Hertfordshire County Council
Flood Investigation Report
Robbery Bottom Lane, Welwyn, Hertfordshire

December 2014

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Revision Schedule

Hertfordshire County Council
Flood Investigation Report

Tuesday 16 December 2014

Rev	Date	Details	Author	Checked and Approved by
1	12/12/14	For internal consultation	Emma Ryder, Flood Risk Partnership and Schemes Officer	
2	16/12/14	Formatting and text revision	John Rumble, Head of Environmental Resource Planning	
3	12/12/14	For RMAs consultation	Emma Ryder, Flood Risk Partnership and Schemes Officer	John Rumble, Head of Environmental Resource Planning
4	16/12/2014	Final amendments	John Rumble, Head of Environmental Resource Planning	John Rumble, Head of Environmental Resource Planning

Explanation of Acronyms

Acronym	Explanation
FWMA 2010	**Flood and Water Management Act 2010** – Legislation that was developed and enacted as a result of the review into serious flooding in the UK during 2007. It brings new powers and duties to local authorities and other regulatory bodies.
HCC	**Hertfordshire County Council**
LDA 1991	**Land Drainage Act 1991** – Legislation that sets out a range of roles and responsibilities relating to flood risk management. It is also the legislation that gives powers to local authorities to manage flood risk from watercourses and highlights the role of the landowner to manage watercourses on their land to maintain the flow of water.
LLFA	**Lead Local Flood Authority** – This is the role assigned to the unitary or county council for an area with a range of duties and powers to support the management of local flood risk.
PLP	**Property Level Protection** – measures residents can take to protect their properties from flooding.
RMAs	**Risk Management Authorities** – Bodies identified in the FWMA 2010 with roles and powers to manage flood risk. This includes the county council, district councils, highway authorities, Environment Agency and water companies.
WHBC	**Welwyn Hatfield Borough Council**

Executive Summary

Following several days of persistent rainfall on 7 and 8 February 2014, Robbery Bottom Lane experienced flooding which caused internal damage to four residential properties, entered the space beneath the floor of a further four residential properties, and caused internal damage to two garages. Flooding previously affected the lane on Christmas Eve 2013, as well as during 2009 and 1993.

Hertfordshire County Council as Lead Local Flood Authority (LLFA) have investigated the February 2014 flood incident under Section 19 of the Flood and Water Management Act 2010 and now publish this report for the following three reasons: because the impact of the flooding on property was so sever; because the road was impassable for over 10 hours; and because the flooding was a repeat occurrence.

The purpose of this report is to establish the causes of the flooding; identify the relevant Risk Management Authorities (RMAs), highlight the roles and responsibilities of the RMAs and confirm if those authorities intend use their relevant powers to help manage flood risk to Robbery Bottom Lane.

It has been concluded that the February 2014 flooding was as a result of rainfall over an extended period of time which saturated the Robbery Bottom Lane catchment. (A catchment is defined as the natural drainage area collecting rain water.) Once saturated, any additional rainfall was unable to soak into the ground, resulting in surface water runoff which more quickly made its way to an open watercourse that runs east to west along fields at the top of the catchment. There were two final showers on 6th and 7th, both of which were unexceptional. The second and more severe shower had a return period of one in two years. The return period refers to the average interval between rainfalls of a specific magnitude. In this case the magnitude of the rainfall was that which caused the flood, this magnitude of rainfall happens on average once every two years. That does not mean it will definitely happen once every two years, it is an average. If the catchment is already saturated, then this magnitude of rainfall event can cause flooding to occur on the lane.

Robbery Bottom Lane is located along the natural watercourse flow route of the valley. When the open watercourse is in low flow, the water naturally flows from where it first appears just south of the junction of White Horse Lane and Robbery Bottom Lane. It then heads west through one field, through a culvert under a bridleway and into another field. (A culvert is defined as a tunnel carrying a watercourse). At the edge of this second field the water enters an inlet which then conveys the water through a culvert downhill and west under Robbery Bottom Lane. From the west of the lane the culvert continues to carry the watercourse under the road until it reaches the east side of Great North road where it becomes open again. The watercourse then travels through various culverts before discharging to the Mimram. Hertfordshire County Council Lead Local Flood Authority have determined the body of water from the junction of White Horse Lane and Robbery Bottom Lane, to the outfall into the Mimram, a watercourse with both closed sections and open sections.

When the open watercourse is in high flow, as it was on 7 and 8 February 2014, the culvert under the lane does not have the capacity to convey all the water and the excess water spills onto the surface of the road and flows down to its low point. A natural bowl shape in the land at the bottom of the lane by the junction of Lower Mardley Hill coupled with the raised road level of Lower Mardley Hill forms the low point and creates a basin in which the water collects.

Other factors identified as contributing to the flooding in February 2014; the lane's highway drain between the inlet and Lower Mardley Hill was blocked with tree and shrub root mass which reduced the drain's capacity to convey water; gullies along the lane had become blocked with tree and shrub debris which reduced their efficiency.

As part of the technical investigation report produced by HCC appointed consultants (see appendix 1), a list of recommendations that might help to manage flood risk to Robbery Bottom Lane has been put forward.

The main recommendations of the technical report are:

- Discuss the findings of this report with affected residents and wider community, including local landowners.
- Work with the local community to create a community flood plan.
- Identify and remove trees and shrubs that are linked to gulley blockage.
- Provide a formal road surface for the unadopted roads of Corpse Hill and Broom Hill to limit debris and silt being washed down into the gullies.
- Implement a regular gulley watch scheme and cleaning regime.
- Keep clear and repair the existing highway drain.
- Replace the trash screen that prevents debris flowing into the highway drain, in line with latest best practice.
- Organise property level surveys and implement a resistance / resilience strategy. This should be done as soon as possible to protect properties.
- Move towards a robust solution in coalition with the local community.
- Take forward the options of a flood defence wall and/or upstream attenuation storage for a more detailed review. Upstream attenuation storage refers to a system of holding the water upstream and allowing it to be released at a slower rate to reduce flooding.

There is no guarantee that flooding can be prevented particularly under conditions similar to those that occurred on the lead up to and on 7 and 8 February 2014. A collaborative approach will be required between all risk management authorities, landowners, and residents to manage flood risk in the future.

1. Introduction

1.1 Lead Local Flood Authority investigation

Under Section 19 of the Flood and Water Management Act 2010 Hertfordshire County Council (HCC) as Lead Local Flood Authority (LLFA), on becoming aware of a flood in its area, must, to the extent it considers it necessary and appropriate:

- investigate the incident;
- identify the risk management authorities (RMAs) with relevant flood risk management functions;
- establish if the relevant risk management authorities have responded to the flood event or are proposing to respond;
- publish the findings in a Section 19 Flood Investigation Report; and
- inform the relevant risk management authorities of the findings.

As defined under Subsection 13, Section 6, of the Flood and Water Management Act, a risk management authority has certain powers to manage, regulate, assess and mitigate flood risk. We have identified the following risk management authorities as part of this Section 19 flood investigation for Robbery Bottom Lane.

- Hertfordshire County Council as Lead Local Flood Authority
- Welwyn Hatfield Borough Council (WHBC)
- Hertfordshire County Council as Highway Authority
- Environment Agency
- Thames Water

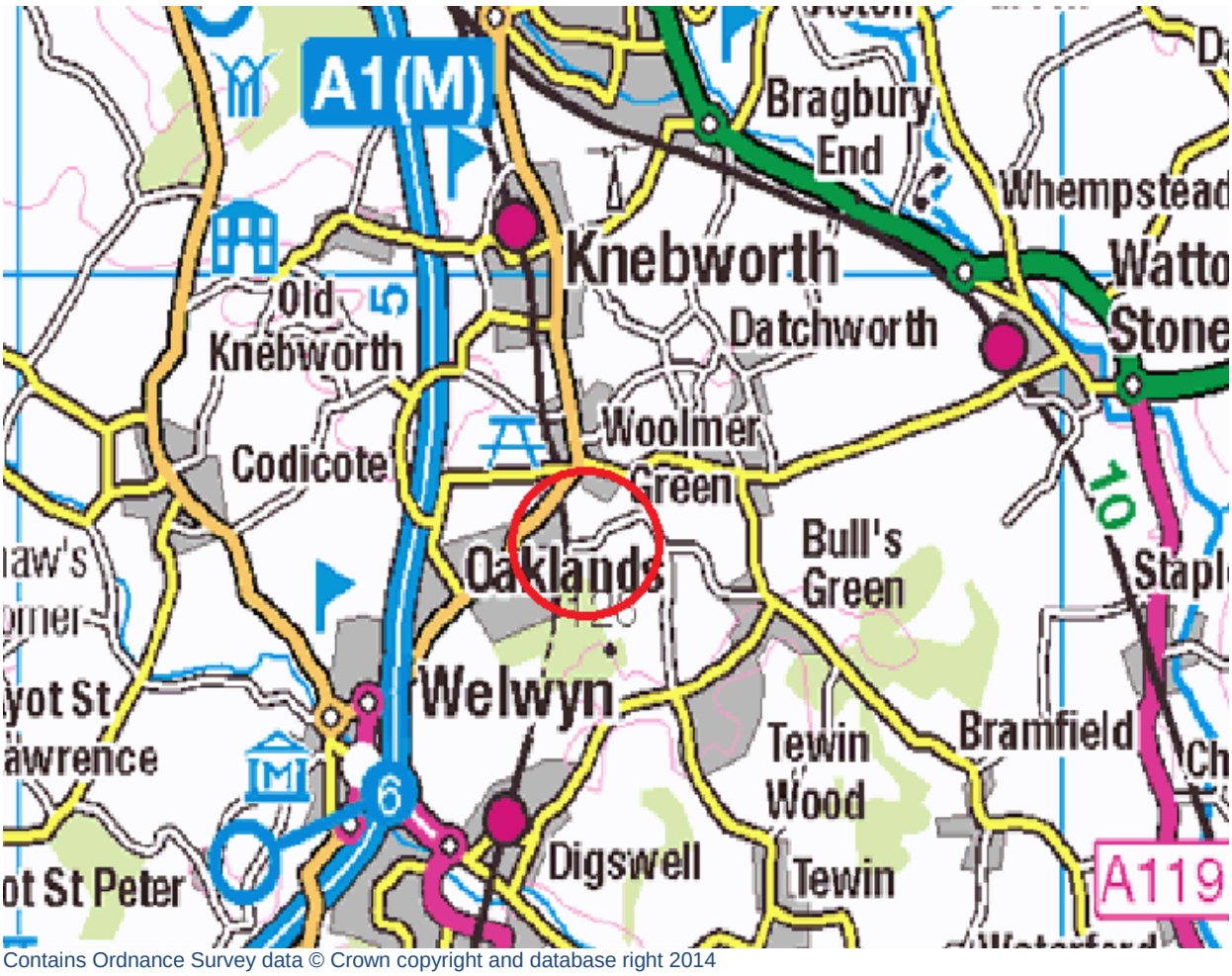
After 8 February 2014, HCC received reports that several residential properties had suffered internal flooding along Robbery Bottom Lane. Officers from the Environmental Resource Planning Team of Hertfordshire County Council visited the lane on 21 February, 10 March, and 30 April 2014, and spoke to residents, to ascertain the detail of what happened and who was affected.

Due to the severity of the flooding, it was determined that this flood incident met the criteria in Policy 2 of Hertfordshire County Council's Flood Risk Management Strategy (http://www.hertsdirect.org/services/envplan/water/floods/floodrisk/lfrmsherts/) and HCC subsequently commissioned this flood investigation.

1.2 Site location

Robbery Bottom Lane is situated north-east of Welwyn, as illustrated in Figure 1.1, below.

Figure 1 Robbery Bottom Lane, Welwyn, Hertfordshire – Location map



Red circle indicates location of Robbery Bottom Lane, Welwyn, Hertfordshire.

2. Background and history of flooding

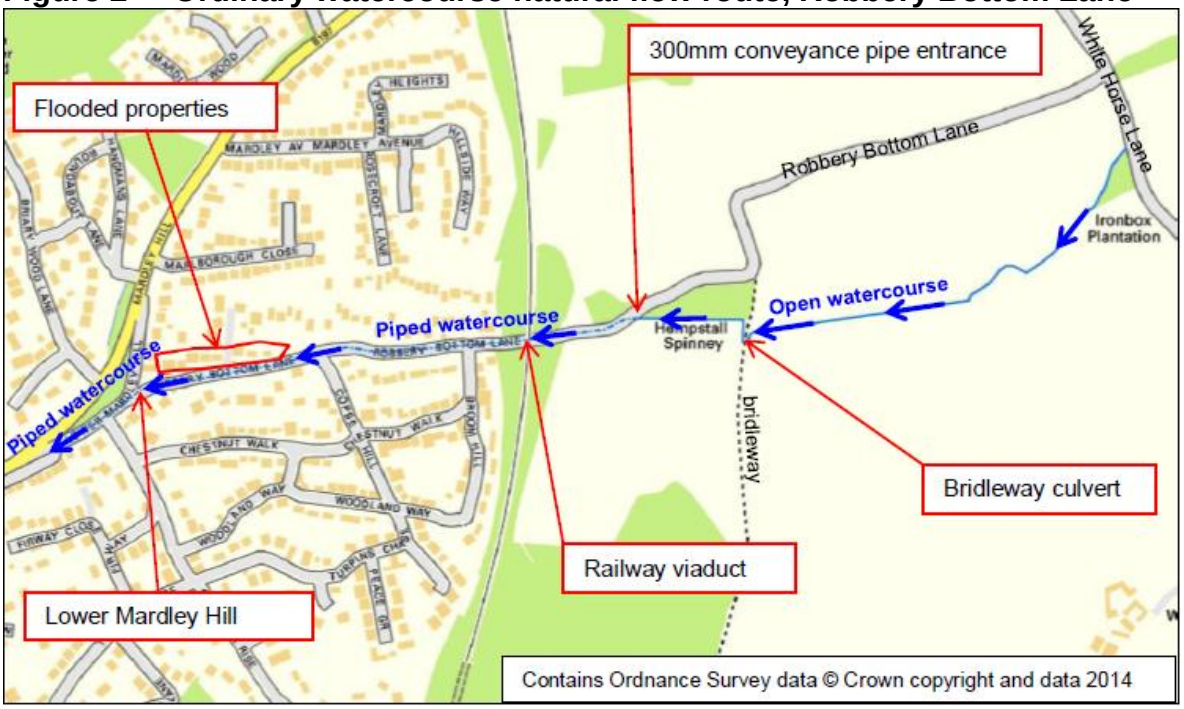
2.1 Catchment characteristics

Robbery Bottom Lane lies at the centre of the valley in which an ordinary watercourse flows west through a field from the junction of White Horse Lane and Robbery Bottom Lane. The watercourse then travels through a culverted bridleway into another field. At the edge of this second field the water enters an inlet which directs the water through a culvert downhill and west under Robbery Bottom Lane. From the west of the lane the culvert continues to carry the watercourse under the road until it reaches the east side of Great North road where it becomes open again. The watercourse then travels through various culverts before discharging to the Mimram.

The west side of the lane at the junction of Lower Mardley Hill forms the bottom of the valley. In the lower part of the catchment west of the viaduct, and to the north and south of the lane, land is developed with residential roads. Land use in the upper catchment east of the viaduct is agricultural. Between White Horse Lane and the inlet where the watercourse is conveyed under road, there is a bridleway where the watercourse passes through a culvert.

The road adjacent to where the open watercourse enters the inlet has a gradient of approximately 1 in 100 going down to the west. The road then falls less steeply before rising again at the junction with Lower Mardley Hill effectively forming a dam at the junction. Ground levels on Robbery Bottom Lane at the junctions with both Broom Hill and Lower Mardley Hill are essentially the same. The ground level between these two points is lower, forming a bowl in the landscape where water collects during times of flood, several residential properties and garages are situated at this lower lying area.

Figure 2 Ordinary watercourse natural flow route, Robbery Bottom Lane



Map of water flow in the area of Robbery Bottom Lane, blue arrows show flow direction down the valley

2.2 Previous flood events causing damage to property

The earliest flood causing damage to property on the lane which residents have memory of occurred during 1993. There is no knowledge or available record of previous flood events. Residents report another flood occurred in 2009, the depth of which was only marginally less than the flood of February 2014. More recently a flood occurred on Christmas Eve 2013 requiring emergency services to evacuate residents from their homes. Shortly after that was the flood on 7 and 8 February 2014.

3. Assessment of the flood event on 7 and 8 February 2014

3.1 Observations

In the early hours of the morning on 7 February 2014 residents of Robbery Bottom Lane awoke to water flowing down the surface of the road and collecting in the low point between the junctions of Broom Hill and Lower Mardley Hill. It was reported that once this basin filled, water then flowed over the Lower Mardley Hill junction and continued west down the road.

Hertfordshire Fire and Rescue attended the scene between the hours of 5am and 2pm to try and alleviate the flooding by pumping the water from the basin to a nearby watercourse located just 60m north of Robbery Bottom Lane on the west side of Mardley Hill.

Once the rainfall ceased, residents stated that the water levels dropped over the course of a day or so, but serious flood damage had already occurred.

It was reported by residents that at the time of flooding the gullies along the lane had been blocked by debris from local trees and shrubs.

3.2 Ground conditions

Environment Agency data showed that following a long period of heavy rainfall, ground conditions, as measured from a local gauge identified as Lee-Chalk close to the area of Robbery Bottom Lane, were near to saturation for the whole of the winter of 2013/14. Information obtained from the Met Office records also indicate that it was the wettest winter since records began in 1910. This meant that the ground had little capacity to allow for the infiltration of surface water.

3.3 Sources of flooding

3.3.1 Ordinary watercourses (Fluvial)

The fluvial source contributing to the flooding along Robbery Bottom Lane in February 2014 is an ordinary watercourse which first appears just south of the junction of White Horse Lane with Robbery Bottom Lane.

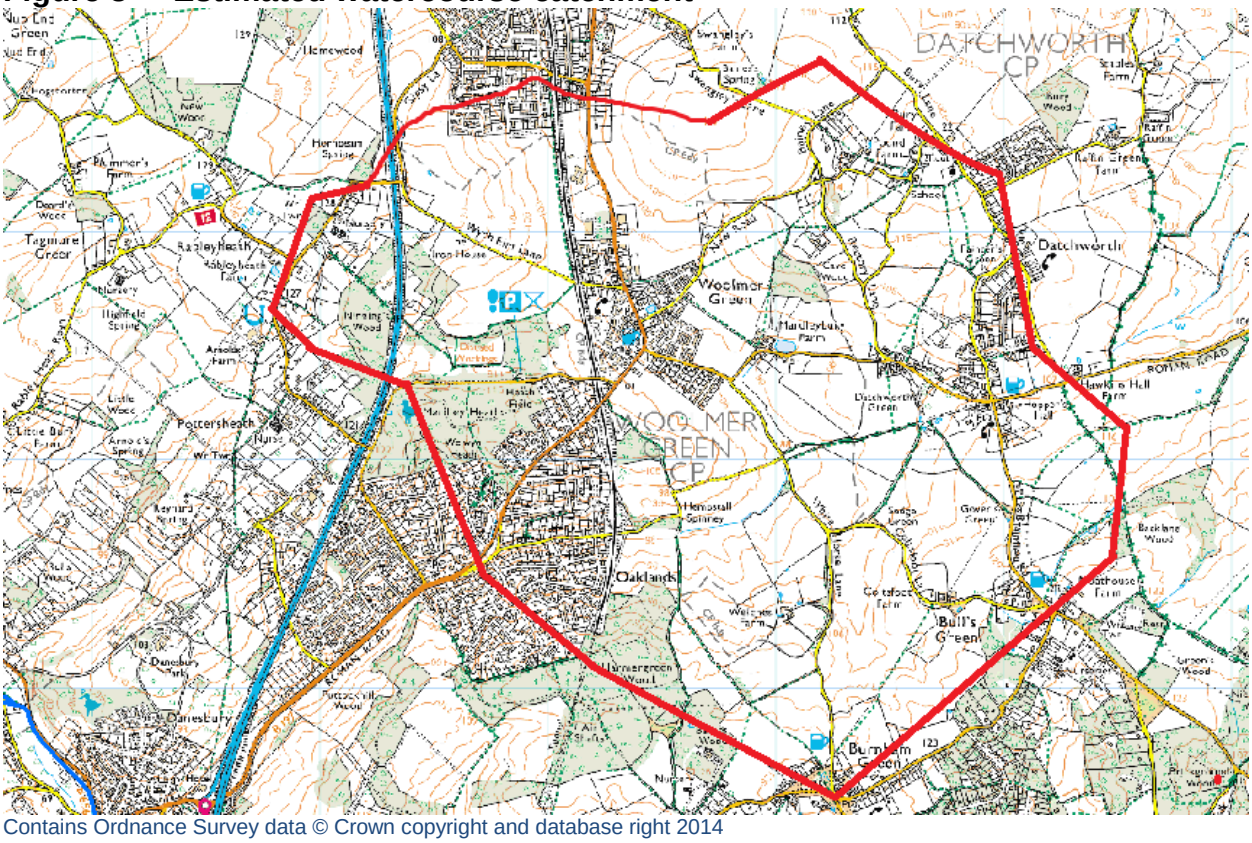
The open watercourse directs water west through a field before passing through a 0.45m plastic culvert beneath a bridleway. At the downstream side of the bridleway the channel turns sharply north then sharply back to the west again, and continues west through another field where it approaches Robbery Bottom Lane. At the edge of the field adjacent to the lane, the flow enters a 0.3m culvert which then runs underneath Robbery Bottom Lane. From the west end of the lane this culvert continues south-west

under Lower Mardley Hill and onto Great North Road where it then flows as open watercourse and travels through various watercourses before discharging to the Mimram.

3.3.2 Surface Water (Pluvial)

Surface water travelled overland to the watercourse in the upper catchment due to the ground being saturated and unable to infiltrate any further rainfall. Once the water reached the watercourse, it was conveyed to the inlet of the piped system that runs under Robbery Bottom Lane. Excess flows that were unable to enter the piped system spilled out onto Robbery Bottom Lane and flowed down to its low point where it became enclosed by the basin created by the raised level of Lower Mardley Hill. Before the basin filled, the only outfalls were the highway drain and the foul Thames Water drain running under the road. Once filled, additional inflow to the basin caused water to spill over the Lower Mardley Hill junction and continue down the road to the next low point.

Figure 3 Estimated watercourse catchment



Map indicating estimated catchment area at the south west end of Lower Mardley Hill road, approximately 7.25km², area indicated by red line.

3.4 Structures and features

There are a number of structures and features along the natural flow route of the watercourse as follows:

3.4.1 Open watercourse from White Horse Lane to the bridleway

Responsibility for maintenance of this watercourse lies with the riparian landowners. More details on the rights and responsibilities of a riparian landowner can be found within the Environment Agency's document called Living on the Edge: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LIT_7114_c70612.pdf

3.4.2 Bridleway

After flowing down through the field from White Horse Lane the watercourse passes through a culvert underneath a bridleway. The bridleway is raised relative to the valley and the watercourse. The culvert allows water to pass beneath the bridleway into the next field at a limited rate. If the rate of water joining the watercourse east of the bridleway is greater than the outflow rate from the culvert, water will back up in the field east of the bridleway until the depth is level with the top of the bridleway, after which time water will overtop the bridleway into the next field and continue down to the lowest point. Therefore under certain circumstances the bridleway will provide localised attenuation to flows coming into Robbery Bottom Lane. Maintenance of the bridleway and its culvert is the responsibility of HCC Rights of Way. At present the bridleway acts as an informal barrier enabling water to collect and pool in the upper field. It is not known whether the bridleway is of sufficient structural integrity for this to be acceptable in the long term.

3.4.3 Open watercourse from the bridleway to the edge of Robbery Bottom Lane

From the bridleway the channel turns sharply north then returns to the west and continues through a field until it reaches the inlet of the culvert which carries the watercourse under Robbery Bottom Lane.

Condition of the Watercourse

In this field section the channel is overgrown and has little definition. Improving the channel would provide a limited amount of storage to attenuate flows. Responsibility for the maintenance of this watercourse lies with the riparian landowner. It is currently unclear if the riparian owner is aware that they have this responsibility. Further information about riparian ownership responsibility can be found at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LIT_7114_c70612.pdf

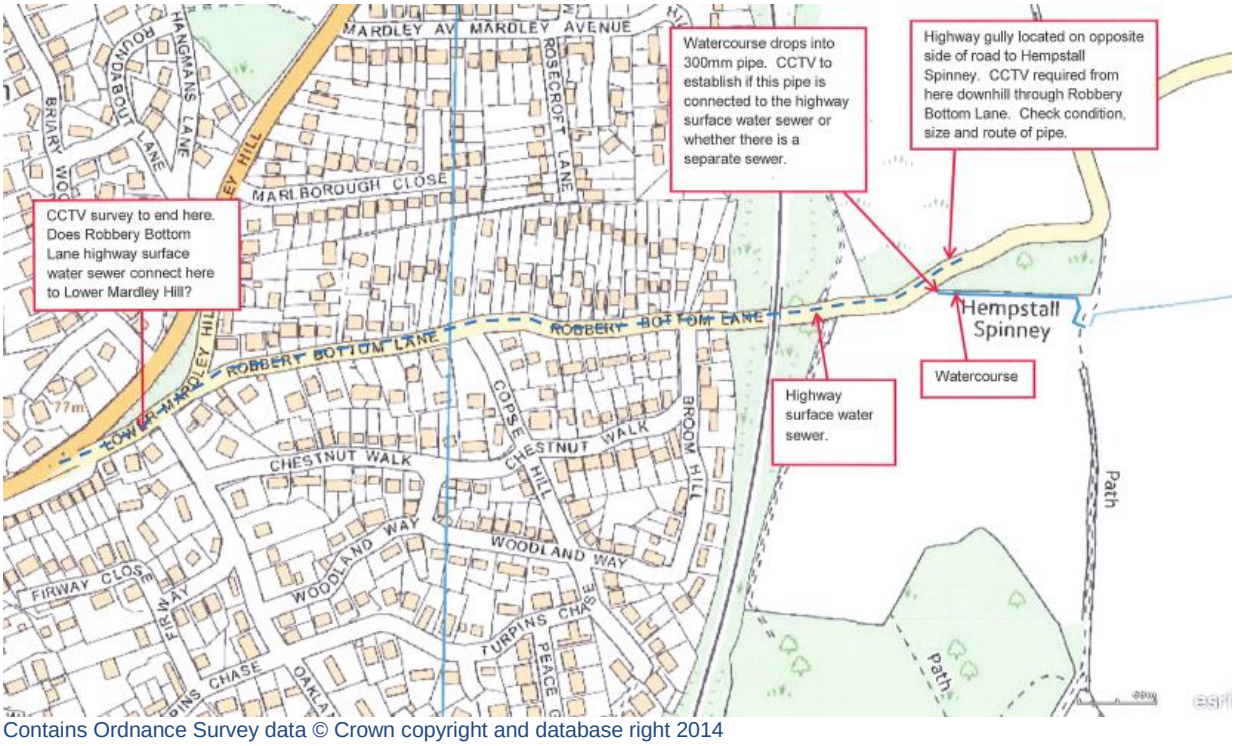
3.4.5 Highway drain inlet

At the edge of the field where the watercourse joins the lane, flow enters a 0.3m diameter culvert that directs the water under the road. Upon inspection in February, March and April 2014, the drain inlet included a crude protection grid which had become blocked with debris and plant growth, both of which would restrict water entry. Responsibility for the maintenance of this inlet lies with the riparian landowner. It is currently unclear if the riparian landowner is aware that they have this responsibility. Again further information about riparian ownership responsibility can be found at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LIT_7114_c70612.pdf

3.4.6 The highway drain

On 7, 8 and 9 July 2014 the highway drain running under Robbery Bottom Lane was inspected using closed circuit television (CCTV) from its inlet to the junction of Lower Mardley Hill and Oaklands Rise, as were all the related gully connections, see figure 4. Concurrently any blockages in the drain within this section were cleared.

Figure 4 CCTV Specification, Robbery Bottom Lane



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CCTV specification, Robbery Bottom Lane.

Condition of Highway Drain

From the CCTV footage it was evident that before being cleared the capacity of the

highway drain was reduced by root mass from trees and shrubs which had grown into the drain in five locations. In some of these locations the root mass was large enough to have caused other local debris and silt to collect on its upstream and downstream sides. During times of high flow these blockages would cause water to back up behind them.

A crack in the highway drain was also identified along Robbery Bottom Lane toward the Lower Mardley Hill junction.

3.4.7 Lower Mardley Hill junction

The junctions of Lower Mardley Hill and Broom Hill are about the same height above average sea level, between these two Robbery Bottom Lane and some of its residential dwellings are lower forming a basin in the land where water collects during times when the flow of the watercourse is greater than the capacity of the culvert carrying it under the lane. The other main outlet is the foul sewer system. Lower Mardley Hill is a public road and an asset of Hertfordshire Highways.

3.4.8 Gullies

It is reported by residents that at the time of the flooding in February 2014 the gullies along the lane were blocked with debris from local trees and shrubs. These gullies are assets of the highway authority (Hertfordshire County Council) and have since been cleared by them.

3.5 Possible causes of flooding

The following are key to the fluvial and pluvial/surface water flooding mechanisms that have been determined as part of this investigation:

- Winter 2013/2014 was one of the wettest on record for the region. Heavy (while not extreme) rainfall falling on already saturated ground caused surface water runoff which added to the flow of the open watercourse in the upper catchment.
- The lane's culvert capacity was insufficient to convey the rate of flow of the watercourse and, as a result excess water overflowed onto the surface of the lane and down to its basin by the junction of Lower Mardley Hill. Subsequently, blockages found within the drain during CCTV inspection on 7, 8 and 9 July were cleared to facilitate flow.
- Efficiency of the gullies along Robbery Bottom Lane was reduced by blockages. These have since been cleared by Hertfordshire County Council's highways department.

4. Responsible authorities and landowners

HCC as the LLFA have investigated the flooding at Robbery Bottom Lane to establish the relevant RMA's with Flood Risk Management Functions in accordance with the FWMA 2010 as part of this study. Those RMA's and their relevant powers and functions are set out below.

4.1 Hertfordshire County Council - Lead Local Flood Authority

HCC as the LLFA for its area has fulfilled its legal responsibility to carry out a Flood Investigation under Section 19 of the FWMA 2010;

(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 the relevant 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.

In order to achieve the responsibilities under Section 19, HCC as LLFA must first establish the cause and impacts of the flooding and where possible identify potential solutions as discussed in this report.

The LLFA has powers to carry out flood risk management works for flooding from surface water runoff and groundwater in accordance with the Local Flood Risk Management Strategy for Hertfordshire.

Hertfordshire County Council is the regulatory authority for all ordinary watercourses in Hertfordshire under the Land Drainage Act 1991.

The relevant sections of the Act are as follows:

- Section 23 of the LDA 1991 requires any works within the channel of an Ordinary Watercourse that could affect the flow to apply for written consent from HCC.
- Section 24 of the LDA 1991 gives powers to HCC to enforce any contravention of Section 23 where works have been carried out without prior written consent.
- Section 25 of the LDA 1991 gives enforcement powers to HCC to ensure riparian landowners of ordinary watercourses keep clear from obstruction from vegetation, debris, failing assets and blocked assets to ensure there is no impedance of flows.

4.2 Welwyn Hatfield Borough Council

The Borough Council has powers to carry out flood improvement works on ordinary watercourses under Section 14A of the Land Drainage Act 1991 as amended by the Flood and Water Management Act 2010. These powers are discretionary and works are subject to consultation with Hertfordshire County Council and the Environment Agency.

Welwyn Hatfield Borough Council are the local planning authority for the valley of Robbery Bottom Lane, their role is to determine planning applications for new development, and assess and approve any impacts from all sources of flooding and any associated proposed drainage.

4.3 Hertfordshire County Council - Highways Authority

Robbery Bottom Lane, Lower Mardley Hill, Mardley Hill, and the roads under which the culvert carrying the watercourse from the catchment of Robbery Bottom Lane down to the open part of the watercourse along the east side of Great North Road, are all Hertfordshire County Council adopted highways. HCC Highways are the responsible authority to maintain and manage HCC adopted highways including associated drainage infrastructure such as gullies drainage pipes and any assets that lie within the highway boundary within their ownership including culverted and open sections of watercourses and trash screens. Where there are sections of open watercourse outside of their ownership, the relevant landowner is responsible for maintenance.

HCC Highways have powers to manage water on an adopted road under the Highways Act 1981, however where water originates from third party land and not from highway runoff these powers are limited.

There are unadopted private roads to the south of Robbery Bottom Lane where there is no formal drainage structure. Riparian owners are responsible for maintenance and management of these roads.

4.4 Thames Water

Thames Water has responsibility for the safe and clean disposal of the foul water sewerage.

4.5 Landowners

Landowners are responsible for the management of their land, including any associated drainage. This will encompass drainage ditches, land management practices and surface water runoff.

4.8 Riparian Land Owners

Riparian owners are landowners where an open watercourse or a culvert that carries a watercourse flows either through, or adjacent to the land for which they hold the title. There are a number of riparian landowners within the Robbery Bottom Lane valley.

Each of these riparian landowners are responsible for maintaining their section of the watercourse to ensure the flow within the channel is maintained and kept free from obstruction. This will include the maintenance and repair of any associated structures such as trash screens, culverts residential crossovers, bridges etc.

5. Conclusions and recommendations

5.1 Conclusions

One major factor contributing to the flooding was the amount and consistency of the rainfall preceding and during the flood event on 7 and 8 February 2014.

The winter of 2013/14 has been confirmed to be the wettest winter on record for the UK. This meant that with saturated soils throughout the catchment, and limited capacity of the highway drain to convey the watercourse, rain water had nowhere else to go but onto the surface of the road on Robbery Bottom Lane.

Blockages in the Robbery Bottom Lane culvert and gullies meant that the full capacity of the system was diminished.

In order to develop and provide a suitable resolution to the flooding, there needs to be a collaborative approach between the LLFA, relevant landowners and all the identified relevant Risk Management Authorities.

5.2 Recommendations

The following are the recommendations of the County Council, in its capacity as Lead Local Flood Authority, they follow from the main findings from the Section 19 flood investigation carried out into the flood event in Robbery Bottom Lane on 7 and 8 February 2014.

No.	Recommendations	Comments	RMA's, stakeholders and other parties to be involved
1	Discuss the findings of this report with affected residents and wider community, including local landowners.	The LLFA has scheduled a meeting to discuss this report with stakeholders and residents in December 2014.	• LLFA. • Residents. • RMAs. • Stakeholders.
2	Organise property level protection surveys and implement a resistance / resilience strategy. This should be done as soon as possible to protect properties.	Residents to take advantage of the Repair and Renew Grant with the guidance of Welwyn Hatfield Borough Council. Individuals who experienced residential or commercial property flooding between 1 April 2013 and 31 March 2014 are eligible. It is important that claimants note the grant deadline and procedure for submitting applications to Welwyn Hatfield Borough Council. It is also advisable that residents carefully read the guidance on the Repair and Renew Grant which can be found on Welwyn Hatfield Borough Council's website http://www.welhat.gov.uk/CHttpHandler.ashx?id=9473&p=0 This WHBC website directs applicants to the Property Protection Adviser website, among other useful sites: http://www.nationalfloodforum.org.uk/property-level-	• Welwyn Hatfield Borough Council. • Residents.

No.	Recommendations	Comments	RMA's, stakeholders and other parties to be involved
		protection-community-tool/ It is recommended that residents take the time to carefully read the information on these sites.	
3	Identify and remove trees and shrubs that are linked to gulley and highway drain blockage.	It is recommended that residents along Robbery Bottom Lane, Broom Hill and Copse Hill remove and fell trees that are linked to highway drain and gully blockage. A maintenance regime for this activity should be agreed among the residents and relevant landowners. Implement a regular gulley watch scheme and cleaning regime. Residents along Robbery Bottom Lane should set out to clear blocked gullies as they become aware of them.	• Residents. • Relevant landowners.
4	Clear blocked gullies.	It is recommended that HCC Highways add Robbery Bottom Lane to the vulnerable gullies list.	• HCC Highways.
5	Maintain and upgrade highway drain inlet.	Riparian owner of the inlet to: (1) clear the tree and shrubs blocking the drain inlet, (2) replace the inlet trash screen in line with latest best practice, (3) upgrade the headwall of the inlet.	• LLFA. • Riparian landowner.
6	Repair the crack in the Robbery Bottom Lane culvert.	It is recommended that HCC Highways repair the crack along the culvert under Robbery Bottom Lane located towards the junction of Lower Mardley Hill.	• HCC Highways.
7	Maintain and refine watercourse between the	Riparian landowner to: (1) remove trees and shrubs that can cause obstruction within the channel, (2) refine and	• LLFA. • Riparian landowner.

No.	Recommendations	Comments	RMA's, stakeholders and other parties to be involved
	bridleway and highway drain inlet.	deepen the channel of the watercourse to increase the capacity of the watercourse contributing to some attenuation of water. LLFA to map and record the watercourse and related assets within this section of the watercourse.	• Welwyn Hatfield Borough Council.
8	Assess feasibility of potential options, and for those which are feasible, carry out further investigations.	Investigate the hydrological implications of feasible options through modelling. Assess the legal implications of these options, and whether an agreement could be made with relevant RMAs, landowners and residents. Any bids for funding of further assessment costs to be submitted by LLFA. Options to be explored include: (1) Flood defence wall around properties which suffer from internal flooding including garages. (2) Upper catchment attenuation, including the possibility of attenuating water within the fields either side of the bridleway during times when the watercourse is in high flow. (3) Create a bypass to channel flow past/through the higher road level of Lower Mardley Hill, located at the junction of this road to Robbery Bottom Lane. The bypass would channel flow from Robbery Bottom Lane into the ditch which lies on the east side of Great North Road. (4) Explore the effect of changes to land management practices in the upper catchment. This will be	• LLFA. • HCC Highways. • Welwyn Hatfield Borough Council. • Riparian landowners. • Residents.

No.	Recommendations	Comments	RMA's, stakeholders and other parties to be involved
		dependent on landowners' agreement to change land use and land management practices. A hydrological study will be required to test for feasibility and to determine what level of flood alleviation such activity would have.	
9	Determine route of drainage of the railway viaduct, and if found to join the Robbery Bottom Lane highway drain, ensure flow free from silt and debris.	Network Rail to confirm if the drainage from the railway viaduct is channelled into the Robbery Bottom Lane highway drain. If this is the case it is recommended that Network Rail ensure the flow is free from silt and debris which could cause blockage of the highway drain.	• Network Rail (stakeholder) • LLFA.
10	Restrict further hard standing development affecting the watercourse.	WHBC to consider what policy approach, and development management approach can be taken to restrict hard standing development within the catchment.	• WHBC. • LLFA.

6. Next Steps and Actions

6.1 Lead Local Flood Authority

The following are agreed actions to be undertaken by Hertfordshire County Council in its capacity as Lead Local Flood Authority;

- Facilitate a meeting with residents to discuss the findings of this report.
- Seek discussions with HCC Highways to discuss maintenance issues in relation to the identified watercourse within the area of Robbery Bottom Lane, and to look at the feasibility of repairs to the highway drain that carries this watercourse underneath the lane.
- Advise riparian landowner of the highway drain inlet of current best practice.
- Advise riparian landowner of the watercourse between the bridleway and highway drain inlet of current best practice.
- Lead assessment of feasibility of potential options, and for those which are potentially feasible, carry out further investigation.
  Subject to funding opportunities being identified carry out an investigative study to determine the feasibility of the options.
- Determine route of drainage of railway viaduct, and if found to join the Robbery Bottom Lane highway drain, recommendations the RMA Network Rail ensures flow is free from debris and silt.
- Consult with WHBC on policy approach and development management approach to restrict hard standing development within the catchment.

6.2 Highway Authority

The following are suggested actions to be undertaken by Hertfordshire County Council in its capacity as Highways Authority;

- Add Robbery Bottom Lane to the vulnerable gullies list.
- Repair the crack in the highway drain under Robbery Bottom Lane near the junction of Lower Mardley Hill.
- Advise the LLFA in the further assessment of potential flood risk management options.

6.3 Welwyn Hatfield Borough Council

The following are suggested actions to be undertaken by Welwyn Hatfield Borough Council;

- Assist residents who have experienced internal flooding between 1 April 2013 and 31 March 2014 to apply for Repair and Renew Grant.

- Approve works to clear and refine the watercourse between the bridleway and the highway drain inlet.
- Advise the LLFA in the further assessment of potential flood risk management options.

6.4 Network Rail

The following are suggested actions to be undertaken by Network Rail;

- Network Rail to confirm if the drainage from the railway viaduct is channelled into the Robbery Bottom Lane highway drain. If this is the case it is recommended that Network Rail ensure the flow is free from silt and debris which could cause blockage of the highway drain.

7. Disclaimer

This report has been prepared as part of Hertfordshire County Council's responsibilities under the Flood and Water Management Act 2010. It is intended to provide context and information to support the delivery of the local flood risk management strategy and should not be used for any other purpose.

The findings of the report are based on a subjective assessment of the information available by those undertaking the investigation and therefore may not include all relevant information. As such it should not be considered as a definitive assessment of all factors that may have triggered or contributed to the flood event. RAB Consulting and Hertfordshire County Council expressly disclaim responsibility for any error in, or omission from, this report and the supporting technical assessment Report arising from or in connection with any of the assumptions being incorrect.

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