected during the flood event has been incorporated into the LLFA Asset Register.

5.2 Natural Resources Wales

Under the Flood and Water Management Act 2010 and The Water Resources Act 1991, NRW have discretionary powers to manage the risk of flooding from main rivers and the sea. They are also recognised as a coastal erosion risk management authority under the Coast Protection Act 1949.

Their strategic oversight role is about having a Wales-wide understanding of all sources of flooding, coastal erosion and the risks associated with them, on a consistent basis across Wales to help inform the RMAs and the public.

NRW is the internal drainage board or carries out the functions of the internal drainage board, for the Internal Drainage Districts (IDDs) in Wales. It is granted powers under the Land Drainage Act 1991 to carry out works to manage the risk of flooding from ordinary watercourses and to regulate obstructions to ordinary watercourses within the IDD. Their main role is the management of water levels in ordinary watercourses in areas where there is a special need for drainage, including flooding.

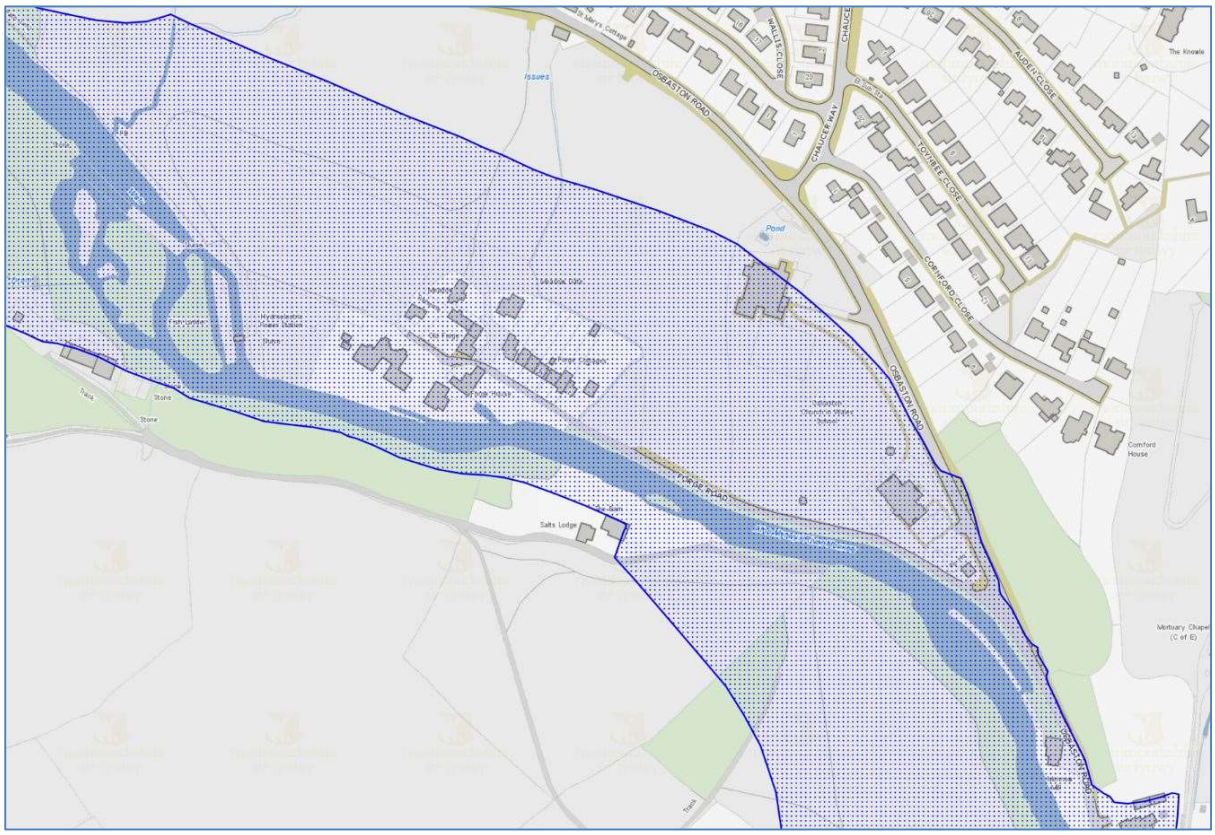
NRW as the Risk Management Authority can use its permissive powers to carry out work in several ways:

- By building new flood defences and other structures such as sluices and pumping stations.
- By maintaining defences and structures once built, keeping them in good condition subsequently, and repairing or improving them if and when required.
- By maintaining main river watercourses, removing obstructions, vegetation and silt or gravel, to keep water flowing and remove significant flooding risks.

Forge Road is in the Lower Wye IDD as shown in Figure 5-1 and Figure 5-2.

Figure 5-1. IDD boundaries within South Wales

Figure 5-2. Lower Wye IDD boundary at Forge Road



5.3 Water / Sewerage Company

Sewerage undertakers are responsible for maintaining the public sewerage systems, including adopted sewers carrying surface water run-off.

In flood conditions, the sewer systems can often become overloaded with a mixture of floodwater and sewage leading to overflow and flooding. Where applicable, Sewerage undertakers are responsible for the removal of surface water from impermeable surfaces through their sewerage system. Where there is frequent and severe sewer flooding, sewerage undertakers are required to address this through their capital investment plans which are regulated by Ofwat. To prevent further flooding, water and sewer companies have a responsibility to monitor levels, prevent overloading of the sewer systems, and maintaining and repairing drainage pipes as necessary. This investigation has not identified any assets or infrastructure belonging to a water or sewage company that may have contributed to the flood event.

5.4 Network Rail

Network Rail has an operational responsibility as a riparian owner and is required to undertake regular maintenance of all assets that pose a risk to flooding. This investigation has not identified any assets or infrastructure belonging to Network Rail that may have contributed to the flood event.

5.5 Highways Authority

The Highway Authority is responsible for ensuring the highway is clear of obstructions and has a drainage system that controls direct surface water falling onto the highway.

MCC is the Highways Authority for all highways in Monmouthshire apart from Trunk Roads which are managed by the Welsh Government. Highways Authorities are also Risk Management Authorities in their own right according to the FWMA 2010 and must adhere to all the responsibilities of Risk Management Authorities.

Under the Highways Act 1980, the Highways Authority has a duty to maintain the highway. This includes ensuring that highway surface water drainage systems are clear and free from blockages.

5.6 Riparian Landowners

A riparian owner is anyone who owns a property where there is a watercourse within or adjacent to the boundaries of their property. A riparian owner possesses rights over and responsibilities for the stretch of a watercourse within or adjacent to their property. A watercourse includes a river, stream or ditch. Riparian owners, (householders and businesses) are responsible for maintaining their rivers, streams, ditches, pipes culverts and bridges.

Riparian landowners are legally responsible under common law for the maintenance of the land generally up to the centreline of any watercourse adjacent to their property. This includes the maintenance of the bed, banks and any boundary features e.g. vegetated strips such as hedging, with routine clearance of debris and/or blockages.

This does not mean that the owner must remove all debris from the watercourse, but it does require the owner to maintain it as far as it does not pose a risk or ‘nuisance’ to a neighbour. Any works to modify the watercourse by the landowner will first require the necessary consents or permits from the relevant RMA, LLFA, or NRW.

Landowners are responsible for ditches and land drainage assets upon their land. NRW has permissive powers to maintain watercourses which are designated as Main Rivers and MCC has permissive powers to maintain the ordinary watercourses respectively.

This investigation has not identified any defects with watercourses (Main River or Ordinary Watercourse) under riparian ownership which would have contributed to the flooding.

5.7 Residents and Property Owners

Residents and property owners are responsible for the maintenance and operation of drainage assets and connecting pipework falling within their ownership. They are also responsible for the protection of their own properties against flooding. Where safe to do so, they should take measures to protect themselves and their property from flooding. Residents and property owners have the right to defend their property as long as they do not subsequently increase the risk of flooding to other buildings and property.

6. Permissive Powers of Risk Management Authorities

Natural Resources Wales has permissive powers under the Flood and Water Management Act 2010 and Water Resources Act 1991 to carry out works to manage the risk of flooding from main rivers. These discretionary powers include the ability to undertake works to clear watercourses, as well as developing and implementing flood alleviation schemes when justifiable.

MCC also has similar permissive powers under the Land Drainage Act 1991 on ordinary watercourses.

7. Flood Alleviation Schemes / Drainage Improvements

Previous flood alleviation and drainage improvement schemes in the local area are outlined in Table 7-1:

Table 7-1. Historical local flood alleviation and drainage improvement schemes

Date	Scheme details
1992	The *EA Easter Floods Report 1998* details proposals to defend Forge Road against flooding in the Monmouth Flood Alleviation Scheme, the proposed dates of the historical works were 1990 to 1992, however the works were deemed economically unviable and were not delivered. Relatively moderate works were carried out including construction of an embankment adjacent to Forge Weir to prevent flood water overspilling during low return period events see Figure 7-1. The flood embankment prevented flood water from prematurely breaking out of the side stream opposite the weir. The flood embankment terminates just downstream of the weir and is not designed to prevent flooding of the River Monnow just downstream.

Figure 7-1. Forge Weir embankment, site visit May 2021

8. Conclusion

The FWMA Section 19 flood investigation into flooding which occurred at Forge Road on 26 October 2019 has determined that the flooding was the result of a prolonged and significant rainfall event named Persistent Wet Weather October 2019 by the Met Office.

The rain fell across the upper catchments of the River Monnow on ground that was very wet from a previous storm on 17, 18 and 19 October. As a result of the intense rainfall river levels on the River Monnow rose rapidly.

The main source of flooding to property has been identified by anecdotal reports as the River Monnow.

At the time of preparing this report 12 properties are reported to have flooded at the Forge Road flood investigation area on 26 October 2019.

Between 1947 and the present day there are records of 6 flood events which have caused internal property flooding at Forge Road, suggesting that on average flooding occurs in this location once every 12 years.

The FEH rainfall return period analysis has calculated that Persistent Wet Weather October 2019 had an FEH return period of 84 years.

MCC held a community meeting with residents on 12 March 2020 in Osbaston. During the meeting concerns were raised with the level of risk residents face from future flood events. Actions to address these concerns were requested during the meeting and during individual meetings held by MCC with residents. These actions have been considered further and related recommendations have been made in section 9 of this report.

The rate of increase of flood depths at the Forge Road properties increases after the Monnow overtops at Forge Weir. Residents have suggested that an investigation is carried out to understand if there may be improvements made to the embankment at Forge Weir.

Residents have also suggested better, more holistic monitoring of levels on the Monnow and the Wye rivers to better understand trigger points. Lead times are vital to allow residents as much time as possible to evacuate and protect their property.

9. Recommendations

In accordance with Section 19 of the FWMA 2010, as LLFA, MCC has investigated this flood event and identified which RMAs have relevant flood risk management functions. As a result of the findings of this investigation and discussions with residents and other authorities, the following recommendations in Table 9-1 have been made.

Table 9-1. Recommendations from the Section 19 Flood Investigation

Reference	Recommendation	Responsible Risk Management Authority(ies)
FR01 (Flood Risk)	Undertake an Initial Assessment of options to reduce flood risk from main river using current Welsh Government FCERM Business Case Guidance and updated hydraulic modelling. The assessment should include a review of all previous historic studies and consider natural flood management options.	NRW
FR02 (Flood assets and land drainage features)	Record detail, ownership and maintenance responsibility of all flood assets and land drainage features and ensure such features are maintained to the required standards.	MCC/NRW
FR03 (Surface water)	Record detail, ownership and maintenance responsibility of all highway surface water drainage features and ensure such features are maintained to the required standards.	MCC
FR04 (Community flood management plan)	Consider the requirement for a multi-agency Community Flood Management and Response Plan to inform and aid the emergency response to future flood events. This should include community engagement, awareness raising and training to enable to community to monitor, interpret, act and respond to river trigger levels on the Monnow. This will give the community more ownership of the flood plan. The plan should also include details of assistance and support available to the community including what financial support might be available following flood events.	NRW/MCC
FR05 (Local protection)	Consider the requirement for a local sandbag store, and other equipment which could be easily accessed by local residents.	MCC
FR06 (Flood warning service)	Raise awareness and understanding of the flood warning service “Floodline” and review take up within the village.	NRW

10. Useful Links and Contacts

- Monmouthshire County Council Flood Pages:
  www.monmouthshire.gov.uk/flood-risk-management

- Natural Resources Wales:
  www.naturalresources.wales/flooding

- Welsh Government:
  www.gov.wales/flooding-coastal-erosion

- Blue Pages
  www.bluepages.org.uk

- Flood Re (Insurance):
  www.floodre.co.uk

- Met Office, Past Weather Events
  https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events#y2019

11. Table of Acronyms

Table 11-1 is a list of acronyms used in the report.

Table 11-1. Table of acronyms

Full text	Acronym
Environment Agency	EA
Flood and Coastal Erosion Risk Management	FCERM
Flood and Water Management Act 2010	FWMA 2010
Flood Estimation Handbook	FEH
Internal Drainage District	IDD
Lead Local Flood Authority	LLFA
Monmouthshire County Council	MCC
Natural Flood Management	NFM
Natural Resources Wales	NRW
Property Flood Resilience	PFR
Risk Management Authority	RMA

Appendix A – Anecdotal evidence

This appendix has been redacted.

Appendix B – Hydrographs

Figure 0-1. Storm Dennis - Rainfall and river levels for the Monnow at Grosmont for the 15-day period 7 to 21 February 2020

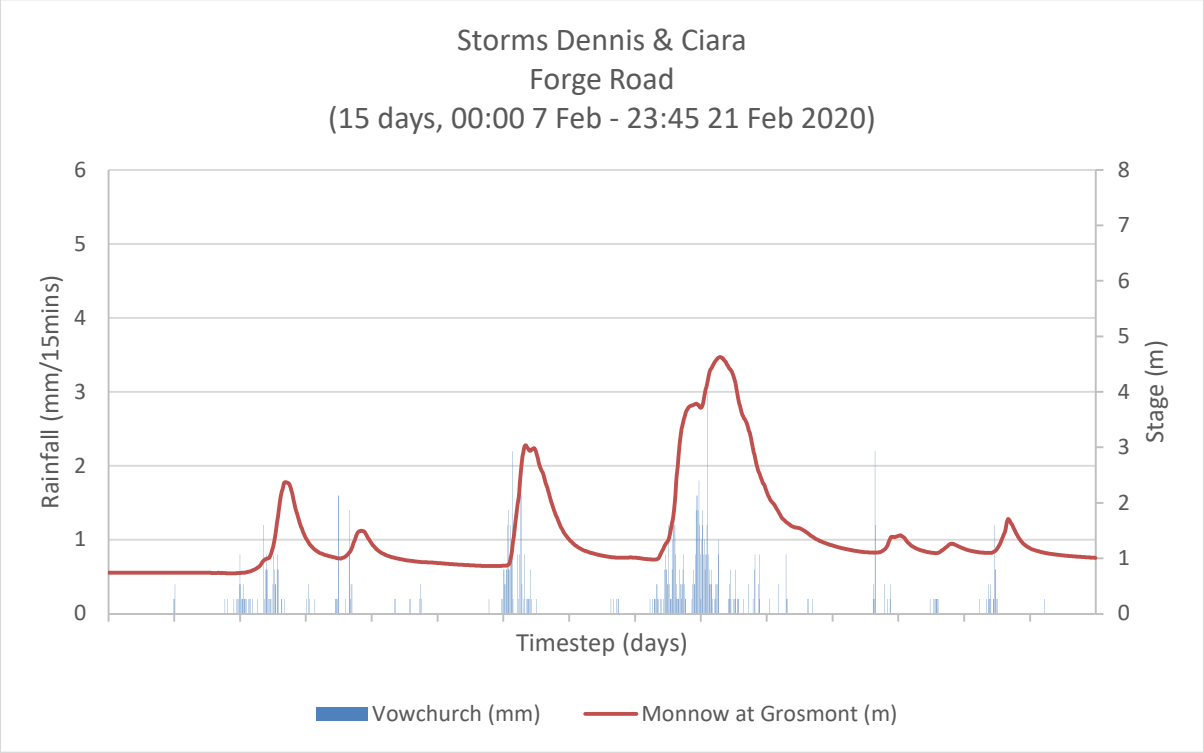


Figure 0-2. Storm Dennis - Rainfall and river levels for the Monnow at Skenfrith for the 15-day period 7 to 21 February 2020

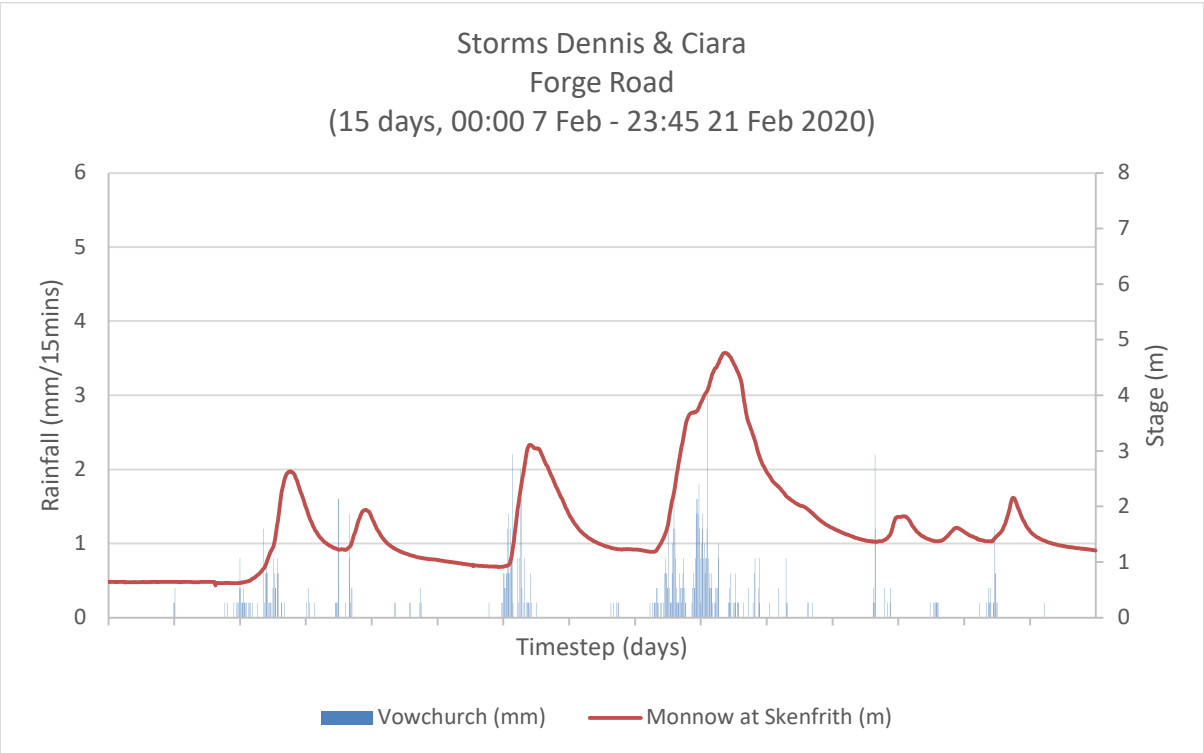


Figure 0-3. Storm Dennis - Rainfall and river levels for the Monnow at Monnow Gate for the 15-day period 7 to 21 February 2020

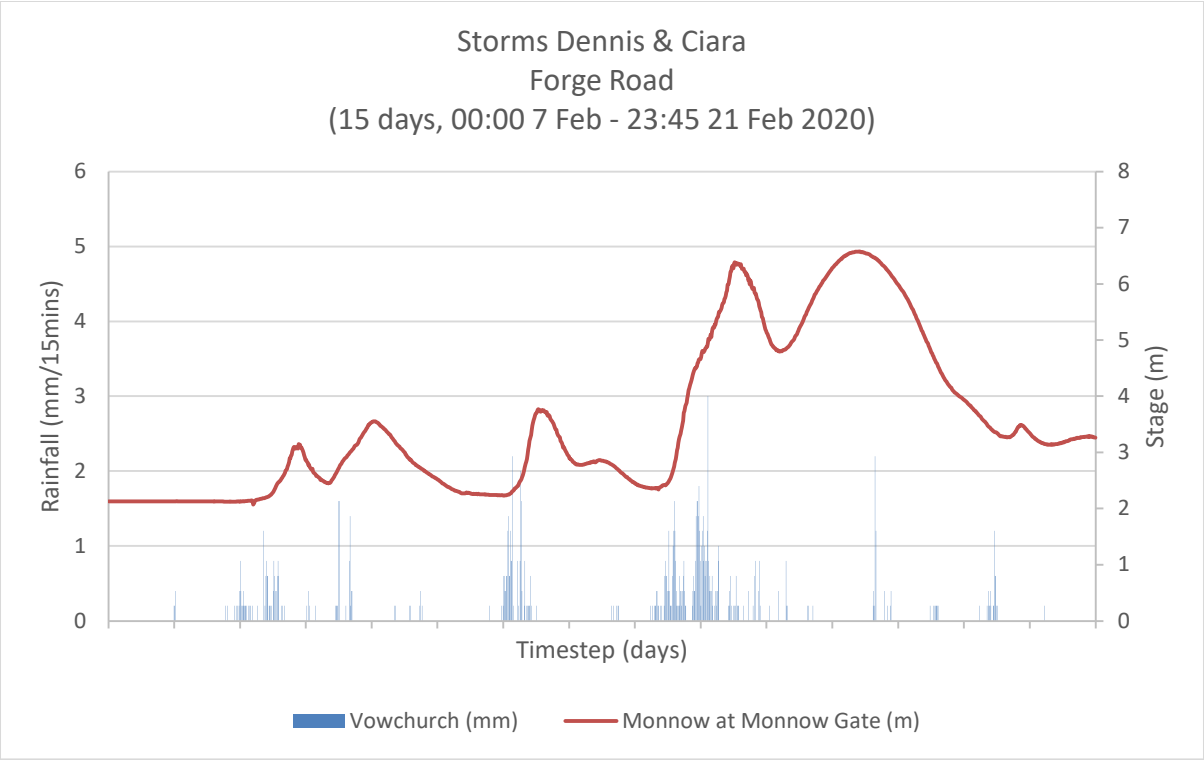


Figure 0-4. Storm Dennis - Rainfall and river levels for the Wye at Ross on Wye for the 15-day period 7 to 21 February 2020

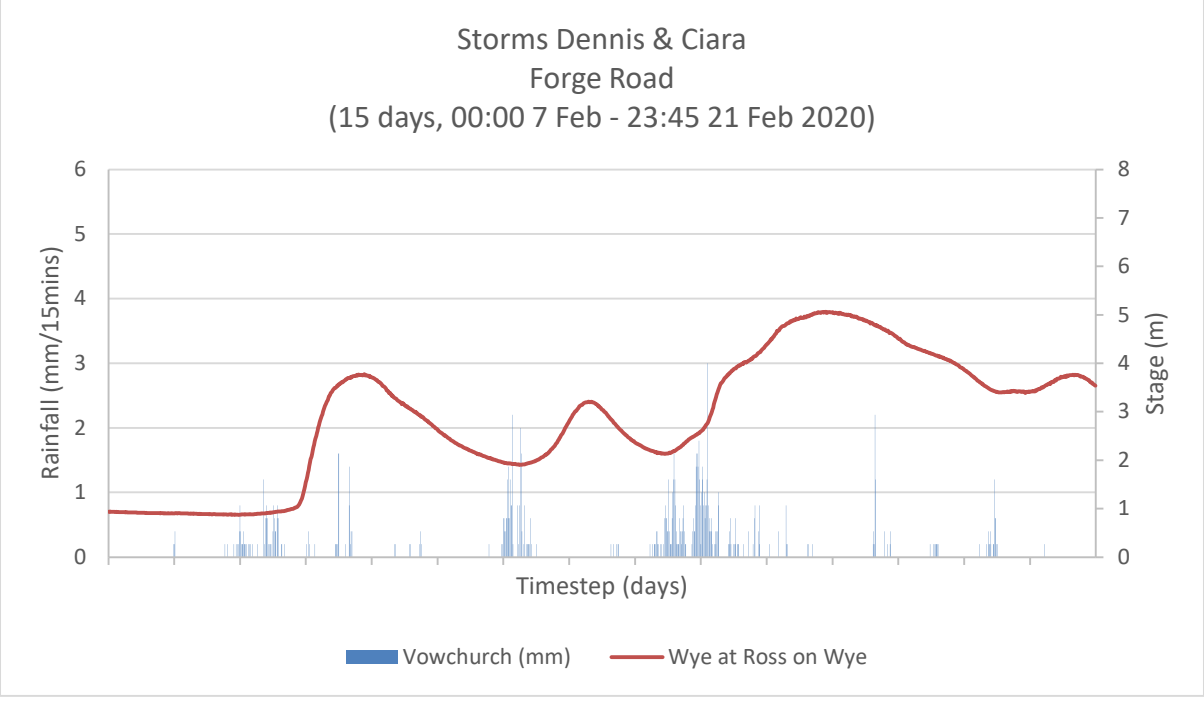


Figure 0-5. Storm Dennis - River levels for the Wye at Monmouth for the 15-day period 7 to 21 February 2020

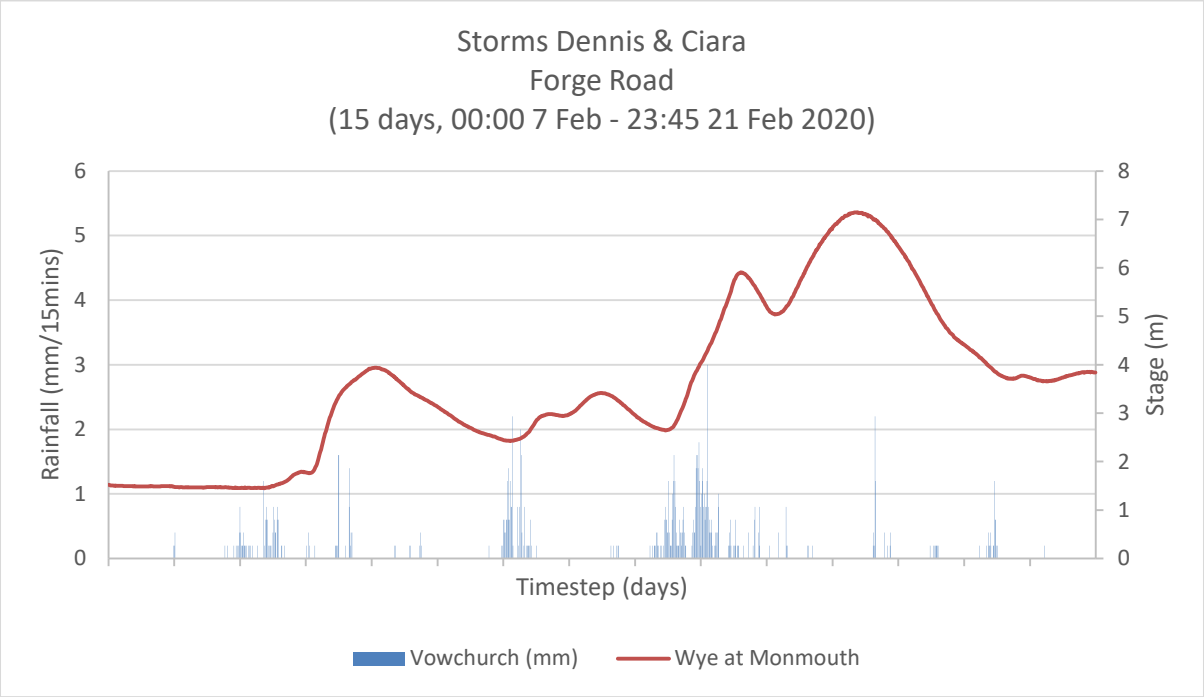


Figure 0-6. Storm Dennis - River levels for the Wye at Redbrook for the 15-day period 7 to 21 February 2020

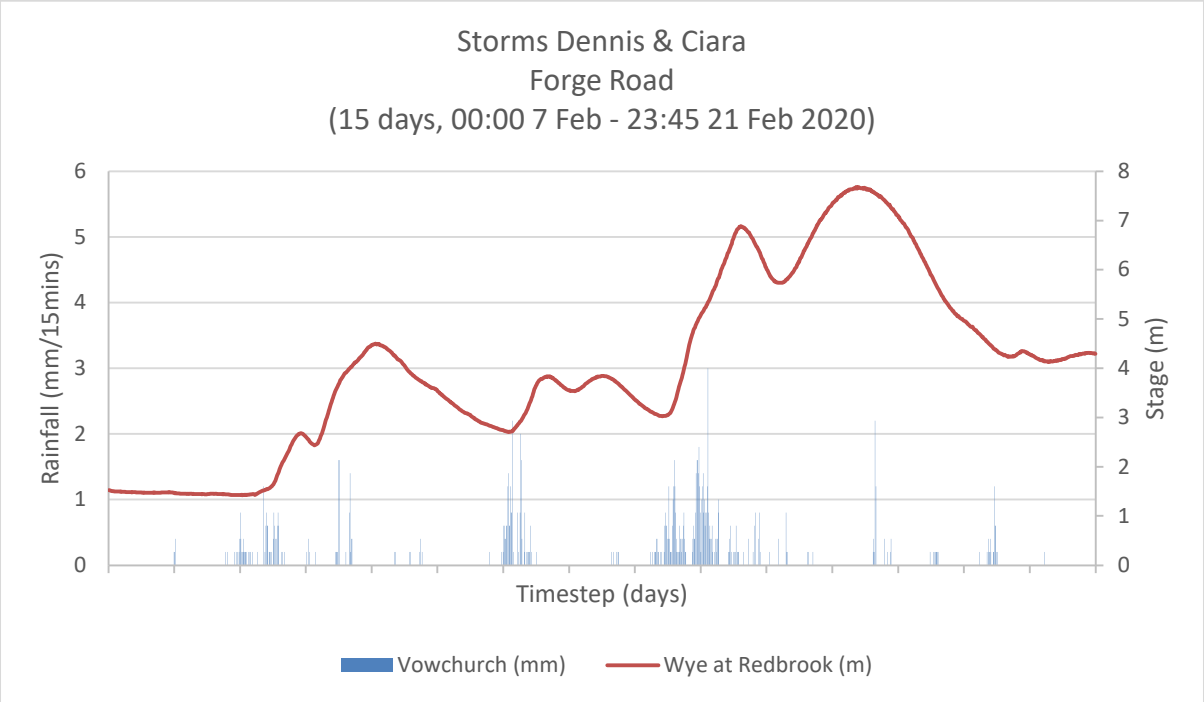


Figure 0-7. Storm Dennis - River levels for the Trothy at Micahel Troy for the 15-day period 7 to 21 February 2020

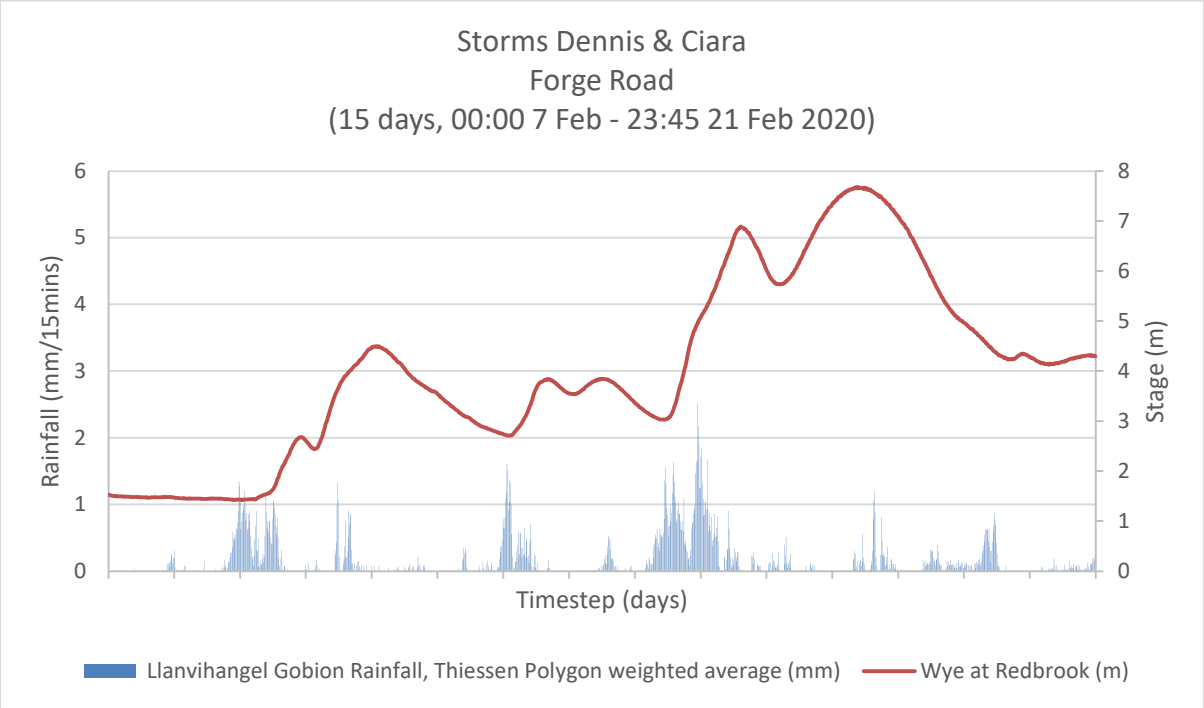


Figure 0-8. Storm Dennis - Tidal levels for the Wye at Tintern Abbey for the 15-day period 7 to 21 February 2020