December 2015 Floods in Lancashire

Flood & Water Management Act 2010

Section 19 Investigation

October 2016

Lancashire County Council

www.lancashire.gov.uk

Contents

EXECUTIVE SUMMARY

The extreme and unprecedented storms and rainfall events of November and December 2015 caused flooding throughout December to approximately 2,500 homes in Lancashire at 229 separate communities across the county. These floods also damaged private gardens, garages and out-buildings, business premises, agricultural property and many items of critical public infrastructure including roads, bridges and retaining walls, water treatment plants, power and communications installations, and essential community buildings such as schools, village halls, and town halls.

Taking into account similar flood events in Cumbria, Greater Manchester, North and West Yorkshire, this was flooding of national significance. In January, the Association of British Insurers estimated the final bill for the flood damage caused by storms Desmond, Eva and Frank to homes, businesses and motor vehicles to be £1.3 billion.

In its role as Lead Local Flood Authority, Lancashire County Council has identified this as a flood event requiring investigation under the requirements of Section 19 of the Flood and Water Management Act 2010, for the purpose of identifying which flood risk management authorities had or still have relevant functions to be exercised in regard to these flood events.

The Lead Local Flood Authority is required to publish the results of this investigation and to notify any relevant risk management authorities of its findings.

This report discharges this responsibility, and launches the major process of publishing the findings of the Lancashire flood risk management authorities into how our communities were flooded, so that we can work together to find ways of managing the risks and impacts of such an event in the future.

The schedule attached identifies the 229 communities in Lancashire affected by flooding in December 2015 and the principal impacts at each location. Over the past 9 months since the flooding, we and our partner authorities have collected much more information than is represented here.

This will be supplemented with further investigations will be published in coming months by the County Council as reports into the flood risk reduction actions taken within each identified community since December 2015. These reports will identify the opportunities we find for more investigations and/or works**.**

SECTION 1 – INTRODUCTION AND PURPOSE OF THE REPORT

1.1 Flood & Water Management Act 2010 Duty

1.1.1 Lancashire County Council (LCC) as a Lead Local Flood Authority (LLFA) has a duty to investigate flooding in accordance with Section 19 of the Flood and Water Management Act 2010 (FWMA) as follows:

1.1.2 Section 19 states:

1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:
   a) Which risk management authorities have relevant flood risk management functions, and
   b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
2) Where an authority carries out an investigation under subsection (1) it must:
   a) Publish the results of its investigation, and
   b) Notify any relevant risk management authorities.

1.1.3 The terms 'risk management functions' and 'risk management authorities' are defined in Section 2.

1.2 Lancashire & Blackpool Local Flood Risk Management Strategy

1.2.1 In addition to the requirements of Section 19 of the FWMA, the Lancashire and Blackpool Local Flood Risk Management Strategy (LFRMS) sets out how flood risk should be managed locally.

1.2.2 The LFRMS states that the Section 19 investigations will help to:

- Improve the understanding of flood risk by providing an invaluable tool for understanding the sources and mechanisms of flooding;
- Identify assets that have a flood risk management function, which may need to be designated; and
- Identify where additional works and studies are likely to be necessary, that LCC or other risk management authorities can integrate into their prioritised flood risk management plans.

1.3 Approach to the investigation of flooding in December 2015

1.3.1 Given the extent and magnitude of the events in Lancashire through December 2015, the number of communities affected and the number of residential properties that reported flooding, LCC has considered how to best deliver its statutory responsibilities as noted above, while also assessing and addressing the diverse issues and impacts relative to each affected community to satisfy the requirements specified in the LFRMS.

1.3.2 LCC has adopted a two-stage approach that will satisfy all the requirements above as follows:

- The first stage is to publish this overarching Section 19 investigation to assess the two major storm events in December and all communities/locations that experienced flooding as a result of these events, focussing on statutory responsibilities and the duties of flood risk management authorities during the events.
- The second stage will report detailed investigations and identification of remedial actions/works in each of the individual communities identified in Appendix A. This approach will deliver the commitments of the LFRMS and is explained further in Section 6.

SECTION 2 - DEFINITIONS AND RESPONSIBILITIES

2.1 Key Definitions

2.1.1 The Risk Management Authorities

2.1.1.1 The risk management authorities (RMAs) are identified in the FWMA as follows:

a. The Environment Agency (EA),
b. The lead local flood authority,
c. A district council for an area for which there is no unitary authority,
d. An internal drainage board,
e. A water company, and
f. A highway authority.

2.1.1.2 Each of these organisations has powers and duties under various legislation and regulations for the responsible management of natural water, flood risk and in some cases coastal erosion.

2.1.1.3 The FWMA requires all the RMAs to cooperate with other relevant authorities in the exercise of their flood and coastal erosion risk management functions.

2.1.1.4 In Lancashire, the RMAs support partnership working in the following ways:

- at operational levels by joint investigations and through the Making Space for Water meetings;
- at tactical level by sharing priorities and direction between organisational managers, and
- at strategic level by engaging with Councillors/Cabinet Members/Senior Managers.

2.1.1.5 Lancashire, Blackpool and Blackburn-with-Darwen are also represented on the North West Regional Flood and Coastal Committee where cross-boundary projects, resources and data are shared with Cumbria, Greater Manchester, Merseyside and Cheshire.

2.1.1.6 The village of Earby in Pendle District is a special case in that it lies within a river catchment that falls towards North Yorkshire, so its local EA services are supplied through the Yorkshire team. This gives the Lancashire partnership a direct connection to the Yorkshire Regional Flood & Coastal Committee. Earby also receives services from the Earby and Salterforth Internal Drainage Board (IDB), which replaces a number of the lead local flood authority functions.

2.1.2 The Risk Management Functions

2.1.2.1 The RMAs have responsibility for flood risk management functions as defined under Section 4 (2) of the FWMA:

(a) a function under this Part,
(b) a function under section 159 or 160 of the Water Resources Act 1991,

(c) a flood defence function within the meaning of section 221 of that Act,
(d) a function under the Land Drainage Act 1991,
(e) a function under section 100, 101, 110 or 339 of the Highways Act 1980, and
(f) any other function, under an enactment, specified for the purposes of this section by order made by the Minister.

2.1.2.2 For the purpose of this investigation, the functions of the RMAs in the emergency response and the emergency recovery to the December 2015 flood events have also been taken into account, because of the scale and extent of flooding in Lancashire during that month.

2.1.3 Riparian Landowners

2.1.3.1 The legal term 'riparian' is applied to landowners who own land adjoining or containing a river or watercourse. They have certain rights to use the water flowing across their land for their own purposes, and in regard to flood risk management they also have a number of responsibilities, including the following:

- to maintain the bed and banks of the watercourse, and also the trees and shrubs growing on the banks;
- to clear any debris, even if it did not originate from their land. This debris may be natural or man-made;
- to keep any structures within their ownership clear of debris. These structures include culverts, trash screens, weirs and mill gates.

2.1.3.2 If riparian landowners do not fulfil their responsibilities they may face enforcement action taken by the relevant RMA.

2.1.4 Interconnections between responsibilities

2.1.4.1 Public sewers in Lancashire are principally the responsibility of United Utilities plc or Yorkshire Water plc. Copies of the record maps indicating the location of public sewers in Lancashire are held in the water companies' head offices. These companies also keep records of pumping stations and any water treatment works which form part of the public sewage system.

2.1.4.2 Private drainage systems are the responsibility of each owner whose property it drains. Where more than one property uses a private pipe, responsibility is normally shared proportionately. The private system comprises all the pipes up to the point of connection with a public sewer (this can include the entire system where connected to a septic tank, cesspool or soakaway). Formal records indicating the location of private drainage systems are not held by any RMA. The deeds of a property may include details.

2.1.4.3 The highway surface water drainage of all adopted public roads, other than trunk roads or motorways, is the responsibility of LCC as the local highway authority, including roadside drainage gullies and certain roadside ditches. Drainage from trunk roads and motorways is the responsibility of Highways England (formerly the

Highway Agency). Drainage of private unadopted roads is normally the responsibility of private property owners who make use of or adjoin the road.

2.1.4.4 Land drainage comprises systems of rivers, watercourses, ditches, culverts, pipes, lakes and ponds intended to drain water resulting from rainfall and flows from underground sources. Typically the primary responsibility for maintaining responsible flows in land drainage systems lies with the riparian owner or owners, with the LLFA, EA, IDB and local councils holding enforcement powers to use if the land owner/s default in their duties.

2.1.4.5 All drainage systems eventually discharge into the sea as the lowest possible point for water to collect. In Lancashire, this is at Morecambe Bay or the Irish Sea directly.

2.1.4.6 All drainage networks are formed from combinations of these systems to overcome historic demands of efficiency, simplicity and convenience. For example, a highway gully may well connect to a length of highway drainage pipe before connecting to a private ditch, or a public surface water sewer, or directly to a main river. The original reasoning for these arrangements may now be forgotten or inappropriate for current needs, but the physical interconnection of drainage systems means that it is often impossible to tell just from looking at flood water exactly where the barrier to flow arises and therefore exactly which organisation may need to take remedial action.

2.1.4.7 It is therefore vital for the RMAs to share information and collaborate during investigations, and for the investigations to be allocated to the appropriate organisation to lead. Where 'appropriateness' is not immediately clear, the LLFA will usually take the lead until better information is available.

2.2 Key Functions of the RMAs

2.2.1 The Environment Agency

The flood risk management responsibilities of the EA include the following:

a. strategic overview for all forms of flooding;
b. provision of a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) to cover all forms of flooding;
c. a power to request information from third parties in connection with flood risk management duties. Risk management authorities have a duty to co-operate with the EA in the provision of such information;
d. a duty to co-operate with other relevant authorities in the exercise of flood risk management functions, which may include the sharing of information with other relevant authorities;
e. a duty to have regard to Local Flood Risk Management Strategies;
f. a duty to be subject to scrutiny from lead local flood authorities' democratic processes;
g. responsibility for managing coastal flooding;
h. responsibility for managing fluvial flooding from main rivers;

i. responsibility for issuing environmental permits for work that might impact on main river flows;
j. responsibility for maintaining its own flood risk management assets including pumps and flood basins;
k. updated provisions for the regulation of reservoirs;
l. permissive powers to carry out maintenance work on main rivers under Section 165 of the Water Resources Act 1991;
m. the provision of flood forecasting and warning services;
n. the provision of flood maps;
o. the provision of flood related information and advice;
p. investment in flood defences, supplemented through partnership funding where appropriate;
q. a power to take enforcement action where flow in a main river has been impeded and may cause a flood risk.

2.2.2 Lancashire County Council

2.2.2.1 LCC has a dual risk management role, in its capacity as both highway authority and LLFA.

2.2.2.2 The County Council as the LLFA has a number of duties and powers, in addition to the duty to investigate flooding set out above. These include:

a. a duty to develop, maintain, apply, monitor and consult on an LFRMS for its area (copy available from the LCC website www.lancashire.gov.uk);
b. a duty to develop and maintain a register of structures or features which might impact on flood risk, including ownership and condition (the Flood Risk Asset Register is available on the LCC website www.lancashire.gov.uk);
c. the management of the consenting process for works that are likely to affect the flow characteristics of ordinary watercourses (Land Drainage Consent – guidance available on the LCC website www.lancashire.gov.uk);
d. a power to undertake works for managing flood risk from surface run-off or groundwater;
e. a power to request information from third parties in connection with flood risk management duties. RMAs have a duty to co-operate with the LLFA in the provision of such information;
f. a power to designate structures and features that affect flooding or coastal erosion.
g. a power to take enforcement action where there is an obstruction to an ordinary watercourse that may cause a flood risk.

2.2.2.3 LCC as the local highway authority has a duty under the Highways Act 1980 to maintain highways that are maintainable at public expense. This includes responsibility for highway drainage, as well as for the condition and safety for users of all highway assets including roads, footways, bridges and culverts, street lighting and traffic signals.

2.2.2.4 as local highway authority, LCC has a duty to co-operate with other relevant authorities in the exercise of flood risk management functions, which may include the sharing of information with other relevant authorities

2.2.2.4 LCC also has private responsibilities for land drainage where it is a land owner.

2.2.3 City and Borough Councils

2.2.3.1 The flood risk management responsibilities of City and Borough councils include the following:

a. a power to designate structures and features that affect flooding or coastal erosion;
b. a duty to exercise their flood risk management functions in a manner consistent with local and national strategies, and to have regard to those strategies in their other functions;
c. a duty to be subject to scrutiny from LLFAs' democratic processes;
d. a power to do works on ordinary watercourses
e. a duty to co-operate with other relevant authorities in the exercise of flood risk management functions, which may include the sharing of information with other relevant authorities.
f. a power to take enforcement action where there is an obstruction to an ordinary watercourse that may cause a flood risk.

2.2.3.2 City and Borough Councils have a number of wider functions and roles that can be relevant to flood risk management and response. These include local planning, housing, environmental health and community engagement activity, as well as private responsibilities for land drainage where they are a land owner.

2.2.4 Internal Drainage Board

2.2.4.1 An Internal Drainage Board (IDB) is a local public authority established in areas of special drainage need in England and Wales. IDBs have permissive powers to manage water levels within their respective drainage districts. IDBs undertake works to reduce flood risk to people and property and manage water levels to meet local needs.

2.2.4.2 The expenses of an IDB are predominantly funded by the local beneficiaries of the water level management work they provide. Each IDB sets a budget for its planned work in the forthcoming year and any investments it needs to make for future projects.

2.2.4.3 More information about IDBs can be found from the Association of Drainage Authorities (www.ada.org.uk)

2.2.5 Water Companies

The flood risk management responsibilities of water companies (in Lancashire: United Utilities plc and Yorkshire Water plc) include the following:

a. a duty as sewage undertakers under Section 94 of the Water Industry Act 1991, to provide & maintain sewers for the drainage of buildings and associated paved areas within property boundaries;
b. responsibility as sewerage undertakers for lateral drains and public sewers, the latter being defined as a conduit, normally a pipe that is vested in a Water and Sewerage Company, or predecessor, that drains two or more properties and conveys foul, surface water or combined sewage from one point to another point and discharges via a positive outfall;
c. responsibility for any flooding which is directly caused by its assets – i.e. its water or sewerage pipes;
d. a duty to be subject to scrutiny from lead local flood authorities' democratic processes;
e. a requirement to exercise flood risk management functions in a manner consistent with the national strategy and guidance and have regard to the local strategies and guidance;
f. a duty to co-operate with other relevant authorities in the exercise of flood risk management functions, which may include the sharing of information with other relevant authorities.

2.3 Civil Contingencies Responsibilities

The RMAs listed above (with the exception of the IDBs) have additional responsibilities under the Civil Contingencies Act 2004, which provides the statutory basis for dealing with a response to flooding in emergency situations. These include flood preparedness planning and flood response.

SECTION 3 – METHODOLOGY

3.1 Interpretation of the Section 19 Duty

3.1.1 A two stage approach is being taken to the investigation of the flooding that occurred across Lancashire during December 2015.

3.1.2 Stage 1 is to satisfy the LLFA's legal responsibilities under the FWMA. That requirement is met by this report which gives an overview of what happened with weather conditions and consequent flooding in Lancashire, documenting how all of the RMAs responded during the events and how they have fulfilled or still are fulfilling their duties.

3.1.3 For the reports that follow the Stage 1, the LLFA relies on information yet to be provided or verified by the RMAs arising from their investigations which commenced during December 2015 and January 2016 – immediately after the emergency events – and which have been progressed during 2016. These investigations and further community liaison will continue wherever necessary to deliver appropriate advice and investment to affected communities.

3.1.4 Stage 2 of the reporting process will identify each individual flooding event in more detail with a focus on the communities or sub-communities affected, accounting for the specific variables for each location and the mechanisms of flooding that occurred, in accordance with commitments in the LFRMS.

3.1.5 The understanding gained from these further investigations will identify remedial actions that can be taken forward by the relevant RMA (or RMAs together) to reduce the risk of internal flooding to properties and manage impact of similar flood events in the future. Findings and recommendations will be published through the Stage 2 reports, which will be published separately to the Stage 1 report.

3.1.6 As described in Section 2 of this report, drainage networks interconnect in sometimes complicated ways for historic reasons. Partnership working and joint investigations between the RMAs are essential to identify the appropriate options in all 229 communities and to deliver flood risk management improvements.

3.2 Stage 1 investigation

3.2.1 This report provides information on the Stage 1 investigations into the flooding that occurred in December 2015. It considers the 2 major storms:

- 5/6 December and further localised incidents (Storm Desmond), and
- 25/26 December (Storm Eva).

It records the extreme magnitude, geographical distribution and impact of these events.

3.2.2 Although there has been significant and widespread impact on infrastructure, commercial properties and the local economy as a whole, the focus of this report is around the responsibilities of the LLFA and other RMAs to manage flood risk with the priority of preserving life and of benefitting people and property, in accordance with national flood risk management priorities and those established in the LFRMS. Most

of the data collected at this stage of the investigations relates to residential property with an emphasis on internal flooding.

3.3 Sources of information used to inform this investigation:

3.3.1 LCC's framework consultant has assimilated relevant data relating to these storms, the rainfall events themselves and how they unfolded in Lancashire, and the impact of this weather on people, properties and communities.

3.3.2 The relevant data includes the following:

a. **EA-recorded flooded properties** – this is the primary source of data used in this report to establish the impacts of the flooding on properties in Lancashire. It was presented as a GIS (Graphical Information Shapefile) property point dataset that included the location and date of the incident. Although the point data is relative to a specific property, no additional information was contained within the dataset regarding the source or mechanism of flooding or of the type of property flooded. It is possible to identify local elements of critical infrastructure from the address provided. This dataset is primarily based on information collected by the EA from local authorities, but also from data collected by the EA's own flood ambassadors who visited affected communities and who were very active following the flooding events.

b. **LCC-recorded flood incidents** - this dataset comprised individual records of flood incidents reported by members of the public directly to LCC and included the incident date, location and general description of the flood event. Many of these reports were collected in the various drop-in events attended by various LCC teams working alongside the other RMAs during January and February 2016 in various venues around Lancashire. Whilst this data source included records of internal flooding to residential properties, it also included other flooding elements including highway and critical infrastructure flooding. The anecdotal nature of the evidence was useful in establishing the source of flooding or understanding the wider context. However, as this data was not collected systematically across the county, it is not appropriate to call it a complete dataset.

c. **EA-recorded flood extent maps** - this GIS dataset illustrates the extent of flooding during the flood incidents representing the EA's best current knowledge of properties that flooded. Generally, the flood extent maps only represent flooding from main rivers, although flood extents relating to other sources of flooding were also recorded in some instances. Occasionally additional information was provided detailing the source and/or the number of properties flooded.

d. **EA Flood Risk Mapping** – these GIS datasets include the updated Flood Map for Surface Water (uFMfSW) and the Flood Map for Planning (FMfP) showing Flood Zones 2 and 3.

3.3.3 In addition to the above GIS datasets, a number of other supporting information was collected, including:

a. **EA District Summary Reports** - these reports (complied by the EA flood ambassadors) comprise brief summaries of the impacts of flooding in some of the affected communities and details of the number of residential properties that flooded internally (linked to the EA recorded flooded properties dataset described above). They also provide some details on the source and mechanism of the flooding and in some cases provide details of indirect impacts such as disruption to transport or utilities infrastructure;

b. **Public Media Records** of flooding from online newspaper articles, blogs, videos and other social media.

3.3.4 Records of groundwater levels were not analysed to assess the significance of groundwater flooding as part of this investigation. This is due in part to the limited number of monitoring boreholes across the region, but also due to the relatively short duration of the flooding experienced across the region, which indicates that groundwater was unlikely to be a primary source of flooding.

3.4 Rainfall and river flow data

3.4.1 Analysis of the rainfall events leading up to December and the major storms of 5/6 December and 25/26 December has been carried out by LCC's framework consultant. This includes reference to:

a. **Water Situation Reports** – the EA issues monthly water situation reports covering England, which provide an overview of various hydrological information, including rainfall, soil moisture and river flows for the month. These reports have been used to help provide an overall picture of the conditions that led to the flooding events in Lancashire on the 5/6 December and 25/26 December 2015.
b. **Rain Gauge Records** - rain gauge data from 17 daily recording rainfall gauges for Lancashire covering the period of record from the start of November 2015 to the end of December 2015.
c. **Met Office records** – historic data and storm information for the months of November and December 2015.

3.5 RMA Responsibilities

3.5.1 The rainfall events in December were subject to an emergency incident declared under the Civil Contingency Act 2004 (CCA). All RMAs have duties as Category 1/2 responders under the CCA and take direction from a central headquarters. The Stage 2 reports will identify all on-going responsibilities and how these are to be taken forward.

3.6 Timeline for December 2015 Flooding Events and Section 19 Investigation

The timeline for the delivery of the Stage 1 (Section 19 investigation) is set out below:

Date	Action	Comment
5/6 December 2015	First flood event	Storm Desmond
12/13 December 2015	Additional to first flood event	Tail-end of Storm Desmond
25/26 December 2015	Second flood event	Storm Eva
December to April 2016	RMA responses	RMAs responding to flood event and collecting relevant data
January 2016 ongoing	RMA responses	Repairs, investigations & improvement programmes underway
April 2016	Lancashire Tactical Group Meeting	Section 19 report proposals presented to RMAs and approach agreed in principal
May – July 2016	Section 19 Investigation - Data Collection	LCC collecting all relevant data from each RMA; appointed consultants; Cabinet Member approval of report structure and programme for delivery; Partnership consultation
July 2016	Section 19 Investigation - Draft list of Communities Affected	Draft list of communities affected and draft recommendations issued to LCC by consultants
	Lancashire Tactical Group Meeting	Review draft list of communities affected and recommended actions
August/September 2016	Section 19 Investigation – Reporting	Section 19 Investigation Report drafted, circulated to consultees & prepared for publication
September 2016	12 x Making Space for Water meetings	Confirm single/joint RMA activities at each flooded community for proposed reports &/or further investigation
October 2016	Section 19 Investigation – Publish Report	Report to Cabinet
November 2016 ongoing	Publish RMA activities at each flooded location	Rolling updates as progress is made with affected communities & conclusions reached

SECTION 4 – PRINCIPAL WEATHER EVENTS AND RAINFALL ANALYSIS

4.1 Winter Storms

4.1.1 Rainfall is one element of the designation by the Met Office of a named storm. The criteria for a storm to be named include a combination of both the impact the weather may have and the likelihood of those impacts occurring. It must include a medium or high impact from strong winds, therefore it is not unexpected for there to be a situation of heavy rainfall unaccompanied by strong winds, which is therefore not designated as a named storm.

4.1.2 Winter 2015 brought a number of named storms to the UK as set out in Table 4.1 below:

Storm Name	Date of impact on UK and/or Ireland
Abigail	12 – 13 November 2015
Barney	17 – 18 November 2015
Clodagh	29 November 2015
Desmond	5 – 6 December 2015
Eva	24 – 27 December 2015
Frank	29 – 30 December 2015

Figure 4.1 – Record of named UK storms November/December 2015

4.1.3 In the period preceding December 2015, Met Office records show that the UK experienced significant heavy rainfall with three major (named) storms occurring in November: Storms Abigail, Barney and Clodagh. The rainfall in the North West during November 2015 was almost twice the normal rainfall for the region (184% of the average based on the period 1981 – 2010).

4.1.4 In December 2015, rainfall reached 2 to 4 times the average in the west and north of the United Kingdom. Storm Desmond on the 4, 5 and 6 December, brought record-breaking rainfall totals for the Lake District and the north of England.

4.1.5 The rainfall events in November 2015 effectively caused the ground to become saturated in advance of the further rainfall events in December. The increase in soil moisture had the effect of decreasing its hydraulic capacity, in effect reducing the ability of the soil to absorb future rainfall and consequently increasing surface water run-off. Where the ground was already saturated, surface water run-off was more rapid in response to rainfall, exacerbating surface water flooding.

Figure 4.2 below illustrates the difference between average December rainfall and that which fell in December 2015:

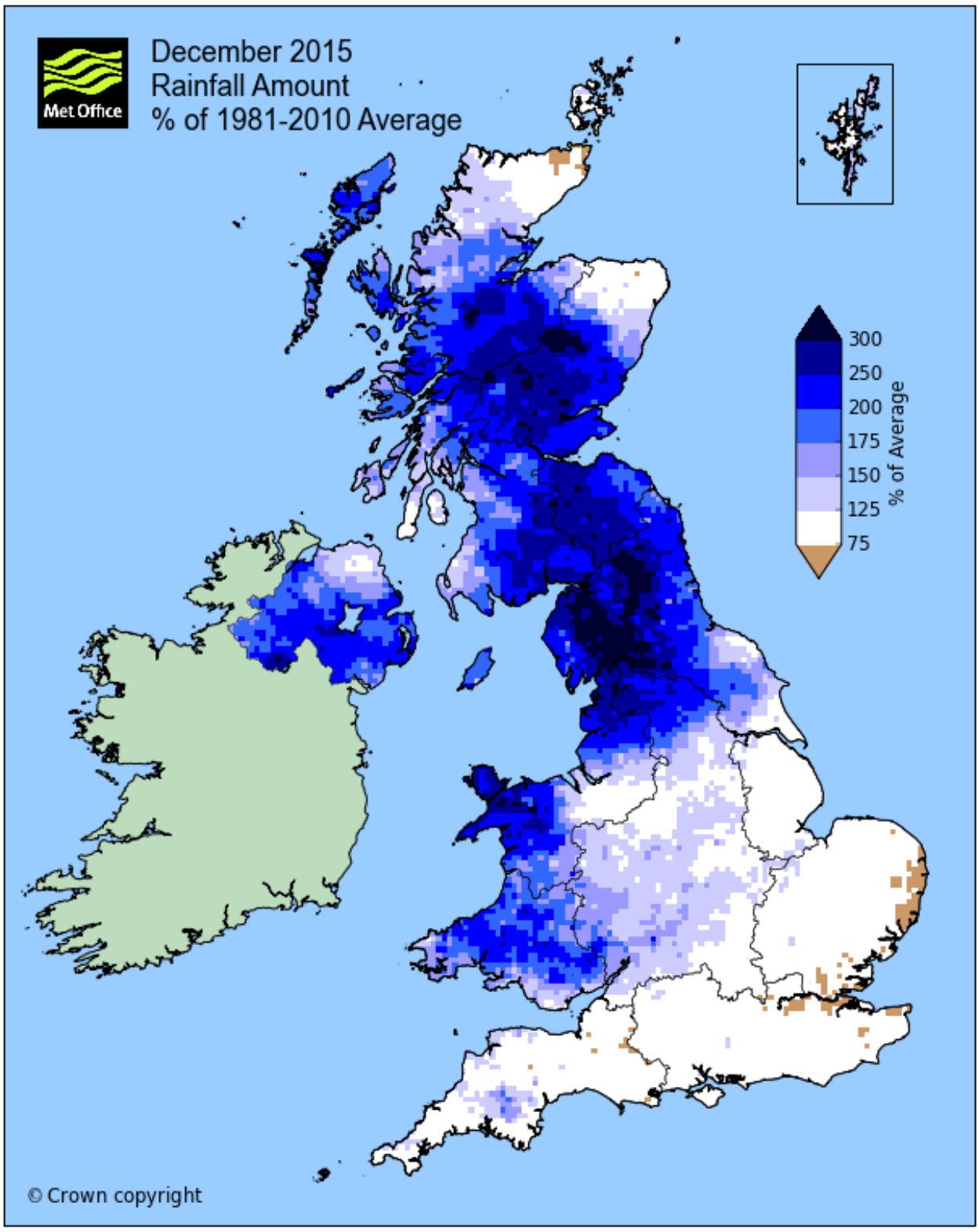

Figure 4.2 - UK distribution of rainfall relative to the average for December 2015

4.1.6 The graph below at Figure 4.3 indicates the rainfall across Lancashire during November and December 2015 with the named storms shown. It is notable that rain fell almost every day throughout this period, with occasional peaks of high intensity rainfall. These instances may also have had an impact on flood events, and will be considered through the Stage 2 reports in more detail.

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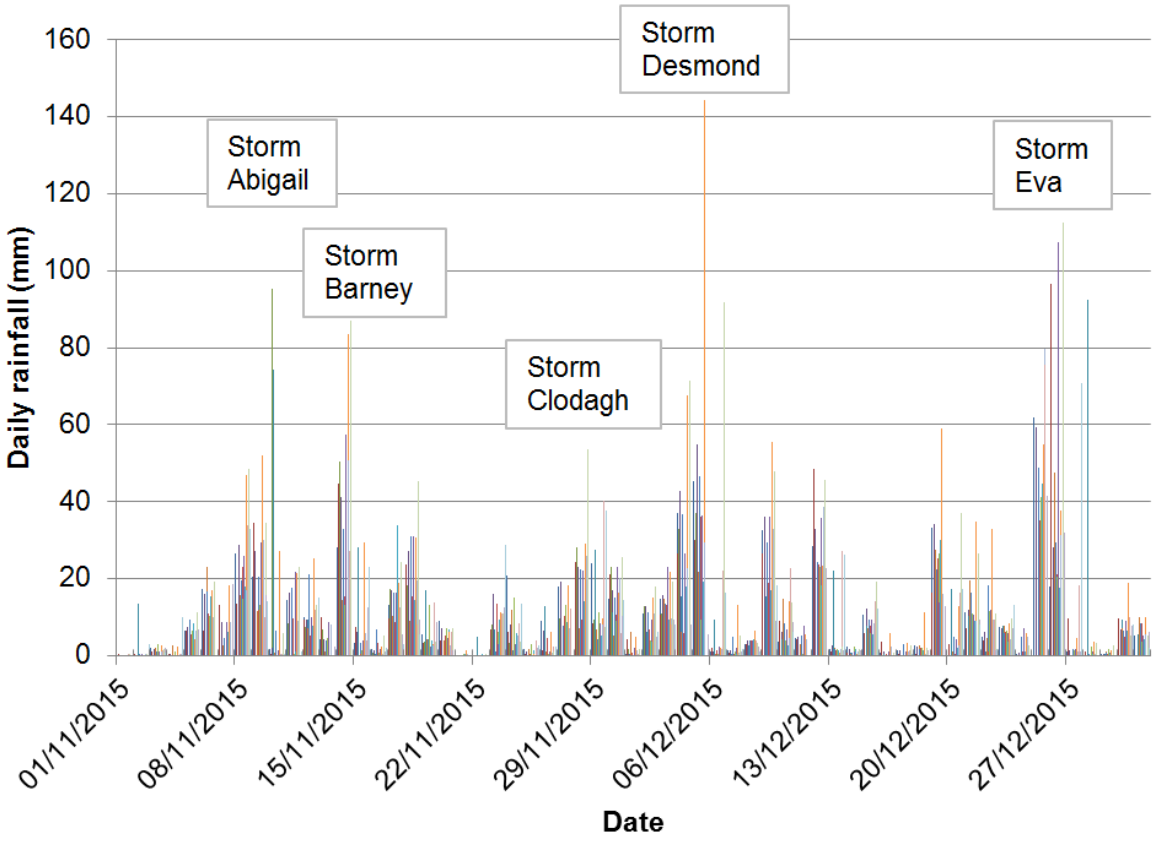

Figure 4.3 – Rainfall in Lancashire, November – December 2015

4.2 River Flows

4.2.1 In response to the significant rainfall events through December, the amount of water flowing in Lancashire's rivers increased substantially. All EA river flow indicator sites across the north of England recorded an increase in monthly mean river flow for December. Exceptionally high river flows were recorded in the North West during November and December 2015. The largest ever flows recorded on an English River were recorded on the River Lune (approximately 1700 cubic meters per second).

The significance of these records is illustrated in Figure 4.4 below:

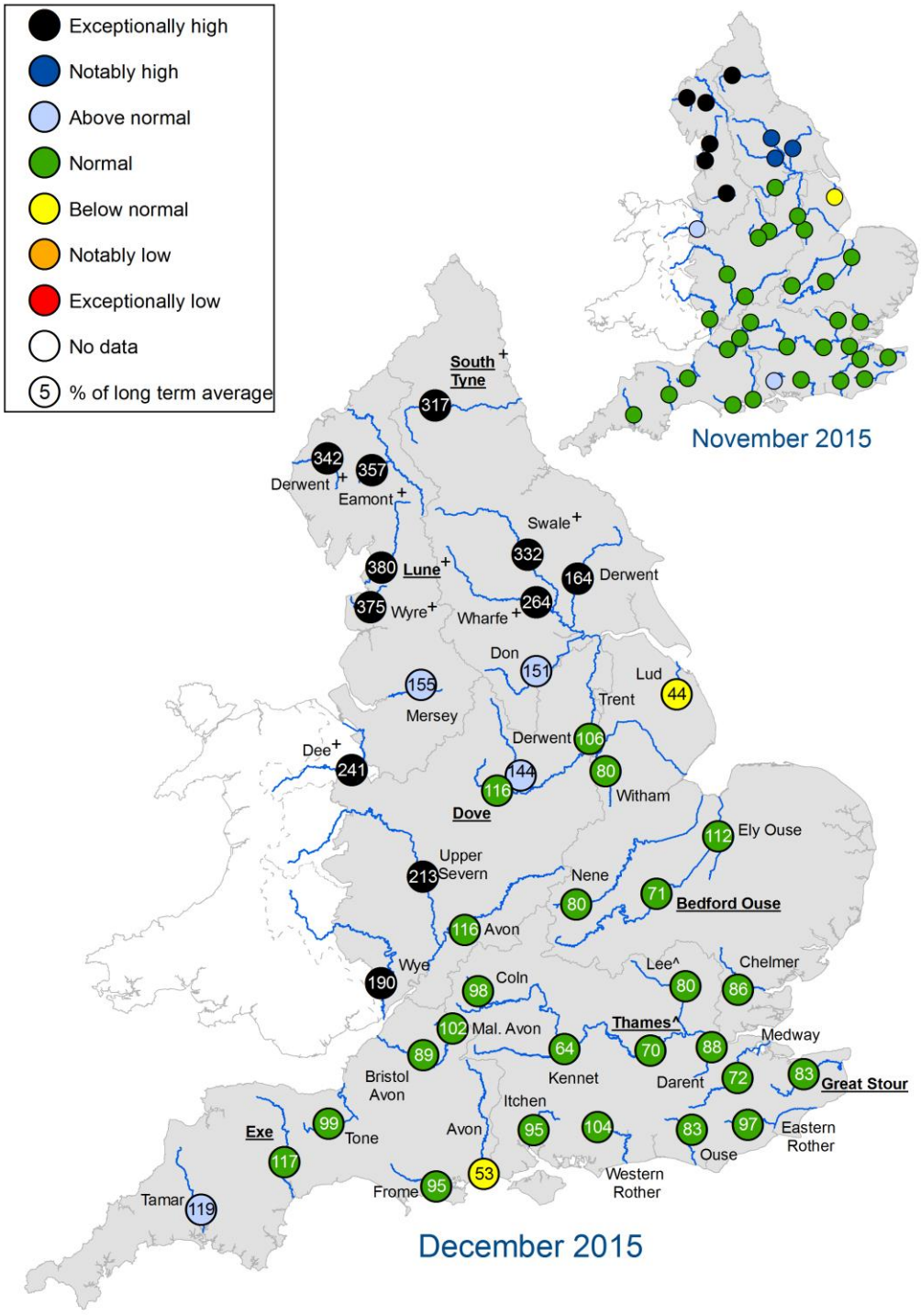

Figure 4.4 – English River Flows compared to average, November & December 2015

4.3 Analysis - 5/6 December 2015 (Storm Desmond)

4.3.1 The rainfall around the flooding event in Lancashire on the 5/6 December is shown on the graph below at figure 4.5 This illustrates that there is a steady, but not exceptionally high, increase in rainfall from 1 to 5 December, when a significant peak suddenly occurs. This will have increased the flow in rivers and all water levels will have risen, affecting the ability of surface water systems to discharge. The rainfall then subsides which allows the river levels to reduce.

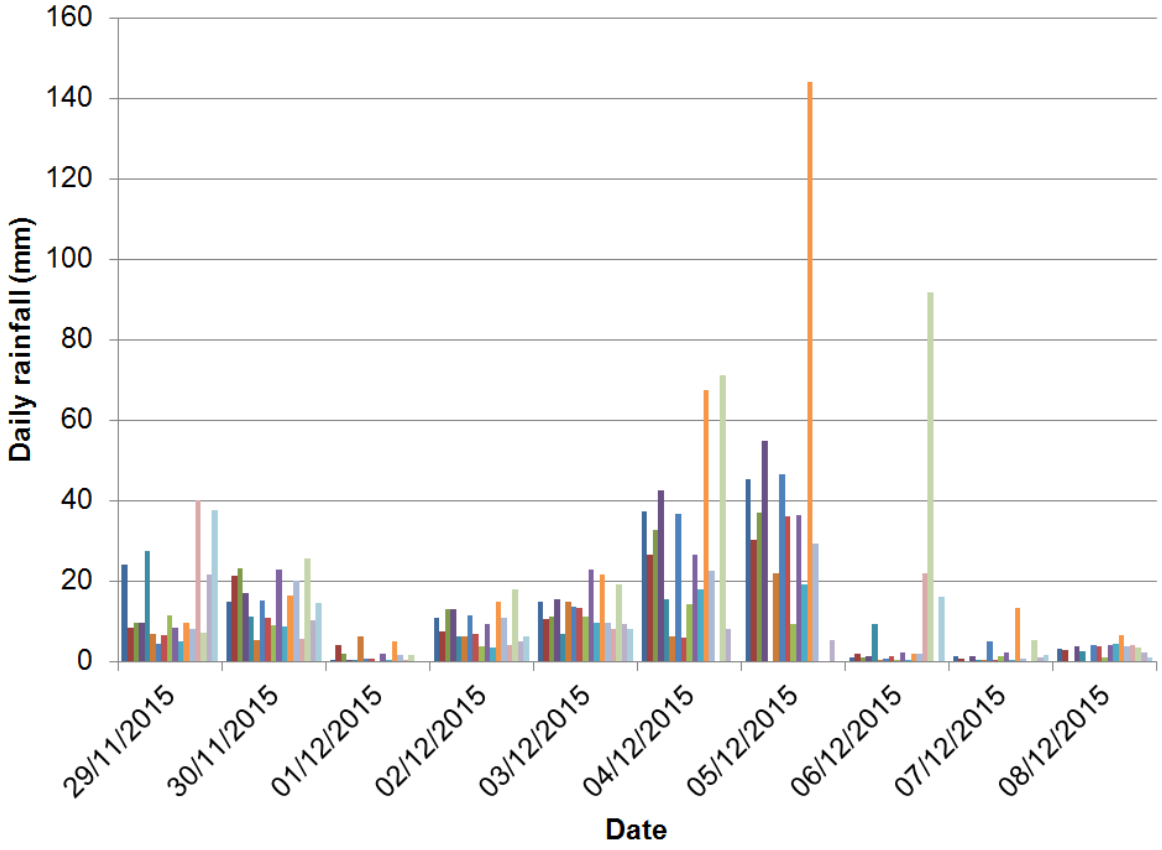

Figure 4.5 - Daily rainfall totals preceding and following 5 December

4.3.3 Analysis of the data collected reflects the event as described by eye-witness accounts. The primary cause of flooding is considered to be fluvial, meaning 'from rivers', often with an additional surface water flooding element. The flooding events of 5/6 December mainly affected the north of Lancashire, which correlates with the rainfall data. This is demonstrated in Figure 4.6 below, showing locations of internal flooding to domestic property alongside recorded sources of flooding.

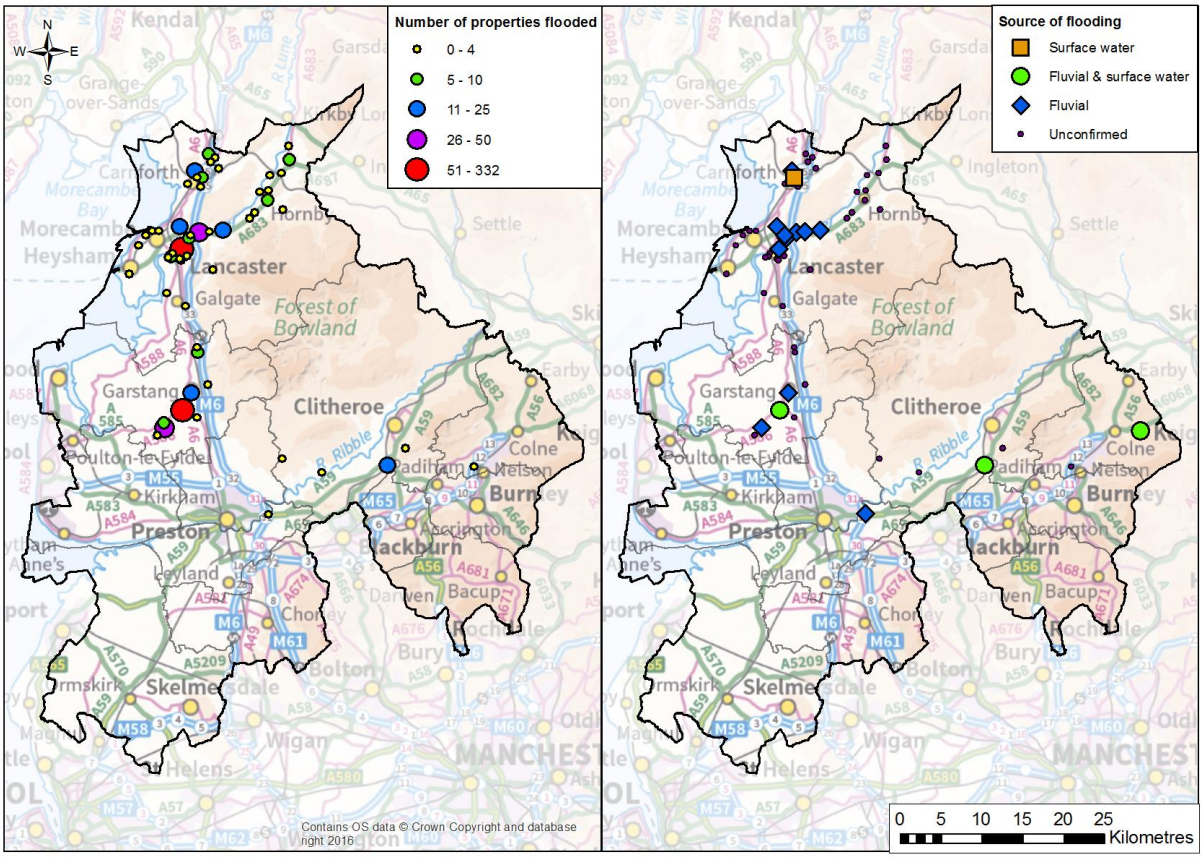

Figure 4.6 - 5 December properties flooded and source of flooding

4.3.4 Flooding that is directly attributable to rivers and out-of-bank flow will occur when the river is already at capacity and additional rainfall occurs. The rivers did not have capacity to accommodate the additional rainfall.

4.3.5 When flooding occurs from rivers, generally water levels will also be so high that surface water drainage systems are unable to discharge. This causes them to back-up and surcharge, generating visible surface water on roads, gardens, and other flatter areas of land. The source of flooding is often perceived to be only from the river, or only from the highway drainage, because the interaction of the various local drainage systems is not understood.

4.4 Analysis - 25/26 December 2015 (Storm Eva)

4.4.1 The rainfall surrounding the event on the 25/26 December is shown on the graph at Figure 4.7 below. This illustrates that there was a significant period of rainfall between 19 and 23 December and although further rainfall was recorded on 25 December, it was less significant and allowed for some minor recovery, or at least a steady state, in river and drainage systems. There is then an increase in rainfall which is sustained over the 25 and 26 December.

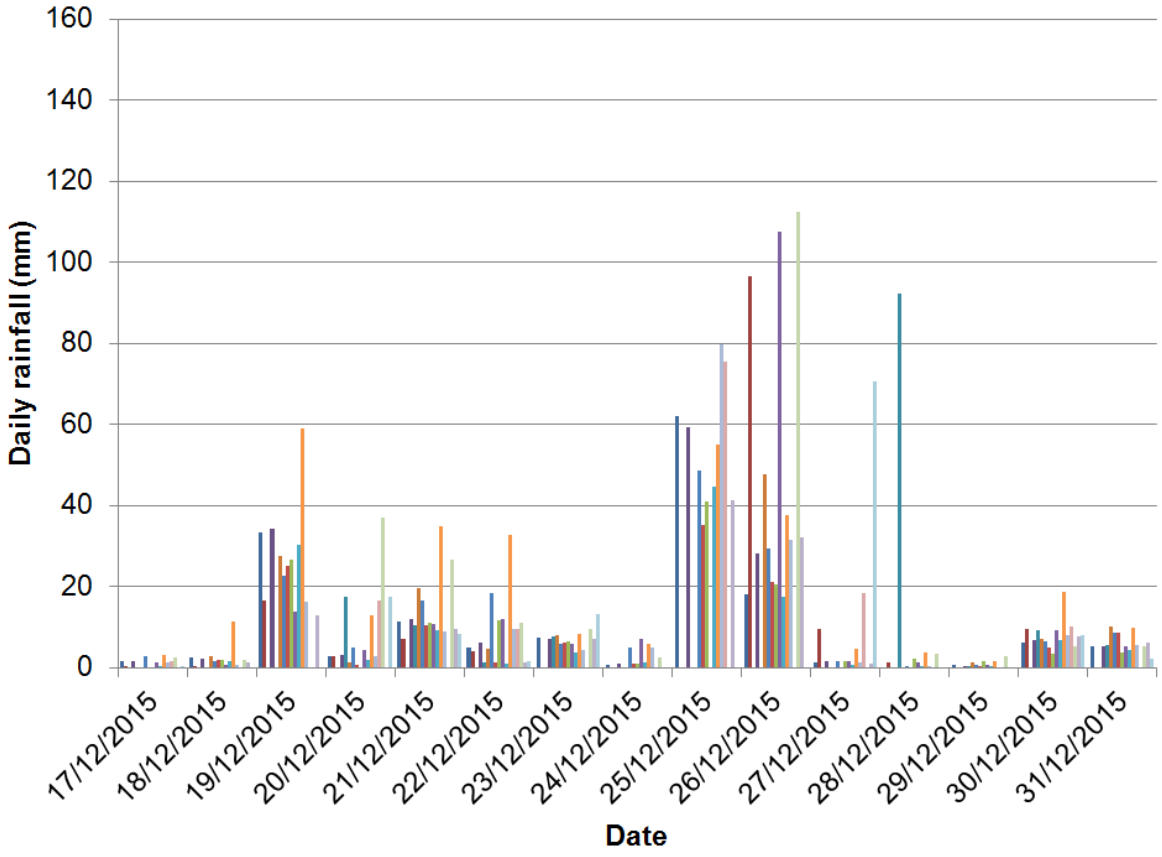

Figure 4.7 - Daily rainfall totals preceding and following 26 December

4.4.2 Analysis of the data collected relating to domestic property flooding revealed that the sources of flooding were much more varied in this event than was identified earlier in the month. The primary source of flooding was typically from surface water, although flooding from rivers was also noted in a number of cases. When comparing this to the rainfall analysis, it is possible to gain a picture of the flood event.

Figure 4.8 below shows the affected properties alongside the mechanisms of flooding that were reported:

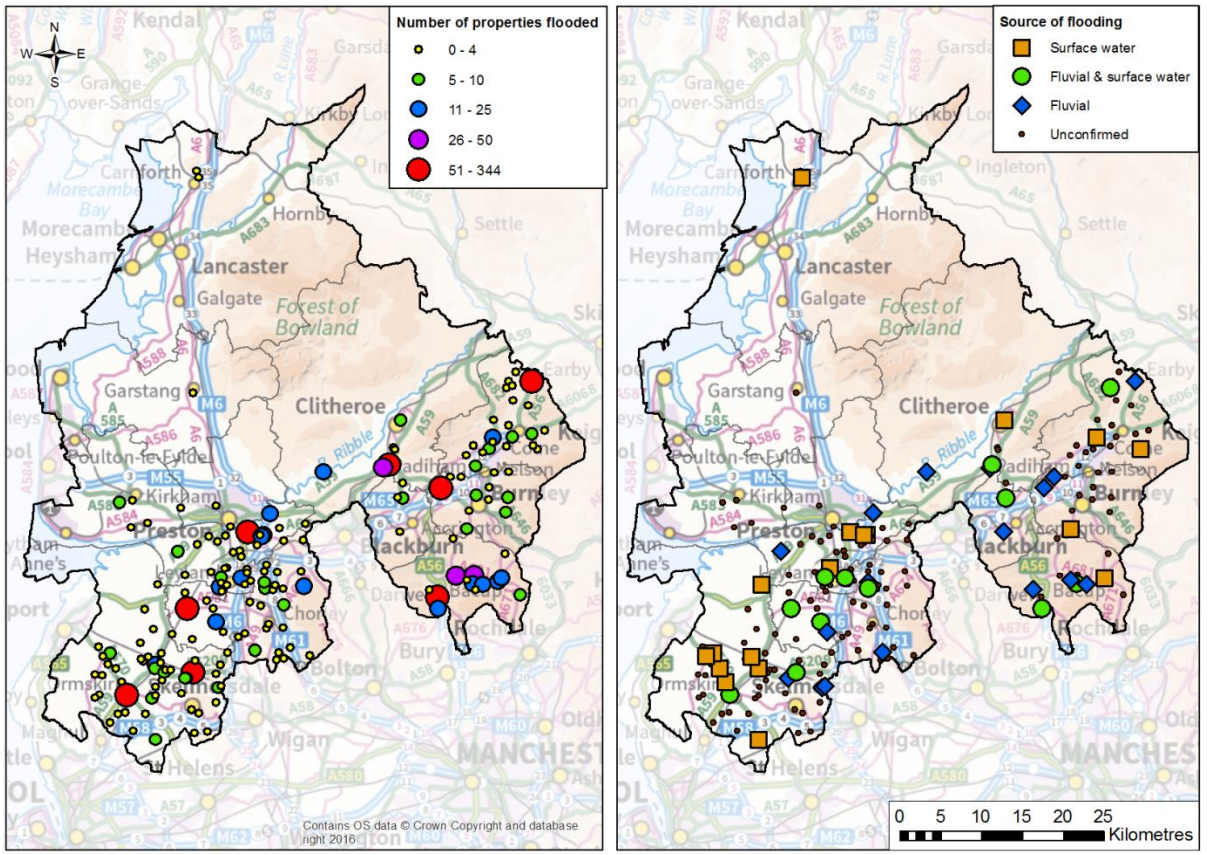

Figure 4.8 – 25/26 December properties flooded and source of flooding

4.4.3 For the event of 25/26 December, the rivers and drainage systems were able to accommodate the steady rainfall during the period in advance of the 25 December. The steady increase experienced on the 25 and 26 December resulted in an increase in river levels. Eventually, all drainage systems were at capacity and unable to discharge due to the risen water levels in streams and rivers, which resulted in the drainage systems surcharging and causing flooding.

4.5 Overview/comparison of the two events

4.5 1 From the data available and analysis undertaken for the purpose of this report into the specific events around Storms Desmond and Eva (5/6 December and 25/26 December), we can understand the overall impact the storms had on the flooding that occurred and the primary mechanisms of the flooding to the various communities.

4.5.2 The primary sources of flooding during both events includes directly from rivers and also from surface water, however the two events are themselves very different. There was a steady increase in rainfall prior to the 5 December which was not replicated prior to the 25 December. This influenced how the drainage systems and rivers accommodated rainfall and when capacity was reached.

4.5.3 Flooding occurs from rivers when they are not able to accommodate a heavy rainfall event and the river flow comes out-of-bank. Water levels in the rivers increase and surface water systems are not able to operate effectively, becoming surcharged and contributing to flooding.

4.5.4 This is not the case in a normal short-term heavy rainfall event, when river levels fluctuate and the drainage systems are able to accommodate storage of flood water when they are not able to discharge to the river or other watercourse.

4.5.5 Similar rainfall patterns are seen throughout November which did not result in the extensive flooding that we saw on 5/6 December. The significant difference is the intensity of the rainfall on the 5 December. The flooding over the 25/26 December was as a result of the excessive and sustained rainfall over that period.

4.5.6 A combination of the magnitude of the events and the rainfall that had already fallen meant that flooding would always be likely with systems and rivers at capacity on both occasions. The event of the 5/6 December was of a shorter duration, but relatively intense, whereas the event of the 25/26 December was less intense but of a longer duration. The mechanisms of flooding were therefore different between these two weather events.

SECTION 5 – EXERCISE OF FLOOD RISK MANAGEMENT FUNCTIONS

5.1 Between them, the RMAs have a variety of flood risk management functions in regard to a flood event.

5.2 In advance of forecast flood conditions, those RMAs with responsibility for flood risk-related assets will take planned preparatory action to minimise the risk of damage to their own property as well as to the properties of others who rely on these assets for protection.

5.3 These activities include (but are not limited to):

- arranging for close monitoring of weather conditions;
- bringing in extra staff resources to be available on the ground or within incident rooms, and out of normal working hours;
- clearing gullies and trash screens;
- activating flood basins and pumps;
- establishing communications with partner organisations;
- activating other pre-planned actions.

5.4 During a flood, those RMAs with responsibilities under the CCA will act under the direction of the Lancashire Resilience Forum (LRF) with the following objectives:

- to save life;
- to prevent escalation of the disaster;
- to relieve suffering;
- to safeguard the environment;
- to protect property;
- to facilitate criminal investigation and judicial, public, technical, or other requirements;
- to continue to maintain normal services at an appropriate level;
- to inform the public;
- to promote self help and recovery;
- to restore normality as soon as possible;
- to evaluate the response and identify lessons to be learned.

5.5 Some of the key impacts experienced in Lancashire during the December 2015 floods include:

- 2,467 homes in 115 towns, villages and the city of Lancaster were flooded (7500 people directly affected);
- 229 separate communities and sub-communities have been identified that require further investigation and technical appraisal;
- Several major roads were flooded and not passable;
- Bridges were closed due to concerns over structural integrity;
- Roads were also closed due to collapse of retaining walls or landslips on adjacent hillsides, or due to deteriorated surface, and were in need of repair before they could be re-opened;

- Disruption to rail services – a landslide on the West Coast Main Line made repairs necessary before services could be resumed;
- 61,000 homes in Lancaster were without power due to electricity sub-stations being flooded.

5.6 More information about how the multi-agency responses to major incidents are organised and delivered can be found at www.lancsresilience.org.uk . Reports into the way the floods were managed as a major incident are also managed through the LRF processes; many details lie outside the scope of the Section 19 reporting process.

> Having worked alongside all the RMAs throughout the November/December 2015 period and having reviewed the LRF debrief process, the LLFA finds that all RMAs that had relevant flood risk functions before and during a flood event, has exercised those functions in regard to this flood event. There are no such functions still to be exercised.

5.7 Immediately following a flood event, RMAs have a variety of functions to discharge including recording details of the flood event for use in understanding how best to manage future flood risks, and assessing and repairing any of their assets that might have been damaged during the flood event.

5.8 Between them the RMAs arranged and/or attended a series of 'drop-in' events held around Lancashire during January and February, to provide information and support to flooded residents and businesses as well as to gather eye-witness reports for future use. There have also been many community-led meetings to explore local conditions, which the RMAs have attended wherever possible.

> Having met with all the RMAs in the 3 months following the floods to review immediate actions and remaining concerns, the LLFA finds that all RMAs that had relevant flood risk functions immediately following a flood event, have exercised those functions in regard to the December 2015 flood events. There are no such functions still to be exercised. *However it should be noted that despite the best efforts of all RMAs, some additional data identifying flooded property may yet come to light. This will need be collected when opportunities arise and whilst other functions are being carried out.*

5.9 For the RMAs, longer-term issues following a flood event relate in the main to understanding how the event occurred in considerable technical detail, and using that detail to assess whether there are any practical means available to minimise the risk of the event reoccurring, or of reducing the damage/costs/time scale to recovery for affected people and organisations if it should reoccur.

These functions therefore include (but are not limited to):

a. understanding the weather conditions during November and December 2015, as far as they relate to flooding events;
b. investigations at the identified flooding locations, to a relevant and appropriate extent;
c. collaboration between RMAs over sharing information, combining investigations and delivering improvements with the widest flood risk management benefits;
d. further (non-urgent) repairs to RMA assets;

e. improvements to RMA assets (for example increased capacity, improved access for inspections/cleaning operations, new trash screens);
f. enforcement relating to unlicensed works in or adjacent to main rivers and water courses;
g. negotiated capacity and/or access improvements along main rivers and water courses with engagement from land owners;
h. relevant changes in upland land management techniques and strategies;
i. community engagement with local flood plans and improved local resilience measures.

5.10 The Department for Environment, Food and Rural Affairs (Defra) currently holds a national budget of £2.3bn, for investment in flood risk reduction projects where there are direct benefits to households at risk of flooding. All RMAs are entitled to bid for these funds, which will support major projects as well as localised improvements. Across Lancashire, the RMAs have started to make bids into these funds and further bids will be made as soon as more detail can be developed to support the relevant projects.

> Having worked with all the RMAs in meetings, on various local investigations and in many projects, the LLFA finds that all RMAs that have relevant flood risk functions in the medium-to-long term period following a major flood event have exercised those functions to some extent, and still have work to do in this regard.

5.11 A principal flood risk management function for all RMAs is the requirement to co-operate in risk management activities. The LLFA feels it is very important to record and commend the high degree of support, communication and collaboration between the Lancashire RMAs following the December flooding at all levels – strategically between Councillors, tactically between lead officers, and operationally between representatives working on the ground with each other and with our communities. The quality and quantity of data now available for our investigations in the Stage 2 process of responding to the December floods owes everything to this shared commitment to reducing flood risk at every possible location and in all possible ways.

SECTION 6 – NEXT STEPS

6.1 This report discharges the duty on the LLFA of the FWMA Section 19:

a. by understanding the various weather conditions leading to flooding that impacted on Lancashire during December 2015; and

b. by identifying the RMAs affected and the relevant functions they had in regard to the flood event (including emergency response, emergency recovery, and investigations leading to possible future actions).

6.2 The next steps for the Lancashire RMAs are to conclude these investigations and to identify how to assist affected people and communities in understanding and managing their flood risk.

6.3 All of the RMAs have their own functions (powers and duties) with respect to flooding and drainage, and all report that they are committed to discharging these functions with regard to the December floods (and also to any subsequent flood events in repeat locations).

6.4 The LLFA has an additional role in coordinating and leading these activities to ensure the free flow of communication and collaborative working.

6.5 With 229 communities and sub-communities locations affected, and some affected again in localised summer flooding events since December 2015, this is a significant task that needs managing responsibly in order for all affected parties to have confidence in the reliability of the recommendations and any future action.

6.6 Every RMA in Lancashire has already started investigations and in some cases remedial works have also been completed. This work started in December 2015 although the early investigations will inevitably have been disrupted by new flooding events later in the month. The District-based Making Space for Water (MSfW) meetings – involving operational representatives of all RMAs - provide a dependable opportunity for the RMAs to understand each others' priorities, to report progress and to engage with each other where joint interests are identified.

6.7 The September 2016 round of MSfW meetings is underway at the time of writing, and is currently generating reports of completed investigations and programmes for those still to be undertaken. These reports and programmes will be published by the LLFA in coming months, to provide relevant information to interested parties regarding the detailed activities arising from the Section 19 process and reassurance that people affected by every flooded location will receive relevant and appropriate support. Figure 6.1 below indicates the range of likely outcomes and recommendations to arise from the investigations.

6.8 The LLFA is already using the information gained from the December floods to help inform responses to new development applications that it receives as a statutory consultee in the planning process.

6.9 Planned flood mitigation works are being re-evaluated against the information we have following the December events.

Nature of flooding	Likelihood of repeat	Possible actions
New location	Unlikely	• Householder advice • Property level protection
New location	Possible	• Householder advice • Property level protection • Upstream attenuation • Downstream investment
Previously known	Likely	• Householder advice • Property level protection • Upstream attenuation • Downstream investment • Flood Action Group • Flood Plans

Figure 6.1 – Range of likely outcomes

6.10 Householder Advice and Property-Level Protection – where there is low risk of flooding incidents re-occurring, householders will be advised accordingly so that they can make informed decisions regarding their own management of flood risk.

6.11 Upstream attenuation – where it may be beneficial to reduce flood risk by reducing the speed at which water reaches a community during heavy rainfall (without increasing flood risk elsewhere unacceptably), investigations will consider options for slowing the flow using appropriate techniques and changes in upland land management such as increased tree planting, natural moorland management, and flood basins/temporary storage. This will require cooperation and collaboration with multiple landowners.

6.12 Downstream investment – where it may be beneficial to reduce flood risk by responsibly managing the speed at which water leaves a location during heavy rainfall (without increasing flood risk elsewhere unacceptably), investigations will consider options for increasing flow rates using techniques such as pipe/culvert capacity improvements, trash screens with maintenance regimes, and enforcement of river and water course flows across private land.

6.13 Flood Action Groups/Flood Plans – where communities seek to help themselves to be more resilient to future flood risk (and potentially to other community emergencies such as interruption to power/water supplies, epidemics, or severe winter weather), the RMAs and other partners will identify appropriate support to empower Flood Action Groups to establish themselves and to access resources

so that they can develop meaningful emergency action plans of their own, ideally integrated with those of the LRF.

6.14 In addition to community-level investigations, other next steps are also necessary as follows:

a. Further bids will be made to access Defra funding for flood risk management studies and schemes, based on informed recommendations and verified justification for investments;

b. The statutory register of flood risk assets in Lancashire will be expanded to include new assets that come to light through the investigations;

c. The LFRMS – already due for review in 2017 – and related LCC policies will be reviewed in light of the December 2015 flooding events so that appropriate future commitments and strategies can be developed with the partner RMAs;

d. The LLFA will consider ways to improve knowledge and understanding of groundwater flooding mechanisms across Lancashire and will develop appropriate actions to support these improvements;

e. Due to the significant impact of the events in December and the need to investigate a large number of individual locations in detail (229), some solutions at some locations will inevitably be implemented sooner than other solutions at other locations. Community engagement will be required to ensure that people are adequately informed of the risks they face with regard to flooding, and what measures they can implement for themselves to manage/reduce the risk of any future severe impact.

SECTION 7 – SUMMARY AND CONCLUSIONS

7.1 The unprecedented severe weather conditions experienced across Lancashire during December 2015 came after a month of almost constant heavy rainfall in November 2015. All normal opportunities for this rainfall to be absorbed into the ground, conveyed securely through surface water drainage channels (water courses and rivers), or through piped drainage networks (highways, sewers, private culverts) were unavailable as capacity was exceeded. Consequently significant volumes of water flowed above ground, damaging property and public assets as well as limiting travel, public services and business operations for many days at a time.

7.2 During the 5/6 December, the mechanisms of flooding were predominantly fluvial - from main rivers flowing out-of-bank. This was attributable to the sustained rainfall prior to the event that put the rivers close to capacity. On the 5 December there was a sharp increase in rainfall and surface water run-off from the catchment quickly found its way into the rivers due to the already saturated ground conditions. The rivers therefore responded quickly and could not accommodate this additional water, causing flooding in various locations. Surface water surcharging from at-capacity drainage systems contributed to the flooding on the 5/6 December.

7.3 The event of 25/26 December followed a period of sustained heavy rainfall, throughout which the rivers were mostly able to accommodate the rainfall. River levels increased gradually until surface water drainage systems were not able to discharge, became surcharged and then flooding occurred. The additional peak rainfall on the 25/26 December did cause some out-of-bank flow and fluvial flooding.

7.4 The severity of flooding during December 2015 resulted in many families having to leave their homes whilst repairs and restoration works were carried out. The LLFA have no reliable record of how many families and businesses are still displaced ten months after the first flooding, but it is believed that some hundreds of people are still affected in this way.

7.5 A principal flood risk management function for all RMAs is the requirement to cooperate in risk management activities. The LLFA feels it is very important to record the high degree of support, communication and collaboration between the Lancashire RMAs following the December flooding at all levels – strategically between Councillors, tactically between lead officers, and operationally between representatives working on the ground with each other and with our communities. The quality and quantity of data now available for our investigations owes everything to this shared commitment to manage flood risk at every possible location and in all possible ways.

7.6 The flooding incidents in December 2015 have been investigated by the lead local flood authority (Lancashire County Council) in accordance with the requirements of Section 19 of the Flood and Water Management Act 2010.

7.7 It is found that:

a. All risk management authorities that had flood risk functions before and during a flood event have exercised those functions in regard to this flood event. There are no such functions still to be exercised.

b. All risk management authorities that had relevant flood risk functions immediately following a flood event have exercised those functions in regard to this flood event. There are no such functions still to be exercised. *However it should be noted that despite the best efforts of all RMAs, some additional data identifying flooded property may come to light and be collected in the future whilst other functions are being carried out.*

c. All risk management authorities that have relevant flood risk functions in the medium-to-long term period following a major flood event have exercised those functions to some extent, and all still have work to do in this regard.