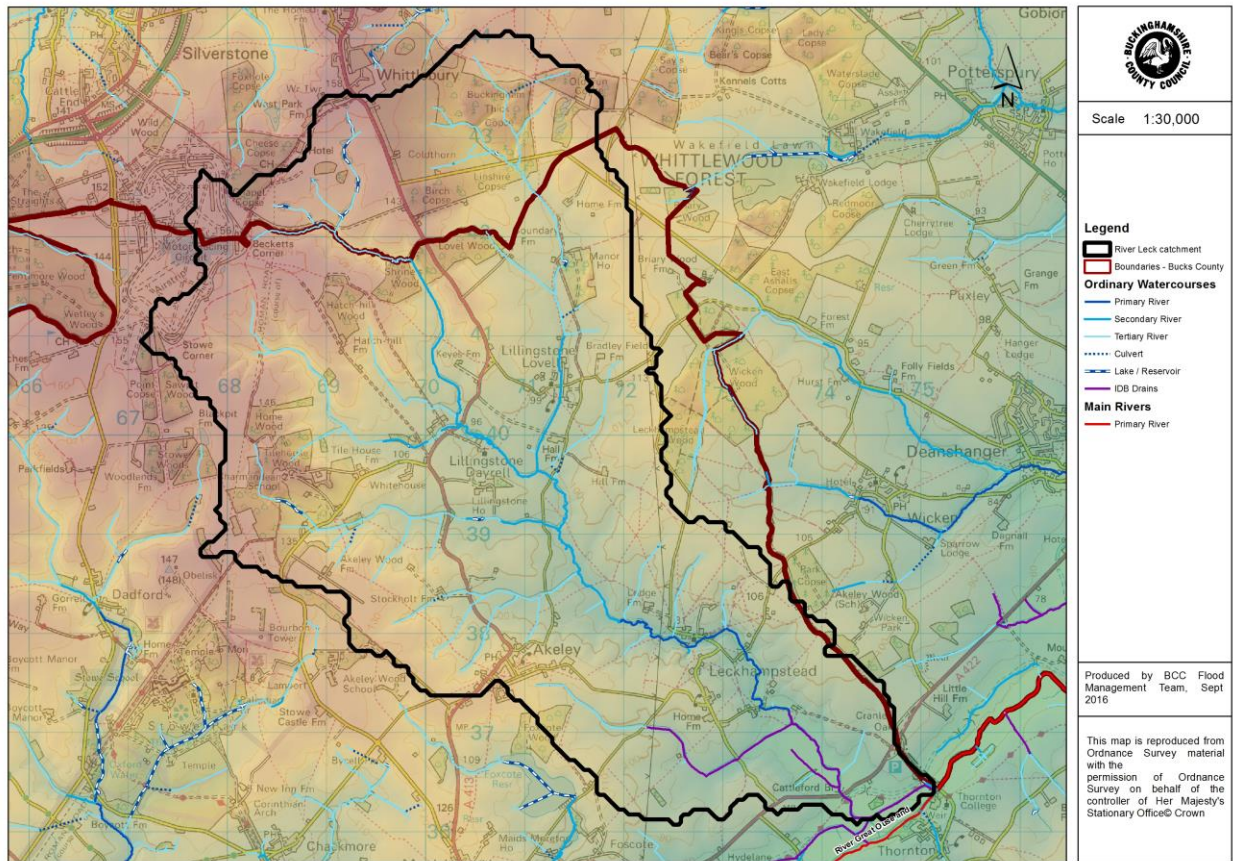


January 9th 2017

Buckinghamshire County Council

Flood Investigation Report

Leckhampstead, 9th March 2016



January 9th 2017

Revision Schedule

Buckinghamshire County Council **Flood Investigation Report**

9th January 2017

Rev	Date	Details	Author	Checked and Approved by
1	20/12/2017	Version 1 – draft	Abigail Alderson	
2	09/01/2017	Version 2 - draft	Abigail Alderson/ Andrew Waugh	Karen Fisher
3	03/12/2018	Version 3 – final	Andrew Waugh	Karen Fisher

January 9th 2017

Table of Contents

1	<i>Executive Summary</i>	5
2	<i>Introduction</i>	6
2.1	Background to investigation	6
2.2	Site Location.....	7
2.3	Drainage system and river network.....	7
3	<i>Background</i>	10
3.1	Catchment characteristics	10
3.2	Previous flood events	12
4	<i>Analysis of March 2016 flood event</i>	13
4.1	Conditions at the time	13
4.2	What happened?	13
4.3	Hazards	15
4.4	Possible causes	15
4.5	Incident response	21
5	<i>Responsible Authorities and Landowners</i>	23
5.1	Lead Local Flood Authority.....	23
5.2	Aylesbury Vale District Council.....	23
5.3	Environment Agency.....	23
5.4	Highways Authority – Transport for Buckinghamshire	23
5.5	Water Utility Company - Anglian Water	23
5.6	Internal Drainage Board - Buckingham and River Ouzel IDB	24
5.7	Landowners and riparian owners	24
5.8	Residents	24
5.9	Emergency Responsibilities	24
6	<i>Conclusions and Recommendations</i>	26
6.1	Conclusions	26

January 9th 2017

6.2 Recommendations.....28

7 Glossary..... 32

8 References 35

9 Contacts..... 36

10 Appendices 38

Appendix A: BCC criteria for a Section 19 Investigation38

Appendix B: HYRAD rainfall radar.....39

January 9th 2017

1 Executive Summary

This report has been produced by Buckinghamshire County Council (BCC) to investigate the flooding that occurred in Leckhampstead between the 8th and 9th March 2016. The report provides details of the event and makes recommendations for Risk Management Agencies (RMAs) to undertake to reduce the risk of a repeat in the future.

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

- Which RMA have relevant flood risk management functions; and
- Whether each of those RMAs has exercised, or is proposing to exercise, those functions in response to the flood.

It was deemed necessary to produce this report as the flood event in Leckhampstead exceeded BCC's criteria for carrying out a Section 19 Investigation.

The aims of the Section 19 Investigation are to outline what happened during the flood event and the responsibilities of the relevant authorities during the event. It is not intended to identify which properties flooded, nor to provide an exhaustive hydraulic analysis of the event. A list of recommendations is included in the report to help the various RMAs learn from the event and improve the management of flood risk in the future. All the RMAs will be involved in taking forward these recommendations.

The investigation indicates that the flood event in Leckhampstead occurred as a result of a month's worth of rainfall falling on already near-saturated ground. Water levels in the River Leck rose rapidly through the morning of 9 March 2016, overtopping the banks through Church End.

This rapid rise in river levels, coupled with overland flows running off the saturated valley sides, resulted in two properties on Church End being affected by floodwater. High velocity and depths of floodwater across the main access route led to the village becoming inaccessible by vehicle for a number of hours.

January 9th 2017

2 Introduction

2.1 Background to investigation

BCC as the LLFA has a responsibility to record and report flood incidents as detailed within Section 19 of the FWMA 2010:

Section 19

- (1) On becoming aware of a flood in its areas, 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.

BCC has established criteria for Section 19 flood investigations which can be found in the appendix.

It was deemed necessary to complete an investigation into the flood incident in Leckhampstead based on a decision by Strategic Flood Management Group on 21st March 2016. The flooding event did not meet agreed thresholds (see Appendix A), but was deemed significant due to the high velocity and depths of floodwater across the main access route, which led to isolation of the village for a few hours. The topography of the catchment makes Leckhampstead prone to a rapid onset of flooding.

January 9th 2017

2.2 Site Location

Leckhampstead is a small village in Aylesbury Vale District in the north of Buckinghamshire as shown in Figure 1, close to the borders of Northamptonshire. The nearest large town is Buckingham.

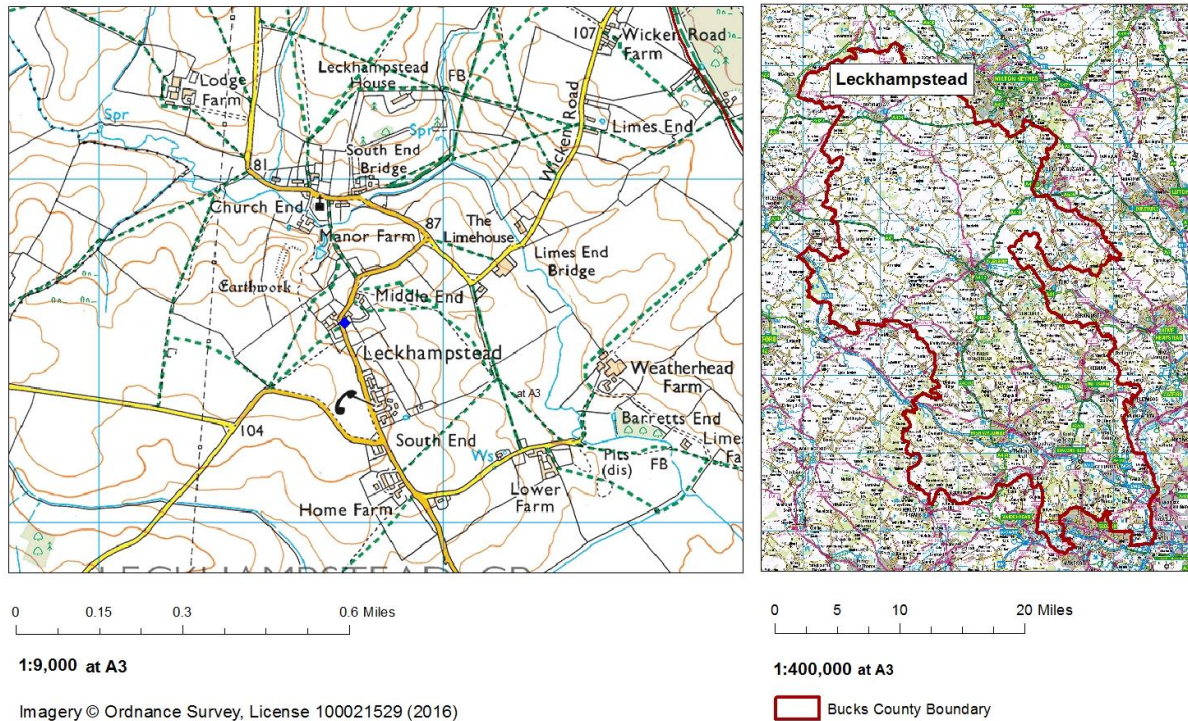


Figure 1: Location of Leckhampstead at local and county level.

2.3 Drainage system and river network

The River Leck is a tributary of the River Great Ouse. The Leck is approx 10km long, with headwaters in Northamptonshire near Silverstone and Whittlebury. Branches flow southwards through Lillingstone Lovell and Lillingstone Dayrell before converging downstream of these settlements, then flowing southwards through Leckhampstead before outfalling onto the River Great Ouse (as shown in Figures 2 and 3). The catchment area of the Leck is approximately 32km².

Buckinghamshire County Council, as Lead Local Flood Authority for Buckinghamshire, is the Risk Management Authority (RMA) for ordinary watercourse sections, as defined in Section 4.

January 9th 2017

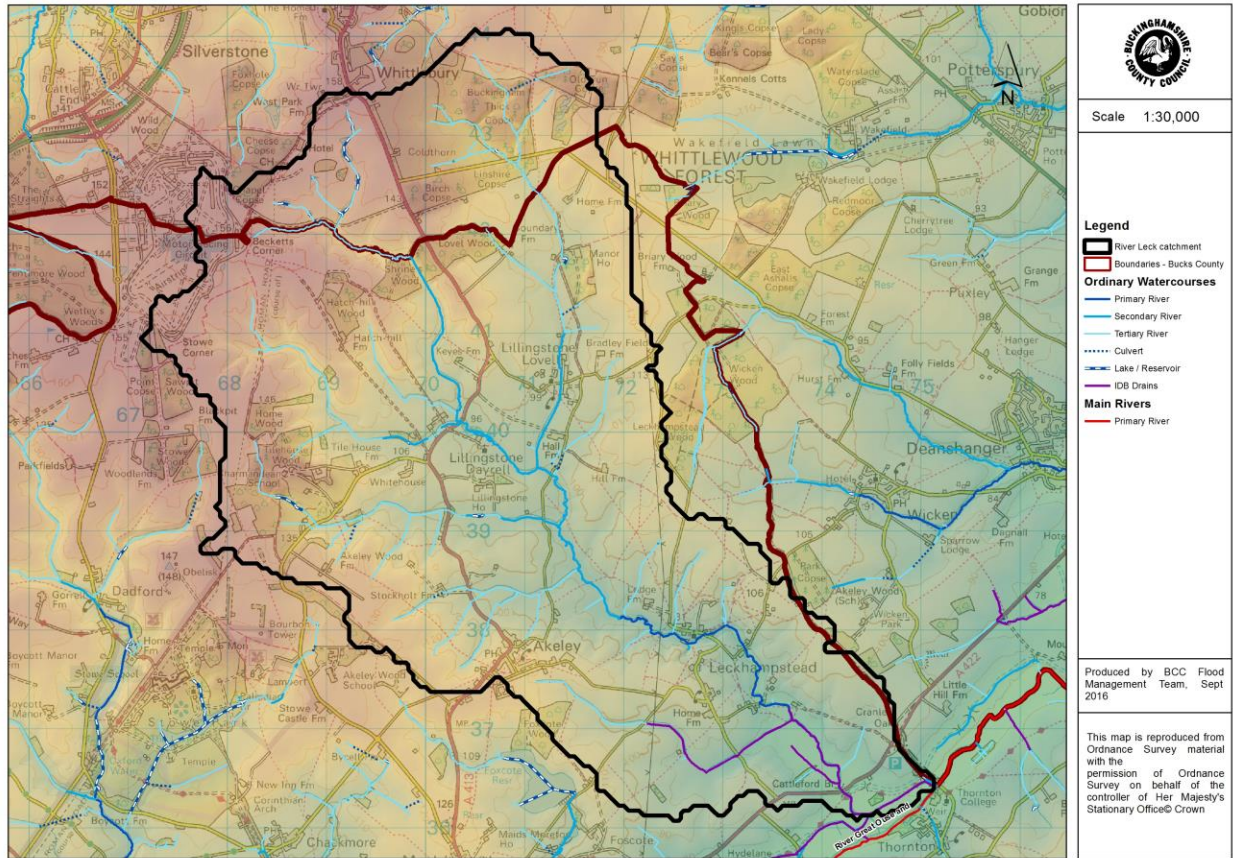


Figure 2: River Leck catchment

January 9th 2017

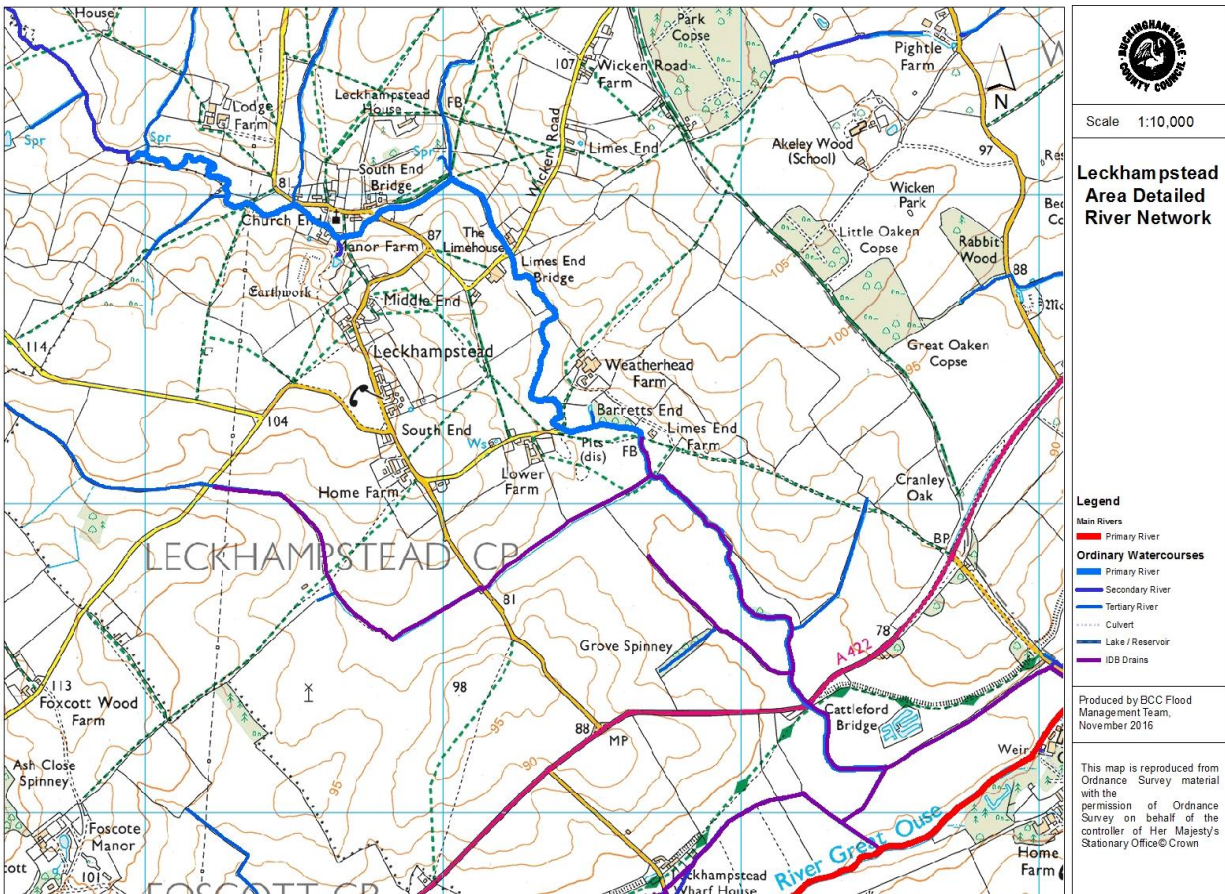


Figure 3: River network in vicinity of Leckhampstead

January 9th 2017

3 Background

3.1 Catchment characteristics

Leckhampstead is situated on clay, silt, sand and gravels along the line of the River Leck. The solid underlying geology comprises limestones, mudstones and sandstones. The valley has a relatively steep gradient for this part of Buckinghamshire, descending from 156m near Silverstone to 76m in the village of Leckhampstead (see Figure 2 for an overview of the relief of the catchment).

The principal source of flood risk is from fluvial sources. The publicly available fluvial Flood Map for Planning (see Figure 4) models the area which could be flooded from the ordinary watercourse by a flood with a 1 in 100 (1%) chance of occurring each year (medium blue/ Flood Zone 3), and by a flood with a 1 in 1000 (0.1%) chance of occurring each year (light blue/ Flood Zone 2). (The information indicates the flood risk to areas of land and is not sufficiently detailed to show whether an individual property is at risk of flooding, therefore properties may not always face the same chance of flooding as the areas that surround them).

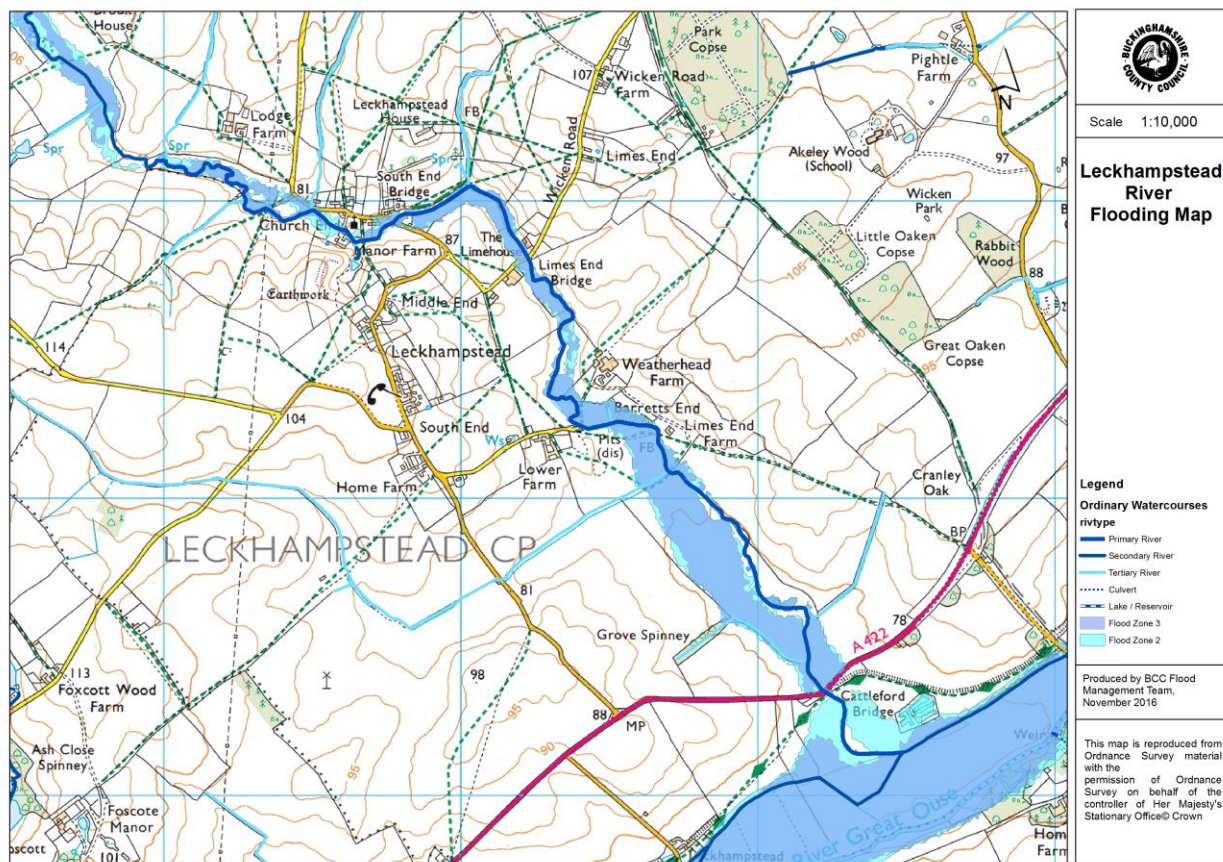


Figure 4: Flood Map for Planning

January 9th 2017

Figure 5 shows the publicly available “Flood Risk from Surface Water” flood mapping, shown here for a flood event with a 1 in 1000 (0.1%) chance of occurring in any given year. Surface water flooding occurs when extreme or prolonged rainfall cannot infiltrate into saturated ground, or flow into the rivers and/or highways drainage due to high volumes of water. The Flood Risk from Surface Water mapping is viewable at: <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>. It has not been possible to reproduce this mapping at a closer scale for the purposes of this report, but different scenarios of depth, velocity and extent can be viewed at various scales via the above link.

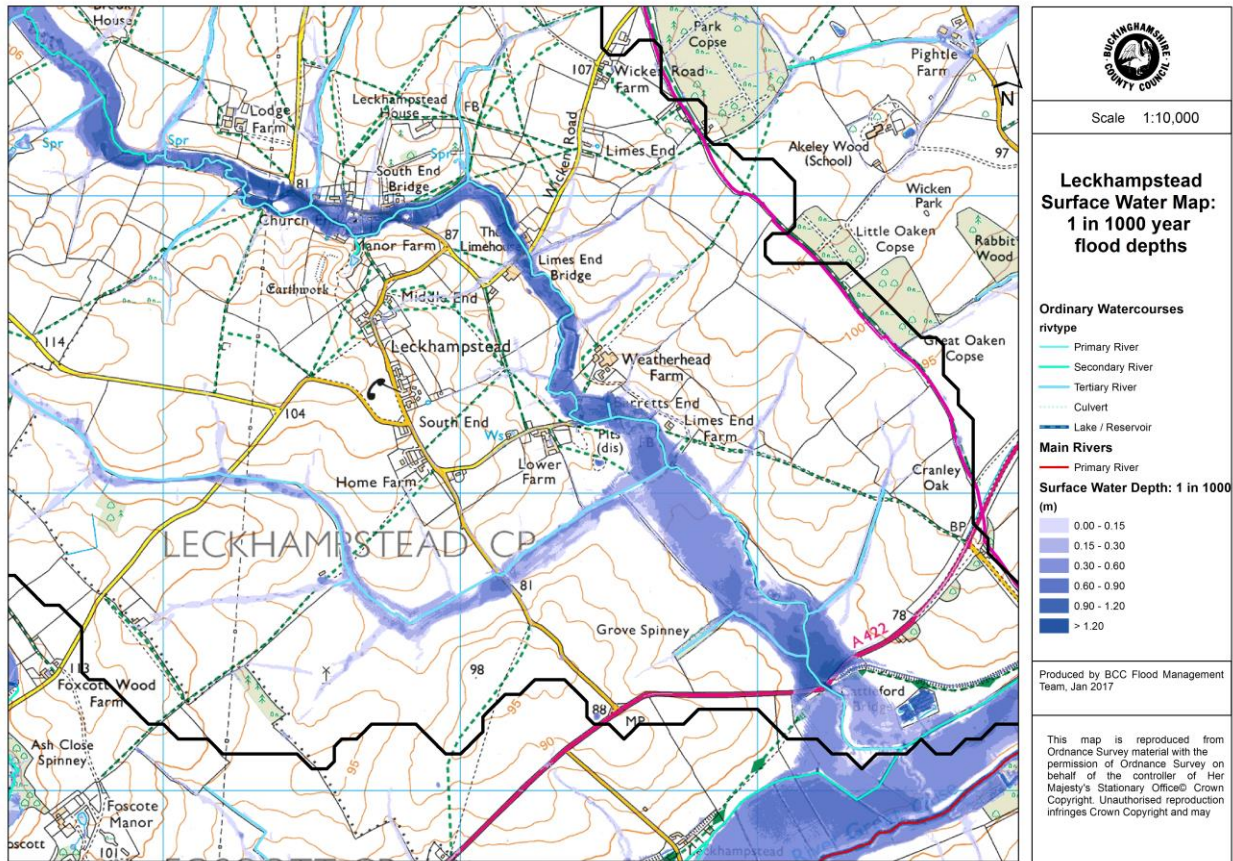


Figure 5: Risk of Flooding from Surface Water: depths for a 1 in 1000 (0.1%) chance event

January 9th 2017

3.2 Previous flood events

Leckhampstead has a long history of flooding, with early historical records indicating flooding in the 15th Century. In more modern times, there are records of flood events occurring in 1932, 1959, 1983, 1986, 1988, 1990, Easter 1998, February 2001, July 2007 and October 2007. Relatively few houses within Leckhampstead have experienced internal flooding, but local knowledge and existing flood mapping indicate that the particular characteristics of the flood events typical to this village also present indirect flood hazards to the wider community, which recurred in the March 2016 event.

In brief, these hazards include a rapid onset of flooding, highway access and egress issues isolating the village, and the hazard posed to people due to the depth and velocity of the floodwater. These are outlined in some further detail within Section 5, based upon existing mapping information.

January 9th 2017

4 Analysis of March 2016 flood event

4.1 Conditions at the time

By March 2016, monthly rainfall totals across England had been above average for a fifth consecutive month.

Following this wet winter, soil moisture deficits¹ (SMDs) around Leckhampstead were just 4mm prior to Wednesday 9th March 2016 (Environment Agency, 2016), indicating that the ground was already saturated and had capacity to store only 4mm more water.

Over the period of 2-8th March 2016, weekly precipitation exceeded 40mm in many parts of the country, including in the vicinity of Leckhampstead (Figure 6).

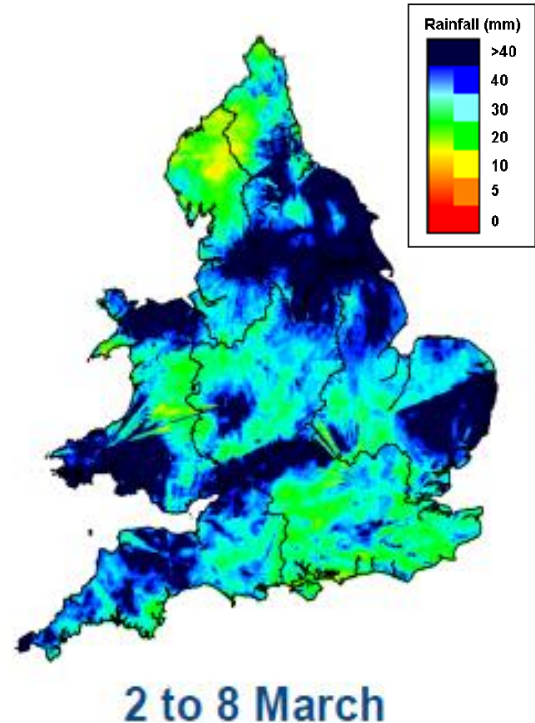


Figure 6: Rainfall totals over the period 2-8th March 2016. Note that radar beam blockages caused anomalous totals in some areas, such as the linear striping in west Wales and south Midlands (EA, 2016).

4.2 What happened?

Water levels in the River Leck rose rapidly through the morning of 9 March, overtopping the banks through Church End. There were also contributions from overland flows running off the saturated valley sides. The floodwater flowed the full length of the road through the village, onto which the majority of the properties front.

Two properties on Church End were affected by floodwater overtopping the River Leck. However, residents within the village were proactive in deploying their own flood prevention measures, which mitigated the potential property impacts, and no internal property damage was sustained.

¹ Soil moisture deficit levels provide a measure of the capacity of the ground to store water: the higher the number, the greater the capacity.

January 9th 2017

4.2.1 River gauges

There are no EA flow or level gauging stations on the River Leck. The nearest gauges are sited some distance away on the River Great Ouse, a much larger river, and therefore are not necessarily representative of flows or levels on the River Leck.

However, information from the gauges can still provide some useful background information to understand the wider hydrological conditions. The nearest gauging station, at Thornborough (SP 73483 35308), showed elevated levels on the Great Ouse from the morning of the 9th March, and a peak at approximately 01:00 on 10th March, close to record levels and well over the normal range of 0.10-0.73m (Figure 7). This reflects the prolonged heavy rainfall and wet antecedent conditions across the wider region at the time.

5-day information for this station

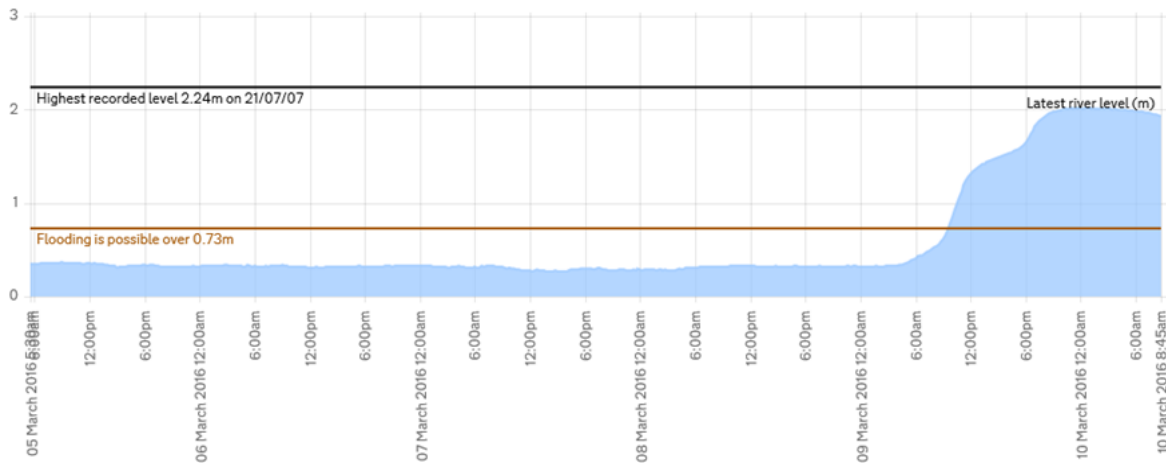


Figure 7: River Gauge data for the River Great Ouse at Thornborough, as of 08:45am 10th March 2016 (EA, 2016).

January 9th 2017

4.3 Hazards

Fast-flowing floodwater up to approx 1m in depth, with the deepest water at the bridge, made the only vehicular access route in and out of the village impassable for a number of hours. The combination of depth and velocity may have resulted in a significant potential hazard to people.

Isolation of the village by local flooding was compounded by concurrent closure of the main transport route in the area (the A422, between Buckingham and Milton Keynes), due to the interaction of high water levels from the River Leck and the Great Ouse. When levels in the Great Ouse are high, the River Leck is unable to discharge into the Great Ouse, which can cause flooding of the A422.

This combination of highway access and egress issues, the hazard posed to people due to the depth and velocity of the floodwater, and the rapid rate of onset of flooding, produced a potentially serious risk from flooding.

4.4 Possible causes

Total 48-hr rainfall accumulations at four nearby rain gauges are provided below (Table 1).

Rain gauges in the region	Total on 9-10 th March 2016 (mm)	Grid Reference
Byfield ⁱ	34.9	SP 52347 52534
Brackley ⁱ	40.2	SP 60115 36084
Foxcote ⁱ	29	SP 70253 35862
Deanshanger ⁱⁱ	35.7	n/a

Table 1: Rainfall totals across the Upper Great Ouse catchment region 9-10th March 2016.

January 9th 2017

Between midnight and 11:00am on Wednesday 9th March, 39.7mm of rainfall³ was recorded at the Environment Agency’s (EA) rain gauge upstream of Buckingham at Brackley. This amount of rainfall is equivalent to the total rainfall that would be expected for the whole of March. BCC have calculated the probability of such a rainfall event occurring in any given year within the Leck catchment as approximately 1 in 6 (17%), using the Flood Estimation Handbook (FEH) methodology (<https://fehweb.ceh.ac.uk/>).

Figure 7 below gives the 15 minute rainfall interval totals from the Brackley rain gauge. The data shows that relatively high intensities of rainfall (over 0.8mm every 15 minutes) were maintained between 01:45am on 9th March to 10:00 9th March.

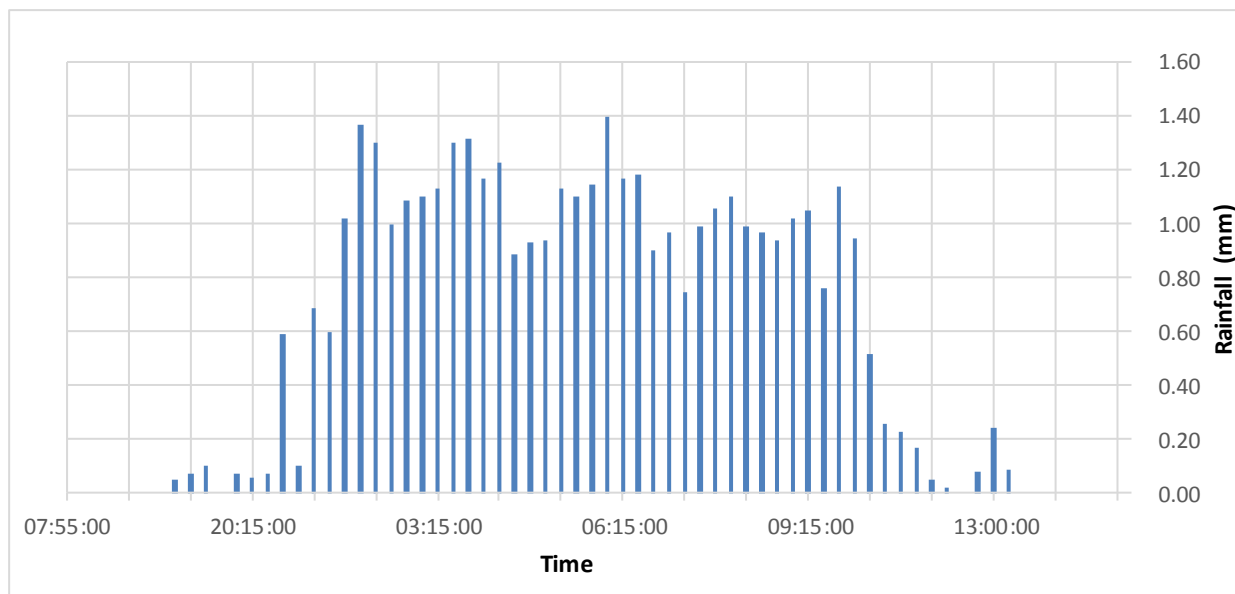


Figure 7: Brackley rain gauge data for the period 07:55 07/03/16 to 19:55 09/03/16 in 15minute intervals.

³ Note that this total is slightly less than the value for Brackley given in Table 1. The 39.7mm was recorded between the 11-hour period between midnight and 11:00am on the 9th March (the period of continuous heavy rainfall), whereas the 40.2mm was recorded in the 48-hour period between midnight on 9th March until midnight on 11th March.

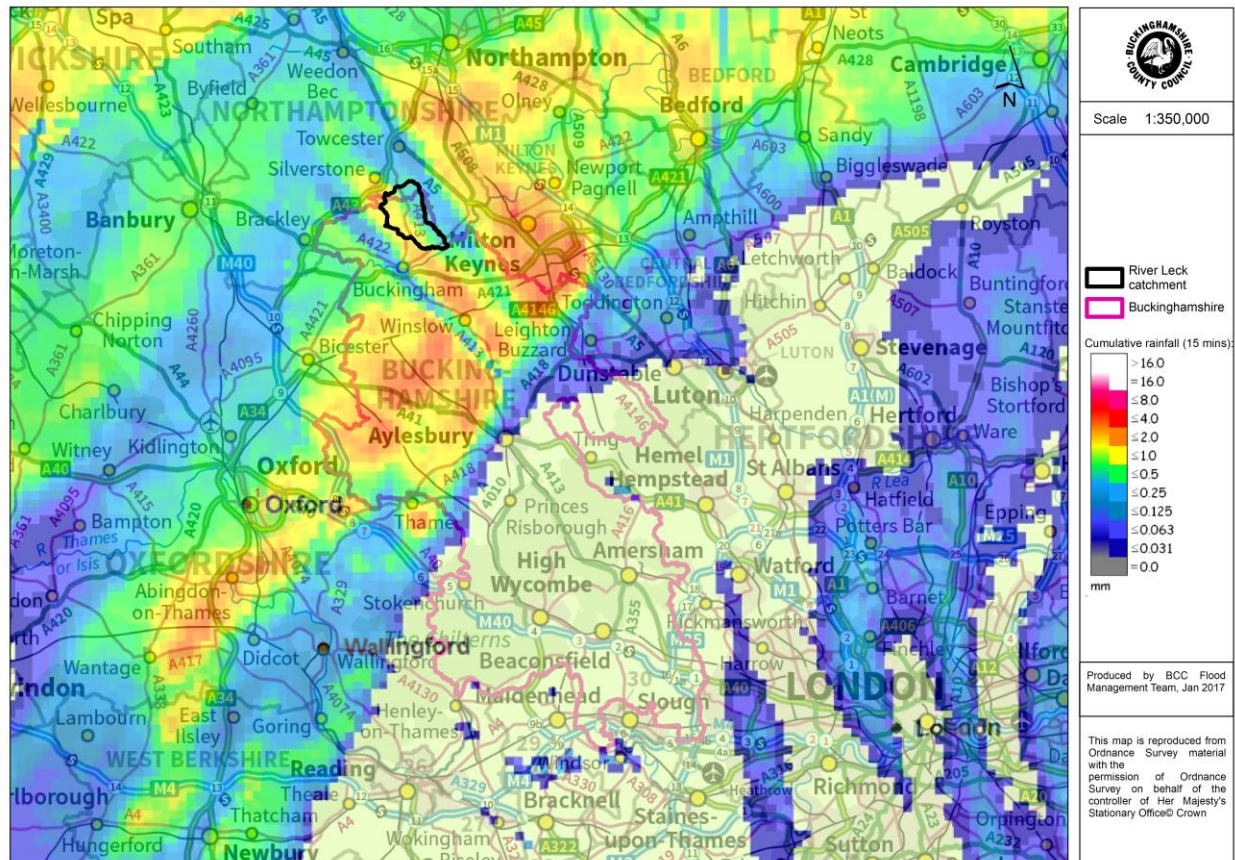
January 9th 2017

Figure 8: HYRAD rainfall radar imagery of Buckinghamshire and the surrounding area for 08:45am 9th March 2016 (provided by EA, 2016). Note that the linear strip of blue colours towards the east of the River Leck catchment (between heavier rainfall denoted by oranges and reds) is likely to be a radar anomaly.

HYRAD rainfall radar data (courtesy of the EA) show persistent heavy rainfall regionwide – an example is shown in Figure 8, above, which shows the 15-min rainfall accumulation preceding 08:45am on 9th March.

Anecdotal reports from local residents indicate that the rainfall experienced within the village itself was surprisingly low compared to that experienced during previous events. It is worth noting that the nearest EA rain gauge to the village, Foxcote near Maids Moreton, recorded 29.0mm in the same 11-hour period as Brackley recorded 39.7mm. This rainfall at Foxcote is estimated to have a probability of occurring in any given year as approximately 1 in 2 (50%), compared to a probability of 1 in 6 (17%) of the rainfall at Brackley. This corroborates the anecdotal evidence that the rainfall close to the village itself was not particularly extreme.

January 9th 2017

However, further investigation of rainfall radar data suggests that higher rainfall totals occurred across many areas of the catchment, upstream of the village. Figure 9 indicates that parts of the catchment received between 42 to 46.8mm of rainfall⁴. Furthermore, Deanshanger, just to the east of the catchment, recorded 35.7mm of rainfall across the same time period. Given the proximity to the catchment, it is reasonable to assume that similar rainfall totals were experienced towards the eastern headwaters of the catchment.

Together, the rainfall radar data and the records from Deanshanger suggest that larger rainfall totals (similar to or greater than at Brackley) fell in the higher topography of many of the headwaters of the catchment in comparison to in the village. Such rainfall figures are equivalent to the entire average rainfall of the month of March.

Given that the soil was already saturated, very little of the storm's rainwater could have been retained within the soil. Water would likely have rapidly arrived into the stream channels via quick throughflow downslope beneath the ground surface, with rapid displacement of 'old' stored soil water pushed out from the bottom of the hillslopes into the channels by new water infiltrating at the top of the slope. There would also likely have been some surface saturation in parts of the catchment, leading to some contributions to the river flow from overland surface flows.

In summary, the flooding occurred following a month's worth of rainfall falling within 11 hours onto an already saturated catchment, leading to a rapid river response with high peak flow.

⁴ It should be noted that this radar imagery appears to show anomalous rainfall totals in a linear strip towards the east of the catchment, as well as running northwest to southeast through Buckingham. Such anomalies are commonly caused by blockages in the radar beam. Analysis of all the radar imagery (shown in Appendix B) received for this area shows the same radar pattern of low totals in precisely the same geographical areas through various time periods, so we have some confidence that these "blue" linear areas of lower rainfall are indeed anomalously low. Thus, it is assumed that areas towards the east of the catchment experienced rainfall totals higher totals than the imagery indicates, likely to be of similar magnitude to the surrounding radar imagery. This is corroborated by the rainfall observer data from Deanshanger, which recorded 35.7mm of rainfall a few kilometres to the east of the catchment.

January 9th 2017

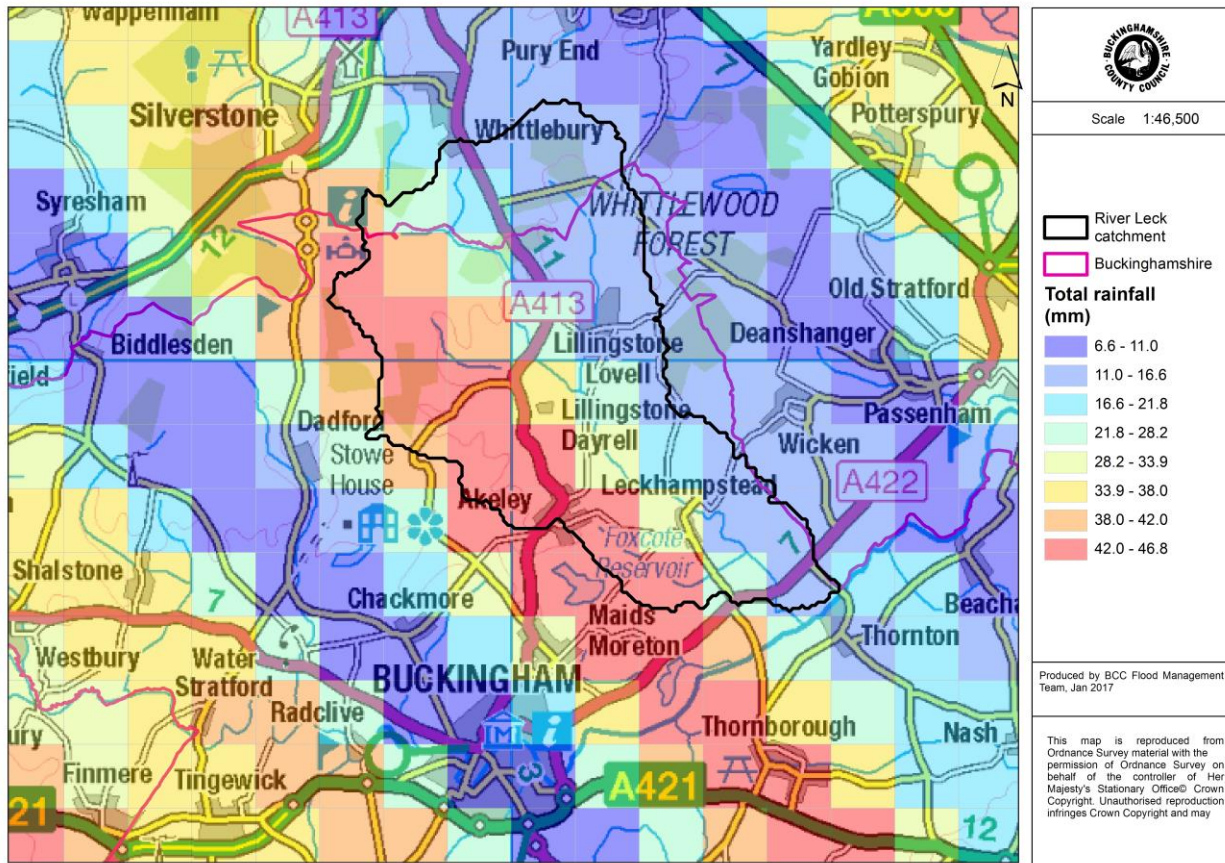


Figure 9: HYRAD rainfall radar totals for the River Leck catchment and the surrounding area for the 48-hour period between midnight on 9th March until midnight on 11th March. Note that the linear strip of blue colours towards the east of the River Leck catchment (between heavier rainfall denoted by oranges and reds) is likely to be a radar anomaly⁴.

January 9th 2017

During the follow-up investigation, local residents queried whether there were any obstructions (such as debris or overgrown vegetation) upstream or downstream of Church End that may have contributed to increased water levels during this event. Debris did collect on South End Bridge, as shown in Figure 10. BCC will be assessing the degree to which channel condition affects flow conveyance and hence flood risk as part of the recently-begun River Leck Catchment Feasibility study (further details in Section 5.2). However, it appears unlikely that this would have a significant effect on higher magnitude flows such as those experienced in this event.



Figure 10: Debris build up on South End bridge at east of village, 11th March 2016 (photo by BCC).

January 9th 2017

4.5 Incident response

Environment Agency

- Church End, Leckhampstead is situated within a wide Flood Alert area, but is not covered by a Flood Warning Area, and therefore does not receive a specific flood warning.
- The Flood Alert covers the Upper Ouse in Northamptonshire, Oxfordshire and Buckinghamshire and is triggered by levels on the Great Ouse at Brackley. Hence, this Flood Alert can be of limited relevance to Leckhampstead since it based on the levels of the Great Ouse, not the River Leck. This limits the ability of the community to prepare for and take action during flood events.
- Whilst the above Flood Alert was issued in this event, those signed up to receive the Flood Alert in the village did not receive it. The Environment Agency has indicated that this was due to a delay in completing an update of the alert area, but that this was rectified following the flood event.

Transport for Buckinghamshire

- Following the heavy rain on the 8th/9th March, Transport for Buckinghamshire (TfB) closed a number of roads in the area (see Table 2)
- TfB's main concern in the region was the Great River Ouse. In places it was on the verge of breaking its banks and the A422, Stratford Road, had to close where the river had risen by 1.6m in places.
- Other locations in the area including Buckingham and Beachampton also faced flooding incidents.

January 9th 2017

Date	Request taken by	CRN Number	Order Number	Time (hrs)	Defect	Address 1	Address 2	Depot	Time Passed (hrs)	Comments
09 March 2016	DF	46016053	5021121	9.17	2hr/Flood	Lillingstone Road	Akley	Gawcott	9.30	COMPLETE
09 March 2016	DF	46016054	5021124	9.18	2hr/Flood	Grenville Road	Buckingham	Aylesbury	9.45	COMPLETE
09 March 2016	DF	46016049	5021129	9.04	2hr/Flood	Church Road	Edgcott	Aylesbury	10.00	COMPLETE
09 March 2016	DF	46016081	5021150	10.33	2hr/Flood	Nash Road	Beachampton	Gawcott	10.38	COMPLETE
09 March 2016	DF	46016066	N/A	9.47	2hr/Flooding	Church Lane	Edgcott	Aylesbury	10.15	COMPLETE
09 March 2016	DF	46016090	N/A	11.01	2hr/Flooding	Winslow Road	Padbury	N/A	11.16	COMPLETE
09 March 2016	DF	46016089	N/A	11.12	2hr/Flooding	Buckingham Road	Newton Purcell	N/A	11.18	COMPLETE
09 March 2016	DF	46016087	5021215	10.43	Flooding	Church Hill	Akeley	Aylesbury	11.35	COMPLETE
09 March 2016	DF	46016093	5021199	11.20	2hr/Flooding	Edgcott Road	Grendon Underwood	Aylesbury	11.50	COMPLETE
09 March 2016	DF	46016092	5021202	11.06	2hr/Flooding	Winslow Road	Nash	Gawcott	12.02	COMPLETE
09 March 2016	DF	46016129	N/A	12.32	2hr/Flooding	Stratford Road	Buckingham	N/A	12.53	COMPLETE
09 March 2016	DF	46016119	N/A	12.17	2hr/Flooding	Main Street	Gawcott	Gawcott	12.58	COMPLETE
09 March 2016	DF	46016137	5021234	13.28	2hr/Flooding	Stratford Road	Leckhampstead	Gawcott	13.39	COMPLETE
09 March 2016	DF	46016130	N/A	12.38	Flooding	Ford Street	Buckingham	Gawcott	14.15	
09 March 2016	DF	46016142	5021243	14.32	2hr/Flooding	Verney Road	Addington	Gawcott	14.33	COMPLETE
09 March 2016	DF	N/A	5021245	14.38	2hr/Road Closure	Main Street	Beachampton	Gawcott	14.35	COMPLETE
09 March 2016	LM	46016136	5021236	13.22	2hr/Flooding	Tingewick Bypass	Tingewick	Gawcott	13.44	COMPLETE
09 March 2016	DF	46016175	N/A	16.44	2hr/Flooding	Fulwell Road	Westbury	N/A	7.01	

Table 2: Transport for Buckinghamshire response sites across the area on 9th March.

Anglian Water

Although Church End is within the Anglian Water region, the village is not connected to the public sewer. Properties are instead served by septic tanks.

January 9th 2017

5 Responsible Authorities and Landowners

There are different responsibilities for flood management depending on the type of flooding. Organisations responsible for flooding are known as Risk Management Authorities (RMAs) and their responsibilities are detailed below. Riparian landowners also have responsibilities for watercourses across their land and these are also detailed below. These are summaries of the details included in the Buckinghamshire County Councils Local Flood Risk Management Strategy (due to be published 2017).

5.1 Lead Local Flood Authority

The Lead Local Flood Authority in this area is Buckinghamshire County Council. Buckinghamshire County Council has a role as a RMA in coordinating management of local flood risk from surface water, ground water and ordinary watercourses in the county.

5.2 Aylesbury Vale District Council

Aylesbury Vale District Council have responsibilities to inspect and maintain watercourses on District Council land, respond to requests for assistance during flood events and have the power, if instructed by Buckinghamshire County Council, to carry out flood risk management work which will benefit management of surface runoff, groundwater and ordinary water courses.

5.3 Environment Agency

The Environment Agency is one of the RMAs as defined by the Flood and Water Management Act 2010. Protecting the river environment and managing flood risk is part of their job. The EA is the RMA for flooding from main rivers.

5.4 Highways Authority – Transport for Buckinghamshire

Any flooding from highways is managed by the Highways Authority which is BCC and the highways function is managed by TfB.

5.5 Water Utility Company - Anglian Water

Anglian Water is responsible for flooding from foul sewers and surface water sewers which they own. Whilst undertaking this they must manage flood risk from sewers. Leckhampstead, however, is not connected to the public sewer.

January 9th 2017

5.6 Internal Drainage Board - Buckingham and River Ouzel IDB

Operate strategic assets to reduce flood risk in partnership with RMAs and public. Maintain stretch of IDB in area.

5.7 Landowners and riparian owners

Landowners and riparian owners must maintain any culvert, or the bed and banks of any adjacent watercourse. They should clear away any debris from the watercourse or culvert even if it did not originate from their land.

Riparian owners can find further guidance on their responsibilities as landowners in the Environment Agency document 'Living on the Edge' which can be found online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LI_T_7114_c70612.pdf

5.8 Residents

Residents have a responsibility to take measures to protect themselves and their property when flooding is imminent.

5.9 Emergency Responsibilities

The emergency responsibilities are outlined in Table 3 below. Please note that Parish and Town Councils do not have a legal obligation to respond to emergencies. Whatever service they provide is voluntary and unique to each Parish or Town Council.

January 9th 2017

Table 3 Roles and responsibilities in an emergency, during and after a flood event

<p>Local (County and District) Authorities</p> <ul style="list-style-type: none"> • Coordinate emergency support within their own functions • Deal with emergencies on 'non main rivers' • Coordinate emergency support from the voluntary sector • Liaise with central and regional government departments • Liaise with essential service providers • Open rest centres • Manage the local transport and traffic networks • Mobilise trained emergency social workers • Provide emergency assistance • Deal with environmental health issues, such as contamination and pollution • Coordinate the recovery process • Manage public health issues • Provide advice and management of public health • Provide support and advice to individuals • Assist with business continuity 	
<p>Police Force</p> <ul style="list-style-type: none"> • Save life • Coordination and communication between emergency services and organisations providing support • Coordinate the preparation and dissemination <p>Fire and Rescue Service</p> <ul style="list-style-type: none"> • Save life rescuing people and animals • Carry out other specialist work, including flood rescue services • Where appropriate, assist people where the use of fire service personnel and equipment is relevant <p>Ambulance Service</p> <ul style="list-style-type: none"> • Save life • Provide treatment, stabilisation and care at the scene 	<p>Utility Providers</p> <ul style="list-style-type: none"> • Attend emergencies relating to their services putting life at risk • Assess and manage risk of service failure • Assist with recovery process, that is, water utilities manage public health considerations <p>Internal Drainage Board</p> <ul style="list-style-type: none"> • Operate strategic assets to reduce flood risk in partnership with RMAs and public <p>Town and Parish Councils</p> <ul style="list-style-type: none"> • Support emergency responders • Increase community resilience through support of community emergency plan development <p>Voluntary services</p> <ul style="list-style-type: none"> • Support rest centres • Provide practical and emotional support to those affected • Support transport and communications • Provide administration • Provide telephone helpline support
<p>Environment Agency</p> <ul style="list-style-type: none"> • Issue Flood Warnings and ensure systems display current flooding information • Provide information to the public on what they can do before, during and after a flood event • Monitor river levels and flows • Work with professional Partners and stakeholders and respond to requests for flooding information and updates • Receive and record details of flooding and related information • Operate water level control structures within its jurisdiction and in line with permissive powers • Flood event data collection • Arrange and take part in flood event exercises • Respond to pollution incidents and advise on disposal • Assist with the recovery process, for example, by advising on the disposal of silt, attending flood surgeries 	

January 9th 2017

6 Conclusions and Recommendations

6.1 Conclusions

The flood event in Leckhampstead occurred as a result of a month's worth of rainfall falling on already near-saturated ground. Water levels in the River Leck rose rapidly through the morning of 9 March 2016, overtopping the banks through Church End.

This rapid rise in river levels, coupled with overland flows running off the saturated valley sides, resulted in two properties on Church End being affected by floodwater. High depths and velocities of floodwater across the main highway access route led to the village being inaccessible for some hours.

The flood event in March 2016 and subsequent investigation by BCC, supported by useful information from knowledgeable local residents, has highlighted a long history of flooding within Leckhampstead. The particular characteristics of flood events typical to the village result in a significant and recurring significant risk from flooding. These are outlined below in some further detail, based upon flood records and existing mapping:

- The highway access routes in and out of the village can rapidly become impassable for a number of hours, with deep (between 30 cm and 1 m approx), fast-flowing floodwater isolating the village from both ends. The deepest water tends to be at each end of the village. The floodwater flows along the full length of the only street through the village, onto which many of the properties front.
- According to the publicly-available Updated Flood Map for Surface Water (uFMfSW) (<https://data.gov.uk/data/search?q=ufmfsw>), the Hazard to People rating from surface water flooding affecting access/egress is up to “Extreme - presenting Danger for All (including to emergency services)”. This rating is based on a function of flood depth and velocity, using the methodology of the Defra/EA study, “FD2321: Flood Risks to People” (randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=12016).
- The river catchment is flashy, with the rapid onset of flooding providing little warning or time for the community or authorities to prepare. Church End, Leckhampstead is situated within a wide Flood Alert area (the “River Great Ouse from Brackley to Haversham including the Padbury Brook”), but is not covered by a Flood Warning Area. The Flood Alert covers the wider Great Ouse catchment rather than being specific to this area.

January 9th 2017

- Isolation of the village by local flooding can be compounded by concurrent closure of the main transport route in the area (the A422, between Buckingham and Milton Keynes), due to the interaction of high water levels from the River Leck and the Great Ouse. When levels in the Great Ouse are high the River Leck is unable to discharge into the Great Ouse, which can cause flooding of the A422.

The investigation has helped inform proactive flood risk management by BCC, working with our partners in other RMAs and Buckingham Town Council. The following provides a brief overview of specific recommendations and activities, some of which are already underway. The Strategic Flood Management Team will regularly monitor the delivery of these recommendations.

January 9th 2017

6.2 Recommendations

Authority / Stakeholder	Recommended Actions	Further comments
All RMAs	<ol style="list-style-type: none"> 1. Work in partnership to help support the BCC-led River Leck Catchment Feasibility Study 2. If the River Leck Catchment Feasibility Study identifies a viable flood management option(s), help support BCC with identification and securing of funding streams; help support with implementation of viable options. 	<ol style="list-style-type: none"> 1. BCC began in Dec 2016 a feasibility study to investigate a range of measures to manage the flood risks, and assess whether there is an economically viable flood management option (or options) that will also be supported by the local community. A range of flood management interventions are to be appraised, including realistic combinations of traditional engineering solutions, community resilience measures such as developing a flood action plan, installing a better flood warning system, and working with natural processes particularly in the catchment upstream. This work is not intended to deliver any solutions on the ground, but only to identify whether any options could be taken forward to a more detailed business case.
BCC	<ol style="list-style-type: none"> 1. Progress the River Leck Catchment Feasibility Study and strategic outline business case. 2. Discuss setting up a Leckhampstead Flood Action Group and/or writing a community-based flood or emergency plan with the Parish Council, residents and relevant RMAs. 3. Investigate options to improve the flood warning arrangements for Church End, in liaison with other 	<ol style="list-style-type: none"> 1. Begun Dec 2016 – ongoing 2. Ongoing 3. In progress

January 9th 2017

	<p>RMA's.</p> <p>4. Discuss purchase of emergency toolkits through the EA-led Community Flood Toolkits project for Leckhampstead with Parish Council, local community and the EA. The aim of this project is to allow volunteer flood groups or parish councils to respond effectively during a flood event using appropriate equipment. These toolkits include items such as Hydrosnakes, high-vis jackets, "road flooded" warning signs, loudhailers, two way radios, emergency blankets, etc. Communities are able to tailor the contents of the flood kit to their needs. A flood/emergency plan must be in place before the kit can be received.</p> <p>5. Facilitate sharing of information between RMA's and the community.</p>	<p>4. BCC supporting EA with this – in progress.</p>
EA	<p>1. Work in partnership on the BCC-led River Leck Catchment Feasibility Study, providing support and advice</p> <p>2. Liaise with BCC with regard to an improved flood warning system.</p> <p>3. Continue to progress the Community Flood Toolkits project in partnership with BCC (see further details above).</p>	<p>1. Ongoing</p> <p>2. In progress</p> <p>3. Ongoing</p>
TfB	<p>1. For TfB culverts, including South End Bridge on Church End, Limes End Bridge on Wicken Road:</p> <ul style="list-style-type: none"> - Continue inspecting culverts above 900mm in diameter in line with current codes of practice, which entail general inspection every two years and principal inspection every 6 years. - For culverts below 900mm in diameter, TfB to continue 	

January 9th 2017

	<p>using the expertise of local area-based teams who look at all road infrastructure aspects in their area. Upon noticing issues, these will be raised as concerns or as work orders.</p> <ol style="list-style-type: none"> Continue to carry out cleansing of all gullies and highway drainage as part of the ongoing maintenance schedule. 	
Leckhampstead Parish Council	<ol style="list-style-type: none"> Continue to liaise with BCC on the River Leck Catchment Feasibility Study. Liaise with BCC and EA on setting up a Flood Action Group and/or community flood/emergency plan. Discuss the Community Flood Toolkits project with BCC and the EA. Report any potentially unconsented works on watercourses to us. 	<ol style="list-style-type: none"> Ongoing In progress Ongoing As required
AVDC	<ol style="list-style-type: none"> Investigate any records of installation of the South End and Limes End bridges (ca. 1980s) and provide to BCC. 	
Anglian Water	<ol style="list-style-type: none"> Liaise with BCC on the River Leck Catchment Feasibility Study. 	<ol style="list-style-type: none"> Ongoing
Riparian Landowners	<ol style="list-style-type: none"> Ensure that the River Leck banks are maintained in a suitable manner. The guidance given in the EA's 'Living on the Edge' guide regarding riparian owner responsibilities should be followed. Undertake clearance of vegetation and debris on the Leck with guidance from relevant RMAs. 	
Residents	<ol style="list-style-type: none"> Sign up for the Environment Agency's flood warning service, where available. Residents are not to move emergency flood measures deployed by agencies (e.g. sandbags). Take measures to protect themselves and their property 	All ongoing

January 9th 2017

	<p>against flooding.</p> <ol style="list-style-type: none">4. Continue to document and photograph flood incidents where possible and report flooding to BCC.5. Consider forming a Flood Action Group and writing a flood/emergency plan (with support from BCC and the EA)	
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January 9th 2017

7 Glossary

Acronym	Definition
AVDC	Aylesbury Vale District Council
BCC	Buckinghamshire County Council
BMKFRS	Buckinghamshire and Milton Keynes Fire & Rescue Service
BGS	British Geological Survey
CFMP/ Catchment Flood Management Plan	Catchment Flood Management Plans are produced by the Environment Agency to give an overview of the flood risk in the two primary catchments in BCC's area: Great Ouse and Thames.
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency, which has a Strategic overview role for flood and coastal erosion risk management
Flood	The temporary inundation by water of property or land not normally covered with water
Flood & Water Management Act 2010 (FWMA)	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which (partly) is to clarify the legislative framework for managing local flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a river.
Groundwater flooding	Occurs when water levels in the ground rise above the natural surface. Low lying areas underlain by permeable strata (e.g. Chalk) are particularly susceptible.
HYRAD imagery	Standard radar display system for flood warning across England, Wales, Scotland, Northern Ireland and Belgium
IDB / Internal Drainage Board	Applicable to only one area in Buckinghamshire for which the Buckingham and River Ouzel Internal Drainage Board has flood risk management responsibilities.
LLFA / Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
Local Flood Risk	Flooding from sources other than Main Rivers, which principally concerns surface runoff, groundwater and ordinary watercourses. BCC has a responsibility under the Flood & Water Management Act to manage flooding from these sources.

January 9th 2017

Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.
Ordinary Watercourses	All watercourses that are not designated Main River, and which are the responsibility of local authorities or IDBs
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authorities (RMA)	Organisations that have a key role in flood and coastal erosion risk management as defined by the Flood & Water Management Act 2010. These are BCC (the Lead Local Flood Authority and Highways Authority), District Councils, Environment Agency, Buckingham and River Ouzel Internal Drainage Board, Anglian Water and Thames Water
SFRA	Strategic Flood Risk Assessment. These are produced by each District to give an assessment of flood risk from all sources and its implications for land use planning.
Soil moisture deficits (SMDs)	Soil moisture deficit levels provide a measure of the capacity of the ground to store water: the higher the number, the greater the capacity
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations; includes the public and communities.
Strategy	Under the Flood & Water Management Act 2010, BCC have a duty to develop, maintain, apply and monitor a strategy for local flood risk management
Sustainability	In the context of this Strategy, the risk of flooding must be reduced now, but in a way which does not compromise the interconnected needs of the economy, society and environment in the future.
SuDS / Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more

January 9th 2017

	sustainable manner than some conventional techniques.
Surface water/runoff	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer. The term 'surface water' is used generically to refer to water on the surface and is often associated with periods of intense rainfall.
SWMP	Surface Water Management Plan
TfB	Transport for Buckinghamshire

January 9th 2017

8 References

Reference in document	Refers to:
Environment Agency, 2016	Flooding in Buckingham: March 2016 Flood Event Summary community newsletter. Environment Agency. (Unpublished).
EA water situation reports	https://www.gov.uk/government/collections/water-situation-reports-for-england
Environment Agency ‘Living on the Edge’, 2016	https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities
Flood and Water Management Act (FWMA) 2010	https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities

January 9th 2017

9 Contacts

Lead Local Flood Authority



Flood Management Team
Buckinghamshire County Council
County Hall
Walton Street
Aylesbury
Bucks, HP20 1UY

Telephone: 084537 08090

Email: FloodManagement@buckscc.gov.uk

Website: www.buckscc.gov.uk/flooding

Environment Agency



**Environment
Agency**

National Customer Contact Centre
PO Box 544
Rotherham
S60 1BY

Telephone: 03708 506506

Email: enquiries@environment-agency.gov.uk

Website: <http://www.gov.uk/government/organisations/environment-agency>

District Council



Aylesbury Vale District Council
The Gateway
Gatehouse Road
Aylesbury
Bucks HP19 8FF

Opening times

Monday - Thursday
8.45am – 5.15pm
Friday
8.45am – 4.45pm*

Telephone: 01296 585858

*Customer service centre closes at 4pm on Friday

Highways Authority

Transport for Buckinghamshire

Telephone: Transport and roads – 0845 2302882

Out of hours emergencies (Highways) – 01296 486630

Email: tfb@buckscc.gov.uk

January 9th 2017

Website: <http://www.transportforbucks.net/Transport-and-roads.aspx>

Water Utility

 Anglian Water
PO Box 4994
LANCING
BN11 9AL

Telephone: 03457 91 91 55

Website: <http://www.anglianwater.co.uk/help-and-contact-us/contact-us/>

Emergency Response:

Buckinghamshire Fire and Rescue Service

Address: Buckinghamshire Fire & Rescue Service, Brigade HQ, Stocklake, Aylesbury, Bucks, HP20 1BD

Telephone: 01296 744400

Website: <http://www.bucksfire.gov.uk/BucksFire/Contact+Us/>

Thames Valley Police

Telephone: 101 in non-emergency, 999 in emergency

Website: <http://www.thamesvalley.police.uk/contactus-phone.htm>

Buckinghamshire Ambulance Service

Telephone: 111 in non-emergency, 999 in emergency

Website: <http://www.southcentralambulance.nhs.uk/content/press-release/buckinghamshire/flooding-advice.ashx>

January 9th 2017

10 Appendices

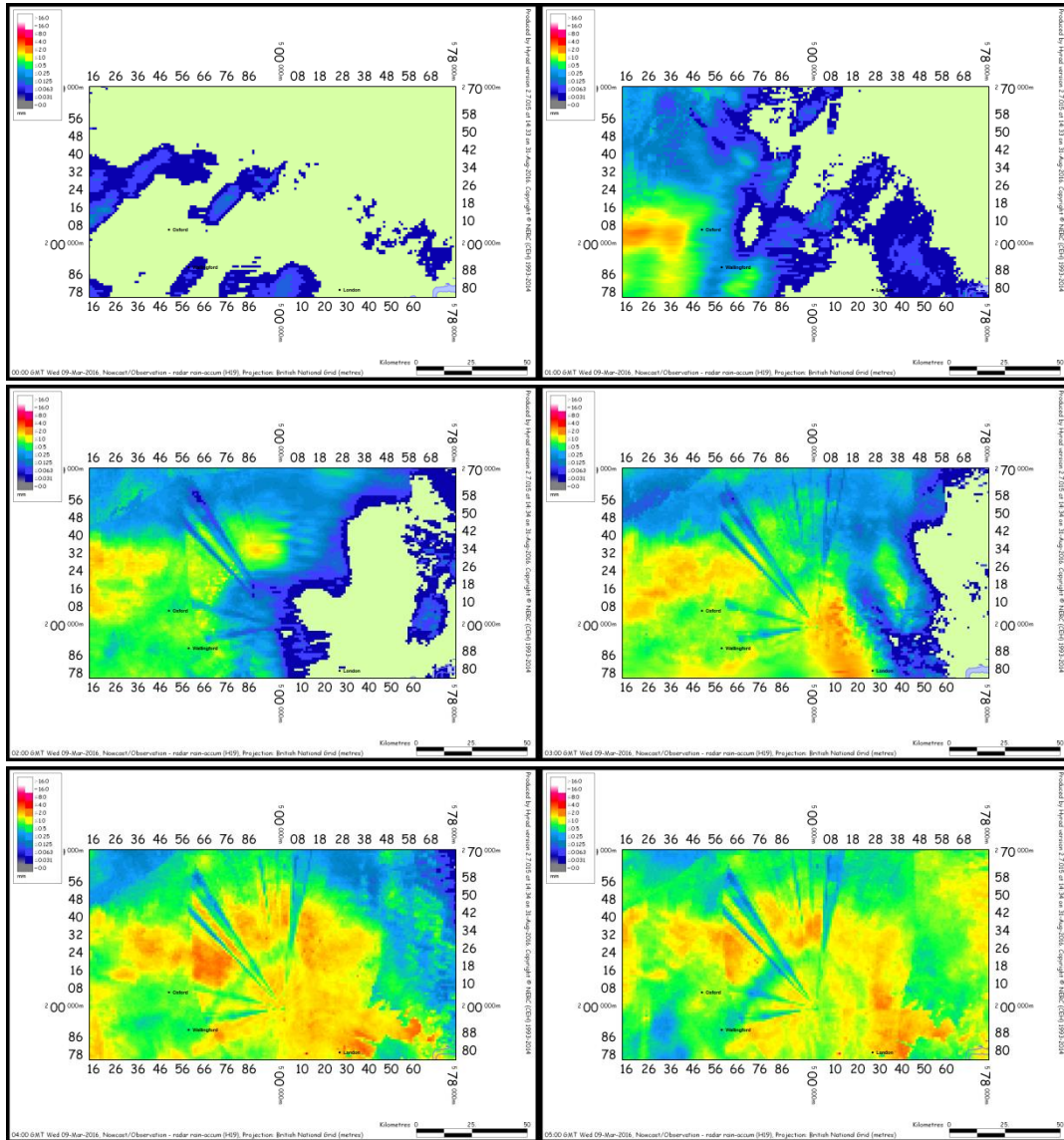
Appendix A: BCC criteria for a Section 19 Investigation

- Internal flooding (including to basements) to five or more residential properties within an area of 1km²
- Internal flooding of two or more business premises within an area of 1km²
- Internal flooding (including to basement) of at least one property for one week or longer
- Flooding of one or more items of critical infrastructure, which could include hospitals, health centres, clinics, surgeries, colleges, schools, day nurseries, nursing homes, emergency services (police, fire, ambulance) stations, utilities and substations.
- Any flooding event that a risk management authority deems significant but does not meet the agreed thresholds should be brought to the next Strategic Flood Management Committee for consideration.

January 9th 2017

Appendix B: HYRAD rainfall radar

Area surrounding Leckhampstead 09/03/2016 00:00 – 11:00 (at hourly intervals).
Data provided by the EA.



January 9th 2017

