Department for Environment Food & Rural Affairs

www.gov.uk/defra

Evidence review of factors contributing to surface water flooding from Section 19 LLFA reports

Final report FD2692

21st October 2015

Llywodraeth Cymru
Welsh Government

Cyfoeth Naturiol Cymru
Natural Resources Wales

Environment Agency

Joint Flood and Coastal Erosion Risk Management
Research and Development Programme

Evidence review of factors contributing to surface water flooding from Section 19 LLFA reports

Final report FD2692

21st October 2015

Funded by the joint Flood and Coastal Erosion Risk Management Research and Development Programme (FCERM R&D). The joint FCERM R&D programme comprises Defra, Environment Agency, Natural Resources Wales and Welsh Government. The programme conducts, manages and promotes flood and coastal erosion risk management research and development.

This is a report of research carried out by Water Evidence Research Consortium led by the Centre for Ecology & Hydrology, on behalf of the Department for Environment, Food and Rural Affairs

Research contractor: Water Evidence Review Consortium (WERC)

Author: R Kellagher (HR Wallingford Ltd)

Publishing organisation

Department for Environment, Food and Rural Affairs
Flood Risk Management Division,
Nobel House,
17 Smith Square
London SW1P 3JR

Contents

Executive Summary

Defra appointed HR Wallingford as part of the consortium led by Centre for Ecology & Hydrology (CEH) to carry out a review of the causes of flooding of events that Lead Local Flood Authorities (LLFA) have assessed under Section 19 of the Floods and Water Management Act 2010 (FWMA).

The purpose of the Section 19 reports review is to complement the evaluation of the arrangements for managing local flood risk commissioned by Defra which is now complete, and to inform Defra's subsequent policy conclusions in relation to the operation of the FWMA in 2015. The objective of the study is stated as being:

"Based on the review of Section 19 reports, assess what have been the principal factors contributing to flooding from surface water in England and Wales since 2010, and how prevalent are they?"

What is a Section 19 report?

A section 19 investigation is a statutory requirement for Lead Local Flood Authorities (LLFA) required under the Flood and Water Management Act (FWMA) 2010. On becoming aware of a flood in its areas, a LLFA must, to the extent that it considers it necessary or appropriate, investigate:

- which authorities (Risk Management Authorities) have relevant flood risk management functions associated with the event; and
- whether each of the authorities has exercised, or is proposing to exercise, those functions in response to the flood event.

Each LLFA produces a report if a threshold level of flooding has been reached. This is usually associated with closure of main roads or internal (and sometimes external) flooding of properties.

The aim of the Section 19 investigation is to give an explanation of what happened in the flood event and what were the various authorities' responsibilities during the event. The recommendations are there to help the authorities learn lessons from the event and, where relevant, to address the surface water drainage infrastructure needs associated with the incident.

Conclusions

A number of conclusions have been made from the assessment of these reports. A few of the main ones are given here.

1. In general there is a reasonable understanding of what the causes of flooding are. Most reports address a specific rainfall incident and the local consequences in detail. Many of the reports have been written after carrying out flood investigations to check on the state of the pipework and other drainage elements. There is less

certainty in the assessment of the causes where field investigations have not been carried out, but in most instances the causes are still relatively obvious. In either case the on-going work following the S19 report should establish what the problems are in order to develop appropriate solutions.

2. The concept of Section 19 reports of all surface water flooding being led by a single authority is very effective as a point of reference that all stakeholders can look to for detailed flooding information and for coordination of an integrated solution to address any drainage problems. In due course the reports will also provide a valuable archive of information on flood risk across the area and any actions that resulted.

3. It would often be helpful for the S19 reports to strengthen their analysis of the hydrological analysis, particularly in providing hourly rainfall information (rather than just daily data) and assessments of the severity of the event. In many instances return period of the rainfall event is not calculated or not calculated in sufficient detail. In no case was a formal assessment made of the runoff frequency even though some reports highlighted that the antecedent conditions had exacerbated the flood response from the catchment. Failure of drainage systems and the mechanisms of failure should be examined in the context of the severity of the event, and solutions will also take this aspect into account.

4. Unsurprisingly highway drainage failures are the most commonplace flooding cause. Failure mechanisms of highway drainage are diverse. Gully gratings are often reported to be covered with debris, particularly during very intense rainfall and the urban environment often naturally provides a source of material such as twigs and leaves. Alternatively, gullies can be blocked with sediment, or the pipework they drain into are partially blocked. These blockages may or may not be as a result of the incident taking place at the time.

5. Similarly for rivers, screen blinding due to rapid accretion of debris occurs during heavy rainfall and is a frequent cause of a flood. In many cases the flooding caused by the screen blinding needs to be mitigated by surface water drainage solutions as prevention of failure of the screen in this manner cannot be guaranteed. This also can apply to flood risk from coastal flooding due to over-topping of defences.

6. In steep catchments there are many instances of rural flooding where there is limited provision for drainage for rural runoff. Flooding often passes to roads from adjacent land while the road drainage is only sized to serve the road itself.

7. Section 19 reports are focused on pluvial issues. It should be noted that flows will pass downstream to other systems and into fluvial systems. Solutions to local flooding issues should recognise the need to take into account hydraulic limitations that might exist further downstream.

Some wider issues

The conclusions for this study are supported by some wider issues showing the need to further develop good drainage practice.

1. The concept of checking for the impact of drainage system failure at any point in the drainage system (or water main burst and the associated flood risk) should become standard practice for assessing the potential flooding impact on the catchment. Current best practice currently only looks at the performance of systems under exceedence conditions and the resulting flow paths. However the development of a resilient urban environment requires consideration of system failures.

2. The assessment of the Section 19 reports have shown that fluvial and coastal flooding have relevance under the obligations of the FWMA Section 19 obligations for local authorities, as the mitigation of such incidents are often associated with local surface water drainage solutions even if the primary defence system is not the responsibility of the LLFA.

3. A major change in design strategy on the use and management of screens on rivers and culverts is needed to address this frequent cause of serious flooding. Modern techniques are available for obtaining real time information and taking appropriate action.

4. Designing for free discharge at outfalls is an assumption which is general practice, whether it is a gully into a receiving pipe, or highway drain or sewer draining into a watercourse. (In tidal areas where sea levels affect an outfall this issue of joint probability / downstream hydraulic influence is addressed). The inappropriateness of this assumption is highlighted by these reports where there are numerous instances of outfalls from drainage systems being constrained by water levels in downstream receiving systems or rivers. The concept of designing drainage using joint probability has been around for a few years, but there is a need to develop best practice in this area with the support of appropriate awareness raising, design guidance and tools.

5. Similarly there is limited support for the drainage engineer in being able to evaluate the return period of runoff (and not just the return period of the rainfall event). This is an essential aspect of producing solutions as the level of service provided is not a function of the rainfall return period even though this is the normal assumption that is made.

1. Introduction

Defra has appointed HR Wallingford as part of the consortium led by Centre for Ecology and Hydrology (CEH) to carry out a review of the causes of flooding of events that Lead Local Flood Authorities (LLFA) have assessed under Section 19 of the Floods and Water Management Act 2010 (FWMA).

The purpose of the Section 19 reports review is to complement the evaluation of the arrangements for managing local flood risk commissioned by Defra which is now complete, and to inform Defra's subsequent policy conclusions in relation to the operation of the FWMA in 2015. The objective of the study is stated as being:

"Based on the review of Section 19 reports, assess what have been the principal factors contributing to flooding from surface water in England and Wales since 2010, and how prevalent are they?"

The following has also been stated by Defra with regards to the objective of the review of Section 19 reports:

Whilst the evaluation has focused on process mainly, it has not gone into any detail about the context of investigations and it is this gap we want to fill with this project. This exercise should purely be a desk review of published documents.

1.1 What is a section 19 report?

A section 19 investigation is a statutory requirement for Lead Local Flood Authorities (LLFA) required under the Flood and Water Management Act (FWMA) 2010. On becoming aware of a flood in its areas, a LLFA must, to the extent that it considers it necessary or appropriate, investigate:

- which authorities (Risk Management Authorities) have relevant flood risk management functions associated with the event; and
- whether each of the authorities has exercised, or is proposing to exercise, those functions in response to the flood event.

Each LLFA produces a report if a threshold level of flooding has been reached. This is usually associated with closure of main roads or internal (and sometimes external) flooding of properties.

The aim of the Section 19 investigation is to give an explanation of what happened in the flood event and what were the various authorities' responsibilities during the event. The recommendations are there to help the authorities learn lessons from the event and, where relevant, to address the infrastructure needs associated with the incident.

2. Review approach

Defra requested that 100 reports should be evaluated. An instruction was given to only use information that could be obtained from the public domain and not to go back to LLFAs for information or clarification. As little more than 100 reports were found (though it is understood that there are over 400 reports that have been produced), the selection process was largely defined by availability. There were a few authorities which had a large number of reports and in these cases only a few were selected to prevent an unbalanced picture from being gained.

Defra has had a review of 40 Section 19 reports already carried out by another contractor looking at the process of the reporting as part of the evaluation on arrangements for managing local flood risk. These 40 reports were provided to HR Wallingford and an additional 100 documents were found using internet searches.

A request was made through Defra by a Welsh Government representative that a sufficient number of the reports should provide a representative sample from Wales. As very few reports were found by the searches, contact information was obtained from a Welsh Government representative and several reports were subsequently obtained.

This review is focused at the causes of flooding rather than the sources. Although closely linked to the what the sources of flooding are, it is important to differentiate between these aspects. The best way to show this is to use an illustration.

An illustration of the causes of flooding

The source of flooding might be the overland flow from a rural catchment, passing down a road and into an urban area, but the cause of the flooding might be that lack of provision of drainage for the rural runoff, or lack of capacity of the highway drainage, or blockage of the gully grating from debris, or blockage of the gully from build up of material in it and lack of maintenance associated with this, or possibly a combination of all of these aspects.

In the context of the standard source / pathway / receptor model that is commonly used by the Environment Agency the causes of flooding can be considered to be deficiencies in the pathway for protecting the receptors (the public).

Appendix 1 provides a list of the Lead Local Flood Authorities (LLFAs) for England and Wales.

Appendix 2 comprises 100 tables; one for each of the Section 19 reports that have been reviewed. These provide the key elements of the incident and brief comments on the incident or the report content.

Two supporting tables in spreadsheet format are provided in Appendix 3. These summarise the causes of flooding and provide details of the reports such as the title, author and so on.

2.1 Evaluation of reports

The evaluation of reports focuses on the causes along with the related aspects of the hydrological and other relevant conditions of the event. It is important to be aware of whether an incident took place as a result of a rare event (when flooding might reasonably be expected), or from a relatively frequent event. It has to be recognised that a lack of capacity for a system for a very extreme event should not necessarily be considered to be a failure even though any flooding impact is to be avoided if possible. There will always be a conflict between meeting the expectations of society, and the provision of cost-effective drainage. This misalignment is well illustrated by the floods in January 2014 when rainfall over several weeks in December 2013 and January 2014 was unprecedented (the wettest January based on information going back to 1766) and yet expectations for effective flood protection were still made. Whether the level of service which is currently accepted as being best practice is appropriate is not really a matter for this review.

Added to this is the issue of climate change where frequencies of occurrence of certain types of events might be changing significantly over the coming years. In the last four years since the Section 19 reports have been requirement of the FWMA, there has been one of the most extreme periods of drought in decades (2011-12), followed by one of the wettest summers on record (2012), and one of the wettest winters on record (2014), and a flood surge in the North Sea of the order of a 1:500 year event. For this reason, and due to the lack of data in many instances, no attempt is made to classify whether the flooding reported should have been avoidable in the context of current design standards.

The evaluation will make passing comment on the quality of each report, particularly on the detail and clarity of the analysis that enables an understanding of the causes of flooding and the severity of the hydrological event. However, the real value of the 100 reviews is the cumulative body of evidence of the key problem areas of the causes of flooding to assist in gaining an understanding of the key issues and areas of weakness with current drainage practice.

Each report has been summarised for its key facts (event date and it's characteristics, number of properties flooded, etc.). Table 2.1 summarises the key headings for which brief comment will be made on each report. A table for each report is provided in Appendix 2. A supporting summary spreadsheet table is provided in Appendix 3. Assessments have also been made on aspects such as the reliability of the analysis and the level of detail that has been provided in the report.

Table 2.1: Report title and authority

Item	Comment
Flood event	Date, Location
Report	Date, LLFA
Authors	Organisations
Topography	Catchment slope
Land Use	land use
Flood severity	Damage, nr. of properties
Flood sources	Flooding sources
Flood causes	Flooding causes
Rainfall	Intensity / duration / frequency rainfall characteristics, Return period analysis, Radar rainfall
Unknowns	Areas of uncertainty and lack of clarity
Historical flooding	Dates, locations, Causes, Rainfall
Reviewer Comments	Assessment of the incident: details and causes

3. Flooding sources and causes

This chapter discusses the technical aspects of the causes of flooding in the context of the types of drainage systems that cater for surface water runoff and relate them to their ownership. An explanation is given on the terminology used to assist in understanding some of the terms used.

The sources and causes of flooding are listed in Table 3.1 and each category is subsequently explained including some explanation of the terminology used. It should be noted that responsible organisation should be treated with a degree of caution in some cases. For instance in putting “Environment Agency” against Main River as being the responsible organisation is a simplification of what is often quite quiet a complex arrangement. The Environment Agency has rights and responsibilities to ensure that rivers are maintained, but they don’t own the river. They may or may not be responsible for funding the maintenance of the defences either even though they must ensure they provide an appropriate level of flood protection.

The definition of “flood” as described in the Flood and Water Management Act 2010 is as follows:

“Flood” includes any case where land not normally covered by water becomes covered by water. It does not matter for the purpose of subsection (1) whether a flood is caused by:

- heavy rainfall;

- a river overflowing or its banks being breached;
- a dam overflowing or being breached;
- tidal waters;
- (e) groundwater; or
- (e) anything else (including any combination of factors).

But “flood” does not include:

- a flood from any part of a sewerage system, unless wholly or partly caused by an increase in the volume of rainwater (including snow and other precipitation) entering or otherwise affecting the system; or
- a flood caused by a burst water main (within the meaning given by section 219 of the Water Industry Act 1991).

The Categories and order of the sources of flooding used in the definitions section of the FWMA 2010 are:

- Main River;
- Watercourse;
- Ordinary watercourse;
- Groundwater;
- Surface runoff.

This last category is qualified as follows:

(a) is on the surface of the ground (whether or not it is moving); and
(b) has not entered a watercourse, drainage system or public sewer.

In practice it is impossible in an urban environment to distinguish whether rainwater at any point on the surface has entered and then left the sewer or drain, or has not entered it. For the purpose of this study this distinction is therefore not attempted.

Table 3.1 uses these same source categories in their respective order, but some sub-division is provided on the basis that there are several organisations responsible for certain categories. Two additional categories are included even though the flooding definition in the FWMA does not consider these in its definition; firstly coastal flooding is included, and secondly flooding from canals and reservoirs and other man-made systems are also potential sources of flooding.

“Drainage” is not defined, and nor is “pluvial” in the FWMA, but the definition for flooding is effectively a definition of what is termed pluvial flooding. Drainage, as used in this report, is the infrastructure that is associated with the conveyance of surface water runoff.

Table 3.1 lists the main mechanisms of the causes of flooding under each source category and each of these is discussed in the following section. It is possibly worth noting that topography does not feature as a cause of flooding. Topography is not a feature of a drainage system, nevertheless topography is both instrumental in the flow path of flooding

as well as affecting the behaviour of the drainage systems. Topography therefore is a key feature in understanding the different types of flooding that occurs and features in the technical discussion on the reports.

Table 3.1 Causes of flooding from all sources of flooding

Source of flooding / Responsible organisation	Flooding description	Causes (mechanism) of flooding
Coastal (defences) Environment Agency / Local authority	Inundation from the sea	• Failure of an embankment • Overtopping of defences
Main River Environment Agency	Flooding from a river categorised as Main river	• Lack of capacity • Screen blinding
Ordinary watercourse Local authority or IDB	Flooding from a river categorised as Ordinary watercourse	• Lack of capacity • Screen blinding
Groundwater LLFA	Flooding from groundwater	• Lack of capacity
Surface water - Rural runoff Riparian owner	Overland runoff from agricultural or other undeveloped area	• Lack of capacity • Pipe or channel blockage
Surface water - Surface water sewers / (Urban runoff) Sewerage Undertaker	Overland runoff from urban surfaces and / or flooding from surface water sewerage systems	• Lack of capacity • Pipe blockage • Mechanical or electrical failure (usually pumping stations)
Surface water – Foul / combined sewer Sewerage Undertaker	Flooding from foul or combined sewerage systems due to rainfall	• Lack of capacity • Pipe blockage • Mechanical or electrical failure (usually pumping stations)
Surface water -	Overland runoff from urban surfaces and / or flooding	• Lack of capacity

Highway drainage Local authority (highways)	associated with Highway drainage	• Gully blinding • Gully blockage
Canal / Lake / Man made structure Riparian owner	Flooding from manmade structures	• Structural failure • Lack of capacity • Screen blinding

Note: Under FWMA LLFAs are responsible for co-ordinating and managing local flood risk in relation to surface water runoff, groundwater and ordinary watercourses. Riparian owners have a responsibility for bed, banks and vegetation and ensuring any works they carry out do not increase flood risk.

Coastal flooding

Failure of an embankment: inundation of an area or property flooding from a structural failure.

Overtopping: Flooding due to overtopping of sea defences due to extremely high sea levels or by wave action.

There is the possibility of back flow of seawater through a drainage systems due to failure of a non-return valve. However, this along with backwater influence on reducing drainage system capacity, is treated as a capacity issue of the system draining into the sea or river with high water levels.

Main River flooding

It should be noted that although Main River is a category for which the Environment Agency is responsible, the maintenance of it may be the responsibility of a riparian owner due to its location beside or within the property curtilage. There are effectively two main categories:

Lack of capacity: A river (or the culvert through which it is passing) can have a lack of capacity due to the channel being too small to convey the flood flow, or due to inadequate maintenance in addressing deposits of material or vegetation growth; and

Screen blinding: A screen (usually at an entrance into a culvert placed there for safety reasons to prevent ingress by people) has blinded with debris reducing the capacity of the system due to partial blockage of the channel or culvert.

A bridge is often a throttle point in the river and contributes to flooding. However, this is also treated as a river capacity issue rather than giving it a separate category. In most cases there is no analysis made as to the degree of causation of fluvial flooding due to bridge affluence.

Ordinary Watercourse flooding

As with Main Rivers, although the local authority is responsible for them rather than the Environment Agency, they tend to be smaller watercourses, but otherwise there is no other

aspect which differentiates them. This means that they contribute the same characteristics and problems in terms of their hydraulic impact. The difficulty arises when ditches are mentioned as un-named or unclassified small streams. Ditches may be part of road and rural drainage systems, but they are sometimes effectively the upper reaches of Ordinary watercourses and are defined as such in these situations.

Lack of capacity: A river which is too small to pass the flood flow which might be partly due to inadequate maintenance in addressing deposits of material or vegetation growth.

Screen blinding: A screen (usually at an entrance into a culvert placed there for safety reasons to prevent ingress by people) has blinded with debris.

Rural runoff

Lack of capacity: Runoff coming from fields. “Lack of capacity” is not really an effective description of the management of flows down through fields and onto roads, but the implication is that there is either inadequate provision for drainage for managing the runoff or that there is none provided. In principle effective surface water management from rural areas should aim to prevent rural runoff from flooding urban areas. Comment is rarely made in the reports on the rural drainage that might exist. The term “capacity” has therefore been used in this category whether or not drainage systems exist in serving these areas if they are the cause of the flooding.

Surface water sewers / Urban runoff

In theory there is no distinction in urban drainage in terms of its assessment. However, ownership is split between local authority, highways and Sewerage Undertakers. Theoretically the highway drainage only serves roads which the Sewerage Undertakers serve properties, but also often drain roads. In this category it is being assumed that these are the assets that belong to the Sewerage Undertakers. A separate category is provided for Highway drainage.

Lack of capacity: Urban runoff is generated from roofs and gardens and paved surfaces. In theory all urban runoff should be managed by drainage systems and therefore it is impossible to distinguish between runoff which takes place that has not entered a surface water drainage system, or flows which have flooded out from the drainage system. Only in situations where a blockage occurs and the source is clearly from a manhole can one be definitive about this.

Pipe Blockage: A blockage (roots, sediment structural state) contributing to a lack of hydraulic capacity. This might be due to inadequate maintenance, poor structural condition, or possibly deposition of sediment caused by the event. Although this also means a lack of capacity, to differentiate this from just a lack of conveyance capability, the term “blockage” is used as the descriptor.

Foul / combined sewers flooding

Lack of capacity: A pipe drain or sewer which is under-sized. The under-sizing of a pipe is rarely associated with the foul flow (and this is never reported anyway). The flooding associated with foul drainage may be due to area misconnections, intentional but excessive contributing surface runoff served by the system, or excessive infiltration from elevated groundwater levels. In many instances the cause of flooding is not distinguishable.

Pipe Blockage: A blockage or constriction contributing to a lack of capacity due to inadequate maintenance or poor structural condition. As with surface water sewers, although there is a lack of capacity, the term “blockage” is used as the descriptor.

Highway drainage flooding

Lack of capacity: A drain which is under-sized or which has developed a lack of capacity due to inadequate maintenance or poor structural condition.

Gully blockage or blinding: Gully blockage can refer to three separate hydraulic conditions:

1. There are several instances of reported gully blockage due to water coming out of gullies. It is quite likely that this conclusion is incorrect in that the hydraulics of the pipework which the gully is connected to may be the main limitation of the system (and therefore “blockage” is not applicable).

2. The second category is that of debris blinding the gratings of gullies. This appears to be a regular feature of thunderstorms where a lot of leaf litter and other material can be washed to the gullies which effectively seals the gratings.

3. The third category is the filling of gullies (and possibly the pipework) with sediment such that the hydraulic connection to the drainage system is severely impaired.

It is important to recognise that the reports will often mention blockage of gullies and any one of these mechanisms may be being referred to. If it is a thunderstorm it is likely that it is either option 1 or 2, while the last category is quite common-place in steep rural catchments with the washoff of high sediment loads with intense rainfall events usually when antecedent conditions have been wet.

Groundwater flooding

Lack of capacity: As for rural runoff, there is often no explicit provision for drainage to deal with flooding caused by groundwater when springs develop and flows pass downhill. The term “capacity” is used to draw attention to the fact that surface water flooding from groundwater is taking place and that provision for this mechanism with some form of drainage could prevent flooding from this source. Similarly flooding of basements by seepage from rising groundwater is given the same descriptor as drainage provision within basements is clearly lacking to address groundwater flooding if flooding has taken place.

Canal / Lake / Man made structure

Structural failure: This is the descriptor used when failure of some element of the structure or supporting drainage component causes flooding.

Lack of capacity: This is the term used if a drainage component which is directly related to the manmade structure does not have sufficient drainage conveyance capacity to address the flow.

Screen blinding: A screen which is directly related to the manmade structure which becomes blinded and has contributed to the flooding.

4. Discussion on Section 19 reporting

The review of the reports has been useful in obtaining an indication of the hydrological conditions that cause flooding, as well as providing information on the causes of flooding.

This discussion section is in four parts:

1. An introduction which provides an overview of the flooding in the last four years;
2. A quantifying of the data using three figures to summarise the findings on the causes of flooding;
3. A commentary on the Section 19 documents on their effectiveness in reporting of the flood incident and the causes of flooding;
4. An explanation of the main issues associated with the causes of flooding.

In particular two main points about the study need to be highlighted:

- This project is aimed at the causes of flooding. It is important to see this in the context of the prevailing weather conditions that have taken place which have been exceptional in the last four years.
- The aim of this project is to look particularly at the causes of pluvial flooding. It will be seen that there are a few instances of coastal flooding and many instances of fluvial flooding. However, the study clearly shows that limiting the source of the flooding to only pluvial situations is inappropriate as the causes of flooding can still be related to the inadequacy of the drainage system to prevent or mitigate the effects of these flooding occurrences. Secondly, the performance of a pluvial system may depend on the state of the river or sea level and therefore there is a blurring of the distinction between pluvial, fluvial and coastal flooding.

One hundred reports have been evaluated by this study. Figure 4.1 shows the LLFAs where at least one report has been assessed.

Although the report selection was based on availability, when one examines Figure 4.1 it can be seen that there is a block in the middle of England and East Wales where no reports have been evaluated. It is unlikely that this is because no flooding took place in those regions, but it is curious that the figure does not show a random spread of LLFA regions.

Table 4.1 provides a supporting list of the authorities and the number of reports assessed. There are a few authorities which have produced a large number of reports, and in these instances only a selection have been taken to ensure representative sampling is achieved. In two cases the reports have been assessed as a compilation of multiple reports with only some of the chapters for a selection of areas chosen for evaluation. A full list of LLFAs is provided in Appendix 1.

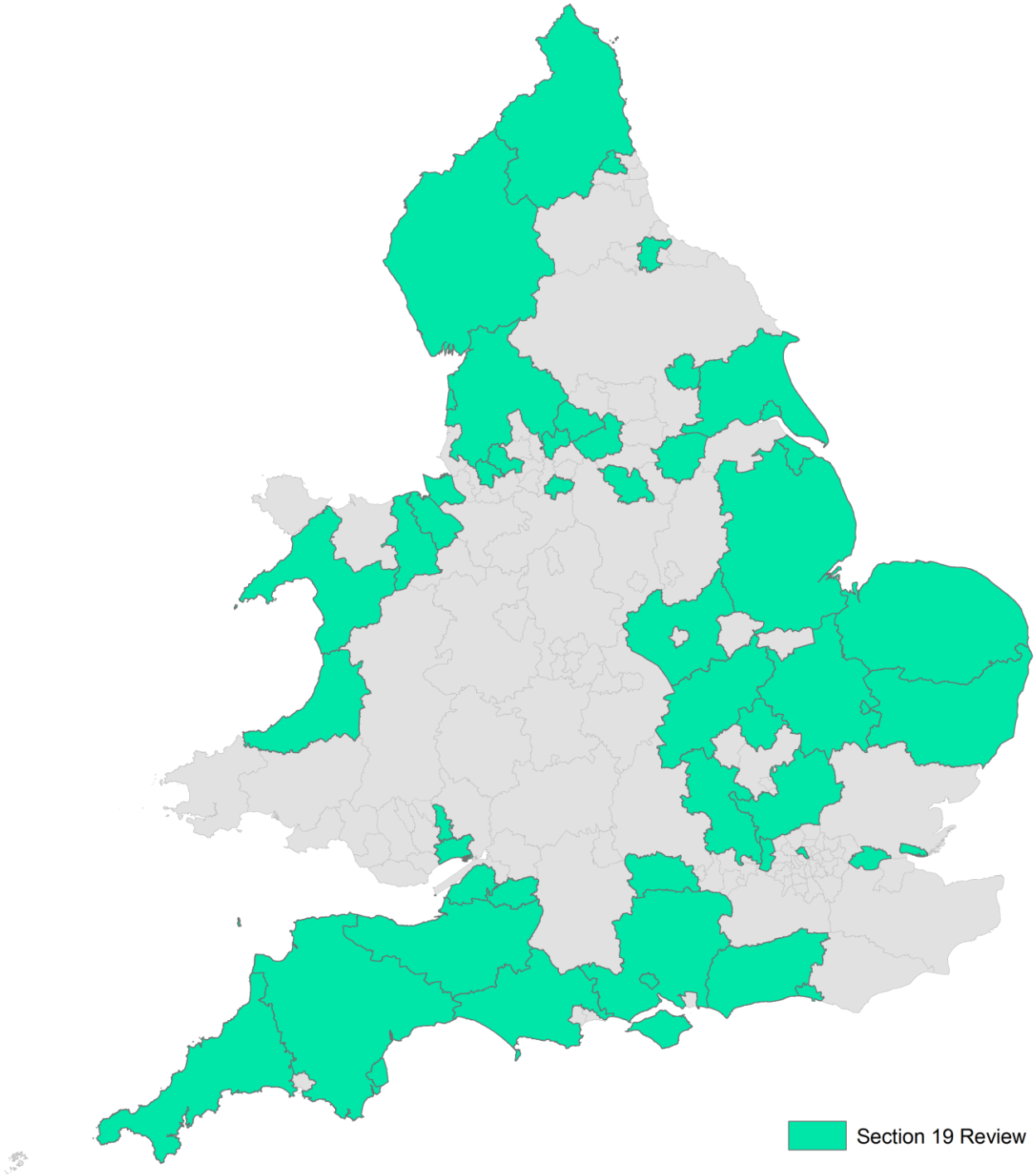

Figure 4.1 LLFA areas where one or more reports have been evaluated

Table 4.1. LLFAs and the number of reports evaluated - England

LLFA - England	No. of reports	LLFA – England	No. of reports
Bath & N E Somerset UA	3	Newcastle upon Tyne	1
Bedford	4	Norfolk	1
Blackpool UA	1	North East Lincolnshire UA	1
Brighton & Hove UA	1	North Somerset UA	1
Buckinghamshire	3	Northamptonshire	7
Calderdale	1	Northumberland	3
Cambridgeshire	1	Rochdale	2
Camden	1	Sheffield	4
Cornwall	2	Somerset	2
Cumbria	4	Southampton UA	1
Devon	3	Southend on Sea UA	1
Doncaster	1	St Helens	1
Dorset	2	Stockport	1
East Riding of Yorkshire UA	1	Stockton on Tees UA	1
Essex	3	Suffolk	1
Hertfordshire	3	Thurrock UA	1
Hillingdon	1	Torbay UA	2
Isle of Wight	1	West Berkshire UA	1 (Multi)
Kingston upon Hull	3	West Sussex	1 (Multi)
Kirklees	1	Wigan	1
Lancashire	1	Wirral	2
Leicestershire	1	York UA	2
Lincolnshire	1		

Table 4.2. LLFAs and the number of reports evaluated - Wales

LLFA - Wales	No. of reports
Ceredigion	1
Conwy	4
Denbighshire	3
Gwynedd	1
Newport	1
Torfaen	1

4.1. Flooding events since 2010

Section 19 reports have been evaluated for the years 2011 through to 2014 inclusive. In that time there have been many flooding events which have taken place; possibly many more than a typical four year period.

From May through to the end of the year in 2012 the rainfall across England and Wales was exceptional and various statistics show that this period is among the wettest ever recorded with nearly every month often being the wettest month on record. Large rainfall events are not of themselves a problem if the rainfall intensities are not high. However, many of the large events were associated with quite intense rainfall. This combination of hydrological conditions provides the worst situation for rapid and high volumes of runoff to take place.

Many of the major events were the result of meteorological conditions which were quite widespread across a region. There are certain dates when storms occurred across much of the country.

A second extreme wet period also occurred in December 2013 through to February 2014. Although this was a winter period and therefore rainfall intensities were generally much lower, the effect was similar in that rainfall depth totals were very high and the land was totally saturated, resulting in very high volumes of runoff taking place. It also had the effect of elevating groundwater levels to heights which caused flooding in many locations.

The fact that these periods have occurred is very useful in providing lots of evidence to examine the various causes of flooding and to be able to deduce a number of useful conclusions, but a key point must be noted. The return period of runoff is often considered to be the same as that of the rainfall that took place which caused the problem. This is a reasonable approximation for rainfall in the urban environment, and in typical weather conditions it also holds true for rural catchments. However, in situations when the antecedent rainfall is very high, the runoff response is much more severe, and the return frequency of the runoff can be more than an order of magnitude greater than the frequency of the rainfall event. What this means is that although the weather conditions reported in the Section 19 documents might suggest that the rainfall is not particular unusual, in many cases the runoff severity is much greater than would normally have occurred. This means that care should be taken in ascribing certain flood events as being failures of the system to meet an expected level of service based on rainfall characteristics.

4.2. Quantification of data associated with the causes of flooding

This section is a presentation of various elements of the study that can be quantified. All the information is plotted from data collected and presented in the tables in Appendix 2.

Where the information is available, quantitative evaluation in the form of graphs and figures can be produced to provide support for qualitative comments and conclusions.

Three figures summarise information from the 100 reports. These are:

- Assessment of the severity of the events in terms of return period of the rainfall event;
- A summary of the numbers of properties flooded by event date;
- The number of instances of a particular cause of flooding found in the 100 reports.

4.2.1. Return period of flooding events

Many of the reports provide a summary of the rainfall statistics. These are shown in Figure 4.2 as a plot of rainfall depth and duration against a backdrop of a plot of return

period curves. The derivation of these curves is linked to a single point in central England and therefore must only be treated as an approximate guide to showing the return period of the event. The data are plotted by season to help in understanding the effect seasonality has on flooding events. A degree of caution needs to be exercised; these figures are based on the information in the reports and no checks have been applied to the data.

Rainfall severity: Even taking into account the comment on the runoff severity being greater than the frequency of the rainfall events, the severity of the rainfall events that cause flooding (see Figure 4.2) are generally fairly high with more than half being more than a 1:10 year event and quite a few events having rainfall severities which are higher than the 1:100 year frequency. Therefore there are quite a large number of events where flooding might have been expected based on current design criteria.

Rainfall season: The seasons used are those normally applied by the Met Office quartiles of the year – December, January, February (DJF), etc.. It can be seen that summer rainfall dominates in causing flooding and tends to be in the region of 1 hour to 6 hours. There are longer duration events for summer flooding, but autumn and winter events also take place. These longer events tend to be linked to more fluvial and elevated groundwater related flooding.

Rainfall duration: The comments on seasonal influence on rainfall show that flooding is largely associated with events under 24 hours. However, a point of clarification should be made; the high numbers of events shown for durations of 24 hours is often due to the fact that the information on rainfall has only been reported as a daily total and not hourly information. It is likely that in many cases the events took place over a shorter period of time and therefore were more extreme.

4.2.2. Numbers of properties flooded

Figure 4.3 provides an overview of the number of properties flooded. It must be understood that the reports often state that figures are approximate and are expected to be an under-estimate due to some households not reporting flooding. Also the definition of flooding used here is related to internal flooding, while in some cases external flooding is also reported. In some cases it is not clear what category the figures refer to. These figures therefore have to be treated with caution.

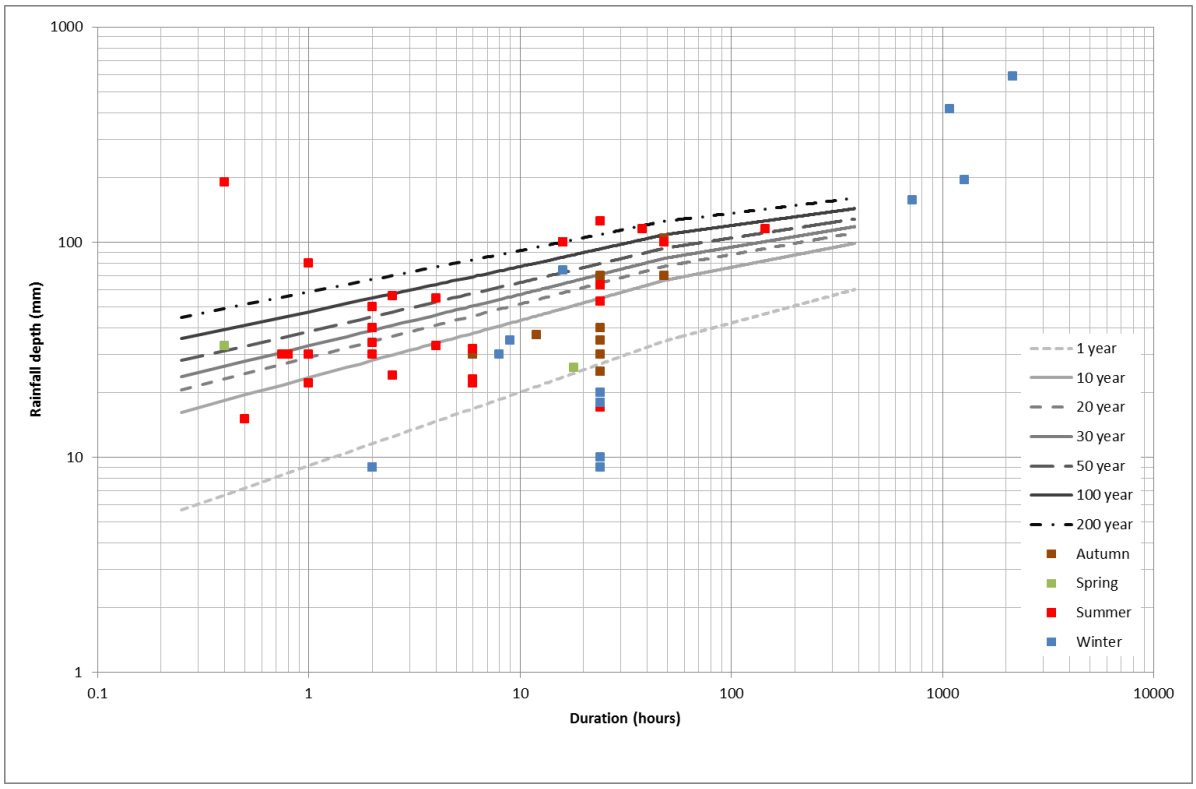

Figure 4.2 Rainfall return period of flood events

Flood incident reports are also produced when road flooding and closure occurs. This information is not detailed in this figure or in the summary tables.

The very high totals of flooded properties are usually associated with either regional reports where rainfall has been across wide areas of a county or a very extreme event has occurred in a heavily urbanised area, often with a significant fluvial component.

There are two main bands of flooding which relate to the unusual weather that has been experienced by the UK in the last four years. If one excludes summer of 2012 and the winter of 2014, the spread and frequency of flooding is much less and perhaps reflects a more likely frequency of flooding events. It should be remembered that these figures probably represent only 25% of all the flooding that has been reported in this four year period as only around 25% of Section 19 reports have been reviewed. Although these periods are considered to be very rare using hydrological analysis based on current weather patterns, climate scientists state that future weather conditions might result in these types of conditions becoming far more common.

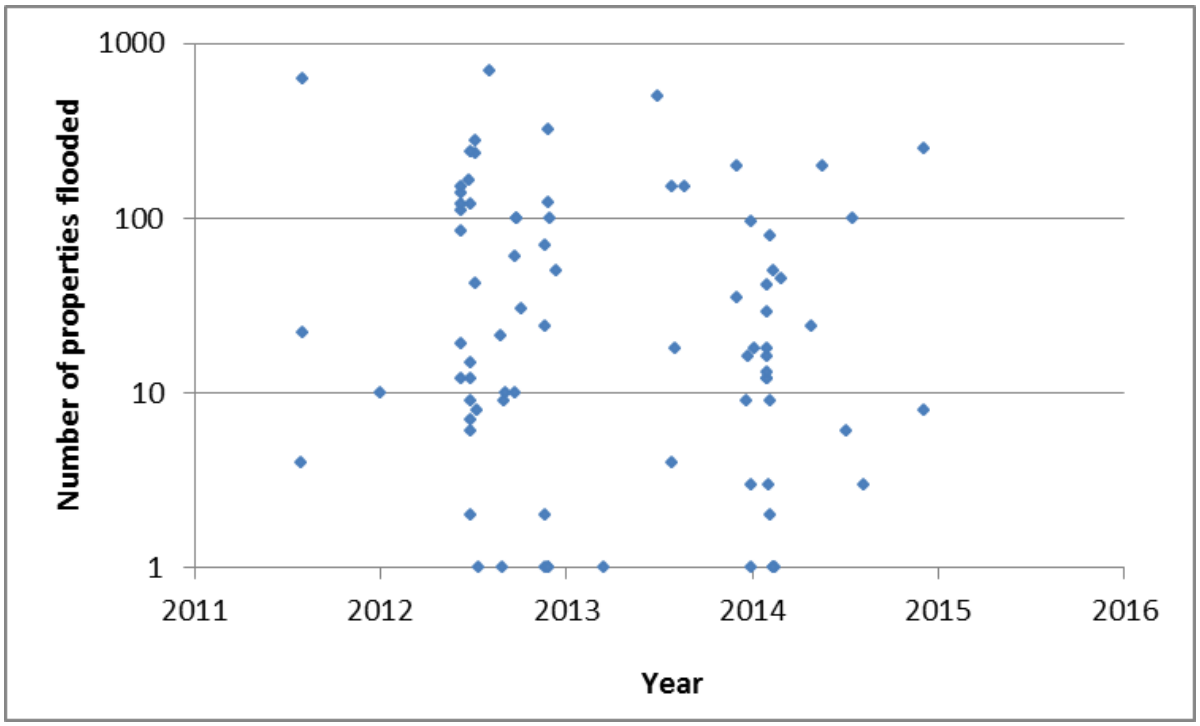

Figure 4.3 Properties flooding by date

4.2.3. Cause of flooding by category

As previously stated, although this study is primarily associated with pluvial flooding, there are many events where more than one source of flooding takes place. In addition the flooding which is strictly fluvial or coastal actually often has a component which is related to surface water management. Two examples of flood management requirements for these flooding categories are illustrated below, both of which are based on the Section 19 reports which have been reviewed.

Figure 4.4 summarises the causes of failure. In principle there are only three main categories:

1. Under-capacity of the conveyance system (river, pipe, ditch etc.);
2. Blockage of the conveyance system (pipe blockage, or screen blinding);
3. Failure of structure or control system (canal breach, pumping station, non-return valve, structural collapse of a pipe etc.).

Two illustrations of the overlap between surface water management for fluvial and coastal flooding

A coastal area suffered from severe overtopping of flood defences, flooding approximately 200 properties. There was a temporary storage area designed for a certain volume of overtopping sea water, but this filled up very quickly. When this storage area was exceeded the intention was to flood a golf course rather than flood properties. Unfortunately the golf course boundary was a robust chainlink fence which completely blinded (vegetation in the flood water matted across the fence due to the water trying to pass through it), but did not fail under the hydraulic load, therefore preventing the passage of flood water draining to the golf course.

A study in Wales came to the conclusion that around 60% of all fluvial flooding was associated with blinding of culvert screens. In many instances the flooding that results passes through urban areas before rejoining the watercourse downstream. Mitigation of such risks need to consider flood routing and other drainage measures, or flood protection mechanisms.

Unfortunately under-capacity effectively covers a host of issues. These include under-sized units, throttles caused by pipe size reduction, sediment deposition, vegetation growth and so on. Included in this is the presumption that rural runoff has not been managed effectively where it causes flooding. Capacity may also be an issue where it was not previously due to development within the catchment creating additional and quicker runoff. In general this later aspect has not been drawn out in the Section 19 reports although there are one or two instances when this was clearly the issue.

Similarly blockage refers to some sediment deposition, excessive tree route intrusion through to debris blinding the gratings of gullies. Where both aspects apply, under-sizing and partial blockage, the term blockage has been used as being the descriptor. Although there is a reasonable amount of blockage reported, it is likely that this is under-represented.

It should be noted that there are two main categories of blockage; there are those instances where an existing condition creates or exacerbates the flooding which takes place, and then there are those cases where a blockage is created by the event resulting in flooding. These situations generally include all instances of screen blinding and many instances of highway flooding due to gully gratings being blinded by leaf litter.

There are some cases where rural runoff has generated a lot of sediment and this has been sufficient to block the drainage system during the event. A comment has been suggested that soil husbandry and agricultural practices may have contributed to these situations. It is quite possible that many of these types of events took place when the soil in the catchment was at risk of high volumes of washoff. Whether a change in practice would result in a significant reduction of such events with high sediment washoff taking place would require more detailed assessment of both rainfall characteristics for an area and farming practices.

Finally there are a number of instances where failure of the drainage network has taken place. There are one or two instances of reverse flow problems being reported due to flap valves not operating correctly, a culvert collapsing during an extreme event, and several pumping station failures. These pump station failures can result from limitations due to other parts of the system and not because they are at fault themselves. For instance a highway drainage system was partially blocked leading to the overflow from a foul pumping station not relieving the water level which resulted in the pump tripping out. In other instances, power to the pumping station failed briefly due to electrical failure from lightning strikes. However, in general, failures were not a significant cause of flooding, and where they occurred, and the number of properties affected tended to be small.

It can be seen from Figure 4.4 that there are multiple causes of flooding in many events. In practice the categorising of sources of flooding into categories sub-divided by ownership is not useful from a simple technical stand-point. Rivers need not be subdivided in terms of their behaviour and similarly there is little difference between highways and surface water sewerage serving roads. It can be seen that urban drainage systems (whether highways or sewers) are the dominant cause of flooding, though this is perhaps unsurprising. However, the high proportion of rural runoff causing flooding is perhaps more surprising and this is reflected in comments in the conclusions and matters needing consideration.

Foul sewerage tends to be a problem when it is a combined sewer due to excessive rainfall runoff. In locations where unusually high groundwater prevail, foul sewers tend to suffer from surcharge and flooding, indicating that the structural condition of these networks allow large volumes of groundwater to enter the pipework.

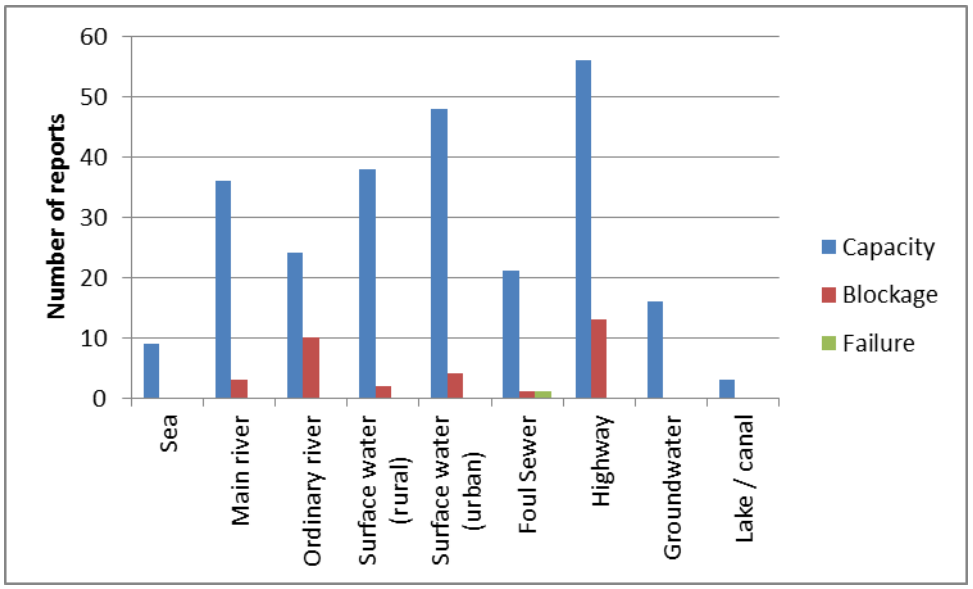

Figure 4.4 Causes of failure

4.3. Section 19 reports – their reporting effectiveness on the causes of flooding

This is a brief discussion of the effectiveness of the reports in terms of their assessment of the causes of flooding.

Section 19 reports vary in style from one line on a spreadsheet style table through to 100 page regional compilation of flooding for a group of locations and several rainfall events. (in the case of the spreadsheet summaries it is possible these are supported by reports within the LLFA which were not available in the public domain). In most cases reports are usually between 10 and 25 pages reporting on one rainfall event and the localities in an urban area suffering from flooding associated with it.

There are several reports which do not state that they are Section 19 reports. Either they are very brief summaries of the flood events listed in spreadsheet format, or they are more extensive studies which go into greater analysis detail and often produce recommended solutions.

Most reports are written by the LLFAs, but not exclusively so. In some authorities it would appear that a standing arrangement has been agreed for a consultant to produce these reports.

Although an assessment of the reporting effectiveness has been carried out, this does not necessarily lead to the conclusion of making a recommendation prescribing what must be in such reports and how they should be structured. What can be stated is that the report must focus on catchment specific topographic and drainage information supported by hydrological and hydrogeological information. It is also suggested that it would help if reports generally focused on each event individually and its impact at each location.

Although some reports provide an overview of a regional flood incident which affected many locations these still need to consider the situation that occurred in each locality where problems were found. In these cases there was a tendency to summarise the key flooding characteristics without sufficient attention to the flood causes to inform all stakeholders about the issues in sufficient detail for the next stage of addressing the problems. It is also worth noting in this regard that rainfall events can vary greatly over a catchment even if it is considered to be the same event. This variability is linked to the type of meteorological condition that occurred.

It was apparent that some reports made definitive claims as to the number of properties that were flooded while others alluded to the issue that not all properties reported their flooding (for a number of reasons) and that the number of properties that were flooded internally were likely to be somewhat greater in number than that reported. In one or two instances surveys were carried out to establish this information with more certainty. Clearly knowing the correct number of houses is not critical for deriving solutions, but it is important to know where flooding took place to ensure the solution is appropriate in addressing the problems.

4.3.1. Hydrological and hydraulic analysis

The authors of the reports tend to be from the relevant LLFA though around 10 percent of documents are produced by consultants.

In general the understanding of hydraulics and the interpretation of the causes of flooding and level of detail is adequate in the majority of cases. The degree of field investigation clearly correlates with the level of detail and certainty associated with establishing the causes of the flooding and its impact. In nearly all cases modelling is not used to evaluate or confirm their conclusions, but it is likely that this is probably carried out in the next stage of these incidents, when solutions are being considered. Although it is accepted that modelling may be the next stage of analysis for these incidents, it is important to recognise that in situations where the flooding is complex or the causes are unclear, modelling can provide valuable insights.

In many cases there is a good understanding of hydrology and its relationship with runoff. In many cases the services of the Met Office are used to provide statistical information on the rainfall event. However, in a few instances it is clear that there is some confusion over the difference in terms such as intensity and rainfall depth, and insufficient resolution is given on rainfall events (hourly rather than daily information). Although many reports use the Met Office services on rainfall, including radar information, and in some instances there is an awareness that antecedent wet conditions has led to the runoff being exacerbated, there is no attempt at assessing the severity of the runoff. This is unsurprising as it requires information on the previous weeks of rainfall along with the services of a hydrologist to assess this information. Although it might be considered to be irrelevant to put a frequency to the flood event, it is this information that is needed if the level of service of the supporting infrastructure is to be judged for its adequacy in serving the catchment. This will lead on to influencing what solutions are proposed to address the

problems. Most of the summer flood events in 2012 were a much greater return period than the rainfall which caused the flooding.

The solution to addressing this issue of the return period of runoff is not clear, but there is potential for providing guidance on calculations or even look-up tables based on historical analysis to give some support in this area.

Also it is important to recognise that a flooding incident is often a compound of events. For instance the high level of rainfall between mid-December 2013 and mid-February 2014 is an extremely rare wet period. This resulted in high groundwater levels as a result. Individual rainfall events that took place during this period were not particularly extreme of themselves, but in conjunction with the high groundwater levels and high depths of flow in rivers through this period, these events sometimes caused significant flooding in terms of surface water runoff as a result. Therefore not only is the concept of runoff return period important to understand, it is also important to recognise that different durations of rainfall have different return periods and have different impacts on different categories of drainage system.

4.3.2. Catchment plans, flood routes and flooding locations

A reasonable proportion of reports provide plans of the contributing catchments, locations of flooding and supporting maps from the Environment Agency of both the flood plain mapping and surface water flood maps. These are very much more effective reports than those which do not provide this information.

In particular it is interesting to note that in many instances the surface water flood maps corroborated the incident, or perhaps one should say the reverse; the incident confirmed the mapping. This implies that pre-emptive studies might be useful in catchments where surface flooding is predicted to pre-empt a flooding incident at that location. Perhaps this finding adds weight to the value of these maps and therefore their importance in being both accurate and publically available. As these are based on a number of relatively simple modelling assumptions in their production, the flooding shown is unlikely to be accurate in all instances, but this assessment indicates that they are a useful data set for the assessment of local flood risk.

4.3.3. Investigations for confirmation of the causes of flooding

Reports fall into two categories on this topic; those that are written shortly after the incident which collate the evidence from visual inspection and feedback from those affected, and then there are those which are written some time after investigations have also been made on the relevant drainage systems in the flooding areas. In the case of the latter, it is notable that there are many cases where blockage has been a contributing factor to the flooding problem. It is not always clear whether the problem pre-existed the flooding incident, but in most cases it would appear to be so.

This does not mean that those reports which have not yet made a survey of the drainage systems will not do so, but it does provide a greater understanding of the causes of flooding and indicate the way forwards for solution development more effectively. In many instances a drainage system was found to be in normal working order and the flooding was due to the unusual amount of flood flow taking place during the event.

The Tables in Appendix 3 summarise the information in the reports with regards to the causes of flooding and the degree of certainty that can be given to the conclusions of the causes of flooding. This degree of certainty assessment is linked to two aspects; firstly the complexity of the flooding incident, and secondly on the degree of detail in the reporting and the investigations that appeared to have been carried out. This assessment must be regarded as being very subjective and should not be treated as a significant evaluation output of this assessment. In practice an evaluation of the accuracy of the assessment can only be made by carrying out a second study of incident to confirm the conclusions.

4.3.4. Topography

Topography is a key aspect with regards to flooding. There are effectively three types of situations:

1. Flat sites such as Canvey island or floodplains by rivers;
2. Locally flat sites or low points within catchments which suffer from local flooding;
3. Sites in the flow path of catchments with gradients , often quite steep.

Each of these categories are represented by the reports. Flat sites and locally flat areas and low spots can have extensive ponding and large numbers of properties can be affected by flooding. A key mechanism of the flooding in a few instances is the downstream control which is often associated with backwater effects from high river levels or throttle drainage systems. Drainage systems in these situations are often in poor condition from sediment deposition over many years due to the low velocities in the pipework serving these locations.

Catchments with significant gradients often have flows with high velocities which can cause significant damage. Often flows come from rural or other catchment areas, often channelled by the roads, conveying debris and sometimes high levels of sediment. Flooding is commonly associated with the event due to debris blinding culverts, and filling pipes and gullies with sediment or covering gullies with debris. However, the numbers of properties damaged due to this form of pluvial runoff tends to be limited due to the flooding pathway being well defined by the topography.

In both cases solutions are fairly intractable as flat areas require large scale investment to achieve significant downstream conveyance capability especially if river levels or the sea is the control. For steeper sites the nature of the flooding flow path means that the flood route is often well defined, but an alternative or enhanced provision for flows to bypass the

endangered properties is often difficult to implement due to existing development constraints.

4.4. Key findings on the causes of flooding

A number of findings have been arrived at from reading of the reports and the most important ones are:

- Level of detail of the Section 19 reports;
- Hydrological analysis of the event;
- Assessing the flood risks to existing drainage systems;
- Joint probability of pluvial and fluvial flooding;
- Coastal and fluvial flooding.

The first two points have been covered in the previous section on reporting effectiveness. The other three points are covered in this section.

4.4.1. Assessing the flood risks to existing drainage systems

This topic area has been touched on already. However, there are key lessons that need to be drawn from these reports. Road drainage and urban sewers, although designed explicitly to serve paved surface and roof runoff, will in many instances, receive additional flows from upstream areas for three different reasons. These are:

1. Extreme events which cannot be served by the drainage system upstream (either due to the size of the event or the limited capacity of the system) will provide much greater inflows than expected. In some locations the consequence of such an occurrence might warrant specific provision for this.
2. Green areas (fields / hillsides) are rarely considered as contributing catchments to road drainage or urban sewers. However, there have been numerous instances where the drainage system has been overwhelmed in this situation. It is very evident that all areas uphill of a drainage system must be considered for its potential for runoff for all types of weather conditions that might take place.
3. Whether in an urban context or rural one, for both extreme conditions and more frequent events, there is clearly a reasonable risk that there might be a blockage in either the systems upstream or in the locality of the drainage point of interest, that could cause flooding. Flat areas suffer from sedimentation effects over time and steep areas can receive large volumes of material during intense events.

One further major lesson on risk has been gained. Blinding of screens to protect against man-entry into culverts is recognised as a major cause of flooding. Unfortunately the

greater the flood event the greater is the need for culverts to work efficiently, but the less likely they are to do so. It is unfortunate that some of the biggest and most intense rainfall is associated with late summer and autumn which is when there is the highest risk of debris being washed into watercourses. Current guidance on the design of screens recognises the risks and tries to address this in good design practice. However, passive systems (screens which are unattended or with no automated mechanical racking mechanism) are always going to have a high risk of causing extensive flooding where high flows occur.

The solution to screen blinding requires radical consideration to make a measurable improvement in reducing flood risk, but if an effective solution can be found it will significantly reduce flood damage. Possible solutions might include remotely activated gates and the use of real time sensor information.

4.4.2. Joint probability of pluvial and fluvial flooding

An important issue which became apparent from the study is that high intensity rainfall cells in summer often were embedded in longer periods of rainfall. Many incidents had situations where river flows were high while surface water flooding was also taking place. In some instances the surface water drainage system could not perform effectively as river levels were high and discharge from the surface water system was not possible or severely constrained. This is particularly an issue to rapid response catchments especially where the town is located in a relatively flat location at the foot of hills. Other critical conditions include rivers which are known to operate at a high level during a flood and remain high for hours or days. Surface water drainage design needs to consider all these situations.

The implication of this is that the general assumption of free discharge from any system into a receiving system (not just surface water drainage into a watercourse) must not be assumed to necessarily apply. This is an area which is currently highly deficient in standard practice. Experts in drainage know that this is an issue, but it has yet to have an impact on normal design procedures. This is particularly important now that Sustainable Drainage Systems (SuDS) principles are generally recognised as being good practice which results in drainage systems providing more storage and attenuation of runoff. These storage elements are often at low points in the drainage system and they usually have critical durations in the order of 12 hours or longer. In these situations the water levels of receiving waters will often be high at the same time as these drainage systems are discharging runoff into them which means that it will be important to check to see whether the water levels are causing any constraint to discharges from the drainage storage elements.

The mechanism for ensuring awareness of this issue and a change in practice is achieved requires this information to be included in the British Standards, Codes of practice such as those issued by Chartered Institution of Water and Environmental Management (CIWEM) and in the SuDS Manual.

4.4.3. Coastal and fluvial flooding

Coastal and fluvial flooding are seen as being different events to pluvial events and seem to be treated as being independent of surface water drainage issues. In practice once water comes out of bank (whether due to screen blinding, overtopping, failure or other reason) it then often becomes an issue of surface water management. It is considered that this dislocation and categorisation of types of flooding is not helpful in ensuring integrated drainage design.

5. Conclusions

A number of conclusions can be made from the assessment of these reports. A brief summary of the main conclusions of this study are listed here.

1. The threshold for Section 19 reports varies a little between authorities, and most report what the threshold they apply is. The threshold level has been left to the LLFAs to set. Although this means that there is not a consistent threshold applied across the country, this does allow consideration of local characteristics (level of urbanisation and so on) to be taken into account. Thresholds have been set based on internal flooding of a number of properties as well as road closures, and sometimes external flooding of properties is also a criterion.

2. Having a threshold which can be changed rather than being a function of legislation is good as it allows flexibility for the LLFAs to modify their criteria in the light of experience in carrying out their Section 19 duties.

3. Reports range from one page up to over 100 pages. The most effective ones tend to be around 25 pages which are concise and focus on reporting the specific event, the hydrological aspects, the drainage systems behaviour and causes of flooding. These are supported with a significant amount of mapping showing flooding locations and flooding flow paths. These are often supported with plans from the Environment Agency websites for surface water and fluvial flood maps.

4. In general there is a reasonable understanding of what the causes of flooding are. Most reports address a specific rainfall incident and the local consequences in detail. Many of the reports have been written after carrying out flood investigations to check on the state of the pipework and other drainage elements. There is less certainty over the accuracy for those that do not carry out field investigations, but in many instances the causes are still relatively obvious. In either case the on-going work following the S19 report should establish what the problems are in order to develop appropriate solutions.

5. The concept of Section 19 reports is very important as it is a point of reference that all stakeholders can look to for detailed flooding information. In due course they will also provide a valuable archive of information on flood risk across the area and any actions that resulted.

6. Most Section 19 reports have a fairly similar structure, but a few reports are more regional in their approach and, in some cases, do not have “Section 19” referenced in the report title. These reports are often due to a hydrological situation which causes flooding over an extended period of days or weeks across a LLFA region. It may also reflect a widespread event across the region where there are multiple events in a day or several days. Although these reports are often broken down into locations, their focus is more for providing an overview and rather less detail is provided regarding the specifics of each flooding incident. It would therefore be useful to ensure that Section 19 reports are specifically referenced as such and aimed at providing information for each incident.

7. There is often a need for the S19 reports to strengthen the analysis of the hydrological analysis, particularly in providing hourly information and assessments of the severity of the event. In many instances return period of the rainfall event is not calculated. In no case was a formal assessment made of the runoff frequency even though some reports highlighted that the antecedent conditions had exacerbated the flood response from the catchment. As failure of drainage systems and the mechanisms of failure should be examined in the context of the severity of the event and solutions will take this aspect into account, it is important that this information is provided.

8. Rainfall is often reported at an adequate resolution hours (even minutes for cloudbursts), but sometimes it is only given in daily depth values. For a high intensity short duration storm, or even a long event which has high intensity cells nested within it, daily data is insufficient to be able to determine the severity of the event. It is recognised that this information is not always available locally from a raingauge, but with radar data now generally available, most locations should be able to report on sub-daily information.

9. Unsurprisingly highway drainage failures are the most commonplace flooding cause. Failure mechanisms of highway drainage are diverse. Gully gratings are often reported to be covered with debris, particularly during very intense rainfall and the environment often naturally provides a source of material such as twigs and leaves. Alternatively, gullies can be blocked with sediment, or the pipework they drain into are either overloaded or partially blocked. These blockages may or may not be as a result of the incident taking place at the time. However, there are some reports that suggest gully problems when this may not in fact be the case. Water can come out from a gully rather than enter it due to hydraulic conditions of the drainage system they serve and this may be mistaken as being a blockage.

10. Many instances of flooding appear to be associated with partial blockage of drainage systems. Similarly for rivers, screen blinding due to rapid accretion of debris occurs, and even well managed rivers often suffer from this problem. In many cases the flooding is an issue of riparian responsibility whether it is pipe blockage or stream management. In some instances the flooding is repeated a

number of times which suggests that either the management is not appropriate or that the location is very susceptible to problems.

11. Many instances are reported of rural flooding where there is limited provision for drainage from rural runoff. In these cases flooding often passes to roads while the road drainage is only sized to serve the road itself.

12. In steeper catchments flood flow routes tend to be down roads which then flood properties when they are located in the flood flow path. The concept of overland flooding from uphill areas and exceedence flow (excess runoff not catered for a drainage system) routing is an aspect which should be a standard procedure for any drainage assessment or design. This concept of exceedence is known to be best practice, but the industry is yet to widely apply it in carrying out drainage analysis.

13. The concept of checking for the impact of drainage system failure at any point in the drainage system (or water main burst and the associated flood risk) should become standard practice for assessing the potential flooding impact on the catchment. Current best practice only looks at the performance of systems assuming that they are operating correctly (Designing for exceedence in urban drainage – good practice, CIRIA 2006). Although this is not standard practice yet, it is an aspect which has been promoted recently for risk based analysis of drainage systems (Dti SAM - Developing a risk-based approach to urban flood analysis). This is an essential aspect of achieving flood resilience in urban areas.

14. Although fluvial flooding is not considered to be part of this brief of assessing the Section 19 reports for pluvial flooding, there are two reasons why fluvial flooding has been included in this report. These are:

    a. In many instances flooding associated with the river is associated with screen blinding, which often takes place in late summer or autumn storms, though it can happen at any time of the year. As these are often located at culvert entrances in urban areas, blinding of screens can result in overland flow passing through streets. A surface water management drainage strategy for addressing this risk needs to be considered as part of a general drainage strategy where screens exist.

    b. Fluvial flooding can take place as part of an event which also causes surface water flooding. In many instances the stream's capacity is reduced due to vegetation growth in it, or the structures such as bridges and culverts increase water levels such that water comes out of bank, and the flooding can be classified as fluvial. However, in many instances elevated water levels in the river (whether out of bank or otherwise), can prevent the effective operation of drainage systems from draining into them when severe rainfall is taking place on the catchment and this might be considered to be pluvial flooding.

15. The assessment of the Section 19 reports have shown that fluvial and coastal flooding have relevance under the obligations of the FWMA Section 19 obligations for local authorities, as the mitigation of such incidents are often associated with local surface water drainage solutions even if the primary defence system is not the responsibility of the LLFA.

16. Designing for free discharge at outfalls is an assumption which is general practice, whether it is a gully into a receiving pipe, or highway drain or sewer draining into a watercourse. (In tidal areas where sea levels affect an outfall this issue of joint probability / downstream hydraulic influence is addressed). The inappropriateness of this assumption is highlighted by these reports where there are numerous instances of outfalls from drainage systems being constrained by water levels in downstream receiving systems or rivers. The concept of designing drainage using joint probability has been around for a few years, but in practice there are few engineers who either understand or design for this situation.

6. Reflections on the S19 reports review and aspects to consider in the context of current drainage practice

Reviewing a large number of reports on flooding and their causes makes a drainage practitioner aware of the current limitations of current procedures that are normally applied. This section draws attention to areas where there are issues that the industry should try and address. This chapter addresses some wider issues than Section 19 reporting requirements, and relate to technical aspects of drainage analysis.

1. The concept of Section 19 reports is a very good idea in providing a lead for investigating local flooding, particularly in UK where responsibilities for various parts of the drainage infrastructure has been divided up so much. Having these reports “badged” as being a Section 19 report will help provide an archive of useful reference material for local flooding. In time these are likely to evolve to a structure which covers all relevant details in a consistent manner; addressing all the hydrological and hydraulic aspects of a flood incident. This ensures a holistic approach is taken in the analysis of flooding problems and development of appropriate integrated solutions between all stakeholders.

2. The blinding of culverts screens is clearly a major cause of flooding and a very intractable problem as these screens are needed for public safety. As watercourses convey large flows, flooding can often result in significant levels of damage. Blinding rates are usually so quick during a rainfall event that current approaches of scheduled screen cleaning is not sufficient and alternative solutions which do not require manual intervention need to be developed. Modern screen design does mitigate the risk, but they can only be seen as reducing the potential problem of causing a serious hydraulic constraint. This is clearly an area where modern

sensors and communications technology could be used to develop new approaches.

3. Gully gratings, like screens in watercourses, are similarly regularly blinded in environments where debris can be expected (particularity in leafy environments). Risk based assessments could be applied to all road drainage to take this issue into account. A generic solution for this problem is difficult as producing alternative solutions to the use of gullies is not feasible in most developed situations. Solutions therefore would need to focus on flood flow paths and impact assessments due to blinding of gratings or the use of more or larger gullies. The use of alternative drainage methods such as swales will grow in areas of new development in line with greater use of SuDS, but constraints in existing urban areas will usually preclude a solution which avoids the continued use of gullies.

4. The concept of exceedence is now a standard element of drainage analysis. However, it tends to be applied in a limited fashion to development drainage design and the implication of a larger event taking place and its subsequent performance. The concept of exceedence should actually be applied to wider area to check where flood flows might be generated by higher ground and cause flood damage, as well as for making risk assessments of blockages in drainage systems or other forms of failure (pumping stations etc.). This will help avoid the many instances where road drainage is designed only for the road runoff, but in practice it receives flows from far further afield during extreme events. This point is supported by the many instances where flooding at a location had been predicted by overland flow by the Environment Agency surface water flood maps.

5. The assumption that drainage systems drain with a free discharge through outfalls needs to be changed. Appropriate guidance could be developed to assist drainage engineers in this aspect for the design and analysis for all types of drainage systems. This will lead to a much greater understanding of inter-dependency between systems to achieve an integrated drainage approach.

6. Similarly there is limited support for the drainage engineer in being able to evaluate the return period of runoff (and not just the rainfall event). This is an essential aspect of producing solutions as the level of service provided is not a function of the rainfall return period even though this is the normal assumption that is made.

7. The capacity of rivers being “inadequate” as considered in this report, can either be considered as needing to increase the conveyance capacity, or a need to reduce the runoff rate into them. The latter option is too often ignored, though it is now recognised that just increasing the conveyance capacity of a system is both expensive and not usually appropriate. This report is not focused at fluvial runoff, but it should be noted that before it enters a fluvial system, much of the runoff will have been pluvial. It is therefore important to recognise that solutions to local flooding problems should take into account hydraulic limitations that might exist further downstream.

Appendix 1 – List of Lead Local Flood Authorities

LLFA - England	LLFA - England	LLFA - England	LLFA - Wales
Barking & Dagenham	Hampshire	Rochdale	Blaenau Gwent
Barnet	Haringey	Rotherham	Bridgend
Barnsley	Harrow	Rutland UA	Carmarthenshire
Bath & N E Somerset UA	Hartlepool UA	Salford	Cardiff
Bedford	Havering	Sandwell	Ceredigion
Bexley	Herefordshire UA	Scilly	Conwy
Birmingham	Hertfordshire	Sefton	Caerphilly
Blackburn with Darwen UA	Hillingdon	Sheffield	Denbighshire
Blackpool UA	Hounslow	Shropshire	Flintshire
Bolton	Isle of Wight	Slough UA	Gwynedd
Bournemouth UA	Islington	Solihull	Isle of Anglesey
Bracknell Forest UA	Kensington & Chelsea	Somerset	Merthyr Tydfil
Bradford	Kent	South Gloucestershire UA	Monmouthshire
Brent	Kingston upon Hull	South Tyneside	Neath-Port Talbot
Brighton & Hove UA	Kingston upon Thames	Southampton UA	Newport
Bristol UA	Kirklees	Southend on Sea UA	Pembrokeshire
Bromley	Knowsley	Southwark	Powys
Buckinghamshire	Lambeth	St Helens	Rhondda Cynon Taff
Bury	Lancashire	Staffordshire	Swansea
Calderdale	Leeds	Stockport	Torfaen
Cambridgeshire	Leicester City UA	Stockton on Tees UA	Vale of Glamorgan
Camden	Leicestershire	Stoke on Trent UA	Wrexham
Central Bedfordshire UA	Lewisham	Suffolk	
Cheshire East UA	Lincolnshire	Sunderland	
Cheshire West & Chester UA	Liverpool	Surrey	
City of Nottingham UA	Luton UA	Sutton	
Cornwall	Manchester	Swindon UA	
Coventry	The Medway Towns UA	Tameside	
Croydon	Merton	Telford & the Wrekin UA	
Cumbria	Middlesbrough UA	Thurrock UA	
Darlington UA	Milton Keynes UA	Torbay UA	
Derby City UA	Newcastle upon Tyne	Tower Hamlets	
Derbyshire	Newham	Trafford	
Devon	Norfolk	Wakefield	
Doncaster	North East Lincolnshire UA	Walsall	
Dorset	North Lincolnshire UA	Waltham Forest	
Dudley	North Somerset UA	Wandsworth	
Durham	North Tyneside	Warrington UA	
Ealing	North Yorkshire	Warwickshire	
East Riding of Yorkshire UA	Northamptonshire	West Berkshire UA	
East Sussex	Northumberland	West Sussex	
Enfield	Oldham	Westminster	
Essex	Oxfordshire	Wigan	
Gateshead	Peterborough UA	Wiltshire	
Gloucestershire	Plymouth UA	Windsor & Maidenhead UA	
Greenwich	Reading UA	Wirral	
Hackney	Redbridge	Wokingham UA	
Halton UA	Redcar & Cleveland UA	Wolverhampton	
Hammersmith & Fulham	Richmond upon Thames	Worcestershire	
		York UA	

Appendix 2 – Section 19 report reviews

Table 1: Report Title: Canvey Island, Castle Point Borough: Essex County Council

Item	Comment
Flood event	20th July 2014, Canvey Island
Report	- 1/8/2014: 1st Draft - 4/10/2014 Final - Author: Essex County Council
Authors	Anglian Water, Castle Point borough Council, Environment Agency, Essex Civil Protection and Emergency Management, Essex Fire and Rescue, Essex Highways, Essex Police
Topography	- Flat
Land Use	- High density, largely residential areas
Flood severity	- Severe and widespread, - Unknown number of properties
Flood sources	- Overland flooding
Flood causes	- Drainage system stated as being under capacity, but even if it wasn't flooding would still have occurred for this event - No details of flooding evaluation at specific locations and causes such as screens, performance of water courses and pumps - Blockages of gullies reported - Maintenance of the drainage system (lack of) not deemed to be a cause - Downstream pumps not considered to be a constraint - Temporary power failure at 8 pumping stations (15 minutes) due to lightning strike, and other short term pump failures occurred.
Rainfall	- Extreme event, - 4hr 20min event, 100mm depth (radar) - Max intensity 1 hour: 80mm/hr (radar), 56mm/hr nearest raingauge - Possible confusion over depth and intensity - Return period : 1:316 years
Modelling	None
Unknowns	No details of drainage and other systems which were overwhelmed
Historic flooding 1	24 / 08 / 2013, large event, Unspecified
Historic flooding 2	No dates, smaller events, Unspecified
Reviewer Comment	1) Such an event will always cause flood damage. Although Canvey is flat and flooding was widespread, it is possible that on a steep catchment the effects would have been worse with greater flood

	depths and high flow velocities. 2) The catchment is prone to sedimentation due to lack of falls 3) Although blockages of gullies are reported, the public are not generally familiar with hydraulics and water not entering or even coming out of gullies can occur during surcharge and flooding of drainage systems. 4) Unclear whether the 1 hour information is depth or max intensity some time in that 1 hour period. 5) Essex Highways had spent £1M on addressing Highway flooding by jetting and CCTV, so blockage would have been at its lowest influence for some years 6) Although the temporary failures of pumps were managed well, and that pumps were not deemed to be a cause of flooding, it highlights the reliance and risks associated with pumping during extreme events (such as the Hull flood of 2008?).

Table 2: Report title and authority: Silver Street, Chacombe. Northamptonshire County Council

Item	Comment
Flood event	16th March 2013, Silver Street in Chacombe
Report	3rd July 2013, Northamptonshire County Council
Authors	Report by David Smith Associates
Topography	Rolling landscape
Land Use	Road gradient with flooding at low point, Residential
Flood severity	Internal flooding of 1 property
Flood sources	Overland flooding
Flood causes	Highway drainage capacity
Rainfall	Approximately 20mm on the day, No detailed duration information
Modelling	None
Unknowns	Lack of rainfall information and analysis
Historic flooding	Numerous instances since 2011
Reviewer Comments	1) Property has been flooded several times in the last 5 years with even moderate rainfall 2) Mechanism of failure is clear 3) Highway drainage is insufficient and is possibly non-existent to serve this location 4) Level of service is inadequate 5) Overland flow path is unavailable to avoid flooding of this property 6) Flooding probably entirely related to hard surface runoff, though rural area is mentioned as a possible contribution also.

Table 3: Report title and authority: Cwmbran. Torfaen County Borough Council

Item	Comment
Flood event	22nd May 2014, Cwmbran
Report	9th October 2014, Torfaen County Borough Council
Authors	Participating authorship not stated
Topography	Steep topography
Land Use	Residential and other areas
Flood severity	Extensive damage, 198
Flood sources	Dowlais Brook and surface flooding
Flood causes	Lack of capacity of Brook and other culverts Screens blinded Lack of capacity of drainage systems
Rainfall	78mm/hr in 25 minutes (33mm), Return period > 100yrs
Modelling	None
Unknowns	Areas of uncertainty and lack of clarity
Historic flooding	Several in last 30 years Severe flooding in 1986 with limited nr. Of properties flooding
Reviewer Comments	1) Severe cloudburst event 2) Lack of clarity on rainfall depth & intensity 3) 108 properties flooding associated with Brook capacity and screen blinding 4) 26 properties due to public sewerage system 5) 64 properties due to overland flow / highway runoff 6) 9 culverts owned by the local authority, 1 by network rail and 1 private. 7) Culvert screens (massive blinding) will always fail in these types of incidences 8) The detailed analysis suggests

Table 4: Report title and authority: Braunton flood incident. Devon County Council

Item	Comment
Flood event	29th July 2011, Braunton
Report	20th September 2011, Devon County Council
Authors	Devon County Council
Topography	Steep
Land Use	Commercial
Flood severity	Medium, 4+ commercial properties
Flood sources	Excessive surface water from the urban area Highway drainage
Flood causes	Blocked drains reported
Rainfall	40mm in 2hrs,
Modelling	No
Unknowns	Areas of uncertainty and lack of clarity
Historic flooding	1979 Main River Caen, Many properties 18/12/2004 Main river Caen with blocked culvert, 45 mainly commercial properties
Reviewer Comments	1) Coastal Floodplain location means downstream (tidal) influenced flooding, with steep hillside delivery of runoff 2) Flashy river response 3) Responsibility sharing allocated (in report) as 20% EA – main river, and 80% from local authority Highways 4) However suspicion that backwater from river may have been major reason for flooding and responsibility proportion is more towards EA. 5) Reference to blocked drains may be incorrect – backwater effects probably

Table 5: Report title and authority: Chew Magna FIR 2011 – 2012. Bath & North East Somerset Council

Item	Comment
Flood event	24th September & 21 – 25th November 2012, Chew Magna
Report	30th August 2013, Bath & North East Somerset Council
Authors	JBA
Topography	Steep
Land Use	Residential
Flood severity	Extensive damage, At least 35 properties and up to 60 possibly
Flood sources	Primarily Fluvial, Rural surface runoff and some groundwater
Flood causes	River capacity Backwater effects from river likely through drainage system Perhaps surface water drainage capacity
Rainfall	69mm in 24 hours, 1:18 yr, (Sept) 13mm in 1hr
Modelling	No
Unknowns	None
Historic flooding	Devastating flood July 1968 8 floods between 1960 and 2004
Reviewer Comments	1) Saturated land from summer 2012 rainfall 2) Approximately 1:100 year runoff 3) Contributing flows from spills from reservoir 4) Primarily fluvial event Main rivers (Winford Brook and River Chew), but some flooding associated with groundwater and rural surface runoff 5) Also tributary (ordinary) water courses caused flooding with grill blocking

Table 6: Report title and authority: Broadmead lane industrial estate FIR Winter 2013 / 2014. Bath & North East Somerset Council

Item	Comment
Flood event	24th December 2013 – 5th January 2014, Keynsham
Report	5th June 2014, Bath & North East Somerset Council
Authors	Bath & North East Somerset Council
Topography	Flat, Floodplain
Land Use	Industrial site
Flood severity	16 industrial units, 1 residence Damage severity unknown
Flood sources	River Avon
Flood causes	Unprotected floodplain
Rainfall	Extended period of high rainfall
Modelling	No
Unknowns	No information on rainfall or runoff frequency analysis
Historic flooding	Many instances of flooding
Reviewer Comments	1) Fluvial flooding 2) Severity of the event is unknown 3) Severity of the incident is unknown

Table 7: Report title and authority: Hedgehope Avenue, Rayleigh Rochford. Essex County Council

Item	Comment
Flood event	3rd January 2012, Rochford
Report	2nd April 2012, Essex County Council
Authors	Essex County Council
Topography	Not stated, gentle gradient
Land Use	Residential, with cemetery with wooded perimeter at top of catchment
Flood severity	several properties
Flood sources	Small stream (ordinary watercourse)
Flood causes	Blinded screen, minimal maintenance
Rainfall	9mm in 2 hrs, 1:1 yr event
Modelling	Confirmation of causes / solutions
Unknowns	Number of houses unknown
Historic flooding	Regular flooding at this location
Reviewer Comments	1) Open section of culverted ordinary water course with trash screen which blocked 2) Very small catchment with cemetery with wooded perimeter at the top 3) No maintenance by riparian owner 4) Debris provided from cemetery 5) Small event but unclear whether a short period of higher intensity occurred 6) Note in winter – lots of twigs and leaf debris from autumn drop and autumn gales 7) Catchment wet (antecedent rainfall) and gauge fairly local

Table 8: Report title and authority: Sandygate and Luton FIR. Devon County Council

Item	Comment
Flood event	5th August 2012, Sandygate and Luton
Report	19th December 2012, Devon County Council
Authors	Devon County Council
Topography	Steep
Land Use	Rural
Flood severity	10 properties + several outbuildings
Flood sources	Un-named ordinary watercourse Highway runoff
Flood causes	Several culvert capacities Highway drainage
Rainfall	42mm in 1 day, Return period unknown,
Modelling	No
Unknowns	Rainfall information insufficient detail
Historic flooding	August 2008, 1 property in Sandygate
Reviewer Comments	1) Most flooded properties in Flood Zone 3 2) Flooding period only 4 hours duration – majority of event likely to have taken place in less than 6 hours due to description of river response. Extreme. Possibly of the order of 20+ years 3) Highway flooding exacerbated by high hedges typical in Devon 4) Highway gullies blocked with high levels of sediment in rural runoff 5) Allocated responsibilities – 37.5% LLFA, 25% Highways, 37.5% District Council

Table 9: Report title and authority: Devon floods 4th – 5th August 2013. Devon County Council

Item	Comment
Flood event	4th August, 9 towns in Devon
Report	January 2014, Devon County Council
Authors	Devon County Council
Topography	Medium or Steep
Land Use	Generally urban
Flood severity	18 properties
Flood sources	Surface water runoff urban surfaces Surface water runoff rural surfaces Some fluvial flooding
Flood causes	Highway drainage capacity Highway drainage blockage
Rainfall	No information
Modelling	No
Unknowns	No analysis of rainfall Low level of detail of flooding mechanisms
Historic flooding	Yes. Brief summary for each town
Reviewer Comments	1) Rainfall of 4th and 5th August was widespread, but no details given 2) Antecedent conditions were probably wet due to volume of runoff 3) Relatively high intensity as rivers are not the main source of flooding. 4) Blockage of gullies from rural runoff

Table 10: Report title and authority: Elland, Halifax – 8th July 2014 FIR. Calderdale Metropolitan Borough Council

Item	Comment
Flood event	8th July 2014, Elland
Report	July 2014, Calderdale Metropolitan Borough Council
Authors	Calderdale Metropolitan Borough Council
Topography	Steep
Land Use	Rural and Urban
Flood severity	6 properties
Flood sources	Surface water (rural and urban)
Flood causes	Blocked grates on gullies Highway capacity Sewer capacity
Rainfall	Very high intensity for 20 minutes 2 hour event, Return period - unknown
Modelling	No
Unknowns	No details on rainfall
Historic flooding	None referred to
Reviewer Comments	1. Localised thunderstorm, 2. Very high intensity rainfall for 20 minutes 3. Various locations of flooding 4. Gully gratings blocked by debris 5. One property flooded due to sewer capacity

Table 11: Report title and authority: Lower road (B4443), Stoke Mandeville, Winter 2013/2014. Buckinghamshire County Council

Item	Comment
Flood event	14th – 16th February 2014, Stoke Mandeville
Report	6th June 2014, Buckinghamshire County Council
Authors	Buckinghamshire County Council
Topography	Medium
Land Use	Rural
Flood severity	Low. 1 property Road closure for 40 hours
Flood sources	Rural runoff
Flood causes	Highway drain blockages Under capacity
Rainfall	Low intensity - 14mm on 7th January, Return period of rainfall Low Return period of runoff High
Modelling	EA flood map shows local ponding
Unknowns	Lack of detail of catchment contribution No analysis of runoff return period
Historic flooding	Many instances of flooding on the road.
Reviewer Comments	1. Highway drainage is flat gradient 2. Blockages probably due to sediment washoff from catchment and settlement 3. Resulting in reduced capacity 4. Return period of runoff although higher than rainfall frequency, it will still probably be lower than road drainage criteria should provide.

Table 12: Report title and authority: The Willows, Aylesbury, 7th February 2014. Buckinghamshire County Council

Item	Comment
Flood event	7th February 2014, Aylesbury
Report	30th April 2014, Buckinghamshire County Council
Authors	Buckinghamshire County Council
Topography	Flat
Land Use	Residential
Flood severity	79 properties
Flood sources	River flows with backwater Surface drainage capacity and blockage
Flood causes	Siltation of surface water outfalls into river High river levels due to downstream culvert and maintenance state
Rainfall	9mm in 2 hours 14mm in 24 hours 136mm in 6 days Return period unknown
Modelling	No
Unknowns	No calculation of rainfall or runoff return period
Historic flooding	None in 5 years
Reviewer Comments	1) High river levels and high surface water runoff 2) Water course capacity reduced due to lack of maintenance 3) Downstream culvert might be a constraint 4) In flood zone 3 (floodplain)

Table 13: Report title and authority: Bishopstone, Aylesbury 24th December 2013 – 14th February 2014. Buckinghamshire County Council

Item	Comment
Flood event	24/12/2013 – 14/02/2014, Bishopstone
Report	30/05/2014, Buckinghamshire County Council
Authors	Buckinghamshire County Council
Topography	Rolling
Land Use	Residential
Flood severity	2 properties Highway flooding and closure twice for several days
Flood sources	Rural surface water runoff
Flood causes	Capacity of Main river
Rainfall	195mm over the period, Return period of rainfall unknown Return period of runoff unknown
Modelling	No
Unknowns	No hydrological analysis No hydraulic analysis
Historic flooding	At least 6 severe events, 1994 - 2014
Reviewer Comments	1) High levels of surface water runoff 2) Standall's Ditch (Main River) under capacity 3) Culvert throttle on river 4) Lack of maintenance by riparian owner of river (unclear who owner is) 5) Poor maintenance of highway drainage

Table 14: Report title and authority: Groundwater flooding in Brighton and Hove City (February 2014). Brighton and Hove City Council

Item	Comment
Flood event	05/02/2014 – 22/02/2014, Patcham and Portslade
Report	1/06/2014, Brighton and Hove City Council
Authors	Brighton and Hove City Council
Topography	Rolling
Land Use	Residential
Flood severity	Several basements of properties
Flood sources	Groundwater
Flood causes	No mechanism for protecting basements, No provision for routing of overland flooding from groundwater
Rainfall	Ditchling Rd gauge – 363mm in 3 months High Park Farm gauge – 589mm in 3 months
Unknowns	Assume basement flooding through seepage from below and not overland flooding
Historic flooding	Groundwater flooding, Winter of 2000/01
Reviewer Comments	1) Surface flooding in a number of locations due to high groundwater levels 2) Pumping of surface flooding into highway drainage, which passes into a combined sewer system

Table 15: Report title and authority: Langtree, Jubilee Lane, Blackpool. Blackpool Council

Item	Comment
Flood event	24/09/2012, Langtree
Report	?/?/2012, Blackpool Council
Authors	Blackpool Council
Topography	Medium
Land Use	Residential
Flood severity	External flooding of one property
Flood sources	Overland runoff
Flood causes	Overland flooding due to lack of highway drainage Backing up from sewer due to failure of pumping station
Rainfall	No rainfall data
Unknowns	No details of runoff routing No rainfall details Lack of clarity on the relevance of historical reference to land clearing and pond construction
Historic flooding	None
Reviewer Comments	1) Not really a Section 19 report, just a minor flood incident 2) Wet summer of 2012 resulting in surface water runoff from rainfall 3) Runoff from stables and other small holdings to house at low point 4) No provision for runoff by Highway 5) UU small pumping station failure of pump caused backing up from sewer

Table 16: Report title and authority: Pilinge rd / Park Crescent, Stewartby. Bedford Borough Council

Item	Comment
Flood event	28/04/2012, Stewartby
Report	05/04/2013, Bedford Borough Council
Authors	Bedford Borough Council
Topography	Flat
Land Use	Residential
Flood severity	No properties flooded (external flooding to several properties)
Flood sources	Surface water runoff from a surface water sewer
Flood causes	Poor state of surface water sewer Poor state of receiving ditch
Rainfall	26mm in 18 hours, Return period unknown
Unknowns	No rainfall analysis No details of runoff routing
Historic flooding	No
Reviewer Comments	1) Threshold for Section 19 report is low 2) Lack of maintenance on the receiving ditch (ownership unknown) is the main problem 3) Surface water sewer owned by water company needing rehabilitation

Table 17: Report title and authority: Newton Rd, Little Shelford. Cambridgeshire County Council

Item	Comment
Flood event	?/?/2014, Shelford
Report	1/9/2014, Cambridgeshire County Council
Authors	Cambridgeshire County Council
Topography	Flat
Land Use	residential
Flood severity	“Several properties flooded internally or externally”
Flood sources	Highway drainage
Flood causes	Highway drainage capacity Partial blockage
Rainfall	Unknown, frequent
Unknowns	No rainfall analysis Numbers properties and type of flooding No information on degree of structural problem or sedimentation blockage
Historic flooding	None mentioned
Reviewer Comments	1) Regular flooding from this location 2) Pipe capacity diminished from either structural state or partial blockage 3) Date of event not stated 4) No comment on weather or other hydrological aspects.

Table 18: Report title and authority: Looe. Cornwall Council

Item	Comment
Flood event	14/12/2012, Looe
Report	1/1/2013, Cornwall Council
Authors	Cornwall Council
Topography	Flat
Land Use	Residential
Flood severity	50 properties
Flood sources	The sea
Flood causes	Overtopping – best guess
Rainfall	None given
Unknowns	No details
Historic flooding	None mentioned
Reviewer Comments	1) Incident report (prior to FIR), date uncertain 2) Massive flooding due to tide and wind 3) Rainfall may or may not have contributed

Table 19: Report title and authority: Frogpool. Cornwall Council

Item	Comment
Flood event	14/2/2014, Frogpool
Report	1/4/2014 (guess), Cornwall Council
Authors	Cornwall Council
Topography	Unknown
Land Use	residential
Flood severity	1 property
Flood sources	Surface flooding runoff
Flood causes	Lack of Capacity of surface water system
Rainfall	No information “heavy rain”
Unknowns	No data or analysis
Historic flooding	Dates, locations, Causes, Rainfall
Reviewer Comments	1) Called an FIR but effectively an incident report 2) Heavy rainfall overwhelming the road drainage in an estate 3) Repeat flooding of a property

Table 20: Report title and authority: Floods in Camden. London Borough of Camden

Item	Comment
Flood event	7.08/2002, Camden
Report	1/06/2003, London Borough of Camden
Authors	London Borough of Camden
Topography	rolling
Land Use	Residential Commercial
Flood severity	Severe flooding Unknown number of properties Several commercial properties
Flood sources	Overland flow
Flood causes	Lack of capacity of Highway drainage Lack of capacity of Combined drainage system
Rainfall	Several localised Thunderstorms No rainfall characteristics
Unknowns	No details of flooding locations No hydrological analysis
Historic flooding	Several big thunderstorms over the last century
Reviewer Comments	1) Pre Section 19 FIR report 2) Lack of capacity of receiving drainage systems.

Table 21: Report title and authority: Badger Hill / Hull Rd, York. City of York Council

Item	Comment
Flood event	10/06/2012, York
Report	1/3/2013, City of York Council
Authors	City of York Council
Topography	Medium
Land Use	Residential
Flood severity	Severe 19 properties Road closure for 5 hours
Flood sources	Overland flooding from urban runoff
Flood causes	Blockage of pipes from inadequate maintenance of Highway drainage Blockage of YWS storage from inadequate maintenance of surface water drainage Failure of equipment (control valve with no power) Poor construction – too few gullies, gullies not connected Additional development (creep) increasing surface water runoff Lack of maintenance of culvert – unclear if this is an ordinary watercourse. Ditch filled in
Rainfall	Wet antecedent period 50 minute thunderstorm 1:7 – 1:31 Year Return period calculated No rainfall depth provided – probably around 30mm
Unknowns	No Rainfall depth information
Historic flooding	Flooding in late 1970s, details unknown Flooding in 2007 – less severe
Reviewer Comments	1) Detailed investigation of problems 2) Good summary of flooding causes 3) Multiple problems, nearly all associated with lack of maintenance 4) Surface water sewers and Highway drainage blocked for various reasons (roots, construction debris) 5) Tanks not operating as designed as virtually completely full and operating through an overflow 6) Electrical Control structure no longer operational – level of flooding impact unknown

Table 22: Report title and authority: South Winterbourne FIR. Dorset County Council

Item	Comment
Flood event	7/7/2012, South Winterbourne
Report	1/7/2013, Dorset County Council
Authors	Parsons Binkerhoff
Topography	Steep
Land Use	Residential
Flood severity	Severe 42 properties
Flood sources	Elevated groundwater levels Rural surface water runoff Fluvial flooding
Flood causes	No provision to protect against high groundwater levels No provision for surface water runoff from groundwater levels Inadequate provision for surface water runoff from rural runoff Inadequate capacity in streams especially bridge crossings
Rainfall	115mm in 38 hours 1:80 year return period
Unknowns	Details of overland flow and drainage provision for this Is the river Main River? Return period of groundwater event Return period of river event Return period of surface water runoff event
Historic flooding	1955 Groundwater and surface water event – like 2012 1930, 1936, 1960, 1979, 1994, 1995, 1996, - mostly fluvial flooding, though some surface water runoff from groundwater flooding
Reviewer Comments	1) Big rainfall event after extended wet period of 3 months 2) Chalk lands are relatively impermeable on the surface (especially when saturated), with rapid response to groundwater levels from antecedent rainfall 3) Combination of flooding from fluvial (Chalk fed streams), and 4) Surface water runoff from rural surfaces 5) Surface water runoff from groundwater springs 6) Ingress of groundwater directly into properties 7) Suggestions of watercourse capacity from limited maintenance 8) Long detailed thorough study 9) Probable that majority of flooding is NOT fluvial 10) Unclear if the river is Main River

Table 23: Report title and authority: Leeman road area. City of York Council

Item	Comment
Flood event	26/9/2012, York
Report	2/2/2013, City of York Council
Authors	City of York Council
Topography	Flat
Land Use	residential
Flood severity	0 properties
Flood sources	High river level (R. Ouse) Backflow through YWS surface water drainage system
Flood causes	2 Stuck open penstocks, (no knowledge of failure to close)
Rainfall	None
Unknowns	Return period of flood event
Historic flooding	Dates, locations, Causes, Rainfall
Reviewer Comments	1) Serious incident though no houses were flooded due to actions taken 2) Implication that YWS staff turnover resulted in inadequate awareness of importance of flood management requirements for high river levels 3) Lack of awareness of Penstock status – no monitoring?

Table 24: Report title and authority: Town End Farm, Coulderton FIR33. Cumbria County Council

Item	Comment
Flood event	30/8/2012, Coulderton
Report	31/3/2014, Cumbria County Council
Authors	Cumbria County Council
Topography	Steep
Land Use	Rural
Flood severity	1 property
Flood sources	Rural runoff
Flood causes	No provision for surface water drainage Limited capacity of highway drainage
Rainfall	Event 1 30/8/2012 – 18mm/hr max intensity, 32mm in 6 hours Event 2 17/10/2012 – 50mm/hr max intensity, 45mm in 13 hours
Unknowns	No rainfall return period No antecedent rainfall No runoff return period
Historic flooding	6 times in 14 years
Reviewer Comments	1) Very good report with diagrams, rainfall data, and hydraulic assessment 2) High volumes of sediment always washed off high ground 3) No explicit provision for high volumes of washoff from rural high ground 4) Limited Highway capacity 5) Limited Highway maintenance (sediment in junction manhole)

Table 25: Report title and authority: Glassonby FIR 64. Cumbria County Council

Item	Comment
Flood event	26/3/2014, Glassonby
Report	28/6/2014, Cumbria County Council
Authors	Cumbria County Council
Topography	Steep
Land Use	Residential
Flood severity	6 properties
Flood sources	1 fluvial – Glassonby beck, Ordinary Watercourse Surface water road runoff
Flood causes	No provision of highway drainage for roads creating runoff Inadequate Highway drainage capacity in village Fluvial stream capacity
Rainfall	40+mm/hr intensity from radar Rainfall depth unknown Rainfall duration ~2.5 hours Unknown return period
Unknowns	lack of clarity on rainfall terminology
Historic flooding	3 events 1989, 1998, 2005
Reviewer Comments	1) Lack of understanding of rainfall terminology 2) Good overview of flooding mechanism 3) Overland flooding generated by runoff from road leading down into the village 4) Flooding of 1 property close to the Beck, erosion mentioned but no implication of any particular failing with the river.

Table 26: Report title and authority: Highgate & Kirkland, Kendal FIR69. Cumbria County Council

Item	Comment
Flood event	28/6/2012, Kendal
Report	Date, Cumbria County Council
Authors	Cumbria County Council
Topography	Steep
Land Use	Commercial
Flood severity	9 properties
Flood sources	Rural runoff Highway runoff Urban runoff
Flood causes	Lack of capacity Highway drainage Lack of capacity surface water sewers
Rainfall	Extreme event Average of 80mm/hr for 15 mins, 30mm in 1 hour est. 39mm in 24 hours Unknown return period, Radar image > 50+mm/hr
Unknowns	No return period analysis
Historic flooding	Yes – no details
Reviewer Comments	1) Very extreme short duration rainfall event 2) Overland runoff from rural areas and roads and urban areas 3) Local flood routing and ponding 4) Inadequate capacity Highway drainage 5) Inadequate capacity Surface water sewerage 6) No information to differentiate two drainage systems

Table 27: Report title and authority: Flood event data recording system. Metropolitan Borough Council of Doncaster

Item	Comment
Flood event	3/8/2011, Doncaster
Report	?, Metropolitan Borough Council of Doncaster
Authors	Metropolitan Borough Council of Doncaster
Topography	Unknown
Land Use	Mixed
Flood severity	Medium 18 residential properties 4 Commercial properties
Flood sources	Surface water runoff
Flood causes	Inadequate capacity of Highway drainage (Majority of properties) Inadequate capacity of Surface water sewer
Rainfall	Unknown rainfall characteristics, Unknown return period
Unknowns	No analysis Minimal information
Historic flooding	Unknown
Reviewer Comments	1) Not really adequate as a S19 FIR 2) Likely to be a short intense thunderstorm 3) Information suggests flooding cause is surface water drainage capacity, primarily Highway drainage

Table 28: Report title and authority: Dorset County Council July 2012 FIR. Dorset County Council

Item	Comment
Flood event	July 2012, Dorset
Report	01/01/2013, Dorset County Council
Authors	Dorset County Council
Topography	Steep
Land Use	Rural
Flood severity	Extensive area 270 properties 18 caravans 71 communities affected
Flood sources	Surface water runoff Overland flows Extreme river flows: River Lin (main river) and River Frome (main river) Groundwater
Flood causes	Lack of sewer capacity Channel maintenance issues (de-silting and weed clearance) Operation of control sluices Lack of highway drainage capacity Depth of flood alleviation channel (Maiden Newton)
Rainfall	Totals for the week (6th-13th July 2012) exceeded 150mm Most intense recorded rainfall, 115mm in 38 hours 1 in 80 year return period Average rainfall recorded from 01/07/12 – 07/01/12 was 115.5 mm over an average of 145 hours
Unknowns	Inconsistent recording of rainfall depths between executive summary and report main text. Return period of groundwater event Return period of river event Return period of surface water runoff event
Historic flooding	Unknown
Reviewer Comments	1) Torrential rain on the 10th fell onto already saturated ground. Groundwater flooding ensued for 2 weeks. 2) 12m increase in groundwater levels 3) Average total rainfall normally 178.2mm; average total rainfall in 2012 was 455.1mm 4) In Bridgeport and Maiden Newton, local drainage could not properly drain to the river due to high river levels.

Table 29: Report title and authority: Report on Romsey FIR – phase 1.

Item	Comment
Flood event	December 2013 and January 2014, Romsey
Report	01/04/2014, Hampshire County Council
Authors	CH2MHILL
Topography	Steep
Land Use	Residential (small town)
Flood severity	Severe. 96 properties estimated to be affected based upon extent incident maps 69 properties certainly affected based upon questionnaire feedback. Threats to gas, electricity and foul sewer facilities in Causeway.
Flood sources	Cupernham lane: rural runoff and groundwater Winchester road: groundwater → inundated sewers → surface water flooding Mainstone and Causeway: 1) surface water flooding; 2) groundwater and fluvial flooding (ordinary watercourse) Riverside gardens: Fluvial (River Test, main river), surface water and foul sewer flooding Middlebridge: Foul sewer and surface water flooding
Flood causes	Lack of highway drainage capacity Culvert blockage Lack of surface water storage Fluvial capacity Building locations e.g. roads much higher level than affected adjacent houses.
Rainfall	415mm total rainfall. 45 days 23rd Dec: 74mm in 12 hours
Unknowns	1) Unclear on the sources of flooding in Winchester road, riverside gardens and Middlebridge (surface water and/or foul sewer flooding?)
Historic flooding	Unknown.
Reviewer Comments	1) In Mainstone and Causeway there were both blockage and capacity issues (due to the rainfall and pipe size from the Ordinary Watercourse to the Test) 2) A new development nearby, Abbotswood, was found to not be at fault of increasing flood risk downstream. However, a number of aspects of the FRA and drainage strategy raise questions following these events. 3) It appears that the cause of flooding was primarily a capacity issue given intense rainfall falling on fully saturated ground with high ground and fluvial water levels. Whilst there was blockage problem, this probably wouldn't have prevented the flooding.

Table 30: Report title and authority: Ceredigion County Council FIR – 8th & 9th June 2012.

Item	Comment
Flood event	8th and 9th June 2012, Ceredigion
Report	June 2012, Ceredigion County Council
Authors	Ceredigion County Council
Topography	Steep
Land Use	Rural
Flood severity	Severe – extent unprecedented 120 commercial and residential properties across 10 communities 200 caravans Road closures
Flood sources	Fluvial
Flood causes	Lack of fluvial capacity High tides preventing discharge Insufficient reservoir storage capacity
Rainfall	Over four catchments: • Dinas: 184 mm • Pwll Peiran: 148 mm • Cwm Rheidol: 117 mm • Nant y Moch: 198 mm
Unknowns	Areas of uncertainty and lack of clarity
Historic flooding	Previous flooding mentioned but not detailed. This extent of flooding is unprecedented.
Reviewer Comments	1) Local reservoirs were used for storage, but releases had to be made in accordance with operating procedures to reduce critical levels 2) River levels in the catchment hit peak recorded levels on the 8th June. 3) High tides on the 9th June prevented discharge of water into Aberystwyth harbour 4) There was no evidence that flow had been impeded through structures due to lack of maintenance.

Table 31: Report title and authority: November 2012 Floods at Glasdir, Ruthin from the River Clwyd. Denbighshire County Council.

Item	Comment
Flood event	27/11/2012; Glasdir, Ruthin
Report	27/08/2013, November 2012 Floods at Glasdir, Ruthin from the River Clwyd: Report on the Review.
Authors	Dr. Jean Venables
Topography	Floodplain
Land Use	Residential
Flood severity	Severe: 122 houses
Flood sources	Fluvial: River Clwyd
Flood causes	Screens to culverts of poor design and blocked (66-95% blockage estimated)
Rainfall	No specific information provided.
Unknowns	This report contains a lot of modelled information, to provide evidence to the cause of the floods and recommend changes to the maintenance regimes in the future. However little recorded data is provided.
Historic flooding	Fluvial events: June 1931; October 1966; 1990; March 1998; and, October/November 2000;
Reviewer Comments	1) This report is a detailed assessment of the flood events and the reason for their occurrence apparently because the community affected was in a new development with assumed protection to 1 in 1000 year. The belief that this development was protected to 1 in 100 year meant that is was not on the list of high risk areas to visit during such a high rainfall event. 2) Actual protection is between 1 in 100 and 1 in 200 years. 3) The flood event was significantly associated with the fact that an access road had been built across the floodplain on an embankment rather than a bridge structure and the five culverts installed had 'poorly designed' screens and were significantly blocked during the event. 4) Whilst November's rainfall was average, most of the rain fell in the week leading up to the 27th November. Thus, the rainfall on the 26/27th November, which was very intense, fell on saturated ground. 5) Quote: "60+% of all flooding from Ordinary Watercourses are due to [screen] blockage." (Based on 34 of 52 sites for Cardiff and Caerphilly project appraisal reports).

Table 32: Report title and authority: FIR Goole Floods, 3rd August 2011. East Riding of Yorkshire Council

Item	Comment
Flood event	03/08/2011, Goole
Report	10/01/2012, Flood Investigation Report Goole Floods, 3 August 2011
Authors	East Riding of Yorkshire Council
Topography	Floodplain
Land Use	Urban
Flood severity	631 internally 112 internally but no address supplied 915 externally but within property boundary 1720 adjacent carriageway or footpaths.
Flood sources	Pluvial
Flood causes	Lack of capacity: combined sewer, highways, gullies and associated pumping stations.
Rainfall	Estimate of: • 30 mm in 45 minutes (1 in 45 years) • Anecdotal evidence: 64 mm (1 in 950 years)
Unknowns	Rainfall had to be estimated because the location has no gauges
Historic flooding	Unknown
Reviewer Comments	1) Rural run-off into surrounding ditches and gullies shouldn't have influenced the flooding. 2) Anecdotal evidence suggests that there might be minor localised drainage issue in this area. 3) A small proportion of residents observed water flowing out of open ditches. 4) The estimated storm intensity exceeded drainage designs by a significant margin. 5) Of the 4,700 gullies, more than 95% had been maintained properly; ~4% were obscured by vehicles or the covers and couldn't be checked and less than 0.5% actually required maintenance. 6) A couple of pumps were out of action due to maintenance or safety reasons. It is not possible to say whether this additional pumping would have influenced the flooding.

Table 33: Report title and authority: St Mary Bourne FIR. Hampshire County Council

Item	Comment
Flood event	December 2012, Hampshire County Council St Mary Bourne Flood Investigation Report
Report	14/12/2014, Hampshire County Council
Authors	Hampshire County Council
Topography	Medium
Land Use	Rural / Residential
Flood severity	Unknown
Flood sources	Sewer
Flood causes	Groundwater infiltration into sewers and backing-up
Rainfall	Unknown
Unknowns	Very little information of any sort provided. No analysis undertaken.
Historic flooding	This is a common problem and has occurred in 1960, 1980, 1995, 2000/01
Reviewer Comments	This is a known problem in this area. High groundwater levels have frequently led to issues with the foul sewer system. Southern Water have previous installed pumps that alleviated the problem for a couple of houses, but the problem was just moved upstream. Southern Water were tasked with investigating what solutions might be available.

Table 34: Report title and authority: Final report on incident investigation into Buckskin flooding. Hampshire County Council.

Item	Comment
Flood event	08/02/2014 – 31/03/2014, Buckskin, Hampshire
Report	09/07/2014, Hampshire County Council
Authors	CH2MHILL
Topography	Steep
Land Use	Residential
Flood severity	45-88 properties
Flood sources	Primary mechanism: Sustained high rainfall leading to surface water flooding and high groundwater levels Secondary mechanism: inundation of surface water and groundwater into sewer network leading to foul water flooding.
Flood causes	Lack of capacity in surface water, highway drainage and foul sewer network and for groundwater. Maintenance issues in some ditches.
Rainfall	18 mm fell in nearby Basingstoke on the 14th Feb; intense storms also recorded (2.2mm and 2.4mm each in 15 minutes).
Unknowns	There is a lack of knowledge of the location and condition of drainage infrastructure in this area. There are boreholes in this area for PWS abstraction. This is expected to influence groundwater levels, but the extent to which this is the case is not fully understood.
Historic flooding	Unknown
Reviewer Comments	1) Groundwater level exceeded previous maxima by ~1 metre (102.5 m AOD at Pack Land and ~ 95.5m AOD at Tile Barn) 2) The drainage network in this area is old and infrastructure location and condition is largely unknown. 3) Soakaways ineffective due to groundwater levels

Table 35: Report title and authority: Llanberis FIR – 22/11/2012. Gwynedd Council.

Item	Comment
Flood event	22/11/2012, Llanberis
Report	22/02/2013, Gwynedd Council
Authors	Ymgynghoriaeth Gwynedd Consultancy
Topography	Steep
Land Use	Urban
Flood severity	70 commercial and residential properties Electricity substation flooded internally River bank walls damaged or washed away along with natural riverbanks.
Flood sources	Pluvial and fluvial flooding
Flood causes	Insufficient capacity of local watercourses and highway drainage systems. Significant erosion and scour of river bed and banks leading to blockages of local drainage infrastructure
Rainfall	Unknown
Unknowns	No information on rainfall depth or duration or return period.
Historic flooding	October 1987
Reviewer Comments	Steady rain interspersed with heavy showers falling on saturated ground exacerbated by two intense down pours: 1) First downpour cause pluvial flooding 2) Second downpour caused “massive fluvial runoff”, severely scoured the riverbanks and beds, causing blockages at several locations that were previous well-maintained. The river burst its banks at several locations.

Table 36: Report title and authority: Thornford Rd Ford, Thornford Rd, Headley FIR. Hampshire country Council

Item	Comment
Flood event	30/04/2012, Headley
Report	1/9/2013, Hampshire country Council
Authors	Hampshire country Council
Topography	Steep
Land Use	Rural
Flood severity	No flood damage 1 fatality (driving across ford)
Flood sources	River flow
Flood causes	Rapid river response to heavy rain 5 ft of flood depth at the Ford
Rainfall	None provided
Unknowns	No uncertainties, though rainfall and river velocities not determined
Historic flooding	Regular vehicle incidences at Ford
Reviewer Comments	1) Idiotic driving (signage visible)

Table 37: Report title and authority: DCC investigations into the November 2012 floods FIR. Denbighshire County Council.

Item	Comment
Flood event	Date, Location
Report	1/2/2013, Denbighshire County Council
Authors	Denbighshire County Council
Topography	Steep
Land Use	urban
Flood severity	320 properties + 70 caravans 1 death
Flood sources	Main river
Flood causes	River capacity Bridge capacity small contribution Drainage backing up from river
Rainfall	1:13 years Flooding >1:100 years
Unknowns	No rainfall details
Historic flooding	Not reported
Reviewer Comments	1) Extreme event 2) High runoff contribution from rural catchment due to ground saturation

Table 38: Report title and authority: Flooding of properties in Rhyl. Denbighshire County Council

Item	Comment
Flood event	5/12/2013, Rhyl
Report	7/5/2014, Denbighshire County Council
Authors	Denbighshire County Council
Topography	Flat
Land Use	Residential
Flood severity	Approx' 200 flooded properties Wave overtopping – storm force winds, plus HAT, plus surge
Flood sources	Sea
Flood causes	Height of sea defences Capacity of flood provision Flood relief to golf course prevented by fence blinding
Rainfall	Return period unknown (very high)
Unknowns	None
Historic flooding	1990
Reviewer Comments	1) High volume of overtopping 2) Storage are filled quickly (before high tide) 3) Relief flow to golf links prevented by fence blinding

Table 39: Report title and authority: Green Street, Chorleywood FIR. Hertfordshire County Council

Item	Comment
Flood event	Date, Chorleywood
Report	Date, Hertfordshire County Council
Authors	Hertfordshire County Council
Topography	Rolling
Land Use	Rural
Flood severity	Road closure (multiple times)
Flood sources	Rural runoff And perhaps contribution from new residential estate
Flood causes	Highway Gully capacity (soakaway) Overland flow flood relief closed off
Rainfall	No details Frequent flooding when 5 days of rainfall occurs
Unknowns	No hydrological analysis
Historic flooding	Many events after flood relief gap closure in 2009
Reviewer Comments	10 highway drainage provision to soakaway cannot cope with overland flood flows. No overland flood relief provision (blocked off in 2009)

Table 40: Report title and authority: Flood investigation 6 Enfield Close, Batley. Kirklees Council.

Item	Comment
Flood event	3/1/2012, Batley
Report	23/1/2012, Kirklees Council
Authors	Kirklees Council
Topography	Rolling
Land Use	Residential
Flood severity	1 property (live-in basement)
Flood sources	Thought to be high groundwater
Flood causes	Porous walls (high flow rate)
Rainfall	None provided Hig levels of antecedent rainfall
Unknowns	No hydrological analysis Field investigations into drainage systems could not establish a cause
Historic flooding	No
Reviewer Comments	1) cause of flooding not established 2) Assumed likely groundwater as other causes investigated and not found to be a likely source / cause. 3) No rainfall information.

Table 41: Report title and authority: Knebworth FIR. Hertfordshire County Council.

Item	Comment
Flood event	7/1/2014, Knebworth
Report	8/1/2015, Hertfordshire County Council
Authors	Hertfordshire County Council
Topography	Rolling
Land Use	Residential
Flood severity	18 properties
Flood sources	Rural runoff Plus motorway runoff
Flood causes	Infiltration capacity of flood pond serving motorway Infiltration capacity of gullies serving local road Flood relief pipe capacity / blockage?
Rainfall	High levels of antecedent rainfall for January ‘14 event However subsequent 4 events in 2014 (external flooding) no information at all
Unknowns	Analysis is very inconclusive
Historic flooding	1987, 1978 (externally), 4 events in 2014
Reviewer Comments	1) Insufficient consideration of other 2014 events 2) Suggests critical event has happened – blockage of relief drain, or reduction in infiltration capacity of pond for Motorway, and reduction in infiltration capacity of road gullies 3) No certainty of the cause of the event, or

Table 42: Report title and authority: Robbery Bottom Lane, Welwyn FIR. Hertfordshire County Council

Item	Comment
Flood event	7/2/2014, Welwyn
Report	10/10/2014, Hertfordshire County Council
Authors	RAB Consultants
Topography	Medium
Land Use	Residential
Flood severity	9 properties
Flood sources	Rural flood flows
Flood causes	Capacity of highway drainage Flood exceedence route not available Possible constraint of debris at gullies
Rainfall	~35mm in 24 hours in two periods of several hours. ~1:3 years
Unknowns	Hydrological analysis is approximate,
Historic flooding	1993, 2009, December 2013,
Reviewer Comments	1) High antecedent wetness so runoff return period is probably less frequent 2) Partial blockage and capacity of highway drain to serve fluvial runoff 3) No flood route for exceedence flows 4) Surface debris may have affected gullies

Table 43: Report title and authority: Cowes and East Cowes FIR. Isle of Wight Council.

Item	Comment
Flood event	14/2/2014, Cowes and East Cowes
Report	24/6/2014, Isle of Wight Council
Authors	Isle of Wight Council
Topography	Flat
Land Use	Commercial
Flood severity	Many commercial properties flooded No details of number or severity, but possibly around 50)
Flood sources	High tides with wave overtopping
Flood causes	Flood defence provision, Limited capacity of surface water drainage to serve over-topping
Rainfall	N/A Nothing on severity of tidal event
Unknowns	Areas of uncertainty and lack of clarity
Historic flooding	Dates, locations, Causes, Rainfall
Reviewer Comments	1) Stated level of defence from over-topping is 1:30 years 2) No information on severity of the event

Table 44: Report title and authority: Cothelstone Avenue. Leicestershire County Council.

Item	Comment
Flood event	28/6/2012, Loughborough
Report	4/6/2014, Leicestershire County Council
Authors	Leicestershire County Council
Topography	Medium
Land Use	Residential
Flood severity	2 flooded properties
Flood sources	Surface flooding from park runoff
Flood causes	Highway capacity. Rural runoff provision > Gullies > surface water sewer > River (level)
Rainfall	22mm in a few hours (guessed 6hr), Wet antecedent conditions Unknown return period of rainfall or runoff
Unknowns	Hydraulic constraints of river level and surface water sewer and gully capacity.
Historic flooding	No
Reviewer Comments	1. Overland runoff from green parkland area onto road with inadequate capacity to cater for flow. 2. Minimal analysis of rainfall 3. No analysis of hydraulics of the drainage 4. No area information of catchment 5. No runoff analysis 6. Failure is likely to be constraint of sewer capacity due to high river levels, and the fact that the sewer is not designed to pick up rural runoff.

Table 45: Report title and authority: Lancashire summer 2012. Lancashire County Council

Item	Comment
Flood event	23/6/2012, Lancashire
Report	1/1/2013, Lancashire County Council
Authors	Lancashire County Council
Topography	Medium
Land Use	Mixed
Flood severity	165 properties
Flood sources	River flow, rural and urban runoff,
Flood causes	Capacity
Rainfall	100mm in 2 days
Unknowns	No hydrological or catchment details or flood mechanisms provided
Historic flooding	Not stated
Reviewer Comments	1. General report of flooding of event in June and also September 2012 2. High rainfall and high antecedent conditions 3. Capacity problems for all sectors – rivers, rural runoff, sewers, highways

Table 46: Report title and authority: Section 19 investigations. Lincolnshire County Council

Item	Comment
Flood event	28/6/2012, Horncastle and other locations
Report	16/6/2014, Lincolnshire County Council
Authors	Lincolnshire County Council
Topography	Medium
Land Use	Mixed
Flood severity	121 properties
Flood sources	River flows rural and urban runoff
Flood causes	Capacity of all drainage systems
Rainfall	Claimed 1:50 year rainfall event Wet antecedent conditions
Unknowns	Limited / no information on hydrology, hydraulics, catchments,
Historic flooding	Not stated
Reviewer Comments	1. Appendix to an unknown document for all Section 19 investigations - 1 line per incident area 2. Information above summary for one event 3. Capacity problems for all drainage elements

Table 47: Report title and authority: Blackbrook Rd / West End Rd September 2012. St Helens Council.

Item	Comment
Flood event	24.9.2012, St. Helens
Report	1/1/2013, St Helens Council
Authors	St Helens Council / Environment Agency
Topography	Medium
Land Use	Residential
Flood severity	10 properties
Flood sources	Canal and river
Flood causes	Capacity of river and subsequent highway drainage
Rainfall	No information
Unknowns	No hydraulics or hydrology provided in the report.
Historic flooding	28/10/2000, similar flooding impact
Reviewer Comments	1. Bowl in shape of land collects flood water originating from canal (presumably from rural runoff or other river inflow). Overflow from canal captured but not catered for by Blackbrook or subsequent demands on highway drainage. 2. No hydrological or hydraulic information and minimal catchment information 3. Historical event should have led to a solution to cater for future flooding

Table 48: Report title and authority: December 2013 – June 2014 FIR. Hillingdon Borough Council

Item	Comment
Flood event	1/1/2013, Hillingdon
Report	1/6/2014, Hillingdon Borough Council
Authors	Hillingdon Borough Council
Topography	Medium
Land Use	Mixed
Flood severity	Low. 1 property flooded internally
Flood sources	Mostly high river levels, Surface water runoff from rural and urban areas Groundwater
Flood causes	Excessive rainfall in December, January and February 2014
Rainfall	157mm in January 2014
Unknowns	General overview report, no specific analysis
Historic flooding	Not stated
Reviewer Comments	1. General report summarising extensive flooding across the area 2. No analysis on specifics (hydrology, hydraulics, catchments) 3. Only I property flooded internally, though extensive flooding externally 4. Mostly concern over river levels, but little flood damage

Table 49: Report title and authority: Summer 2012 Flooding in Newcastle on Tyne. Newcastle City Council.

Item	Comment
Flood event	28/6/2012, Newcastle on Tyne
Report	1/7/2013, Newcastle City Council.
Authors	Newcastle City Council.
Topography	Varied
Land Use	Mixed
Flood severity	500 properties
Flood sources	Surface water flooding
Flood causes	Surface water and Highway drainage
Rainfall	50mm in 2 hours 2nd event: 40mm in 90minutes 5th August 2012
Unknowns	No specifics of flooding analysis
Historic flooding	~30% of properties had previous flooding
Reviewer Comments	1. Not really a Section 19 – a review of flooding based on survey 2. Flooding causes due to capacity of surface water drainage systems, but no analysis of hydraulic performance.

Table 50: Report title and authority: King's Lynn & West Norfolk, Walpole Cross keys, Sutton Rd. Norfolk County Council

Item	Comment
Flood event	26/11/2012, Walpole Cross keys
Report	Date, Norfolk County Council
Authors	Norfolk County Council
Topography	Flat
Land Use	Residential
Flood severity	1 property
Flood sources	Water course and local drainage
Flood causes	Capacity / partial blockage and poor maintenance
Rainfall	No information
Unknowns	No hydraulics, hydrology or catchment information
Historic flooding	Not stated
Reviewer Comments	1. Assessment for two events to same property (2nd event 8/12/2012) 2. High antecedent rainfall therefore likely to have high component of rural runoff 3. IDB local drainage but no clarity as to exact flooding mechanism.

Table 51: Report title and authority: North Somerset 2012 Flood investigations. North Somerset Council.

Item	Comment
Flood event	4/8/2012, North Somerset
Report	1/6/2013, North Somerset Council
Authors	North Somerset Council
Topography	Varied
Land Use	Mixed
Flood severity	700+ properties flooded from multiple events
Flood sources	Rivers, rural runoff and urban runoff
Flood causes	Drainage capacity of all systems
Rainfall	4/8/2012 – 63mm in 24 hours (probably less) 24/9/2012 – 47mm 21– 25/11/2012 – 88mm 22/12/2012 – 36mm
Unknowns	Summary report of regional flooding General comment on each flooding location
Historic flooding	Not stated
Reviewer Comments	1. Regional report on several events 2. August event likely to be different in terms of rainfall intensity severity and causes of flooding 3. All drainage failure mechanisms likely to be the issue 4. In many cases Highway drainage is implicated 5. Also lots of rural runoff

Table 52: Report title and authority: Gainsborough Rd, Corby FIR. Northamptonshire County Council

Item	Comment
Flood event	23/12/2013, Corby
Report	Date, David Smith Associates
Authors	Northamptonshire County Council
Topography	Medium
Land Use	Main road
Flood severity	0 flooded properties
Flood sources	Ordinary watercourse, surface runoff
Flood causes	grill partial blockage exacerbated overland flow, capacity of surface water drainage limited by high river levels
Rainfall	20mm in 1 day, perhaps in only several hours
Unknowns	No analysis of hydrology and hydraulics
Historic flooding	Yes
Reviewer Comments	1. Arterial road flooded, but no properties 2. Flooding implied from 2 sources – surface runoff and highway drainage capacity, and river flooding exacerbated by grills partially blinding

Table 53: Report title and authority: Flooding on the A45 Eastbound between Great Doddington and Wilby Way. Northamptonshire County Council

Item	Comment
Flood event	14/7/2012, Doddington
Report	Date, Northamptonshire County Council
Authors	Northamptonshire County Council
Topography	Medium
Land Use	Rural
Flood severity	0 flooded properties
Flood sources	Rural and road runoff
Flood causes	Blocked Highway drainage
Rainfall	20mm in 1 hour, 40mm in 4 hours Wet antecedent conditions
Unknowns	No hydraulic or catchment information
Historic flooding	Not at this location
Reviewer Comments	1. High levels of rural runoff from intense rainfall 2. Blockage in highway drainage. 3. Jetting needed to clear it. 4. No hydraulic analysis to assess blockage source and risk

Table 54: Report title and authority: Deenethorpe, Nr corby. Northamptonshire County Council

Item	Comment
Flood event	14/2/2014, Deenethorpe
Report	Date, David Smith Associates
Authors	Northamptonshire County Council
Topography	Steep
Land Use	Residential
Flood severity	External flooding
Flood sources	Rural runoff
Flood causes	Insufficient provision / capacity of drainage Poor maintenance of ditches and ponds
Rainfall	10mm rainfall in the day Wet antecedent conditions
Unknowns	No specific hydraulic analysis
Historic flooding	Dates, locations, Causes, Rainfall
Reviewer Comments	1. Relatively small rainfall event, but on very wet catchment 2. Capacity and maintenance of rural drainage system main cause of flooding 3. Relatively good assessment of problem without carrying out any specific analysis

Table 55: Report title and authority: Duck End, Denford. Northamptonshire County Council

Item	Comment
Flood event	21/11/2012, Denford
Report	17/4/2013, David Smith Associates
Authors	Northamptonshire County Council
Topography	Medium
Land Use	Residential
Flood severity	1 flooded property
Flood sources	Rural runoff
Flood causes	Backwater effects from R. Nene and capacity of ordinary watercourse, rural and highway drainage systems.
Rainfall	25mm in 24 hours Wet antecedent conditions
Unknowns	No hydrological or hydraulic capacity.
Historic flooding	Yes, 4 times in 2012
Reviewer Comments	1. General under capacity of drainage systems; rural drainage, ordinary watercourse, culverts and backwater from R. Nene 2. No return period analysis 3. Qualitative assessment is fairly thorough

Table 56: Report title and authority: Harts lane, East Farndon FIR. Northamptonshire County Council

Item	Comment
Flood event	21/11/2012, East Farndon
Report	26/2/2013, David Smith Associates
Authors	Northamptonshire County Council
Topography	Medium
Land Use	Residential
Flood severity	2 flooded properties
Flood sources	Rural runoff and ordinary watercourse flooding
Flood causes	Capacity of ordinary watercourse Capacity of rural drainage and Highway drainage Maintenance of systems Debris in river
Rainfall	30mm in 1 day Wet antecedent conditions
Unknowns	No hydrological or hydraulic capacity
Historic flooding	Yes, several events
Reviewer Comments	1. Inadequate rural drainage, and highway provision 2. Capacity of ordinary watercourse affected by debris to some degree 3. No return period analysis of runoff 4. Qualitative assessment is fairly thorough

Table 57: Report title and authority: Acomb. Northumberland County Council.

Item	Comment
Flood event	28/6/2012, Acomb
Report	12/11/2012, Northumberland County Council
Authors	Northumberland County Council
Topography	Medium
Land Use	land use
Flood severity	Damage, nr. of properties
Flood sources	Main river Pervious area and Highway runoff
Flood causes	Main river capacity Highway drainage capacity
Rainfall	Very intense rainfall No details
Unknowns	No specific details or analysis
Historic flooding	Yes, several events.
Reviewer Comments	1. Two separate causes – local runoff from steep bank and highway, and Main river spilling 2. No indication of river spilling due to blockage though river is immediate upstream of road crossing

Table 58: Report title and authority: Investigations of the summer 2012 floods. Northumberland County Council.

Item	Comment
Flood event	28/6/2012, Northumberland
Report	12/11/2012, Northumberland County Council
Authors	Northumberland County Council
Topography	Various
Land Use	Mixed
Flood severity	240+ properties
Flood sources	Main river through to rural drainage
Flood causes	Capacity of all drainage systems Blockages due to autumnal drainage
Rainfall	Very intense rainfall Long rainfall events Wet antecedent conditions
Unknowns	No Hydraulic analysis (general report)
Historic flooding	No information.
Reviewer Comments	1. Good hydrological summary of rainfall and return periods 2. No return period analysis of runoff 3. Flooding due to range of critical conditions 4. Blockage of gullies due to autumnal debris 5. No mention of culvert grills blocking 6. Return period of 3 of 4 events are medium, and one is very high.

Table 59: Report title and authority: Upper Calder Valley – 29th July 2013 FIR. Calderdale Metropolitan Borough Council.

Item	Comment
Flood event	27/7/2013, Walsden
Report	12/11/2012, Calderdale Metropolitan Borough Council
Authors	Calderdale Metropolitan Borough Council
Topography	Steep
Land Use	Mixed
Flood severity	151 properties
Flood sources	Ordinary watercourses Pervious area and Highway runoff
Flood causes	River capacities and structural failure Rural drainage capacities Highway drainage capacity
Rainfall	Very intense short duration rainfall twice in the day Nearly 150mm/hr (2 mins) No details of depths and return periods
Unknowns	No hydrological analysis
Historic flooding	Yes, several events.
Reviewer Comments	1. Steep catchments creating high velocities and structural damage 2. No understanding of hydrology 3. Fluvial flooding due to capacity and structural failures 4. Surface water runoff from rural and urban surfaces 5. Return period unknown though likely to be high.

Table 60: Report title and authority: Investigation of flood incident affecting areas of south east Sheffield on 30th April 2014. Sheffield City Council.

Item	Comment
Flood event	30/4/2014, Sheffield
Report	16/6/2014, Sheffield City Council
Authors	Sheffield City Council
Topography	Steep
Land Use	Residential
Flood severity	24 flooded properties
Flood sources	Rural runoff Ordinary watercourses Surface runoff from urban and rural areas Foul sewer flooding
Flood causes	Grills partially blocked and ordinary water course capacity Highway capacity Surface water sewer and structural condition
Rainfall	Very intense rainfall No details
Unknowns	No specific details or analysis
Historic flooding	No information.
Reviewer Comments	1. Intense event with high runoff from rural and urban surfaces 2. Capacity exacerbated by condition of sewers 3. Grill blockage on culverts

Table 61: Report title and authority: Investigation of flooding on 28th July 2013 in Chapletown, Sheffield. Sheffield City Council.

Item	Comment
Flood event	28/7/2013, Sheffield
Report	18/9/2013, Sheffield City Council
Authors	Sheffield City Council
Topography	Steep
Land Use	Residential
Flood severity	4 flooded properties Sewage flooding
Flood sources	Culverted ordinary watercourse Combined sewer Surface water sewer possibly
Flood causes	Culvert capacity Combined sewer capacity
Rainfall	Intense rainfall 24mm/hr 1:17 year rainfall return period
Unknowns	Limited specific hydraulic details
Historic flooding	Yes, reference to previous several events.
Reviewer Comments	1. Urban ordinary culverted watercourse has a throttle due to pipe size reduction 2. Combined sewer flooding just a capacity problem 3. Surface water sewer had some sediment 4. Reporting of investigations is useful 5. Also the assessment of return period, but no reporting of rainfall depth and duration 6. Clean up campaign needed to remove silt and debris.

Table 62: Report title and authority: Investigation of flooding on 10th June 2012. Sheffield City Council.

Item	Comment
Flood event	10/6/2012, Sheffield
Report	29/8/2012, Sheffield City Council
Authors	Sheffield City Council
Topography	Steep
Land Use	Residential
Flood severity	12 flooded properties
Flood sources	Highway drainage Sewerage flooding (foul / surface / combined??)
Flood causes	Highway drainage capacity Sewer blockage
Rainfall	Intense rainfall 32+mm/hr Unknown rainfall return period No depth or duration information
Unknowns	Unclear as to what system was not coping and blocked
Historic flooding	Yes, reference to previous several events.
Reviewer Comments	1. Flooding from road drainage, but unclear whether this is highway drainage or Yorkshire water sewers 2. Return period analysis being sought 3. Mostly just a capacity problem, but blockage on a sewer 4. Reporting of investigations is useful 5. No reporting of rainfall depth and duration 6. Clean up campaign needed to remove silt and debris.

Table 63: Report title and authority: Croscombe, Shepton Mallet, Somerset. Somerset County Council.

Item	Comment
Flood event	11/7/2012, Croscombe
Report	4/10/2012, Somerset County Council
Authors	Somerset County Council
Topography	Steep
Land Use	Residential
Flood severity	8 flooded properties
Flood sources	Rural runoff Foul flooding
Flood causes	Rural drainage capacity Highway drainage capacity Sewer capacity
Rainfall	Very intense rainfall 25mm in 2.5 hrs, 29mm in 5.5hrs, 1:4 year return period (rainfall) Wet antecedent conditions
Unknowns	None
Historic flooding	Yes, several events.
Reviewer Comments	1. Rural runoff entering town and overwhelming highway drainage capacity 2. Clean up needed of debris etc. 3. Foul flooding from combined sewer due to surcharge of river and overflow 4. Bridge analysis shows it is not a significant constraint 5. Information on return periods and catchments 6. No attempt on analysis of return period of runoff

Table 64: Report title and authority: Cuckoo Hill, North Bruton, Somerset. Somerset County Council.

Item	Comment
Flood event	28/6/2012, North Bruton
Report	12/11/2012, Somerset County Council
Authors	Somerset County Council
Topography	Steep
Land Use	Residential
Flood severity	10 to 15 properties affected
Flood sources	Surface runoff from rural and urban surfaces
Flood causes	Lack of rural drainage provision Highway drainage capacity
Rainfall	Intense rainfall during extended rainfall 27.4mm in 16.5 hrs 53mm in 3 days Return period of rainfall up to 1:10 years Return period of runoff is higher
Unknowns	No return period of runoff analysis
Historic flooding	No. New development flooded
Reviewer Comments	1. Surface runoff form saturated land 2. No information on previous rainfall and as it was November and likely to have been wet before this. 3. Great example of the need for designing for exceedence and uphill ingress of runoff

Table 65: Report title and authority: Daisy Dip. Southampton City Council.

Item	Comment
Flood event	25/04/2012, Southampton
Report	16/05/2012, Southampton City Council
Authors	Southampton City Council
Topography	Medium
Land Use	Residential
Flood severity	No properties flooded
Flood sources	surface water sewer
Flood causes	Structural damage to surface water sewer
Rainfall	Many incidents, getting worse
Unknowns	No specific hydrological or hydraulic details or analysis
Historic flooding	Yes, many events.
Reviewer Comments	1. Surface water sewer damage / blockage causing regular flooding in park and into properties

Table 66: Report title and authority: Southend-on-Sea flooding 24th August 2013. Southend-on-Sea Borough Council.

Item	Comment
Flood event	24/8/2013, Southend-on-Sea
Report	1/10/2014, URS
Authors	Southend-on-Sea Borough Council
Topography	Medium
Land Use	Mixed
Flood severity	151+ properties flooded
Flood sources	Main river Ordinary water course Surface water sewer Highway drainage
Flood causes	Main river capacity Ordinary water course capacity Main river and Ordinary watercourse blockages Surface water sewer capacity Highway drainage capacity Pumping station failure High tide backwater effects
Rainfall	Very intense rainfall 55mm in 4 hours 1:30 – 1:50 year event
Unknowns	Most details provided.
Historic flooding	Not reported
Reviewer Comments	1. Extreme event with probably limited antecedent influence. 2. Backwater influence from sea upstream through all systems 3. Blockage of grills and gully gratings

Table 67: Report title and authority: Cataract bridge mill, Mellor, Stockport. Stockport Metropolitan Borough Council.

Item	Comment
Flood event	11/5/2012, Stockport
Report	1/7/2012, Stockport Metropolitan Borough Council
Authors	Stockport Metropolitan Borough Council
Topography	Flat
Land Use	Residential
Flood severity	No flooded properties
Flood sources	Main river
Flood causes	Main river culvert blockage Main river grill blockage
Rainfall	No details
Unknowns	No specific details or analysis
Historic flooding	No.
Reviewer Comments	1. Main river culvert partially blocked and also grill partially blocked 2. Event not mentioned and presumably not significant

Table 68: Report title and authority: Flooding incidents in various locations in the Borough of Stockton on Tees on 25th and 26th September 2012. Stockton on Tees Borough Council.

Item	Comment
Flood event	25/9/2012, Stockton on Tees
Report	1/1/2013, Stockton on Tees Borough Council
Authors	Stockton on Tees Borough Council
Topography	Flat
Land Use	Mixed
Flood severity	Many properties
Flood sources	Main river Ordinary river Urban runoff
Flood causes	Primarily Main river capacity Backwater effects on surface water sewers and Highway drainage capacity
Rainfall	Big rainfall event 104mm in 48 hours Return period 1:50years (guess)
Unknowns	No specific details or analysis
Historic flooding	Yes, 1979, 2000.
Reviewer Comments	1. Very large event, critical for rivers rather than drainage – lots of fluvial flooding 2. Backwater effects to all drainage systems (surface water and Highway) 3. Wet antecedent conditions (but not mentioned) 4. FIR summarised in 6 catchment areas

Table 69: Report title and authority: Quebec Rd, Tilbury. Thurrock Council.

Item	Comment
Flood event	1/9/2012, Tilbury
Report	1/11/2013, Thurrock Council
Authors	Thurrock Council
Topography	Flat
Land Use	Residential
Flood severity	Several properties
Flood sources	Main river Surface water sewer
Flood causes	Main river capacity Surface water capacity
Rainfall	Many events No details
Unknowns	No specific details or analysis
Historic flooding	Yes, many events.
Reviewer Comments	1. River (ditch) heavily overgrown. 2. Backwater effects into surface water sewer 3. Blocked sewer due to silting up

Table 70: Report title and authority: Torbay Council FIR 6th October 2012. Torbay Council.

Item	Comment
Flood event	6/10/2012, Torbay
Report	?, Torbay Council
Authors	Torbay Council
Topography	Medium
Land Use	Residential
Flood severity	30 properties flooded
Flood sources	Main river Combined sewer Groundwater Highway drainage
Flood causes	Main river capacity Culverted watercourse screens blinded Combined sewer capacity Combined sewer blockage Highway gullies blocked Soakaway capacity Groundwater level (basement tanking)
Rainfall	Big rainfall event 66mm in 3 days 35mm in 1 day Return period max 1:8years (15 hours)
Unknowns	No
Historic flooding	Not reported.
Reviewer Comments	1. Significant but not extreme event. 2. Contribution of rural runoff unknown 3. Investigations carried out to establish causes of failure 4. Backwater effects unknown 5. Wet antecedent conditions (but not mentioned) 6. FIR summarised in 4 catchment areas plus 3 other regions

Table 71: Report title and authority: Torbay Council FIR 21st - 26th November 2012. Torbay Council.

Item	Comment
Flood event	21/11/2012, Torbay
Report	1/1/2013, Torbay Council
Authors	Torbay Council
Topography	Medium
Land Use	Residential
Flood severity	24 internally flooded properties
Flood sources	Rural runoff Urban runoff
Flood causes	Primarily Main river capacity Combined sewer capacity Highway drainage capacity
Rainfall	Big rainfall event 132mm in 7 days 40mm in 1 day Return period 1:25years for 7 days
Unknowns	No specific details or hydraulic analysis
Historic flooding	Yes.
Reviewer Comments	1. Very large long event, critical for rivers rather than drainage – lots of fluvial flooding 2. Backwater effects to drainage systems (combined. surface water and Highway) 3. Wet antecedent conditions (but not mentioned) 4. FIR summarised by catchment areas

Table 72: Report title and authority: Flooding in West Berkshire Winter 2013/14 – East Ilsley. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, East Ilsley
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	13 internally flooded properties
Flood sources	Groundwater
Flood causes	Surface runoff from groundwater Rural / Highway drainage capacity Foul sewer infiltration
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Groundwater driven event resulting in surface flows overwhelming rural and highway drainage systems 2. Major infiltration into foul sewers causing flooding from manholes

Table 73: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Lambourn. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Lambourn
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	12 internally flooded properties
Flood sources	Groundwater
Flood causes	Surface runoff from groundwater Culvert grill blockage Rural / Highway drainage capacity Foul sewer infiltration
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Groundwater driven event resulting in surface flows overwhelming rural and highway drainage systems 2. Major infiltration into foul sewers causing flooding from manholes

Table 74: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Great Shefford. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Great Shefford
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	16 internally flooded properties
Flood sources	Main river Groundwater
Flood causes	Main river capacity Surface runoff from groundwater Rural / Highway drainage capacity Foul sewer infiltration
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Main river overtopping 2. Groundwater driven event resulting in surface flows overwhelming rural and highway drainage systems 3. Major infiltration into foul sewers causing flooding from manholes

Table 75: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Newbury. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Newbury
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	41 internally flooded properties
Flood sources	Main river Urban runoff
Flood causes	Main river capacity Rural / Highway drainage capacity Combined sewer capacity
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Main river overtopping 2. Backwater effects from river on drainage systems 3. Foul sewers flooding from manholes

Table 76: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Burghfield. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Burghfield
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	18 internally flooded properties
Flood sources	Main river Ordinary watercourses Canal and Lakes Rural runoff
Flood causes	Main river capacity Rural drainage capacity Rural drainage blockage Highway drainage capacity Flooding from canal
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Main river overtopping 2. Backwater effects from river and lakes on drainage systems 3. Canal flooding

Table 77: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Streatley. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Streatley
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Medium
Land Use	Residential
Flood severity	12 internally flooded properties
Flood sources	Main river Ordinary watercourses groundwater Rural runoff
Flood causes	Main river capacity Rural drainage capacity Groundwater infiltration into foul sewers
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Main river (Thames) overtopping 2. Belief that silt levels enhanced flooding 3. Groundwater flooding 4. High levels of infiltration into foul sewers

Table 78: Report title and authority: Flooding in West Berkshire Winter 2013/14 – Purley on Thames. West Berkshire Council.

Item	Comment
Flood event	1/2/2014, Purley on Thames
Report	1/6/2014, West Berkshire Council
Authors	West Berkshire Council
Topography	Flat
Land Use	Residential
Flood severity	29 internally flooded properties
Flood sources	Main river
Flood causes	Main river capacity infiltration into foul sewers and sewage flooding
Rainfall	Overview of winter rainfall
Unknowns	No specific details or analysis
Historic flooding	Yes.
Reviewer Comments	1. Main river (Thames) overtopping 2. High levels of infiltration / ingress of water into foul sewers 3. Sewage pollution

Table 79: Report title and authority: Report on 2012 flood event - Middleton and Elmer. West Sussex County Council.

Item	Comment
Flood event	10/6/2012, Middleton and Elmer
Report	1/11/2012, West Sussex County Council
Authors	West Sussex County Council
Topography	Flat
Land Use	Residential
Flood severity	152 affected properties
Flood sources	Main river Rural runoff
Flood causes	Main river capacity Rural drainage capacity Highway drainage capacity Maintenance and blockage issues Infiltration capacity Backwater effects between drainage systems Tidal influence
Rainfall	Big rainfall event 100+mm in 16 hours Return period 1:200years
Unknowns	No specific details or analysis
Historic flooding	Not discussed
Reviewer Comments	1. Very large event, critical for both rivers and other drainage systems 2. High intensity periods within the rainfall 3. Flooding contributed to by blockages and lack of maintenance 4. Backwater effects between all drainage systems (surface water and Highway) 5. Wet antecedent conditions (but not mentioned) 6. FIR summarised in catchment areas

Table 80: Report title and authority: Report on 2012 flood event - Littlehampton. West Sussex County Council.

Item	Comment
Flood event	10/6/2012, Littlehampton
Report	1/11/2012, West Sussex County Council
Authors	West Sussex County Council
Topography	Flat
Land Use	Residential
Flood severity	152 affected properties
Flood sources	Urban runoff Rural runoff
Flood causes	Highway drainage capacity Infiltration and flows into surface, foul and combined sewers capacity Possible backwater effects
Rainfall	Big rainfall event 100+mm in 16 hours Return period 1:200years
Unknowns	No specific details or analysis
Historic flooding	Not discussed
Reviewer Comments	1. Very large event, critical for both rivers and other drainage systems 2. High intensity periods within the rainfall 3. Overloading of surface water and combined sewers 4. Wet antecedent conditions (but not mentioned)

Table 81: Report title and authority: Report on 2012 flood event – Bognor Regis and Bersted. West Sussex County Council.

Item	Comment
Flood event	10/6/2012, Bognor Regis and Bersted
Report	1/11/2012, West Sussex County Council
Authors	West Sussex County Council
Topography	Medium
Land Use	Residential
Flood severity	140 affected properties
Flood sources	Urban runoff Rural runoff
Flood causes	Main River capacity influencing backwater Rural drainage capacity Highway drainage capacity Surface water sewer capacity Possible backwater effects
Rainfall	Big rainfall event 100+mm in 16 hours Return period 1:200years
Unknowns	No specific details or analysis
Historic flooding	Not discussed
Reviewer Comments	1. Very large event, critical for both rivers and other drainage systems 2. High intensity periods within the rainfall 3. Overloading of rural, highway and surface water sewers 4. Wet antecedent conditions (but not mentioned)

Table 82: Report title and authority: Report on 2012 flood event – Manhood Peninsula. West Sussex County Council.

Item	Comment
Flood event	10/6/2012, Manhood Peninsula
Report	1/11/2012, West Sussex County Council
Authors	West Sussex County Council
Topography	Flat
Land Use	Residential
Flood severity	110 affected properties
Flood sources	Rural runoff
Flood causes	Rural drainage capacity Highway drainage capacity Surface water sewer capacity Possible backwater effects
Rainfall	Big rainfall event 100+mm in 16 hours Return period 1:200years
Unknowns	No specific details or analysis
Historic flooding	Not discussed
Reviewer Comments	1. Very large event, critical for both rivers and other drainage systems 2. High intensity periods within the rainfall 3. Very flat landscape 4. Low capacity drainage systems 5. Backwater and overloading of rural, highway and surface water sewers 6. Tidal influence 7. Wet antecedent conditions (but not mentioned)

Table 83: Report title and authority: Eleanor Street / Saddle Street / Wallgate, 24 - 26 September 2012. Wigan Council.

Item	Comment
Flood event	25/9/2012, Wigan
Report	7/11/2013, Wigan Council
Authors	Wigan Council
Topography	Medium
Land Use	Mixed
Flood severity	Unknown flooded properties
Flood sources	Main river Urban runoff
Flood causes	High river levels Backwater effects on combined sewers and Highway drainage capacity
Rainfall	Big rainfall event No information provided
Unknowns	No specific details or analysis
Historic flooding	Yes, 7 events since 2000
Reviewer Comments	1. Very large event, critical for rivers rather than drainage 2. Backwater effects from river on all drainage systems (surface water and Highway) 3. Wet antecedent conditions (but not mentioned)

Table 84: Report title and authority: Reeds lane / Reedville Grove, Leasowe. Wirral Metropolitan Borough Council.

Item	Comment
Flood event	25/9/2012, Leasowe
Report	1/1/2013, Wirral Metropolitan Borough Council
Authors	Wirral Metropolitan Borough Council
Topography	Flat
Land Use	Mixed
Flood severity	Low – external flooding
Flood sources	Main river Urban runoff
Flood causes	Main river capacity Backwater effects on surface water sewers and Highway drainage capacity Combined sewer pumping station capacity
Rainfall	Big rainfall event 70mm in 48 hours Return period 1:20years
Unknowns	No specific details or analysis
Historic flooding	Yes, 2008.
Reviewer Comments	1. Very large event, critical for rivers rather than drainage 2. Backwater effects to all drainage systems (surface water and Highway) 3. Combined sewer pumping station limiting capacity 4. Wet antecedent conditions (but not mentioned)

Table 85: Report title and authority: December 5th 2013. Wirral Metropolitan Borough Council.

Item	Comment
Flood event	5/12/2012, West Kirby and New Brighton
Report	1/1/2013, Wirral Metropolitan Borough Council
Authors	Wirral Metropolitan Borough Council
Topography	Flat
Land Use	Mixed
Flood severity	12 residential properties flooded 23 commercial businesses flooded
Flood sources	Sea
Flood causes	Surge and storm force waves tidal overtopping
Rainfall	No rainfall
Unknowns	No specific details or analysis
Historic flooding	No.
Reviewer Comments	1. Extreme flooding due to overtopping – not just wave effects.

Table 86: Report title and authority: St Andrews Avenue, Llandudno. Conway County Borough Council.

Item	Comment
Flood event	5/8/2013, Llandudno
Report	21/1/2014, Conway County Borough Council
Authors	Conway County Borough Council
Topography	Flat
Land Use	Residential
Flood severity	Several properties
Flood sources	Rural runoff Urban runoff
Flood causes	Surface water Pumping station capacity
Rainfall	rainfall event 23.4mm in around 6 hours Return period unknown, but not extreme
Unknowns	No specific details or analysis
Historic flooding	Yes, 1993, 2009.
Reviewer Comments	1. Intense rainfall event, not sufficiently quickly responded to by surface water pumping station – not a system failure 2. Culverted watercourses are now surface water sewers 3. Rapid runoff response from catchment 4. Low certainty as rainfall details not provided.

Table 87: Report title and authority: Hen Ffordd Conwy, Dwygyfylchi. Conway County Borough Council.

Item	Comment
Flood event	15/2/2014, Dwygyfylchi
Report	20/12/2014, Conway County Borough Council
Authors	Conway County Borough Council
Topography	Steep
Land Use	Residential
Flood severity	1 property
Flood sources	Rural runoff
Flood causes	Lack of rural drainage provision Highway drainage capacity Gully blockage debris
Rainfall	Medium rainfall event 30mm in 8 hours Wet antecedent condition Return period unknown
Unknowns	No specific details or analysis
Historic flooding	No
Reviewer Comments	1. Medium event, but wet antecedent conditions (but not mentioned) 2. Highway drainage overwhelmed from rural runoff and some gullies blocked

Table 88: Report title and authority: Llys y Goppa, Abergele. Conway County Borough Council.

Item	Comment
Flood event	6/7/2012, Abergele
Report	17/04/2013, Conway County Borough Council
Authors	Conway County Borough Council
Topography	Steep
Land Use	Residential
Flood severity	No properties flooded internally
Flood sources	Rural runoff
Flood causes	Blocked rural drainage
Rainfall	Small rainfall event 17mm in 24 hours Return period less than 1 year Return period of runoff higher
Unknowns	No specific details or analysis
Historic flooding	Yes,
Reviewer Comments	1. Small event, 2. Steep rural landscaped and rapid runoff 3. Unmaintained rural drainage - blocked 4. Wet antecedent conditions

Table 89: Report title and authority: Llanelian Rd, Old Colwyn. Conway County Borough Council.

Item	Comment
Flood event	25/9/2012, Colwyn
Report	22/1/2013, Conway County Borough Council
Authors	Conway County Borough Council
Topography	Steep
Land Use	Residential
Flood severity	no properties flooded
Flood sources	Rural runoff
Flood causes	Rural drainage capacity Highway drainage blockage
Rainfall	Big rainfall event 37mm in 12 hours Return period unknown Runoff return period higher
Unknowns	No specific analysis
Historic flooding	Yes, frequent flooding.
Reviewer Comments	1. Medium event 2. Highway drainage blocked by washoff from rural areas 3. Very wet antecedent conditions led to rapid rural runoff

Table 90: Report title and authority: Stour Way, Bedford. Bedford Borough Council.

Item	Comment
Flood event	13/7/2012, Bedford
Report	24/7/2012, Bedford Borough Council
Authors	Bedford Borough Council
Topography	Medium
Land Use	Residential
Flood severity	no properties flooded
Flood sources	Rural runoff
Flood causes	Rural drainage capacity Surface water grills blinding Highway drainage capacity
Rainfall	No rainfall details – (intense event) Return period unknown Runoff return period higher (wet conditions)
Unknowns	No specific analysis
Historic flooding	Yes, 2005, 2008
Reviewer Comments	1. Event size unknown 2. Provision being made to improve and intercept rural runoff 3. Very wet antecedent conditions led to rapid rural runoff

Table 91: Report title and authority: Kenneth Hill, Sharnbrook. Bedford Borough Council.

Item	Comment
Flood event	14/7/2012, Sharnbrook
Report	10/12/2012, Bedford Borough Council
Authors	Bedford Borough Council
Topography	Flat
Land Use	Residential
Flood severity	1 property flooded
Flood sources	Foul sewage
Flood causes	Pumping station failure due to Highway drainage blockage preventing overflow operation
Rainfall	Big rainfall event No information provided
Unknowns	No specific analysis
Historic flooding	Yes, 2010 and 2 times in 2012.
Reviewer Comments	1. Regular problem during rainfall due to Highway drainage blockage 2. Pumping station trips out when it floods out. 3. Presumably either combined sewer or high inflows of rainfall runoff

Table 92: Report title and authority: Silver Street, Stevington. Bedford Borough Council.

Item	Comment
Flood event	26/11/2012, Stevington
Report	12/2/2013, Bedford Borough Council
Authors	Bedford Borough Council
Topography	Medium
Land Use	Residential
Flood severity	1 property flooded
Flood sources	Rural runoff
Flood causes	Rural drainage blockage
Rainfall	rainfall event no information Return period unknown Runoff return period likely to be higher
Unknowns	No specific analysis
Historic flooding	Yes, frequent flooding.
Reviewer Comments	1. Blockage of land drain 2. Riparian responsibility 3. Very wet antecedent conditions led to rapid rural runoff

Table 93: Report title and authority: Hallgarth, Kendal. Cumbria County Council.

Item	Comment
Flood event	28/6/2012, Kendal
Report	5/3/2013, Cumbria County Council
Authors	Cumbria County Council
Topography	Steep
Land Use	Residential
Flood severity	7 properties internally flooded
Flood sources	Rural runoff Urban runoff
Flood causes	Rural drainage capacity Surface water sewer flooding (capacity) Combined sewer flooding and infiltration
Rainfall	Big rainfall event 52mm in 24 hours 20mm in 15mins Return period unknown (high) Runoff return period higher
Unknowns	No specific analysis
Historic flooding	Yes, frequent flooding.
Reviewer Comments	1. Big event 2. Overloading of sewers possibly exacerbated by infiltration 3. Very wet antecedent conditions led to rapid rural runoff

Table 94: Report title and authority: City wide flash flooding – August 2012. Hull City Council.

Item	Comment
Flood event	25/8/2012, Hull
Report	23/1/2013, Hull City Council
Authors	Hull City Council
Topography	Flat
Land Use	Mixed
Flood severity	21 properties flooded
Flood sources	Urban runoff
Flood causes	Highway drainage capacity
Rainfall	Intense rainfall event Very localised in extent 34mm in 2 hours Return period up to 1:300 yrs Runoff return period the same
Unknowns	No specific analysis
Historic flooding	Yes
Reviewer Comments	1. Intense event 2. Highway drainage inflow capacity not sufficient to drain runoff 3. Downstream system not full 4. Necessity for temporary storage attenuation on the surface

Table 95: Report title and authority: Section 19 – heavy rain August 2014. Hull City Council.

Item	Comment
Flood event	10/8/2014, Hull
Report	23/3/2015, Hull City Council
Authors	Hull City Council
Topography	Flat
Land Use	Mixed
Flood severity	3 properties flooded
Flood sources	Urban runoff
Flood causes	Surface water sewers capacity Highway drainage capacity
Rainfall	Medium sized rainfall event 33mm in 4 hours Return period unknown Runoff return period similar
Unknowns	No specific analysis
Historic flooding	Yes.
Reviewer Comments	1. Medium event 2. Highway drainage overwhelmed – probably backwater effects 3. Surface water sewers overwhelmed

Table 96: Report title and authority: December 2013 City Centre Tidal Surge flood event. Hull City Council.

Item	Comment
Flood event	5/12/2012, Hull
Report	4/2/2014, Hull City Council
Authors	Hull City Council
Topography	Flat
Land Use	Mixed
Flood severity	250 properties flooded
Flood sources	Sea level
Flood causes	Tidal surge
Rainfall	No rainfall
Unknowns	None
Historic flooding	Yes.
Reviewer Comments	1. No rainfall occurred during the event. 2. No discussion on drainage provision for addressing tidal surge

Table 97: Report title and authority: Carisbrooke / Newport. Isle of Wight Council.

Item	Comment
Flood event	23/12/2013, Newport
Report	24/6/2014, Isle of Wight Council
Authors	Isle of Wight Council
Topography	Steep
Land Use	Residential
Flood severity	unknown properties flooded
Flood sources	Rural runoff Urban runoff
Flood causes	Uncertain Main river capacity Highway drainage capacity Surface water sewer capacity
Rainfall	Big rainfall event 74mm in 16 hours Return period unknown (High) Runoff return period similar or higher (no antecedent info)
Unknowns	No specific analysis
Historic flooding	No
Reviewer Comments	1. Very poor description of event and circumstances 2. Type of event would make it critical for rivers but possibly also drainage systems 3. Likely to be wet antecedent conditions at this time of year for rapid rural runoff

Table 98: Report title and authority: Chew Stoke FIR 2011 - 2012. Bath and North East Somerset Council.

Item	Comment
Flood event	24/9/2012, Chew Stoke
Report	30/08/2013, Bath and North East Somerset Council
Authors	JBA
Topography	Steep
Land Use	Residential
Flood severity	unknown number of properties flooded
Flood sources	Rural runoff River flooding
Flood causes	Main river capacity Ordinary watercourse capacity Rural drainage capacity Highway drainage capacity Surface water sewer capacity
Rainfall	Big rainfall event 70mm in 24 hours Return period 15 years Runoff return period higher (antecedent wetness)
Unknowns	
Historic flooding	yes
Reviewer Comments	1. Not really a Section 19 report – multi-event analysis 2. Focus on hydrology and not impact and causes 3. River flooding and surface runoff flooding 4. Wet antecedent conditions so higher return period of runoff

Table 99: Report title and authority: Investigation of tidal surge 5th / 6th December 2013. Northumberland County Council.

Item	Comment
Flood event	5/12/2013, Amble and other locations
Report	14/1/2014, Northumberland County Council
Authors	Northumberland County Council
Topography	flat
Land Use	Residential
Flood severity	8 properties flooded
Flood sources	Sea level
Flood causes	Overtopping
Rainfall	No rainfall Return period ~1:450 years
Unknowns	No specific analysis
Historic flooding	No
Reviewer Comments	1. No description of circumstances 2. No discussion of flooding provision or drainage

Table 100: Report title and authority: Devon summer floods 7th – 8th July 2012. Devon County Council.

Item	Comment
Flood event	7/7/2012, Avonwick and another 12 regional locations
Report	6/12/2012, Devon County Council
Authors	Devon County Council
Topography	Steep
Land Use	Residential
Flood severity	237 properties flooded internally
Flood sources	Rural runoff Urban runoff River runoff
Flood causes	Main river capacity Ordinary watercourse capacity Highway drainage capacity Highway drainage blockage Surface water sewer capacity Rural drainage capacity
Rainfall	Big rainfall event 125mm in 24 hours (Axe catchment) Return period unknown 1:100 years Runoff return period higher
Unknowns	No specific analysis – 12 regional summaries
Historic flooding	Yes
Reviewer Comments	1. FIR for 36 towns and villages, in 12 regional groupings 2. Reasonable evaluation of the issues and causes 3. Fluvial and pluvial causes 4. Rural runoff washoff of debris and silts an issue 5. wet antecedent conditions would have made these even rarer than 1:100 year events, though each location will have its own critical duration.

Table 97: Report title and authority: Carisbrooke / Newport. Isle of Wight Council.

Item	Comment
Flood event	23/12/2013, Newport
Report	24/6/2014, Isle of Wight Council
Authors	Isle of Wight Council
Topography	Steep
Land Use	Residential
Flood severity	unknown properties flooded
Flood sources	Rural runoff Urban runoff
Flood causes	Uncertain Main river capacity Highway drainage capacity Surface water sewer capacity
Rainfall	Big rainfall event 74mm in 16 hours Return period unknown (High) Runoff return period similar or higher (no antecedent info)
Unknowns	No specific analysis
Historic flooding	No
Reviewer Comments	1. Very poor description of event and circumstances 2. Type of event would make it critical for rivers but possibly also drainage systems 3. Likely to be wet antecedent conditions at this time of year for rapid rural runoff

Appendix 3 – Tables of Causes of flooding

Section 19 Reviews - Causes of flooding

ref	Section 19 report	LLFA	Date of report	Flood location	Date of event	Damage severity	Flood causes												
							Sea	Main river	Ordinary water course	Surface water (rural)	Surface water (urban)	Foul Sewer flooding	Highway drainage	Ground water	Lake / canal	Level of detail	Confidence in the assessment	Nr. of flooded properties	Nr. Certainty
nr	Title	Authority Name	Date	Town	Date	H/M/L/N										H/M/L	H/M/L		
1	Canvey Island, Castle Point Borough	Essex County Council	04/10/2014	Canvey Island	20/07/2014	H	N/A	N/A	Capacity	N/A	Capacity	N/A	Capacity	N/A	N/A	L	H	99.9	Many
2	Silver Street, Chacombe	Northamptonshire County Council	03/07/2013	Chacombe	16/03/2013	L	N/A	N/A	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	M	H	1	
3	Cwmbran	Torfaen County Borough Council	09/10/2014	Cwmbran	22/05/2014	H	N/A	N/A	Blockage	Capacity	Capacity	N/A	Capacity	N/A	N/A	H	H	198	
4	Braunton flood incident	Devon County Council	20/09/2011	Braunton	29/07/2011	M	N/A	Capacity	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	H	H	4	
5	Chew Magna FIR 2011 - 2012	Bath & North East Somerset Council	30/08/2013	Chew Magna	24/09/2012	H	N/A	Capacity	Blockage	Capacity	Capacity	N/A	Capacity	Capacity	Capacity	L	M	60	Estimate
6	Broadmead lane industrial estate FIR Winter 2013 / 2014	Bath & North East Somerset Council	05/06/2014	Keynsham	24/12/2013	H	N/A	Capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L	M	16	
7	edgehope Avenue, Rayleigh Rochford	Essex County Council	02/04/2012	Rochford	03/01/2012	M	N/A	N/A	Blockage	N/A	N/A	N/A	N/A	N/A	N/A	L	M	9.9	Few
8	Sandygate and Luton FIR	Devon County Council	19/12/2012	Sandygate and Luton	05/09/2012	M	N/A	N/A	Capacity	N/A	N/A	N/A	Blockage	N/A	N/A	M	H	10	
9	Devon floods 4th - 5th August 2013	Devon County Council	01/01/2014	9 towns across Devon	04/08/2013	L	N/A	Capacity	Capacity	N/A	Capacity	N/A	Blockage	N/A	N/A	L	L	18	
10	Elland, Halifax – 8th July 2014 FIR	Calderdale Metropolitan Borough Cour	01/01/2015	Elland	08/07/2014	L	N/A	N/A	N/A	N/A	Capacity	Capacity	Blockage	N/A	N/A	L	H	6	
11	Lower road (B4443), Stoke Mandeville, Winter 2013/2014	Buckinghamshire County Council	06/06/2014	Stoke Mandeville	14/02/2014	L	N/A	N/A	N/A	N/A	N/A	N/A	Blockage	N/A	N/A	H	H	1	
12	The Willows, Aylesbury, 7th February 2014	Buckinghamshire County Council	30/04/2014	Aylesbury	07/02/2014	H	N/A	N/A	Capacity	N/A	Capacity	N/A	N/A	N/A	N/A	H	H	79	
13	Bishopstone, Aylesbury 24th December 2013 – 14th February 2014	Buckinghamshire County Council	30/05/2014	Bishopstone	07/02/2014	H	N/A	Capacity	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	M	H	2	
14	Groundwater flooding in Brighton and Hove City	Brighton and Hove City Council	01/06/2014	Patcham, Portslade	05/02/2014	L	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	Capacity	N/A	M	H	3	Several
15	Langtree, Jubilee Lane, Blackpool	Blackpool Council	01/12/2012	Langtree	24/09/2012	N	N/A	N/A	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	L	M	0	
16	Pilinge Rd / Park Crescent, Stewartby. Bedford Borough Council		05/04/2013	Stewartby	28/04/2012	N	N/A	N/A	N/A	Capacity	Capacity	N/A	N/A	N/A	N/A	M	M	0	
17	Newton Rd, Little Shelford	Cambridgeshire County Council	01/09/2014	Shelford	01/01/2014	L	N/A	N/A	N/A	N/A	N/A	N/A	Blockage	N/A	N/A	L	M	3	Several
18	Looe	Cornwall Council	01/01/2013	Looe	14/12/2012	H	Overtopping	N/A	N/A	N/A	Capacity	N/A	N/A	N/A	N/A	L	M	50	
19	Frogpool	Cornwall Council	01/04/2014	Frogpool	14/02/2014	L	N/A	N/A	N/A	N/A	Capacity	N/A	N/A	N/A	N/A	L	M	1	
20	Floods in Camden	London Borough of Camden	01/06/2003	Camden	07/08/2002	H	N/A	N/A	N/A	N/A	Capacity	Capacity	Capacity	N/A	N/A	L	M	99.9	Not stated
21	Badger Hill / Hull Rd, York	City of York Council	01/03/2013	York	10/06/2012	H	N/A	N/A	N/A	N/A	Blockage	Capacity	Blockage	N/A	N/A	H	H	19	
22	South Winterbourne FIR	Dorset County Council	01/07/2013	South Winterbourne	07/07/2012	H	N/A	N/A	Capacity	Capacity	Capacity	N/A	N/A	Capacity	N/A	H	H	42	
23	Leeman road area	City of York Council	02/02/2013	York	26/09/2012	L	N/A	Capacity	N/A	N/A	Capacity	N/A	N/A	N/A	N/A	M	H	0	
24	Town End farm, Coulderton. FIR33	Cumbria County Council	31/03/2014	Coulderton	30/08/2012	L	N/A	N/A	N/A	Capacity	N/A	N/A	Capacity	N/A	N/A	H	H	1	
25	Glassonby FIR64	Cumbria County Council	26/03/2014	Glassonby	28/06/2012	M	N/A	N/A	Capacity	Capacity	N/A	N/A	Capacity	N/A	N/A	H	H	6	
26	Highgate & Kirkland, Kendal FIR69	Cumbria County Council	28/04/2013	Kendal	28/06/2012	M	N/A	N/A	N/A	Capacity	Capacity	N/A	Capacity	N/A	N/A	M	M	9	estimate
27	Flood event data recording system	Doncaster MBC	-	Doncaster	03/08/2011	M	N/A	N/A	N/A	N/A	Capacity	N/A	Capacity	N/A	N/A	L	M	22	
28	Dorset County Council July 2012 Flood Investigation Report	Dorset County Council	01/01/2013	70 communities acros	06/07/2012	H	N/A	Capacity	Capacity	Capacity	Capacity	Capacity	Capacity	Capacity	N/A	M	M	279	Estimate
29	Report on Romsey Flooding Incidient Investigation - Phase One: Technical Report	Hampshire County Council	01/04/2014	Romsey: 5 communiti	23/12/13 - 06/02	H	N/A	Capacity	Blockage	Capacity	Capacity	Capacity	Capacity	Capacity	N/A	M	M	96	Estimate
30	Ceredigion County Council Flood Investigation Report	Ceredigion County Council	09/06/2012	North Ceredigion	08/06/12 - 09/06	H	N/A	Capacity	Capacity	N/A	N/A	N/A	N/A	N/A	Capacity	L	M	120	
31	November 2012 Floods at Glasdir, Ruthin from the River Clwyd: Report on the Review.	Denbighshire County Council	27/08/2013	Glasdir, Ruthin	27/11/2012	H	N/A	Capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L	M	122	
32	Flood Investigation Report Goole Floods, 3 August 2011	East Riding of Yorkshire Council	01/01/2012	Goole	03/08/2011	H	N/A	N/A	N/A	N/A	Capacity	Capacity	Capacity	N/A	N/A	L	M	631	
33	Hampshire County Council St Mary Bourne Flood Investigation Report	Hampshire County Council	14/12/2014	St Mary Bourne, Hamp	01/12/2012	L	N/A	N/A	N/A	N/A	N/A	Capacity	N/A	Capacity	N/A	L	M	99.9	Not stated
34	Final report on Incident Investigation into Buckskin flooding	Hampshire County Council	09/07/2014	Buckskin, Hampshire	08/02/2014 - 31	M	N/A	N/A	N/A	N/A	Blockage	Capacity	Capacity	Capacity	N/A	L	M	45	45 certainly, 88 estimated
35	Flood Investigation Report, Location - Llanberis, Date - 22/11/2012	Gwynedd Council	22/02/2013	Llanberis	22/11/2012	H	N/A	Capacity	Blockage	N/A	Blockage	N/A	Capacity	N/A	N/A	L	M	70	
36	Thornford Rd Ford, Thornford Rd, Headley	Hampshire county council	01/09/2012	Headley	30/04/2012	L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	H	H	0	1 death
37	DCC investigation into the November 2012 Floods FIR - Part 1.	Denbighshire County Council	01/02/2013	Glasdir, St. Asaph	27/11/2012	H	N/A	Capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L	M	320	plus 70 caravans
38	Flooding to properties in Rhyl	Denbighshire County Council	07/05/2014	Rhyl	05/12/2013	H	Overtopping	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	M	H	200	Estimate
39	Green Street, Chorleywood, Hertfordshire FIR.	Hertfordshire county Council	30/06/2014	Chorleywood	01/12/2013	L	N/A	N/A	N/A	Capacity	N/A	N/A	Capacity	N/A	N/A	L	H	0	Road closures
40	Flood investigation 6 Enfield Close, Batley	Kirklees council	23/01/2012	Batley	03/01/2012	L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	capacity	N/A	L	L	0	Road closures
41	Knebworth FIR. Hertfordshire	Hertfordshire county Council	08/01/2015	Knebworth	07/01/2014	H	N/A	N/A	N/A	Capacity	N/A	N/A	capacity	capacity	N/A	L	L	18	
42	Robbery bottom Lane, Welwyn FIR.	Hertfordshire county Council	10/10/2014	Welwyn	07/02/2014	H	N/A	N/A	N/A	Capacity	N/A	N/A	capacity	N/A	N/A	H	H	9	
43	Cowes and East Cowes FIR	Isle of Wight Council	24/06/2014	Cowes	14/02/2014	H	Overtopping	N/A	N/A	N/A	Capacity	N/A	N/A	N/A	N/A	L	H	50	Estimate
44	Cothelstone Avenue	Leicestershire County Counicl	04/06/2014	Loughborough	28/06/2012	L	N/A	Capacity	N/A	Capacity	Capacity	N/A	capacity	N/A	N/A	L	M	2	
45	Lancashire summer 2012	Lancashire County Council	01/01/2013	Lancashire	23/06/2012	H	N/A	Capacity	Capacity	Capacity	Capacity	N/A	capacity	N/A	N/A	L	H	165	
46	Section 19 investigations	Lincolnshire County Council	16/06/2014	Horncastle and others	28/06/2012	H	N/A	Capacity	Capacity	Capacity	Capacity	N/A	capacity	N/A	N/A	L	H	121	
47	Blackbrook Rd / West End Rd September 2012	St. Helens Council	01/01/2013	St. Helens	24/09/2012	H	N/A	Capacity	N/A	Capacity	N/A	N/A	capacity	N/A	N/A	L	M	10	
48	December 2013 - June 2014	Hillingdon Borough Council	01/06/2014	Hillingdon	01/01/2014	L	N/A	Capacity	Capacity	Capacity	Capacity	N/A	capacity	capacity	N/A	L	M	1	
49	Summer 2012 Flooding in Newcastle upon Tyne	Newcastle City Council	28/06/2012	Newcastle upon Tyne	01/07/2013	H	N/A	N/A	N/A	N/A	Capacity	N/A	capacity	N/A	N/A	L	L	500	
50	King's Lynn & West norfolk Walpole Cross Keys Sutton Rd.	Norfolk county Council	15/08/2013	Walpole Cross keys	26/11/2012	L	N/A	N/A	blockage	N/A	N/A	N/A	capacity	Capacity	N/A	L	L	1	

ref	Section 19 report	LLFA	Date of report	Flood location	Date of event	Rainfall severity	Max' Intensity	Depth 1	Duration 1	Depth 2	Duration 2	Max' Rainfall R.Period	Analysis detail	Data Certainty	Topography	Land use	Historic flooding
nr	Title	Authority Name	Date	Town	Date	H/M/L	mm/hr	mm	Hr	Nr	Hr	Nr.	H/M/L/N	H/M/L/N			Y/N
1	Canvey Island, Castle Point Borough	Essex County Council	04/10/2014	Canvey Island	20/07/2014	H	80	80	1	100	4	316	M	M	Flat	Residential	Y
2	Silver Street, Chacombe	Northamptonshire County Council	03/07/2013	Chacombe	16/03/2013	L	-	20	24	-	-	-	L	M	Steep	Residential	Y
3	Cwmbran	Torfaen County Borough Council	09/10/2014	Cwmbran	22/05/2014	H	78	33	0.4	-	-	150	H	M	Steep	Residential	Y
4	Braunton flood incident	Devon County Council	20/09/2011	Braunton	29/07/2011	M	-	40	2	-	-	-	H	H	Flat	Commercial	Y
5	Chew Magna FIR 2011 - 2012	Bath & North East Somerset Council	30/08/2013	Chew Magna	24/09/2012	M	-	69	24	13	1	18	H	H	Steep	Residential	Y
6	Broadmead lane industrial estate FIR Winter 2013 / 2014	Bath & North East Somerset Council	05/06/2014	Keynsham	24/12/2013	H	-	-	-	-	-	-	N	N	Flat	Industrial	Y
7	edgehope Avenue, Rayleigh Rochford	Essex County Council	02/04/2012	Rochford	03/01/2012	L	-	9	2	-	-	1	M	H	Medium	Residential	Y
8	Sandygate and Luton FIR	Devon County Council	19/12/2012	Sandygate and Luton	05/09/2012	H	-	30	6	42	24	20	L	H	Steep	Rural	Y
9	Devon floods 4th - 5th August 2013	Devon County Council	01/01/2014	9 towns across Devon	04/08/2013	H	-	-	-	-	-	-	N	N	Steep	Mixed	Y
10	Elland, Halifax – 8th July 2014 FIR	Calderdale Metropolitan Borough Council	01/01/2015	Elland	08/07/2014	H	-	-	0.4	-	2	-	N	N	Steep	Mixed	N
11	Lower road (B4443), Stoke Mandeville, Winter 2013/2014	Buckinghamshire County Council	06/06/2014	Stoke Mandeville	14/02/2014	L	-	9	24	195	1272	-	L	H	Medium	Rural	Y
12	The Willows, Aylesbury, 7th February 2014	Buckinghamshire County Council	30/04/2014	Aylesbury	07/02/2014	L	-	9	2	136	144	-	L	H	Flat	Residential	N
13	Bishopstone, Aylesbury 24th December 2013 – 14th February 2014	Buckinghamshire County Council	30/05/2014	Bishopstone	07/02/2014	L	-	195	1272	-	-	-	L	H	Medium	Residential	Y
14	Groundwater flooding in Brighton and Hove City	Brighton and Hove City Council	01/06/2014	Patcham, Portslade	05/02/2014	H	-	589	2160	-	-	-	L	H	Medium	Residential	Y
15	Langtree, Jubilee Lane, Blackpool	Blackpool Council	01/12/2012	Langtree	24/09/2012	H	-	-	-	-	-	-	N	-	Medium	Residential	N
16	Pilinge Rd / Park Crescent, Stewartby. Bedford Borough Council		05/04/2013	Stewartby	28/04/2012	M	-	26	18	-	-	-	L	H	Flat	Residential	N
17	Newton Rd, Little Shelford	Cambridgeshire County Council	01/09/2014	Shelford	01/01/2014	L	-	-	-	-	-	-	N	-	Flat	Residential	N
18	Looe	Cornwall Council	01/01/2013	Looe	14/12/2012	H	-	-	-	-	-	-	N	-	Flat	Residential	N
19	Frogpool	Cornwall Council	01/04/2014	Frogpool	14/02/2014	H	-	-	-	-	-	-	N	-	Medium	Residential	N
20	Floods in Camden	London Borough of Camden	01/06/2003	Camden	07/08/2002	H	-	-	-	-	-	-	N	-	Medium	Mixed	Y
21	Badger Hill / Hull Rd, York	City of York Council	01/03/2013	York	10/06/2012	H	-	30	0.8	-	-	20	L	H	Medium	Residential	Y
22	South Winterbourne FIR	Dorset County Council	01/07/2013	South Winterbourne	07/07/2012	H	-	115	38	-	-	80	M	H	Steep	Residential	Y
23	Leeman road area	York Council	02/02/2013	York	26/09/2012	-	-	-	-	-	-	-	H	H	Flat	Residential	Y
24	Town End farm, Coulderton. FIR33	Cumbria County Council	31/03/2014	Coulderton	30/08/2012	H	18	32	6	-	-	-	M	H	Steep	Residential	Y
25	Glassonby FIR64	Cumbria County Council	26/03/2014	Glassonby	28/06/2012	H	40	40	-	-	-	-	M	M	Steep	Residential	Y
26	Highgate & Kirkland, Kendal FIR69	Cumbria County Council	28/04/2013	Kendal	28/06/2012	H	100	30	1	-	-	-	M	M	Steep	Commercial	Y
27	Flood event data recording system	Doncaster MBC	-	Doncaster	03/08/2011	-	-	-	-	-	-	-	-	-	Medium	Mixed	-
28	Dorset County Council July 2012 Flood Investigation Report	Dorset County Council	01/01/2013	70 communities across Dorset	06/07/2012	-	-	115.5	145	-	-	80	N	M	Steep	Rural	-
29	Report on Romsey Flooding Incidient Investigation - Phase One: Technical Report	Hampshire County Council	01/04/2014	Romsey: 5 communities	23/12/13 - 06/02/1	-	-	415	1080	74	12	-	N	M	Steep	Residential	-
30	Ceredigion County Council Flood Investigation Report	Ceredigion County Council	09/06/2012	North Ceredigion	08/06/12 - 09/06/1	-	-	190	0.4	161.75	0.6	200	N	L	Steep	Rural	Y
31	November 2012 Floods at Glasdir, Ruthin from the River Clwyd: Report on the Review.	Denbighshire County Council	27/08/2013	Glasdir, Ruthin	27/11/2012	-	-	-	-	-	-	100	M	L	Floodplain	Residential	Y
32	Flood Investigation Report Goole Floods, 3 August 2011	East Riding of Yorkshire Council	01/01/2012	Goole	03/08/2011	-	-	30	0.75	64	0.75	45	L	L	Flat	Mixed	-
33	Hampshire County Council St Mary Bourne Flood Investigation Report	Hampshire County Council	14/12/2014	St Mary Bourne, Hampshire	01/12/2012	-	-	-	-	-	-	-	N	L	Medium	Rural	Y
34	Final report on Incident Investigation into Buckskin flooding	Hampshire County Council	09/07/2014	Buckskin, Hampshire	08/02/2014 - 31/0	-	-	18	24	2.4	0.25	-	N	L	Steep	Residential	-
35	Flood Investigation Report, Location - Llanberis, Date - 22/11/2012	Gwynedd Council	22/02/2013	Llanberis	22/11/2012	-	-	-	-	-	-	-	N	L	Steep	Urban	Y
36	Thornford Rd Ford, Thornford Rd, Headley	Hampshire county council	01/09/2012	Headley	30/04/2012	H	-	-	-	-	-	-	L	H	Steep	Rural	Y
37	DCC investigation into the November 2012 Floods FIR - Part 1.	Denbighshire County Council	01/02/2013	Glasdir, St. Asaph	27/11/2012	H	-	-	-	-	-	100	L	H	Steep	Urban	-
38	Flooding to properties in Rhyl	Denbighshire County Council	07/05/2014	Rhyl	05/12/2013	-	-	-	-	-	-	200	M	H	Flat	Urban	Y
39	Green Street, Chorleywood, Hertfordshire FIR.	Hertfordshire county Council	30/06/2014	Chorleywood	01/12/2013	L	-	-	-	-	-	-	L	H	Medium	Rural	Y
40	Flood investigation 6 Enfield Close, Batley	Kirklees council	23/01/2012	Batley	03/01/2012	L	-	-	-	-	-	-	L	H	Medium	Residential	N
41	Knebworth FIR. Hertfordshire	Hertfordshire county Council	08/01/2015	Knebworth	07/01/2014	L	-	-	-	-	-	-	L	H	Medium	Residential	Y
42	Robbery bottom Lane, Welwyn FIR.	Hertfordshire county Council	10/10/2014	Welwyn	07/02/2014	L	-	35	9	-	-	3	H	M	Medium	Residential	Y
43	Cowes and East Cowes FIR	Isle of Wight Council	24/06/2014	Cowes	14/02/2014	-	-	-	-	-	-	-	L	N	Flat	Commercial	Y
44	Cothelstone Avenue	Leicestershire County Counicl	04/06/2014	Loughborough	28/06/2012	H	-	22	6	-	-	-	L	M	Medium	Residential	N
45	Lancashire summer 2012	Lancashire County Council	01/01/2013	Lancashire	23/06/2012	H	-	100	48	-	-	-	L	M	Medium	Mixed	-
46	Section 19 investigations	Lincolnshire County Council	16/06/2014	Horncastle and others	28/06/2012	H	-	-	-	-	-	50	L	M	Medium	Mixed	-
47	Blackbrook Rd / West End Rd September 2012	St. Helens Council	01/01/2013	St. Helens	24/09/2012	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
48	December 2013 - June 2014	Hillingdon Borough Council	01/06/2014	Hillingdon	01/01/2014	-	-	157	720	-	-	-	L	M	Medium	Mixed	N
49	Summer 2012 Flooding in Newcastle upon Tyne	Newcastle City Council	28/06/2012	Newcastle upon Tyne	01/07/2013	H	-	50	2	-	-	-	L	H	Medium	Mixed	Y
50	King's Lynn & West norfolk Walpole Cross Keys Sutton Rd.	Norfolk county Council	15/08/2013	Walpole Cross keys	26-Nov-12	-	-	-	-	-	-	-	L	H	Flat	Residential	-
51	North Somerset Flod investigations	North Somerset Council	01/06/2013	North Somerset	04/08/2012	H	-	63	24	-	-	-	L	L	Medium	Mixed	Y
52	Gainsborough Rd Corby FIR	Northamptonshire County Council	08/04/2014	Corby	23/12/2013	M	-	20	24	-	-	-	L	M	Medium	Mixed	Y
53	Flooding on the A45 eastbound between Great Doddington and Wilby Way	Northamptonshire County Council	29/08/2012	Doddington	14/07/2012	H	-	22	1	40	4	-	L	H	Medium	Rural	N
54	Deenethorpe Nr. Corby	Northamptonshire County Council	10/11/2014	Deenethorpe	14/02/2014	L	-	10	24	-	-	-	M	H	Medium	Residential	N

ref	Section 19 report	LLFA	Date of report	Flood location	Date of event	Rainfall severity	Max' Intensity	Depth 1	Duration 1	Depth 2	Duration 2	Max' Rainfall R.Period	Analysis detail	Data Certainty	Topography	Land use	Historic flooding
nr	Title	Authority Name	Date	Town	Date	H/M/L	mm/hr	mm	Hr	Nr	Hr	Nr.	H/M/L/N	H/M/L/N			Y/N
55	Duck End, Denford FIR	Northamptonshire County Council	17/04/2013	Denford	21/11/2012	M	-	25	24	-	-	-	M	H	Medium	Residential	N
56	Harts lane, East Farndon FIR.	Northamptonshire County Council	26/02/2013	East Farndon	21/11/2012	M	-	30	24	-	-	-	M	H	Medium	Residential	N
57	Acomb	Northumberland County Council	12/11/2012	Acomb	28/06/2012	H	-	-	-	-	-	-	L	H	Medium	Residential	Y
58	Investigations of the summer 2012 floods	Northumberland County Council	30/12/2013	Northumberland	28/06/2012	H	-	56	2.5	-	-	195	L	M	Steep	Mixed	Y
59	Upper Calder Valley - 29th July 2013 FIR	Calderdale Metropolitan Borough Council	28/11/2013	Walsden	29/07/2013	H	140	30	2	-	-	-	L	H	Steep	Residential	Y
60	Investigation of flood incident affecting areas of south east Sheffield on 30th April 2014	Sheffield City Council	16/06/2014	Sheffield	30/04/2014	H	-	-	-	-	-	-	M	H	Steep	Residential	-
61	Investigation of flooding on 28th July 2013 in Chapletown, Sheffield	Sheffield City Council	18/09/2013	Sheffield	28/07/2013	H	24	-	-	-	-	17	M	M	Steep	Residential	Y
62	Investigation of flooding on 10th June 2012 in Chapletown, Sheffield	Sheffield City Council	29/08/2012	Sheffield	10/06/2012	H	32	-	-	-	-	-	L	M	Steep	Residential	Y
63	Croscombe, Shepton Mallet, Somerset	Somerset County Council	04/10/2012	Croscombe	11/07/2012	H	20	24	2.5	29	5.5	4	M	H	Steep	Residential	Y
64	Cuckoo Hill, North Bruton, Somerset	Somerset County Council	12/11/2012	North Bruton	28/06/2012	H	40	15	0.5	27	16.5	10	M	H	Steep	Residential	N
65	Daisy Dip	Southampton City Council	16/05/2012	Southampton	25/04/2012	H	-	-	-	-	-	-	L	H	Medium	Residential	Y
66	Southend-on-Sea flooding 24th August 2013	Southend-on-Sea Borough Council	01/10/2014	Southend-on-Sea	24/08/2013	H	-	55	4	-	-	50	M	H	Medium	Residential	N
67	Cataract bridge mill, Mellor, Stockport	Stockport Metropolitan Borough Council	01/07/2012	Stockport	11/05/2012	-	-	-	-	-	-	-	L	H	Flat	Residential	N
68	Flooding incidents in various locations in the Borough of Stockton on Tees on 25th and 26th September 2012	Stockton on Tees Borough Council	01/01/2013	Stockton on Tees	25/09/2012	H	-	104	48	-	-	-	L	H	Flat	Mixed	Y
69	Quebec Rd, Tilbury	Thurrock Council	01/11/2013	Tilbury	01/09/2012	-	-	-	-	-	-	-	L	H	Flat	Residential	Y
70	Torbay Council FIR 6th October 2012	Torbay Council	01/11/2013	Torbay	06/10/2012	H	-	35	24	132	72	8	M	H	Medium	Residential	Y
71	Torbay Council FIR 21st - 26th November 2012	Torbay Council	01/11/2013	Torbay	21/11/2012	H	-	40	24	66	168	25	M	H	Medium	Residential	Y
72	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	East Ilsley	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
73	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Lambourn	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
74	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Great Shefford	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
75	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Newbury	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
76	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Burghfield	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
77	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Streatley	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
78	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Purley on Thames	01/02/2014	-	-	-	-	-	-	-	L	M	Flat	Residential	Y
79	Report on 2012 flood event - Middleton and Elmer	West Sussex County Council	01/11/2012	Middleton and Elmer	10/06/2012	H	-	100	16	-	-	-	M	M	Flat	Residential	Y
80	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Littlehampton	10/06/2012	H	-	100	16	-	-	-	M	M	Flat	Residential	Y
81	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Bognor Regis and Bersted	10/06/2012	H	-	100	16	-	-	-	L	M	Medium	Residential	Y
82	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Manhood Peninsula	10/06/2012	H	-	100	16	-	-	-	L	M	Flat	Residential	Y
83	Eleanor Street / Saddle Street / Wallgate, 24 - 26 September 2012	Wigan Council	07/11/2013	Wigan	25/09/2012	H	-	-	-	-	-	-	L	L	Medium	Mixed	Y
84	Reeds lane / Reedville Grove, Leasowe	Wirral Metropolitan Borough Council	01/01/2013	Leasowe	25/09/2012	H	-	70	48	-	-	-	L	L	Flat	Mixed	Y
85	December 5th 2013	Wirral Metropolitan Borough Council	01/01/2014	West Kirby and New Brighton	05/12/2013	-	-	-	-	-	-	-	L	H	Flat	Mixed	-
86	St Andrews Avenue, Llandudno	Conway County Borough Council	21/01/2014	Llandudno	05/08/2013	M	-	23	6	-	-	-	L	M	Flat	Residential	-
87	Hen Ffordd Conwy, Dwygyfylchi	Conway County Borough Council	20/12/2014	Dwygyfylchi	15/02/2014	M	-	30	8	-	-	-	M	H	Steep	Residential	N
88	Llys y Goppa, Abergele	Conway County Borough Council	17/04/2013	Abergele	06/07/2012	L	-	17	24	-	-	-	M	H	Steep	Residential	Y
89	Llanelian Rd, Old Colwyn	Conway County Borough Council	22/01/2013	Colwyn	25/09/2012	M	-	37	12	-	-	-	M	H	Steep	Residential	Y
90	Stour Way, Bedford	Bedford Borough Council	24/07/2012	Bedford	13/07/2012	H	-	-	-	-	-	-	L	M	Steep	Residential	Y
91	Kenneth Hill, Sharnbrook	Bedford Borough Council	10/12/2012	Sharnbrook	14/07/2012	H	-	-	-	-	-	-	L	M	Flat	Residential	Y
92	Silver Street, Stevington	Bedford Borough Council	12/02/2013	Stevington	26/11/2012	-	-	-	-	-	-	-	M	M	Medium	Residential	Y
93	Hallgarth, Kendal	Cumbria County Council	05/03/2013	Kendal	28/06/2012	H	-	53	24	20	15	-	M	M	Medium	Residential	Y
94	City wide flash flooding – August 2012	Hull City Council	23/01/2013	Hull	25/08/2012	H	-	34	2	-	-	-	L	M	Flat	Mixed	Y
95	Section 19 – heavy rain August 2014	Hull City Council	23/03/2015	Hull	10/08/2014	H	-	33	4	-	-	-	L	M	Flat	Mixed	Y
96	December 2013 City Centre Tidal Surge flood event	Hull City Council	04/02/2014	Hull	05/12/2014	-	-	-	-	-	-	-	M	H	Flat	Mixed	Y
97	Carisbrooke / Newport	Isle of Wight Council	24/06/2014	Newport	23/12/2013	H	-	74	16	-	-	-	M	H	Steep	Residential	Y
98	Chew Stoke FIR 2011 - 2012	Bath and North East Somerset Council	30/08/2013	Chew Stoke	24/09/2012	H	-	70	24	-	-	15	M	H	Steep	Residential	Y
99	Investigation of tidal surge 5th / 6th December 2013	Northumberland County Council	14/01/2014	Amble	05/12/2014	-	-	-	-	-	-	-	L	L	Flat	Residential	N
100	Devon summer floods 7th – 8th July 2012	Devon County Council	06/12/2012	Avonwick	07/07/2012	H	-	125	24	-	-	100	M	M	Steep	Residential	Y

ref	Section 19 report	LLFA	Date of report	Flood location	Date of event	Rainfall severity	Max' Intensity	Depth 1	Duration 1	Depth 2	Duration 2	Max' Rainfall R.Period	Analysis detail	Data Certainty	Topography	Land use	Historic flooding
nr	Title	Authority Name	Date	Town	Date	H/M/L	mm/hr	mm	Hr	Nr	Hr	Nr.	H/M/L/N	H/M/L/N			Y/N
55	Duck End, Denford FIR	Northamptonshire County Council	17/04/2013	Denford	21/11/2012	M	-	25	24	-	-	-	M	H	Medium	Residential	N
56	Harts lane, East Farndon FIR.	Northamptonshire County Council	26/02/2013	East Farndon	21/11/2012	M	-	30	24	-	-	-	M	H	Medium	Residential	N
57	Acomb	Northumberland County Council	12/11/2012	Acomb	28/06/2012	H	-	-	-	-	-	-	L	H	Medium	Residential	Y
58	Investigations of the summer 2012 floods	Northumberland County Council	30/12/2013	Northumberland	28/06/2012	H	-	56	2.5	-	-	195	L	M	Steep	Mixed	Y
59	Upper Calder Valley - 29th July 2013 FIR	Calderdale Metropolitan Borough Council	28/11/2013	Walsden	29/07/2013	H	140	30	2	-	-	-	L	H	Steep	Residential	Y
60	Investigation of flood incident affecting areas of south east Sheffield on 30th April 2014	Sheffield City Council	16/06/2014	Sheffield	30/04/2014	H	-	-	-	-	-	-	M	H	Steep	Residential	-
61	Investigation of flooding on 28th July 2013 in Chapletown, Sheffield	Sheffield City Council	18/09/2013	Sheffield	28/07/2013	H	24	-	-	-	-	17	M	M	Steep	Residential	Y
62	Investigation of flooding on 10th June 2012 in Chapletown, Sheffield	Sheffield City Council	29/08/2012	Sheffield	10/06/2012	H	32	-	-	-	-	-	L	M	Steep	Residential	Y
63	Croscombe, Shepton Mallet, Somerset	Somerset County Council	04/10/2012	Croscombe	11/07/2012	H	20	24	2.5	29	5.5	4	M	H	Steep	Residential	Y
64	Cuckoo Hill, North Bruton, Somerset	Somerset County Council	12/11/2012	North Bruton	28/06/2012	H	40	15	0.5	27	16.5	10	M	H	Steep	Residential	N
65	Daisy Dip	Southampton City Council	16/05/2012	Southampton	25/04/2012	H	-	-	-	-	-	-	L	H	Medium	Residential	Y
66	Southend-on-Sea flooding 24th August 2013	Southend-on-Sea Borough Council	01/10/2014	Southend-on-Sea	24/08/2013	H	-	55	4	-	-	50	M	H	Medium	Residential	N
67	Cataract bridge mill, Mellor, Stockport	Stockport Metropolitan Borough Council	01/07/2012	Stockport	11/05/2012	-	-	-	-	-	-	-	L	H	Flat	Residential	N
68	Flooding incidents in various locations in the Borough of Stockton on Tees on 25th and 26th September 2012	Stockton on Tees Borough Council	01/01/2013	Stockton on Tees	25/09/2012	H	-	104	48	-	-	-	L	H	Flat	Mixed	Y
69	Quebec Rd, Tilbury	Thurrock Council	01/11/2013	Tilbury	01/09/2012	-	-	-	-	-	-	-	L	H	Flat	Residential	Y
70	Torbay Council FIR 6th October 2012	Torbay Council	01/11/2013	Torbay	06/10/2012	H	-	35	24	132	72	8	M	H	Medium	Residential	Y
71	Torbay Council FIR 21st - 26th November 2012	Torbay Council	01/11/2013	Torbay	21/11/2012	H	-	40	24	66	168	25	M	H	Medium	Residential	Y
72	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	East Ilsley	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
73	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Lambourn	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
74	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Great Shefford	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
75	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Newbury	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
76	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Burghfield	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
77	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Streatley	01/02/2014	-	-	-	-	-	-	-	L	M	Medium	Residential	Y
78	Flooding in West Berkshire Winter 2013/14	West Berkshire Council	01/06/2014	Purley on Thames	01/02/2014	-	-	-	-	-	-	-	L	M	Flat	Residential	Y
79	Report on 2012 flood event - Middleton and Elmer	West Sussex County Council	01/11/2012	Middleton and Elmer	10/06/2012	H	-	100	16	-	-	-	M	M	Flat	Residential	Y
80	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Littlehampton	10/06/2012	H	-	100	16	-	-	-	M	M	Flat	Residential	Y
81	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Bognor Regis and Bersted	10/06/2012	H	-	100	16	-	-	-	L	M	Medium	Residential	Y
82	Report on 2012 flood event - Littlehampton	West Sussex County Council	01/11/2012	Manhood Peninsula	10/06/2012	H	-	100	16	-	-	-	L	M	Flat	Residential	Y
83	Eleanor Street / Saddle Street / Wallgate, 24 - 26 September 2012	Wigan Council	07/11/2013	Wigan	25/09/2012	H	-	-	-	-	-	-	L	L	Medium	Mixed	Y
84	Reeds lane / Reedville Grove, Leasowe	Wirral Metropolitan Borough Council	01/01/2013	Leasowe	25/09/2012	H	-	70	48	-	-	-	L	L	Flat	Mixed	Y
85	December 5th 2013	Wirral Metropolitan Borough Council	01/01/2014	West Kirby and New Brighton	05/12/2013	-	-	-	-	-	-	-	L	H	Flat	Mixed	-
86	St Andrews Avenue, Llandudno	Conway County Borough Council	21/01/2014	Llandudno	05/08/2013	M	-	23	6	-	-	-	L	M	Flat	Residential	-
87	Hen Ffordd Conwy, Dwygyfylchi	Conway County Borough Council	20/12/2014	Dwygyfylchi	15/02/2014	M	-	30	8	-	-	-	M	H	Steep	Residential	N
88	Llys y Goppa, Abergele	Conway County Borough Council	17/04/2013	Abergele	06/07/2012	L	-	17	24	-	-	-	M	H	Steep	Residential	Y
89	Llanelian Rd, Old Colwyn	Conway County Borough Council	22/01/2013	Colwyn	25/09/2012	M	-	37	12	-	-	-	M	H	Steep	Residential	Y
90	Stour Way, Bedford	Bedford Borough Council	24/07/2012	Bedford	13/07/2012	H	-	-	-	-	-	-	L	M	Steep	Residential	Y
91	Kenneth Hill, Sharnbrook	Bedford Borough Council	10/12/2012	Sharnbrook	14/07/2012	H	-	-	-	-	-	-	L	M	Flat	Residential	Y
92	Silver Street, Stevington	Bedford Borough Council	12/02/2013	Stevington	26/11/2012	-	-	-	-	-	-	-	M	M	Medium	Residential	Y
93	Hallgarth, Kendal	Cumbria County Council	05/03/2013	Kendal	28/06/2012	H	-	53	24	20	15	-	M	M	Medium	Residential	Y
94	City wide flash flooding – August 2012	Hull City Council	23/01/2013	Hull	25/08/2012	H	-	34	2	-	-	-	L	M	Flat	Mixed	Y
95	Section 19 – heavy rain August 2014	Hull City Council	23/03/2015	Hull	10/08/2014	H	-	33	4	-	-	-	L	M	Flat	Mixed	Y
96	December 2013 City Centre Tidal Surge flood event	Hull City Council	04/02/2014	Hull	05/12/2014	-	-	-	-	-	-	-	M	H	Flat	Mixed	Y
97	Carisbrooke / Newport	Isle of Wight Council	24/06/2014	Newport	23/12/2013	H	-	74	16	-	-	-	M	H	Steep	Residential	Y
98	Chew Stoke FIR 2011 - 2012	Bath and North East Somerset Council	30/08/2013	Chew Stoke	24/09/2012	H	-	70	24	-	-	15	M	H	Steep	Residential	Y
99	Investigation of tidal surge 5th / 6th December 2013	Northumberland County Council	14/01/2014	Amble	05/12/2014	-	-	-	-	-	-	-	L	L	Flat	Residential	N
100	Devon summer floods 7th – 8th July 2012	Devon County Council	06/12/2012	Avonwick	07/07/2012	H	-	125	24	-	-	100	M	M	Steep	Residential	Y