Staffordshire County Council

October 2019 Flood Event:

Flood and Water Management Act

Section 19 – Investigation Report

Staffordshire County Area

Staffordshire County Council

This report has been prepared by Staffordshire County Council as Lead Local Flood Authority for the County of Staffordshire, under Section 19 of the Flood and Water Management Act 2010, with the assistance of Severn Trent Water and the Environment Agency.

This report is based on the information available at the time of preparation. Consequently, there is potential for further information to become available, which may lead to future alterations to the conclusions drawn in this report for which Staffordshire County Council cannot be held responsible.

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Revision	**Date**	**Description**	**Originated**	**Checked**	**Authorised**
0.1	01/04/2020	Draft for Internal Review	A Bushnell	J Cooper	
1.0	06/09/2021	Reformat and alignment to current standards.	A Bushnell		
2.0	01/04/2022	Complete Final Issue	A Bushnell	J Cooper	D Arthur

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Executive Summary

When made aware of flooding, Staffordshire County Council, in its role as Lead Local Flood Authority, has a duty to investigate, if certain criteria or thresholds are met, to determine the causes of the flooding and determine appropriate actions that may be undertaken by the relevant Risk Management Authority.

Over the weekend of 25 and 26 October 2019, the weather was characterised by cool, damp conditions with persistent and incessant, rather than severely intense and heavy, rainfall. The whole of the county of Staffordshire was affected, with the County Town of Stafford and close surrounds being particularly impacted. Best estimates are that over 70 properties were flooded internally in the county, with many more near misses. As a result of these storms, a significant number of flooding incidents were reported to Staffordshire County Council.

In order to gather information and understand the specific areas affected, Staffordshire County Council distributed flood questionnaires to residents following reports of flooding in these areas.

Staffordshire County Council, in partnership with the Environment Agency and Severn Trent Water, has undertaken an investigation into these areas where internal property flooding was reported, to determine the most likely cause of flooding (surface water flooding, flooding from rivers, flooding from sewer infrastructure and flooding from highway drainage).

For each of the areas, the investigation undertaken has been summarised, outlining the extent of flooding reported, the most likely cause of the flooding and the actions that have been completed, or are proposed to be completed in the future.

Introduction

A number of storms occurred across the county of Staffordshire in the autumn of 2019, with significant widespread rainfall occurring on 25th and 26th October 2019. These storms caused flooding to highways and properties across Staffordshire and as a result, Staffordshire County Council has undertaken investigations in areas where flooding occurred. This report provides a broad overview of the causes of the flooding in October 2019 and identifies the next steps, if any, to be taken.

Lead Local Flood Authority

Following Royal Assent of the Flood and Water Management Act in 2010 (FWMA), Staffordshire County Council (SCC) became the Lead Local Flood Authority (LLFA) for Staffordshire. As such, SCC is responsible for the management of surface water food risk, groundwater flood risk and the flood risk from ordinary watercourses[1].

As LLFA, SCC is required to work in partnership with other agencies and authorities to manage flood risk. These agencies and authorities include, but are not exclusively limited to:

- Environment Agency, who manage responsibility for Main Rivers and Reservoirs;
- Severn Trent Water, who hold responsibility for the public sewer network;
- Emergency service providers; and,
- Other public agencies and bodies.

Section 19 Requirements

The FWMA also places a duty on Lead Local Flood Authorities to investigate incidents of flooding. This is set out in Section 19 of the Act and the investigations are therefore typically termed '*Section 19 Reports*.' The Act 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.

It should be noted that not all flooding will require a formal investigation and report.
SCC has, set out in its *Local Flood Risk Management Strategy, (Appendix D)* the process which will be used to determine to what extent it considers is 'necessary or appropriate' to investigate and what constitutes a significant flood event.

1 An ordinary watercourse is defined as any watercourse not designated as 'Main River,' i.e. watercourse that are not managed by the Environment Agency

2 https://www.staffordshire.gov.uk/environment/Flood-Risk-Management/Local-Flood-Risk-Management-Strategy.aspx

There are three stages to any SCC LLFA investigation. Stage one is an initial assessment, sufficient to ascertain with some confidence the extent of the flooding consequences. The second stage is to carry out a detailed investigation of the sites where it has been deemed necessary and appropriate. Reporting and publishing is the third, and final, stage. These stages may be described as: -

- Stage 1: Initial assessment
- Stage 2: S19 Investigation
- Stage 3: S19 Report and publish

It follows that there will be requirements for coordination and cooperation between Risk Management Authorities at each stage and, where required, following the outcome of a S19 Investigation. This will be undertaken via day-to-day officer communication, and through the LLFA's governance process for flood risk management.

Flood Investigation Methodology

SCC will undertake/coordinate a Flood Investigation in accordance with Section 19 of the Flood and Water Management Act (2010) when one or more of the following thresholds are exceeded.

Consequence Staffordshire County Flood Investigation Thresholds:

- Five or more residential properties are reported to have been internally flooded during a single flood event in one location;
- Two or more business properties are reported to have been internally flooded during a single flood event in one location, or;
- One or more items of critical infrastructure are reported to have been adversely affected during a single flood event in one location

SCC may, in exceptional circumstances, investigate flooding outside these categories. These guidelines set numerical thresholds, however, in recognition of the fact that all floods will be different; a certain amount of discretion will be required in order to implement this policy effectively.

This policy only relates to how flood investigations will be prioritised and does not guarantee that any flood risk mitigation works will be installed at the locations where investigations are undertaken.

This report has been based on the number of reported incidents of flooding; however, it is likely that the actual number of incidents of flooding was higher than that reported. This data is the best currently available.

October 2019 - General Meteorological Synopsis[3]

From Met Office reports- during October 2019 there was a slow-moving weather front that brought persistent and heavy rainfall across England and Wales on 25th to 26th October 2019.

Impacts of this persistent wet weather:

The heavy rain, falling on already saturated ground, caused disruption due to flooding, across Wales, Shropshire, Staffordshire and Manchester. Across these areas, roads were blocked by flooding.

From a meteorological perspective the Met Office reported that a slow-moving front stretched from South Wales across to Lincolnshire. A large temperature gradient was associated with this weather front; with temperatures on 26 October reaching 17°C in London and only 7°C in Birmingham.

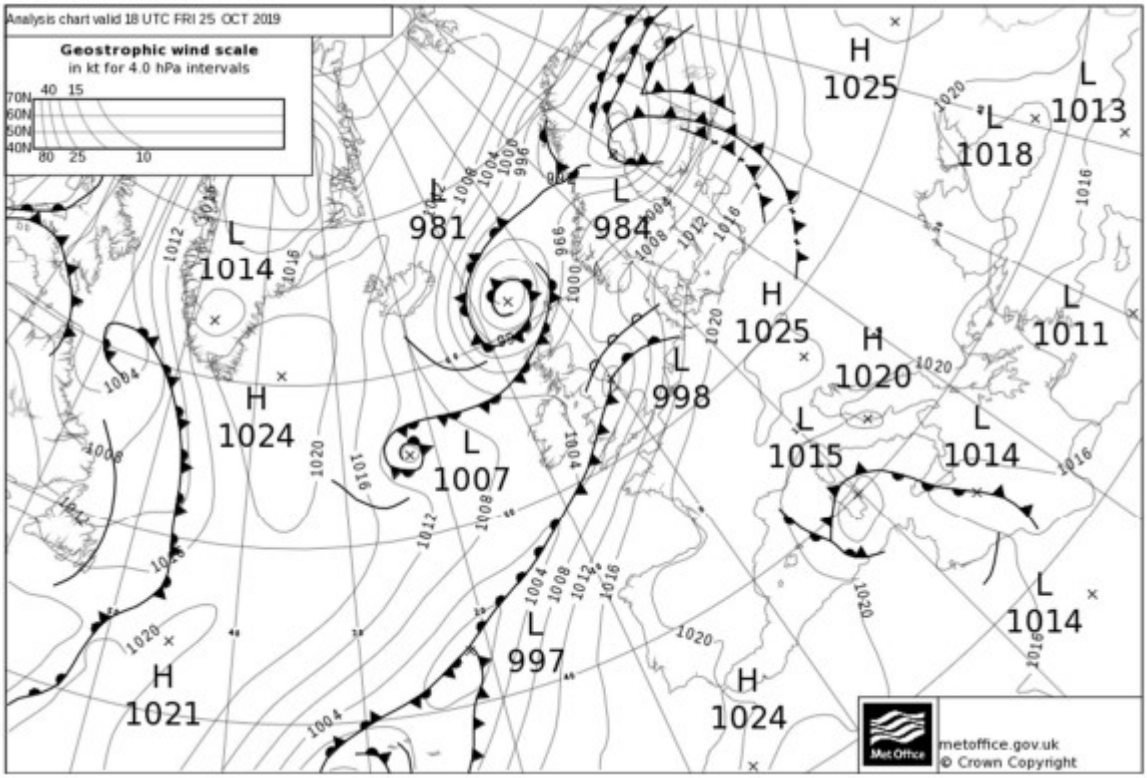


Figure 1: General Meteorological Situation on 25/10/2019 – source: Kendon (2019) - Met Office.[3]

[3]. Kendon, M (2019) 'Met Office- Persistent wet weather October 2019'. *Met Office National Climate Information Centre,* Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2019/2019_010_october_rainfall.pdf (Accessed: 01 April 2022).

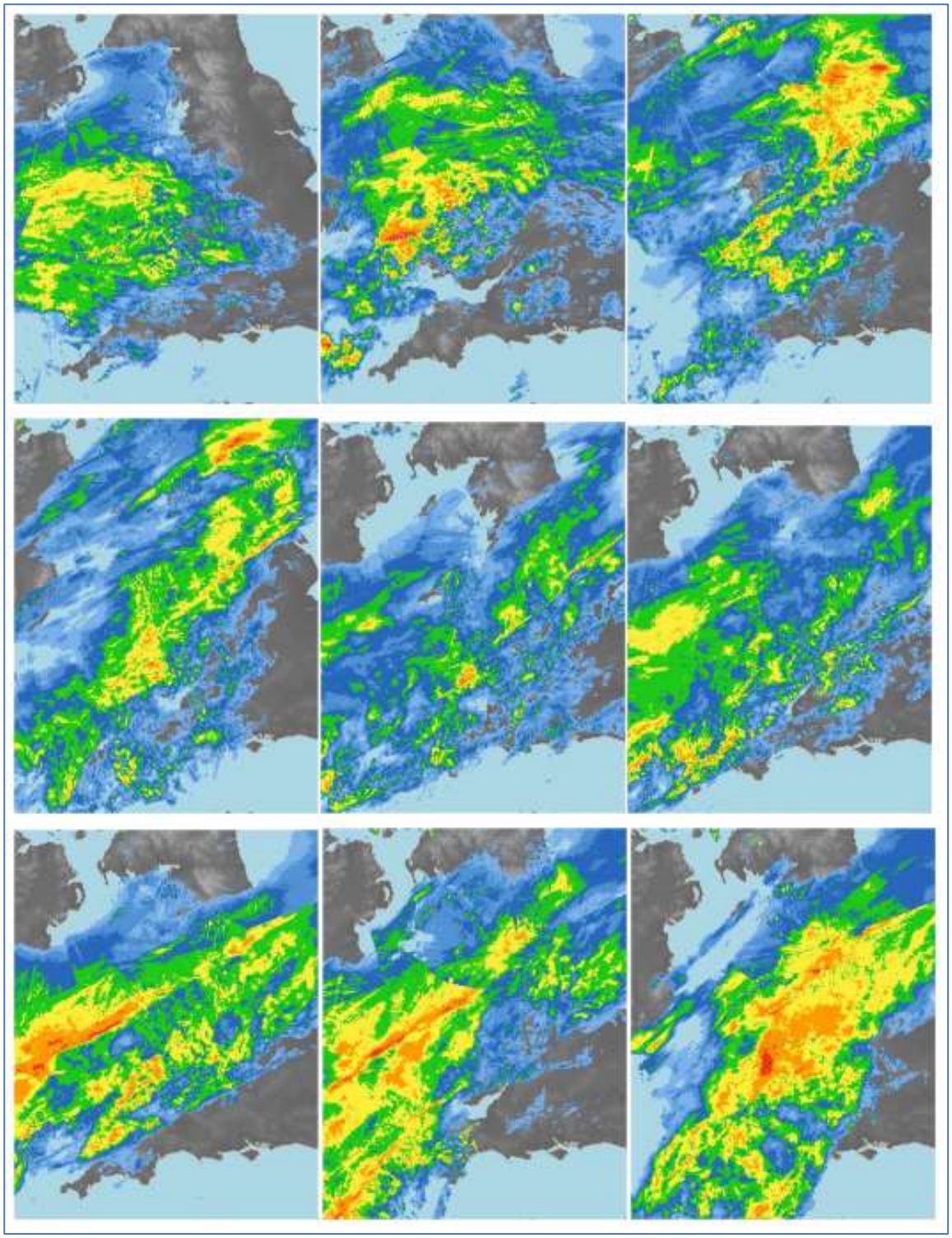


Figure 2: Rain-radar image panel indicates persistence of heavy rainfall. 0900 UTC 25/10/2019 to 0900 UTC 26/10/2019 - 3- hour intervals – Source: Kendon (2019) - Met Office.[3]

[3]. Kendon, M (2019) 'Met Office- Persistent wet weather October 2019'. *Met Office National Climate Information Centre,* Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2019/2019_010_october_rainfall.pdf (Accessed: 01 April 2022).

October 2019

As a result of the October 2019 rainfall event, more specifically the storms that occurred over the weekend of 25th and 26th October 2019, widespread flooding occurred across Staffordshire. Numerous incidents of flooding were reported, ranging from waterlogged gardens, impassable roads, and water inundating highways. Watercourses also breached their banks. This resulted in instances of internal property flooding.

From analysis, the rainfall event on 25th and 26th October 2019 was characterised as a long duration, moderate to high intensity rainfall event, spread over large catchments. This can be typical of autumn and winter rainfall events. Some rain gauges recorded a significant total rainfall.

DEFRA Environment Agency rain gauges at Rock End (in the north of the county), recorded 72.4 mm over a period of approximately 36 hours for this event. Rodbaston (in the south), recorded 51.8mm for a similar period over 25th and 26th October 2019.

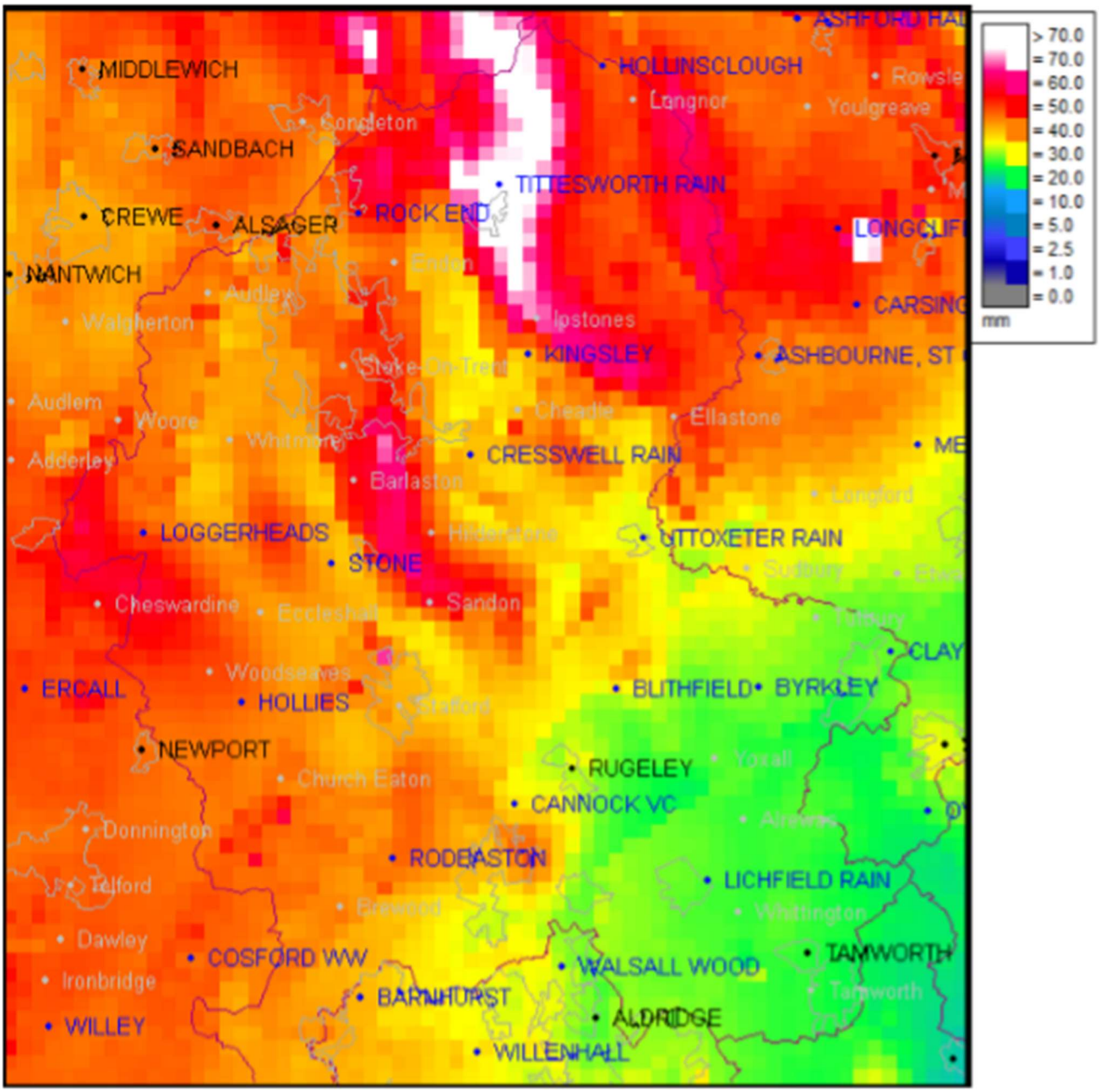


Figure 3: EA Radar from the 25-26 October 2019 Rainfall Event.

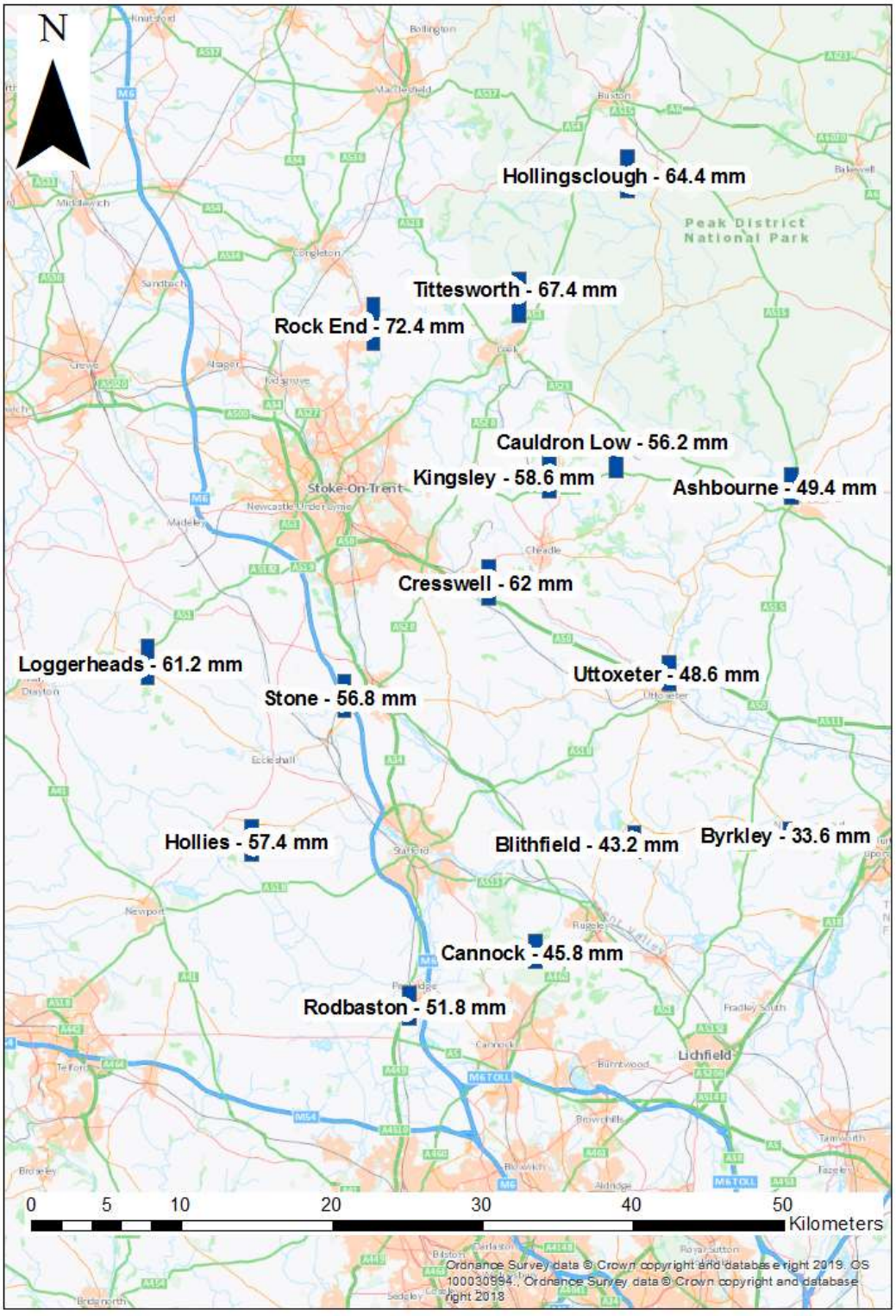


Figure 4: EA Rain gauges with total rainfall 25-26 October 2019

Figure 1-1

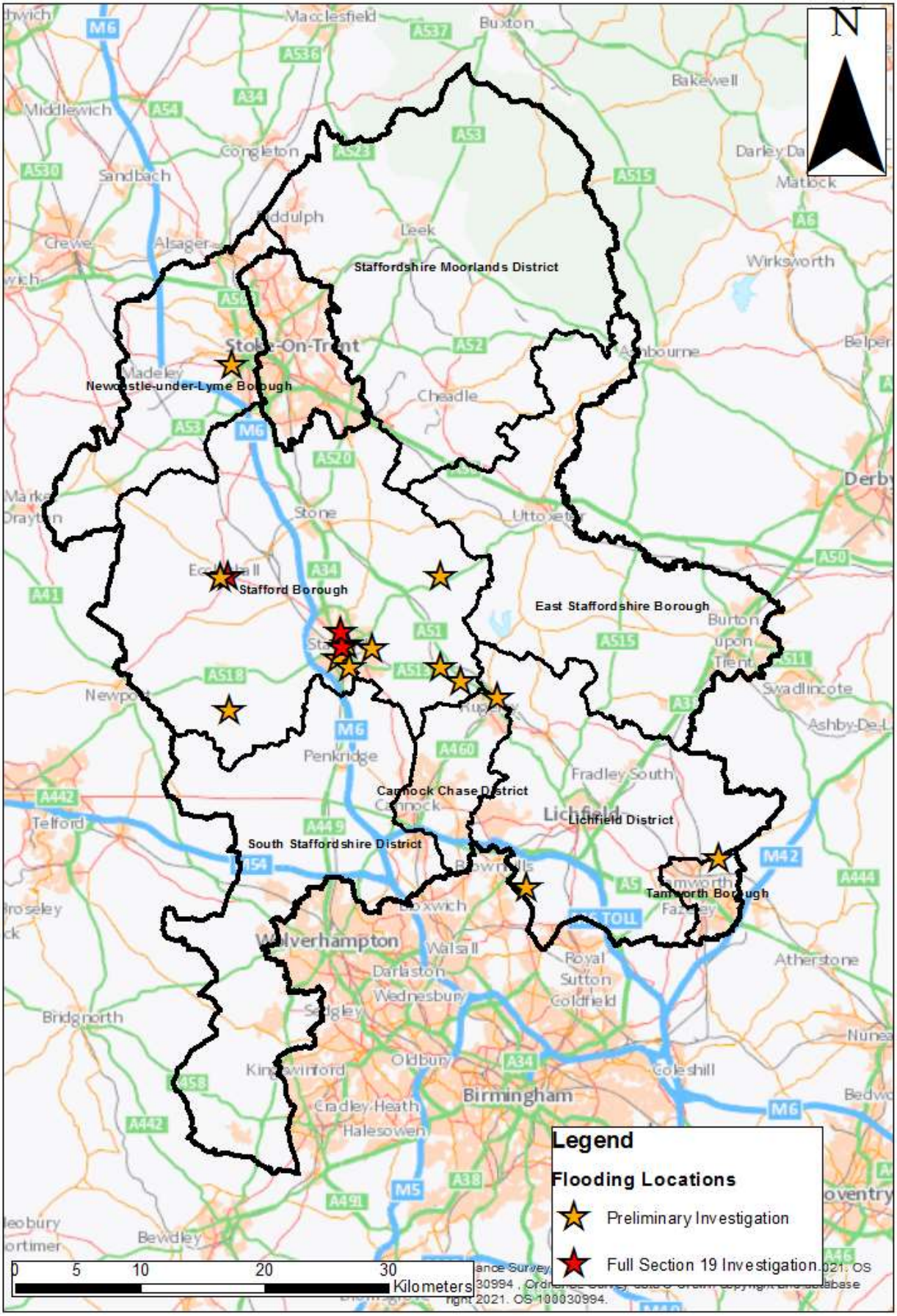


Figure 5: Locations affected by flooding in Staffordshire in October 2019

Investigation into Flooded areas

Following the rainfall event in October 2019, SCC in its role as LLFA, has undertaken the steps as outlined below:

Step 1: During the Flood Event
SCC received a high number of calls during the event, which reported flooding of properties, gardens and highways.

During the flood events, the LLFA coordinated with multiple Risk Management Authorities (RMAs) to ensure that flooding was managed effectively and the risk to people and properties was mitigated as far as reasonably practicable

Step 2: Initial Investigations

Through the use of communication records and site visits, the LLFA identified the locations where flooding occurred and distributed 'Flood Surveys' or questionnaires to property owners and residents directly affected by flooding and those within the surrounding area.

Responses were received, providing personal accounts of the flood event including the estimated time, duration, extent, and depth with any other information which was felt pertinent.

Following receipt of the Flood Survey responses, the LLFA identified areas where at least one property experienced internal flooding.

Step 3: Detailed Investigation and Analysis

The LLFA conducted more detailed investigation and individual location analysis of each of the areas where a minimum of one property experienced internal flooding. It should be noted that SCC have defined internal property flooding as:

'Flooding that occurs in a habitable room within a single property, excluding garages, porches and underfloor ingress of water.'

These investigations typically included a review of existing infrastructure and topography, identification of predominant flow paths, site visits and local knowledge gathering

Through a detailed analysis, the LLFA have identified the types of flooding that occurred at each location during the events of October 2019.

The LLFA does not undertake detailed investigation of external flooding to garages, gardens and highways due to limited resources. Indeed, gardens often act as flood storage areas and highways can be designed to convey flood waters reducing the extent/level of internal property flooding.

Step 4: Recommended Actions

Following the analysis of the affected areas, the LLFA have worked in collaboration with other RMAs to identify opportunities and options to mitigate the potential that a similar rainfall event will result in similar outcomes. These have been summarised as 'Recommended Actions' and a lead RMA has been identified to undertake these actions.

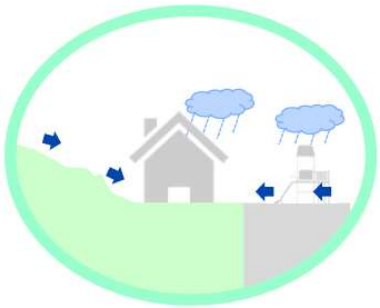
The following section of this report provides a summary of the findings from the works undertaken to date with regard to the affected areas.

Types of Flooding

The following section explores the various types of flooding that were experienced during the events in October 2020.

Surface Water Flooding

Surface water is rainwater which is on the surface of the ground and has not soaked into the ground or entered a watercourse, drainage system or sewer. During a storm event, rainfall will land on the ground and depending on the characteristics of the ground it will behave in different ways.



Permeable surfaces, sometimes colloquially known as *'soft surfaces'*, allow water to soak (infiltrate) into the ground. These are typically in the form of gardens, parks, fields, and green spaces.

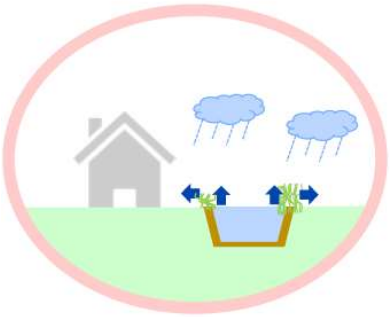
Impermeable surfaces, sometimes colloquially known as, '*hard surfaces'* do not allow any rainfall to soak into the ground and this rainfall will become (surface water) runoff. Runoff is usually very quick too. These are typically in the form of highways and roads, roofs, car parks and public squares.

Surface water flooding occurs under a number of circumstances, most commonly when:

- There has been a prolonged period of rainfall and the permeable surface becomes saturated therefore no more water can infiltrate into the ground;
- The rainfall intensity is very high, and the rain is falling faster than it can infiltrate into the ground;
- There has been a prolonged warm dry period, the permeable surface may be baked hard and effectively turn the permeable surface into hard impermeable surface;
- It rains on impermeable surfaces, and there is no formal means of managing the rainfall;
- There is heavy rainfall on impermeable surfaces and surface water cannot enter the drainage system provided to manage rainfall as the system is at capacity.

During most storm events, the rainfall rate is low enough to allow surface water to soak into the ground or drain into formal drainage systems (e.g. gully pots). However, during an extreme event, where the intensity of the rainfall is high or there is an excessive volume of water, it is unable to soak into the ground or enter formal drainage systems and as such it will flow across a surface in an uncontrolled manner.

River Flooding



River flooding occurs when the flow volume of water in a river channel exceeds its flow capacity. This causes the water level in the river channel to rise above the riverbanks, where water flows from the channel into the surrounding area.

In terms of flood risk management there are two classifications of rivers/watercourses:

Main River; and, Ordinary Watercourse.

The Environment Agency holds responsibility for the management of flood risk on Main Rivers. All other watercourses, which are not specified as Main Rivers are termed Ordinary Watercourses. Flood risk management of these watercourses is the responsibility of the LLFA. However, in both cases, the riparian owner, that is anyone who owns land or property beside, or over, a watercourse, is responsible for maintenance of watercourse through their land.

River flooding occurs under a number of circumstances, most commonly occurring when:

There has been a prolonged period of rainfall and the river levels have risen due to surface water runoff and inflow from sewer infrastructure;

There has been a prolonged period of rainfall whereby permeable surfaces become saturated and the rate of surface water runoff increases thereby reaching the river faster;

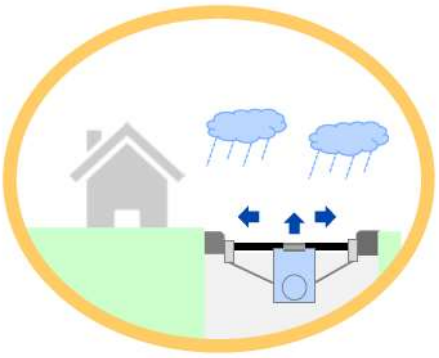
There is heavy rainfall on impermeable surfaces and the provided drainage system conveys water to the river quickly;

There are high flows within the river which become restricted by structures (e.g. bridges and culverts) which results in water levels upstream rising and spilling from the banks;

Sediment and debris building up in the river channel and reduces the capacity of the river channel causing flows to spill from the banks.

During most storm events, rivers are capable of conveying flows within their channels however, during an extreme event where the volume of water may be significant, flows may exceed the channel capacity and spill from the river in an uncontrolled manner.

Flooding from Sewer Infrastructure



Where rainfall falls on an impermeable surface, it will typically be served by a formal drainage system, most commonly this is a sewer.

There are different types of sewer, including:

***Surface Water Sewers** carry rainfall and surface water away from properties to watercourses;*

***Foul Water Sewer**, carries wastewater away from properties to be treated; and,*

Combined Sewer, drain both wastewater from properties along with runoff from highways, roofs, car parks and other sources. These systems were typically constructed up to the 1950s and hence are still found in historic areas of cities.

Flooding from sewer infrastructure occurs under a number of circumstances, most commonly when:

There is a blockage, or the sewer itself collapses, which restricts or prevents flow within the sewer network. This causes water to back-up through the network and find its way to the surface, typically through a manhole or associated drainage structure.

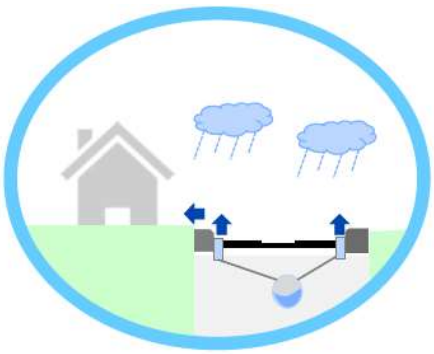
There is a period of heavy and/or prolonged rainfall, which results in significant flows that exceed the capacity of the sewer network. This prevents water from entering the sewer network and may result in surface flooding.

Severn Trent Water and United Utilities, as the sewerage companies, are responsible for the operation and maintenance of the public sewers within the Staffordshire area.

Surface water and foul water sewers are currently designed in accordance with Sewers for Adoption (8th Edition, 2018). This guidance states that sewers should have to capacity to deal with all runoff from a storm with a 3.33% or greater probability of occurring in any given year and not cause any above ground flooding. This guidance is relatively recent having been brought into effect in the last approximately 15 years. In addition, improvements in computer aided design and calculations also ensure designs are in agreement with the existing standards.

Therefore, at the time of construction of much of the sewer network across Staffordshire, the design standards may have been to accommodate a smaller storm event. The designs will likely have been done by hand and may have used “rules of thumb” to determine the required sizes. As a result, the drainage network is complex with some sewers able to accommodate storms well above current design standards and other sewers much lower. Thus, when a large storm event occurs, the existing drainage network (combined or surface water sewers) may be significantly overwhelmed.

Flooding from Highway Drainage



Highway drainage consists of gullies, drainage channels and other features which collect and drain rainfall away from the highway. These features are typically located on one, or both, side(s) of the highway where they connect to an underground highway drainage system which ultimately typically connect to the public sewer infrastructure. Where rainfall falls onto the highway, this will enter the highway drainage system or flow within the highway channel until a point where it enters the system or ponds on the surface.
In new development, it is common practice to use highways to contain and convey heavy rainfall events away from properties, however historically this practice has not happened.

Across Staffordshire, properties can be seen at or below the level of the adjacent road. This means that should a carriageway not be able to contain the water flowing within it, flow will overtop the kerbs on the highway and spill over adjacent land into properties.
Flooding from highway infrastructure occurs under a number of circumstances, most commonly occurring when:

There is a blockage or build-up of surface debris in the vicinity of a gully, typically trash, leaves and twigs, which prevents, or restricts, the highway runoff from entering the gullies and subsequent highway infrastructure.

There is a period of heavy and/or prolonged rainfall, whereby the volume of rainfall falling onto the highway overwhelms the highway drainage features and is unable to be captured. The resulting flows are then conveyed or contained within the highway, until such times as the water level overtops the kerbs and flows overland into properties. Highway drainage systems are not designed for a capacity as large as that for sewers.

The sewer, culvert or watercourse to which the highway drainage is connected is at full capacity and therefore the highway run-off has no-where to drain to.

Staffordshire County Council, in their role as the local highway authority, is responsible for the highway drainage and gullies across Staffordshire. This work includes maintenance of the highway drainage including roadside gully pots.

Flood Risk Mapping

Flooding is traditionally difficult to predict, and while there are many local factors that influence flooding, there are a number of publicly available, national information tools which can enhance our understanding of the potential flood risks within a local area, more specifically risk of flooding from surface water and from rivers.

Surface Water Flood risk

In 2013, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water map.

This is the third national surface water map produced by the Environment Agency under their Strategic Overview role and is the first publicly available surface water flood risk map.

Storms are usually given with an annual probability or the chance of occurring in any given year. Typically, smaller storms have a higher probability of occurring in any given year and larger storms have a lower probability of occurring. However, the probability only describes the chance a storm will occur and not when.

This means that if a large, low probability storm occurs, it can happen again soon after or can happen a long time after.

This mapping assesses surface water flood risk as a result of the chance of rainfall occurring in any given year, and is categorised into the following three scenarios:

High Risk: Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year or 3.3% chance that the storm will occur in a single year

Medium Risk : Flooding occurring as a result of rainfall between 1 in 100 and 1 in 30 chance in any given year or between 1% and 3.3% chance that the storm will occur in a single year

Low Risk: Flooding occurring as a result of rainfall between 1 in 1000 and 1 in 100 chance in any given year or between 0.1% and 1% chance that the storm will occur in a single year

Very Low Risk: Flooding occurring as a result of rainfall with less than 1 in 1000 chance in any given year or less than 0.1% chance that the storm will occur in a single year.

It should be noted that this mapping has been produced at national scale with a number of assumptions and therefore there are some limitations at a local scale and is not appropriate for identifying individual property level flood risk. This mapping is publicly available for use, and is available online.

https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode

Figure 6: Example of Environment Agency updated Flood Map for Surface Water mapping

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River flood risk

With regards to river flooding the Environment Agency publish the Flood Risk from Rivers or the Sea map. This shows the flood risk from Environment Agency Main Rivers and from the sea, taking into account any flood defences that may be present.

Storms are usually given with an annual probability or the chance of occurring in any given year. Typically, smaller storms have a higher probability of occurring in any given year and larger storms have a lower probability of occurring. However, the probability only describes the chance a storm will occur and not when. This means that if a large, low probability storm occurs, it can happen again soon after or can happen a long time after.
This mapping assesses flood risk from rivers or the sea as a result of the chance of rainfall occurring in any given year, and is categorised into the following four scenarios:

High Risk: Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year or 3.3% chance that the storm will occur in a single year

Medium Risk : Flooding occurring as a result of rainfall between 1 in 100 and 1 in 30 chance in any given year or between 1% and 3.3% chance that the storm will occur in a single year

Low Risk: Flooding occurring as a result of rainfall between 1 in 1000 and 1 in 100 chance in any given year or between 0.1% and 1% chance that the storm will occur in a single year

Very Low Risk: Flooding occurring as a result of rainfall with less than 1 in 1000 chance in any given year or less than 0.1% chance that the storm will occur in a single year.

This modelling is publicly available as the Environment Agency's Flood Risk from Rivers or the Sea map and is available online.

https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode

Figure 7: Example of Environment Agency Main River Flood Zones mapping

Analysis of Flooding Locations

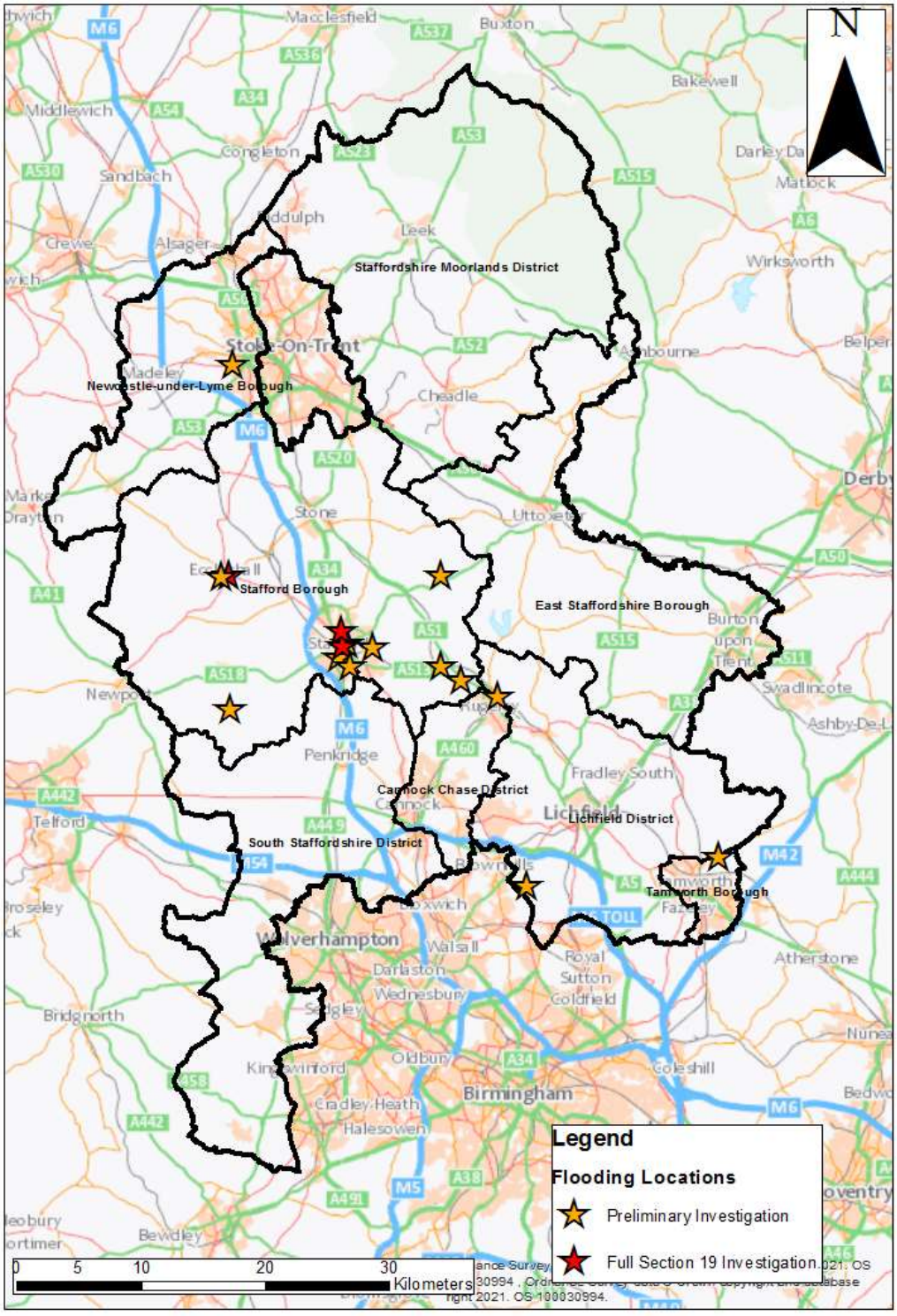

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Table 1 Flood Locations Summary

SETTLEMENT	DISTRICT	EVENT RETURN PERIOD (BASED ON RADAR IMAGES)	EVENT RETURN PERIOD- (BASED ON NEAREST RAIN GAUGE).	DISTANCE TO NEARERST RAIN GAUGE (KM)	PROPOERTIES REPORTED AS FLOODED	PROPERTIES FLOODED INTERNALLY	INITIAL PRELIMINARY INVESTIGATIONS UNDERTAKEN.	MEETS REQUIREMENTS FOR FULL S19 INVESTIGATION	SOURCES
AMINGTON, TAMWORTH	TBC	< 1 in 1 year	< 1 in 2 year	18.3	1	1	Yes	No	Surface water run-off from adjacent field
BASWICH LANE, STAFFORD	SBC	< 1 in 1 year	1 in 3 year	9.4	2	2	Yes	No	As the River Sow (Main River), and the Kingston Brook were the primary sources in this location, the Environment Agency are the lead Risk Management Authority, so the LLFA will liaise with and assist them where required.
GLOUCESTER ROAD, NEWCASTLE (KIDSGROVE)	NBC	< 1 in 1 year	1 in 38 year	12.3	2	1	Yes	No	A blocked debris screen exacerbated the effect of excessive rainfall.
DOXEY ROAD/CHELL ROAD/CASTLE STREET, STAFFORD	SBC	< 1 in 1 year	1 in 14 year	5.6	2	2	Yes	No	River Sow (Main River)
HERBERT ROAD, STAFFORD	SBC	< 1 in 1 year	1 in 8 year	10.6	2	3	Yes	No	Tributary of Rising Brook
STAFFORD CENTRE	SBC	< 1 in 1 year	1 in 14 year	10.2	1	1	Yes	No	Pearl Brook, Tributary of River Sow (Main River), brook is heavily silted. Urgent dredging works are needed.

LINACRES ROAD, ECCLESHALL	SBC	< 1 in 1 year	1 in 14 year	5.6	5	5+ (unsure)	Yes	Yes	Highway drain into brook (under riparian ownership).
LITTLE HAYWOOD, WOLSELEY BRIDGE	SBC	< 1 in 1 year	1 in 3 year	6.0	2	2	Yes	No	Culvert back-up under Meadow Lane
SANDON ROAD/ PEEL TERRACE/FREEMAN STREET	SBC	< 1 in 1 year	1 in 14 year	9.0	37	37	Yes	Yes	Marston Brook, Sandyford Brook and Pearl Brook- these are designated as Main River, so E.A.is lead RMA in this location.
SILKMORE LANE	SBC	< 1 in 1 year	1 in 3 year	9.5	1	1	Yes	No	Silkmore tributary to River Penk – Issues related to River Penk Floodplain. Therefore Environment Agency to act as lead Risk Management Authority.
RIVERWAY, STAFFORD	SBC	< 1 in 1 year	1 in 3 year	10.4	3	3	Yes	Yes	River Sow and riparian Brook at rear of St George's Road
MEADOW LANE/RAILWAY – LITTLE HAYWOOD	SBC	< 1 in 1 year	1 in 3 year	9.0	-	-	-	-	River Trent and Highways
ST PETERS CLOSE, STONNALL	LDC	< 1 in 1 year	1 in 3 year	13.5	2	2	Yes	No	Ordinary Watercourse- blockage of culvert debris screen.
SHAWS LANE, ECCLESHALL	SBC	< 1 in 1 year	1 in 14 year	6.1	1	1	Yes	No	Surface water from neighbouring land

BLITHBURY ROAD, RUGELEY	LDC	< 1 in 1 year	1 in 3 year	4.2	4	3	Yes	No	Moreton Brook, River Trent (both Main River), and surface water- EA to act as lead Risk Management Authority at this location
GOOSEMOORCHURCH EATON	SBC	< 1 in 1 year	1 in 17 year	5.0	1	1	Yes	No	Eaton Brook. Liaised with local farmers to ensure drainage is effective.
SNEYD AVENUE	NuLBC	< 1 in 1 year	1 in 38 year	12.9	Unknown	Unknown	Yes	No	Reports of sewer flooding and runoff from surrounding land.
BALMORAL DRIVE	CCDC	< 1 in 1 year	1 in 3 year	2.9	Unknown	Unknown	Yes	No	Flooding originated from cul-de-sac (Highway), and flowed down driveway, inundating properties.
MILL MEECE	SBC	< 1 in 1 year			Unknown	Unknown	Yes	No	Main River source, so Environment Agency to act as lead Risk Management Agency in this location.

Due to the high number of sites where preliminary investigations were carried out, as set out in the Staffordshire County Council Local Flood Risk Management Strategy, only locations where the threshold criteria were met for full Section 19 investigations will be reported fully. These are covered in the following section.

Sandon Road, Peel Terrace and Freemen Street, Stafford

What happened?

Identified Flooding Type(s)	
	
	

The rainfall event at this location during 25 – 26 October was that of an approximately 1 in 14-year return period according to third party data. Through rainfall and hydrological analysis, we can however estimate that the return period of the flow event on the Sandyford Brook at this location was between 1 in 5 and 1 in 10 years. The peak flow during the event was 2.11m^3/s. Due to complicated interacting factors, this return period figure is very difficult to approximate in this location.

See Appendix A for further details on hydrological analysis.

The water level in the Sandyford Brook (Main River), which runs from the Astonfields Balancing Ponds to the north, in a south-eastern direction to the rear of the affected properties on Sandon Road, rose significantly. This, coinciding with overwhelmed drainage infrastructure on the Sandon Road highway, caused water to inundate the properties from the rear. The rising water levels at the front of these properties also meant that the excess water had nowhere to drain to, exacerbating the already serious issue and causing multiple internal property flooding incidents.

Why did it happen?

The issue here was of the Sandyford Brook (Main River) not conveying flow effectively. Compounding this, there was compromised highway drainage and sewerage infrastructure. The Environment Agency have reported ongoing and historic subsidence issues relating to brine extraction. The historic flooding in this area has been identified as being a result of a lack of positive drainage infrastructure. Simply, it has been noted that the gradient of the Sandyford Brook here, is not suitable to drain the area sufficiently; there is not sufficient fall in the brook. The water levels in the brook therefore 'back up' and combining with lack of effective sewerage infrastructure and highways drains, flood water then inundates properties. Rising water levels at the front of the properties prevented there being a clear path for the water to drain to from the rear.

Figure 8: Flow Directions (Blue)

What has been done?

Following the initial reports of flooding at Sandon Road following this event, questionnaires were delivered to affected residents to gather information and assist with building up an understanding of the mechanisms contributing to flooding at Sandon Road.

Highways drainage (e.g. gully pots) has been cleansed and will continue to be cleansed at the appropriate frequency.

Meetings with residents, local Councillors and the Member of Parliament for Stafford have been held, along with the Environment Agency, as the flooding here has been an ongoing, historic issue. A Community Flood Action Group has been formed also. As a large proportion of the flooding dynamics in the Sandon Road location relate to Main River issues (the Sandyford Brook), the Environment Agency will lead on the location, going forward. Works are being considered with regard to hydraulic modelling of the Sandyford Brook and potential sewer and highway improvement work are also being reviewed by the EA.

The Environment Agency report an initial assessment for a Flood Alleviation Scheme for Sandon Road, however a funding gap has been identified, with a considerable amount required from external partners. The surface water flood risk has been reviewed and a partnership with Severn Trent Water is being considered. Detailed hydraulic modelling will inform a short listing of potential intervention options, which include bunds and surface water pumps, linear defences and channel regrades. All of these options are subject to assessment, funding and benefit analysis.

What next?

The Environment Agency have stated that they will evaluate intervention options with business cases being prepared.

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	**Identified Party / RMA**
Community Flood Action Group to meet regularly to provide a single point of consistent contact for community engagement.	Residents/County Councillor / LLFA (SCC)/MP
A detailed channel survey of the Sandyford Brook and the Astonfields Pools is to be carried out. To gain a fuller understanding of the hydraulics, characteristics and other factors affecting the risk of flooding in the Sandon Road locality.	EA
The results from the above survey may then inform an update of a hydraulic model of the area.	EA
A Business Case for a detailed design for relevant- 'good, sensible, and viable investment moving forward' can then be implemented.	LLFA (SCC)/ EA
Officers from the Environment Agency and the Lead Local Flood Authority, to collaborate with local residents- meeting on site when able, to gain a fuller local understanding.	EA, LLFA, Sandon Road Residents- Flood Action Group.

Environment Agency Estimated Timescales

1. Strategic Outline Case complete November 2021
2. Outline Business Case Estimated completion Summer 2022
3. Full Business Case complete Autumn 2022
4. Construction 2022-23

The Orchards / Linacre Road, Eccleshall

Identified Flooding Type(s)	
	

What happened?

On 25 and 26 October 2019 numerous properties to the immediate north of Green Lane (on The Orchards and Linacre Road), reported flooding. This was as a result of an approximately 1 in 14-year return period rainfall event. However, SCC HydroMaster software approximates the return period of this rainfall event as being less than a 1 in year event. Therefore, caution needs to be used in quoting these figures. It is very difficult, due to complex interacting factors to precisely evaluate this number.

A considerable volume of water draining from the surrounding farmland to the south was routed through an unnamed ordinary watercourse running south to north parallel to The Orchards. A debris screen had become blocked and although the rainfall event as well as the runoff it generated were excessive, some of the water was prevented from draining into the downstream culvert, therefore contributing to flooding of property.

Why did it happen?

The flooding in this area has been identified to originate from surface water runoff and associated water channels.

What has been done?

Following the October 2019 storms, Staffordshire County Council has visited the location multiple times, surveyed the location and inspected assets.

SCC are considering options for an improved debris screen.

What next?

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
Staffordshire County Council have carried out a CCTV survey of the downstream drainage culvert infrastructure.	LLFA (SCC)
Staffordshire County Council to implement an upgrade of an existing debris screen.	LLFA (SCC)

Riverway, Stafford

The rainfall event at this location during 25 – 26 October was that of an approximately 1 in 14-year return period according to third party data. Staffordshire County Council hydrological system HydroMaster however estimates a lower return period for the rainfall at this location, specifically, less than a 1 in 1 year. Due to complicated interacting factors, this return period figure is very difficult to approximate in this location.

What has been done?

A Flood Risk Officer from Staffordshire County Council attended the site and confirmed the reported status. The Environment Agency have been liaised with and Officers attended the site on 1/11/2019.

Environment Agency Officers are working to develop a Sow and Penk hydraulic model. This will inform any future works at this location. The model will give the latest information on flood risk and whether there may be justification for looking at improvements.

The Environment Agency have stated in a recent briefing that:

"There has been considerable work undertaken to update the entire River Sow and River Penk hydraulic flood model. We had hoped to begin work on investigating flood risk reduction options during this summer. However, we have faced difficulties in calibrating the model to the observed levels recorded at the various gauges along the two watercourses. We have a consultant working to develop new models for the three river gauges to support this calibration. This is a lengthy process but is the most appropriate step to achieving a calibrated and approved model that can be used for a variety of purposes. We anticipate this modelling work to be complete in February 2022. We do however, recognise that this has implications for projects looking to use this model."

What next?

The Environment Agency are aware of the location and as the issues relate to Main Rivers, (River Sow), the EA are to lead on this location.

RECOMMENDED ACTIONS

ACTIONS

While many of the recommended actions noted above are tailored specifically to the location where the flooding occurred, there are some actions that are applicable in multiple locations.
The following section provides a summary of what these actions may entail:

Sewer Infrastructure:

Assess the condition and capacity of the sewer network –

The above recommended action may incorporate multiple tasks which may include:

An assessment of the sewer network, ensuring that the existing infrastructure is capable of draining the catchment effectively

Investigation and survey of existing assets, for example using CCTV and in-person inspections, to ensure blockages and flow restrictions (e.g. silt accumulation) are removed

Feasibility assessment and optioneering of means to increase capacity of sewer network

Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks

Hydraulic modelling and performance analysis.

Highway Drainage:

Assess the condition and capacity of the highway drainage network
Review of maintenance schedule of highway assets (e.g. gullies)
The above recommended actions may incorporate multiple tasks which may include:

Review of the location and condition of existing highway drainage assets, to ensure flows are not impeded and that sufficient gullies are in place to collect flows.

Assessment of the capacity of the local highway drainage network to explore opportunities to increase capacity

Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks

Rivers and Watercourses:

Assess the condition and capacity of the watercourse

Review of maintenance regime for the watercourse

The above recommended actions may incorporate multiple tasks which may include:

Site visits and surveys to identify current condition of rivers, watercourses and assets, including culverts, outfalls and structures

Rehabilitation works including sediment removal, debris removal, clearance of vegetation and restoration of channels where required

Exploration of opportunities to enhance flow capacity of channels and storage capacity of adjacent floodplains

Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks

Property Level Resilience:

Explore the potential for flood mitigation
The above recommended action may incorporate multiple tasks which may include:

Site visits and surveys to identify potential flood resilience/mitigation

Exploration of property level resilience products and vendors to establish if potential resilience measures may be appropriate

Investigation into previously installed or existing property level resilience measures to assess the effectiveness of the installed measures

Explore community and catchment wide solutions including, property flood walls and gates, flood defence walls/banks, flood storage areas.

Hydraulic Modelling:

Construct a hydraulic model
The above recommended action may incorporate multiple tasks which may include:

Construction of computation models to replicate how watercourses and/or sewers behave when subjected to a significant storm to enhance understanding of flooding mechanisms and properties which are most vulnerable

Feasibility assessment and optioneering of potential measures that may mitigate flood risk. These measures may be strategic or local scale.

RISK MANAGEMENT AUTHORITIES AND OTHER PARTIES

In addition to the recommended actions, an RMA or alternative party has been identified to undertake these actions.
While some actions require collaboration and partnership, the RMA or alternative party identified will co-ordinate all parties to ensure that the action is completed in a timely manner.
A summary of each of the RMAs, with regard to their role in flood risk management, is provided below:

Staffordshire County Council (LLFA)
LLFAs are county councils or unitary authorities which are required to prepare and maintain a strategy for local flood risk management in their areas, investigate significant local flooding incidents and publish the results of such investigations and play a lead role in emergency planning and recovery after a flood event.

Staffordshire County Council (Highways)
Highways authorities have the lead responsibility for providing and managing highway drainage.

Leisure Services
Leisure Services, otherwise known as Parks and Recreation Services, are responsible for the maintenance of public open space. In particular, if this public open space contains or is bound by a watercourse (or feature) Leisure Services hold responsibility for the maintenance and management of this watercourse.

Housing Authority
Housing authorities are county councils or unitary authorities who are required to provide essential housing for the area and maintain property level drainage systems. In some cases, if the properties back onto a watercourse or are constructed above a culverted watercourse, Housing will hold responsibility for the maintenance and management of this feature.

Environment Agency
https://www.gov.uk/government/organisations/environment-agency
The Environment Agency has a strategic overview of all sources of flooding and hold responsibility for flood risk management activities on Main Rivers.

Severn Trent Water
https://www.stwater.co.uk/my-supply/pipes-and-drains/help-with-pipes/sewer-flooding/
As a water and sewerage company, Severn Trent Water manage the risk of flooding to water supply and sewerage facilities and the risk to others from the failure of their infrastructure. They ensure their systems have the appropriate level of resilience to flooding, and maintain essential services during emergencies, maintain and manage their water supply and sewerage systems to manage the impact and reduce the risk of flooding and pollution to the environment and they provide advice to LLFAs on how water and sewerage company assets impact on local flood risk.

Highways England
https://www.gov.uk/government/organisations/highways-england
Highways England is the highway authority with lead responsibility for maintaining and managing trunk roads and motorways, including drainage.

Riparian Owners
https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities
A riparian owner is any party or individual who has a watercourse within or adjacent to any boundary of their property. They are responsible for maintaining the riverbed and banks within their section of the watercourse to preventing obstruction to the water flow and mitigate flood risk.

Conclusions

Following the storm events during 2020, incidents of flooding were reported which included internal property flooding, external flooding to gardens and flooding to highways and other areas.

Estimates of the return period of this event have been included in this report. However, as stated, it is very difficult to be sure of a specific value here. There are complex meteorological, hydrological and hydraulic factors, as well as residual risks such as blockages and highway asset compromises, that all can interact. Therefore, return periods should be referenced and quoted with caution.

Four types of flooding have been identified as causes for the instances of reported flooding. These include surface water flooding, flooding from rivers, flooding from sewer infrastructure and flooding from highway drainage.

In many locations, surface water runoff was channelled by highways ultimately ponding in low point in the road. Across the reported areas, it was noted the affected properties were usually at or below the level of the adjacent highway.

Therefore, surface water runoff ponded within the low points of the highway and when the highway could not contain any more surface water, it would spill from the highway into properties.
The surface water flooding was then further exacerbated by the other three types of flooding. In some areas, the flow in watercourses exceeded the available capacity, particularly where watercourses entered a culvert. This resulted in a constriction of flows, causing water to back up, overtopping the riverbanks and spilling from the river channel.

In some areas, the capacity of the Severn Trent Water sewer infrastructure was overwhelmed causing water to be issued out of the sewer manholes and highway gullies. This has been further exacerbated due to highway gullies being unable to adequately capture the surface water runoff, particularly on steep catchments where the intensity of the rainfall, and volume of runoff, was such that it flowed over or around a gully pot.

For each of the areas, a set of actions have been proposed. The actions that have been proposed are related to the identified cause of the flooding, the severity of the flooding and identified constraints.

Staffordshire County Council, in their role as Lead Local Flood Authority, are continuing to work in partnership with all other relevant Risk Management Authorities; such as the Environment Agency, Severn Trent Water and SCC (Highways)

APPENDIX A: HYDROLOGICAL & RAINFALL ANALYSIS

In performing a hydrological analysis utilising Flood Estimation Handbook (FEH) Webservice catchment data and rainfall data sourced through HydroMaster software, the return period for the October 2019 storm on this particular watercourse, the Sandyford Brook at Sandon Road, can be estimated. An analysis was performed utilising the Revitalised Flood Hydrograph method in ReFH2 hydrological modelling software.

The observed flow event at this location had a peak rate of 2.11^3/s. The 'design' 1 in 5 year return period peak flow (that which has a probability of occurring of 1% in any year), is estimated at 2.08 m^3/s The 1 in 10 year year 'design flow' is estimated as approximately 2.44 m^3/s. Therefore, we can have a degree of confidence that the actual return period of this flow event on the Sandyford in October 2019 is between 1 in 5 years and 1 in 10 years and therefore had between a 10% and 20% probability of occurring in that year.

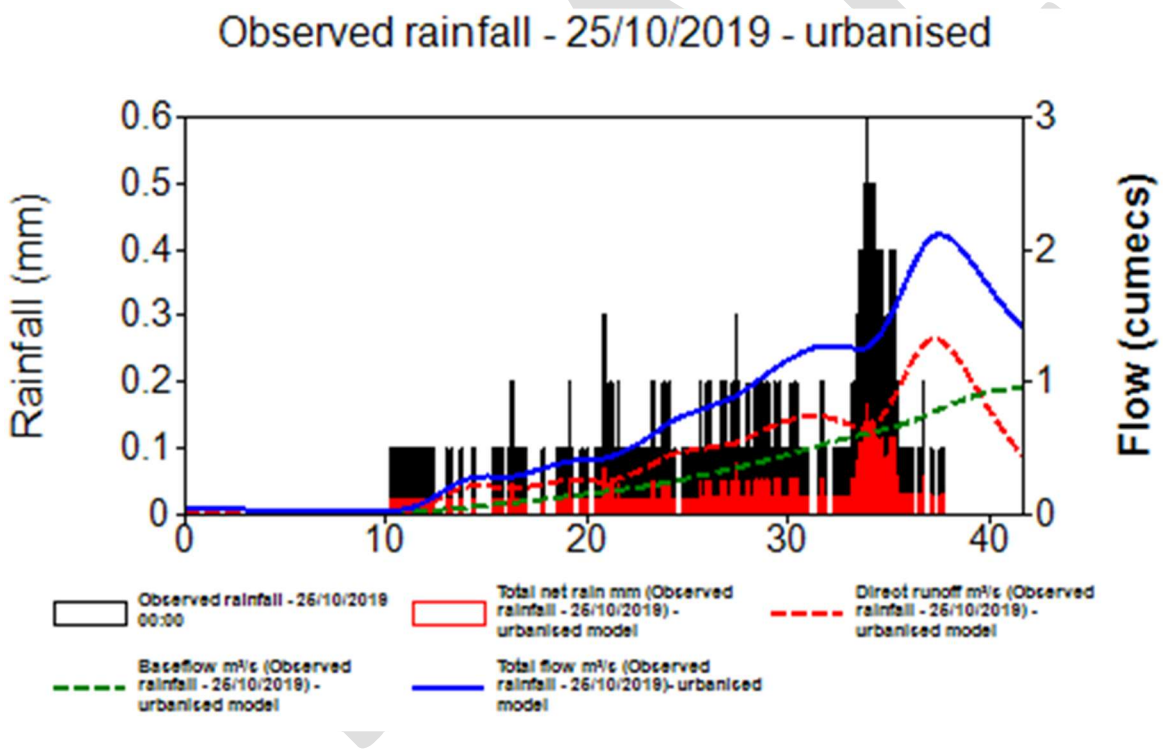

Figure 9: ReFH2 Generated Hydrograph for the Sandyford Brook in October 2019, indicating a peak total flow of 2.11m^3/s (read from the blue line and right hand vertical axis).

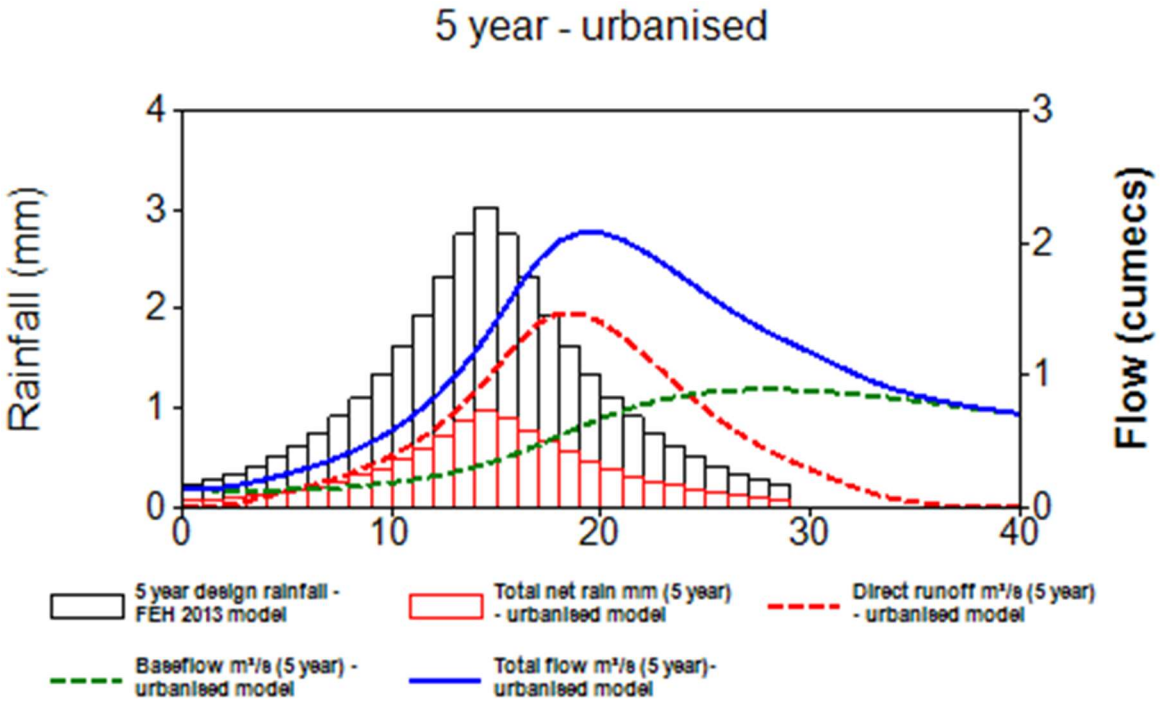

Figure 10: ReFH2 Generated Hydrograph for the Sandyford Brook in October 2019, indicating 1 in 5 year design flow with a peak total flow of 2.08 m³/s (read from the blue line and right hand vertical axis).

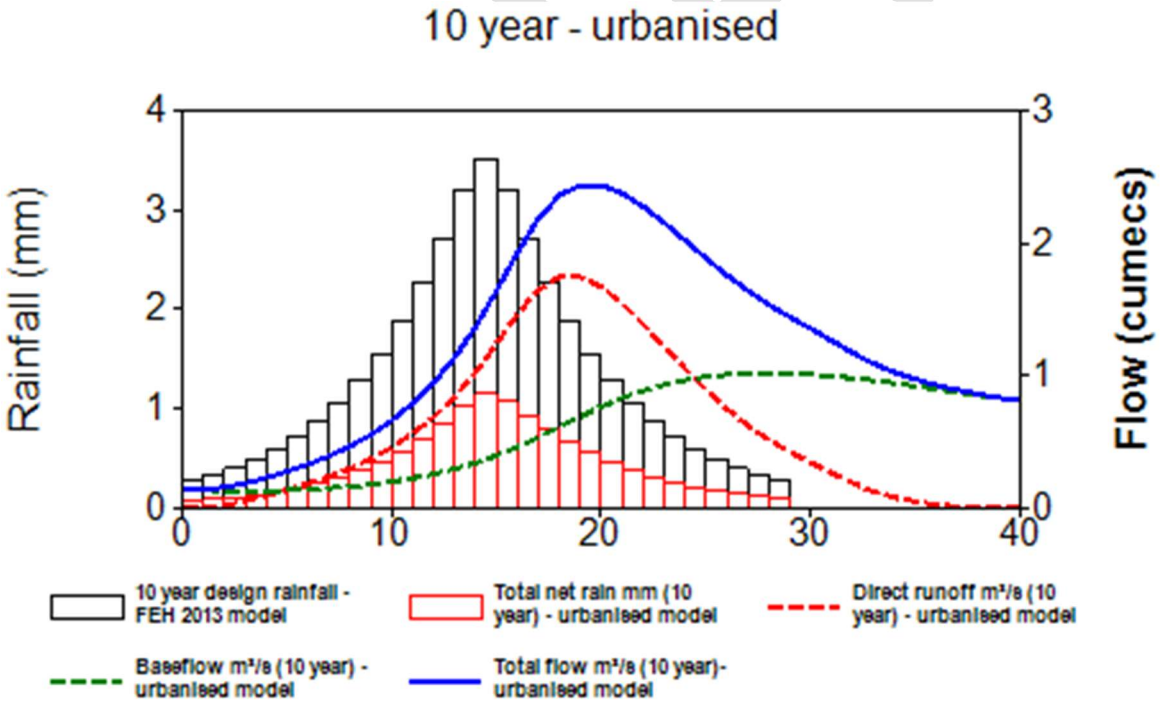

Figure 11 11