London Borough of Havering Section 19 Flood Investigation Report

Revision no: 4

London Borough of Havering

London Borough of Havering Section 19 Flood Investigation Report 2022

11 October 2023

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Acronyms

AEP	Annual Exceedance Probability
EA	Environment Agency
FRMA	Flood Risk Management Authority
LBH	London Borough of Havering
LFB	London Fire Brigade
LLFA	Lead Local Flood Authority
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
TfL	Transport for London
TW	Thames Water

Executive Summary

The London Borough of Havering experienced a major flood event on 25th June 2021. There were reports of flooding at approximately 49 different properties within the borough, the majority of which could be grouped into eight main areas. As the Lead Local Flood Authority (LLFA), London Borough of Havering (LBH) has a duty to investigate, where appropriate, all floods that occur within its jurisdiction in accordance with the Flood and Water Management Act (2010). Jacobs was therefore commissioned to complete a flood investigation report in accordance with Section 19 of the Flood and Water Management Act. The scope of the investigation includes:

- An assessment of the magnitude of the rainfall event that resulted in the flooding;
- A high-level assessment of the possible causes of the flooding;
- Liaison with Flood Risk Management Authorities (FRMA) to establish incident response functionality and how these functions were carried out as part of their response to the flood event in question;
- Recommendations for improvements to flood response for FRMAs, where necessary.

This report focuses on eight groupings of reported flooding locations across the borough. The findings of this investigation suggest that the primary cause of flooding experienced on 25th June 2021 was the volume and intensity of the rainfall experienced. It is estimated that one third of June's average rainfall fell across the borough over 24 hours. Hydrological analysis indicates an event frequency for the 25th June flood event of 20% (1 in 5) annual exceedance probability.

The correlation between Environment Agency Risk of Flooding from Surface Water (RoFSW) mapping and the observed flood extents for the June 2021 event was generally quite good, although flooding occurred in a smaller magnitude event than that predicted by the mapping, as many of the properties were located within the medium and low RoFSW extents, rather than high as would be anticipated given the magnitude of the event.

The Environment Agency, London Borough of Havering and London Fire Brigade have provided responses and information regarding the observed flooding. It was apparent that the differences in reporting systems for the various FRMAs resulted in mismatches between specific locations detailed in this investigation. Records also appear to lack necessary detail to allow for full investigation of the events and are incomplete in places.

- It is recommended that a more refined, detailed, and consistent reporting system be applied across all FRMAs. This would assist in delineating mechanisms of flooding and allow for improved lessons learnt and identification of potential mitigation following flood events.
- It is also recommended that LBH put in place processes to allow for more rapid commencement of investigations following flood events, as the significant delay in commencement of the investigation of this flood event may have contributed to the lack of evidence available to assess what occurred during the flood event.

Statement of limitations

The sole purpose of this report is to provide Jacobs' client, the London Borough of Havering, an assessment of the flooding that occurred within specified areas of Havering on 25th June 2021. This document has been prepared on behalf of, and for the exclusive use of London Borough of Havering, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and London Borough of Havering. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party.

The data within this report is derived from multiple sources including the London Borough of Havering, Environment Agency, other risk management authorities and Jacobs. The data sourced from others, which the recommendations and conclusion within this report rely upon, is done so on the assumption that the data requested reflects all available data and is accurate.

1. Introduction

1.1 Background

London Borough of Havering (LBH) experienced a major flood event on 25th June 2021. There were reports of flooding at approximately 49 properties within the borough.

This flood investigation report focuses on the hydrological conditions at the time of the event to estimate its severity, possible factors (both human and natural) contributing to the impact of the event, and the response of the Flood Risk Management Authorities (FRMAs).

Jacobs was commissioned by LBH in October 2022 to complete a flood investigation report in accordance with Section 19 of the Flood and Water Management Act (2010)[1]. The scope of the investigation includes:

- An assessment of the magnitude of the rainfall event that resulted in the flooding;
- High level analysis of the possible causes of the flooding;
- Liaison with responsible FRMAs to establish incident response functionality and how these functions were carried out as part of their response to the flood event in question; and
- Recommendations for improvements to flood response for FRMAs, where necessary.

This report focuses on eight groupings of reported flooding locations across the borough. The locations investigated do not include all locations reported to have flooded within LBH during the June 2021 event. Grouped flooding locations investigated were primarily selected based on reported locations where properties were affected by internal flooding. Reports of flooding where road locations could not be confirmed or where there were no reports of internal flooding or significant disruption to infrastructure have not been investigated further.

Table 1.1 provides details of the reported flood locations provided by LBH and identifies those considered further as part of this investigation report. Reported locations were included in this investigation where a LBH report was supported by other sources (see Section 3) or where internal flooding was reported.

[1] Flood and Water Management Act (2010). Available from: http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf. Accessed 08/02/2023.

Table 1.1: Locations of reported flooding provided by London Borough of Havering

Address	Issue	Internal Property damage reported?
Balgores Lane, RM2 5JX (8 reports)	Highway Flooding	Yes (7), No (1)
Beaumont Close, RM2 6LJ	Highway Flooding	No
Douglas Road, RM11 1AR (2 reports)	Highway Flooding (2)	No (2)
Fairford Way, RM3 9YR	Housing Flooding	No
Globe Road, RM11 1BN	Housing Flooding	Yes
Hitchin Close, RM3 7EG (6 reports)	Housing Flooding (6)	Yes (6)
Hitchin Close	Housing Flooding	Yes
Honey Suckle Close, RM3 8XH	Housing Flooding	Yes
Kings Lynn Drive, RM3 8XP	Housing Flooding	Yes
Kingston Road RM1 3NB	Housing Flooding	Yes
Links Avenue	Housing Flooding (2)	Yes (2)
Launceston Close	Highway Flooding	No
Lodge Avenue	Housing Flooding	Yes
Marlowe Gardens, RM3 (4 reports)	Housing Flooding (4)	Yes (4)
Mashiters Walk	Highway Flooding	No
North Hill Drive, RM3 7XR	Housing Flooding	Yes
Park Lane, RM11 1BD (2 reports)	Highway Flooding (1) & Housing Flooding (1)	Yes
Park Lane, RM11 1BB	Highway Flooding	No
Pettits Lane North, RM1 4NU (2 reports)	Highway Flooding (2)	Yes (1), No (1)
Ramsey Gardens, RM3 (6 reports)	Housing Flooding (5) & Highway Flooding (1)	Yes (6)
Shenstone Gardens, RM3 7NX (5 reports)	Housing Flooding (3) & highway Flooding (2)	Yes (3)
Squirrels Heath Road (2 reports)	Highway Flooding (2)	No (2)
Stanley Avenue (5 reports)	Housing Flooding (5)	Yes (5)
Taunton Road, RM3 7PJ (3 reports)	Housing Flooding (3)	Yes (3)
Taunton Road, RM3 7ST (2 reports)	Housing Flooding (1) & Highway Flooding (1)	Yes (1) No (1)

1.2 Flood and Water Management Act, Section 19

As Lead Local Flood Authority (LLFA), London Borough of Havering has a duty to investigate, where appropriate, all flood events that occur within its jurisdiction in accordance with the Flood and Water Management Act (2010). The Act details the responsibilities of a LLFA with respect to investigating flooding and any action taken by FRMAs. Section 19 states:

"(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considered 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 carried out an investigation under subsection (1) it must –

(a) Publish the results of its investigation, and

(b) Notify any relevant risk management authorities."
The introduction of Section 19 clearly defined a responsibility for LLFAs to investigate flooding within their jurisdiction where considered 'necessary or appropriate'.

1.3 Risk Management Authority Responsibilities

On 22 December 2011, the Environment Agency (EA) published guidance for LLFAs on producing Preliminary Flood Risk Assessments (PFRAs)[2], updated December 2019. In light of this guidance, it is the responsibility of LLFAs to record flooding information if an event occurs. Table 1.2 indicates the FRMA responsible for all sources of flooding. It is important to note that in Havering, LBH assumes the position of LLFA, District Council and Highways Authority.

Table 1.2: Flood risk management authority responsibilities for all flood sources

Flood Source	Environment Agency	Lead Local Flood Authority	Thames Water	Transport for London	Highways Authority
Main river	✓				
The sea	✓				
Surface water		✓			
Surface water (on/from highways)				✓	✓
Sewer flooding			✓		
Ordinary watercourse		✓			
Groundwater		✓			
Reservoirs (as defined by the reservoir act)	✓				

Transport for London (TfL) is responsible for the maintenance of several major roads within the Borough. However, the majority of the roads fall under the jurisdiction of LBH Highways. LBH Highways are also responsible for highway gullies and any lateral drainage to the Thames Water (TW) sewer infrastructure.

[2] PFRA Guidance. Available from: https://www.gov.uk/government/publications/preliminary-flood-risk-assessments-and-flood-risk-areas/preliminary-flood-risk-assessments-and-flood-risk-areas. Accessed 10/10/2022.

2. Flood Incident, Extent, and Impact

2.1 Sources of Information

A number of sources were used to inform this section of the report:

- Environment Agency Flood Map for Planning[3]
- Environment Agency Risk of Flooding from Surface Water[4]
- Environment Agency rain gauge, gauging station and radar data (24-25th June 2021)
- LBH Strategic Flood Risk Assessment (2016)
- Responses from FRMAs (see Table 2.1)

Table 2.1: Summaries of responses received to request for information from FRMAs

Source	Response received
London Borough of Havering	• List of impacted properties • Could not comment regarding their highway responsibilities due to lack of records. • Photos sent in from residents of Havering
Environment Agency	• Rain gauge data • River gauging station data • Overview of event
Thames Water	Responded stating they were unable to provide information
Metropolitan Police	Responded stating they were unable to provide information
London Fire Brigade	Flooding incident record
Transport for London	Did not respond

The FRMAs were contacted in October 2022 for information. Responses were received from five out of the six relevant FRMAs, three of these responses included information that was able to assist with this report.

2.2 Antecedent Conditions

The Environment Agency Water Situation Report Summary[5] indicates that June 2021 was a relatively dry month nationally. There was below average rainfall across England, but above average rainfall was recorded across South-East England, with soils at the end of the month being wetter in this region. The south-east region of the UK was well above for the month of June.[6].

According to the Hydrological Summary for the United Kingdom for June 2021[7] "*June was generally a settled month with summery conditions but was punctuated by occasional thunderstorms and heavy rainfall, particularly in the south-east of England*." The summary also mentions transport disruption in and around London between the 25th and 29th due to heavy rainfall. The monthly rainfall recorded for the Thames region was 72mm which was 142% above the long-term average. The monthly rainfall map for June 2021 shows rainfall at Havering to be between 150 to 170% rainfall as a percentage of the 1981-2010 average.

Jacobs have received data for rainfall, river level and surface water level gauges for the period between the 24th and 26th of June 2021, which are located in close proximity to the study area. Table 2.2 notes the gauges with information available in proximity to the area.

Table 2.2: Environment Agency Gauges

[3] Available from: https://flood-map-for-planning.service.gov.uk/. Accessed 03/11/2022.

[4] Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. Accessed 03/11/2022.

[5] Environment Agency (2021). Monthly water situation report. Available from: https://nora.nerc.ac.uk/id/eprint/530705/. Accessed 03/11/22.

[6] Met Office (2022). UK Climate Averages. Available from: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/u10hb54gm. Accessed03/11/2022.

[7] National River Flow Archive (2021). Hydrological summary for the United Kingdom: June 2021. Available from: https://nora.nerc.ac.uk/id/eprint/530705/. Accessed 03/11/22.

Gauge Name	Gauge Type
Nag's Head Lane	Rainfall
Havering Bower	Rainfall
Gaynes Park (River Ingrebourne)	River Level
Elm Park (River Beam)	River Level
New Road	Surface Water Level (temporary)
Hornchurch Park	Surface Water Level (temporary)

The location of rainfall gauges and the river water level gauges within the Havering study area are shown in Figure 1.

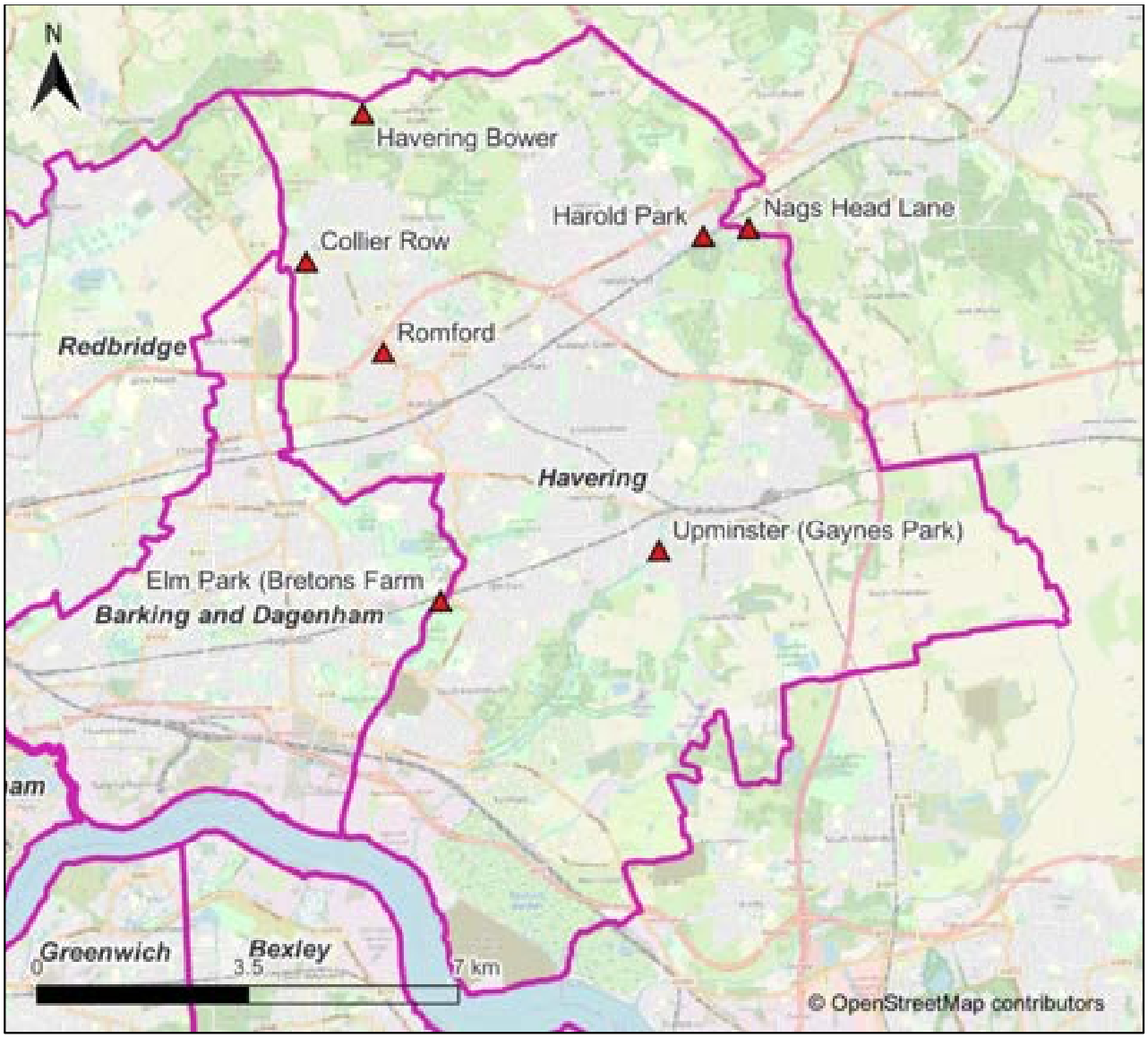


Figure 2.1: Rainfall and Hydrometric gauges in Havering

2.3 Rainfall and River Flow Analysis

A full Hydrological Analysis Report was also completed by Jacobs, based on the information provided by the Environment Agency, which can be found in full in Appendix C of this report. This section of the report includes a summary of the information from the hydrological analysis report on rainfall and river flow analysis. See Appendix C for details of how this assessment was undertaken.

Both the Havering Bower and Nags Head Lane gauges show recorded rainfall after 18:00 on the 25th of June 2021. At the Havering Bower gauge, this was recorded between 18:15 and 21:30, totalling three hours and fifteen minutes, with a peak rainfall depth of 10mm and a total rainfall depth of 26mm. At the Nags Head Lane gauge, rainfall was recorded between 18:00 and 20:15, totalling two hours and fifteen minutes, with a peak rainfall depth of 9mm and a total rainfall depth of 20mm.

At the Havering Bower gauge, the highest frequency rainfall event occurred at 1 hour and 30 minutes, where the total rainfall depth is 24mm, and the frequency was estimated as being 1 in 5.49 years. At the Nags Head Lane gauge, the highest frequency rainfall event occurred at both the 45 minute and 1 hour storm durations, where the total rainfall depths are 18 and19mm and respectively, and the frequency is estimated as being 1 in 4.5 years.

Therefore, it is assumed that these rainfall totals are from the same singular storm event. This is expected since the distance between the gauges is less than 7km. It can therefore be assumed that the June 25th rainfall event was approximately a 1 in the 5-year event, or an annual exceedance probability (AEP) of 20%, at least in the north of the borough.

The 26mm of rainfall recorded in 3 hours at the Havering Bower gauge, is just over a third of what the Thames region recorded for the whole month of June in 2021, which was 72mm.

The impact of the rainfall on river levels has also been assessed, with the level (stage) gauges at Gaynes Park (River Ingrebourne) and Bretons Farm (River Beam) both analysed. The flood frequency analysis of the Gaynes Park annual maximum data shows the rarity of the 25th of June 2021 as approximately 1 in 5 years, which is line with the rarity of the rainfall event at the two rainfall gauges. However, the rarity of the same event at Bretons Farm gauge is much larger (approximately 1 in 19 years). Although both gauges have neighbouring catchments, the reason for the different frequency within the same event could be due to the variability of rainfall in the two catchments, quality of the flow data or a combination of both, further investigation of which is beyond the scope of this study. It is possible that some areas within the borough experienced larger magnitude rainfall events on a local scale, which went unrecorded due to the small number of operational rain gauges in the borough. Further analysis can be found in Appendix C.

2.4 Observed Flooding

Table 2.3 indicates the number of flooded properties at the investigated locations based on all reported sources of data, where sufficient information is available. These figures are reliant on flooding being reported to the appropriate agencies; therefore, it is possible that additional unreported property flooding occurred. There were 49 reports of flooding, which have been then grouped based on their proximity. There were some properties who reported flooding whose locations were not in proximity to others, and therefore could not be grouped. These properties are listed below the eight groups and were not investigated further as this is considered disproportionate for a single isolated property.

Appendix B includes pictures that have been sent to LBH by a resident in grouped flood location two (Links Avenue).

Table 2.3: Reported Flooded Properties by Location

Grouped Flood Location	Number of flooded properties with internal damage	Total number of properties (internal and external)
1. North Hill (North Hill Drive, Taunton Road, Hitchin Close)	17	18
2. Gallows Corner (Ramsay Gardens, Shenstone Gardens, Marlowe Gardens & Launceston Close, Links Avenue)	15	16
3. Balgores Lane	7	8
4. Frances Bardsley School (Douglas Road, Park Lane, Globe Road)	3	6
5. Stanley Avenue	5	5
6. Hulse Avenue	2	2
7. Squirrels Heath Road	0	2
8. Pettits Lane North	0	2

Single Property Flood Location	Internal Damage?
Kings Lyn Drive	Yes
Kingston Road	Yes
Mashiters Walk	No
Lodge Avenue	No
Beaumont Close	No
Fairford Way	No
Honey Suckle Close	Yes

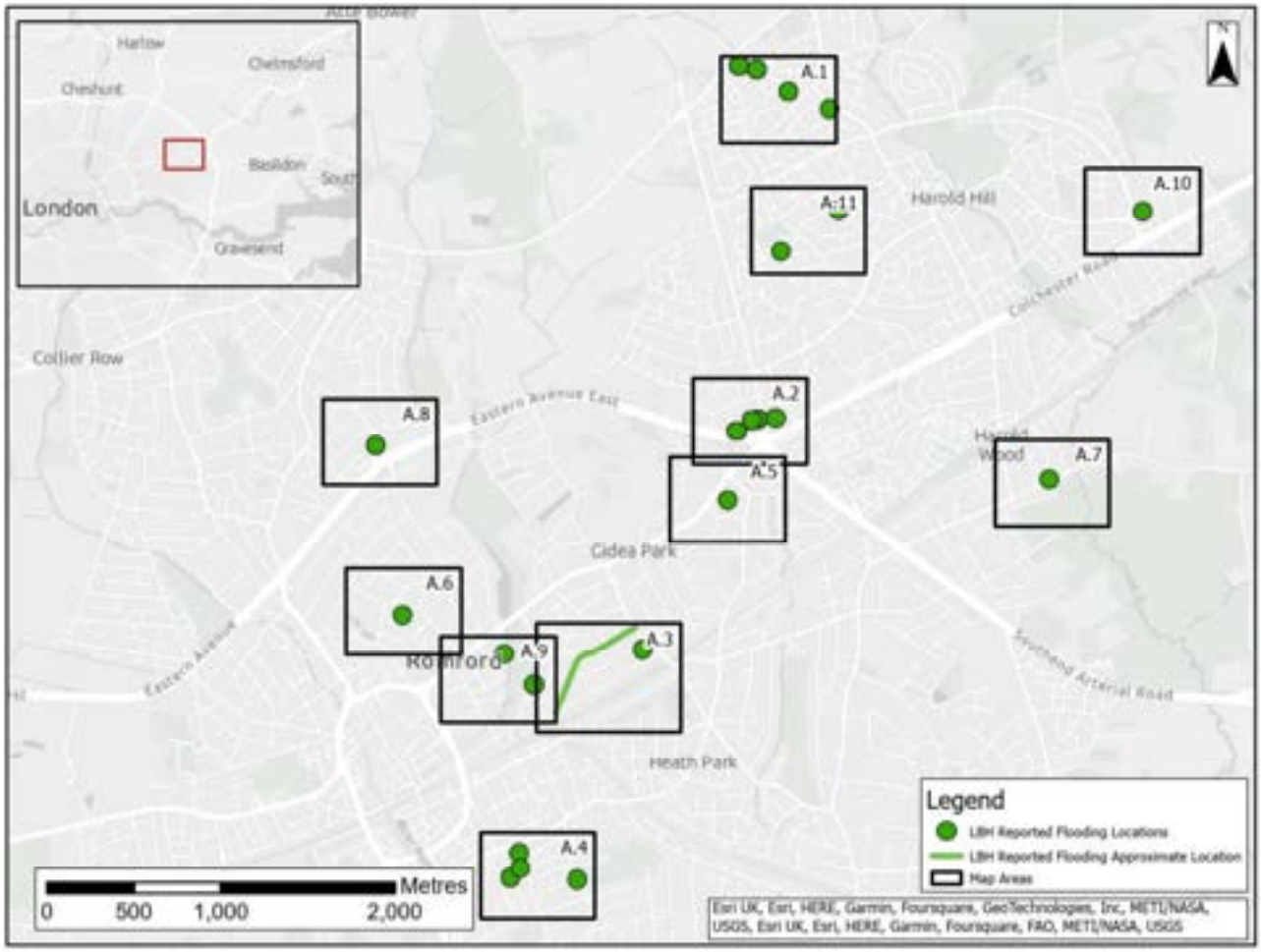


Figure 2.2: Map of flooded properties reported to the Environment Agency

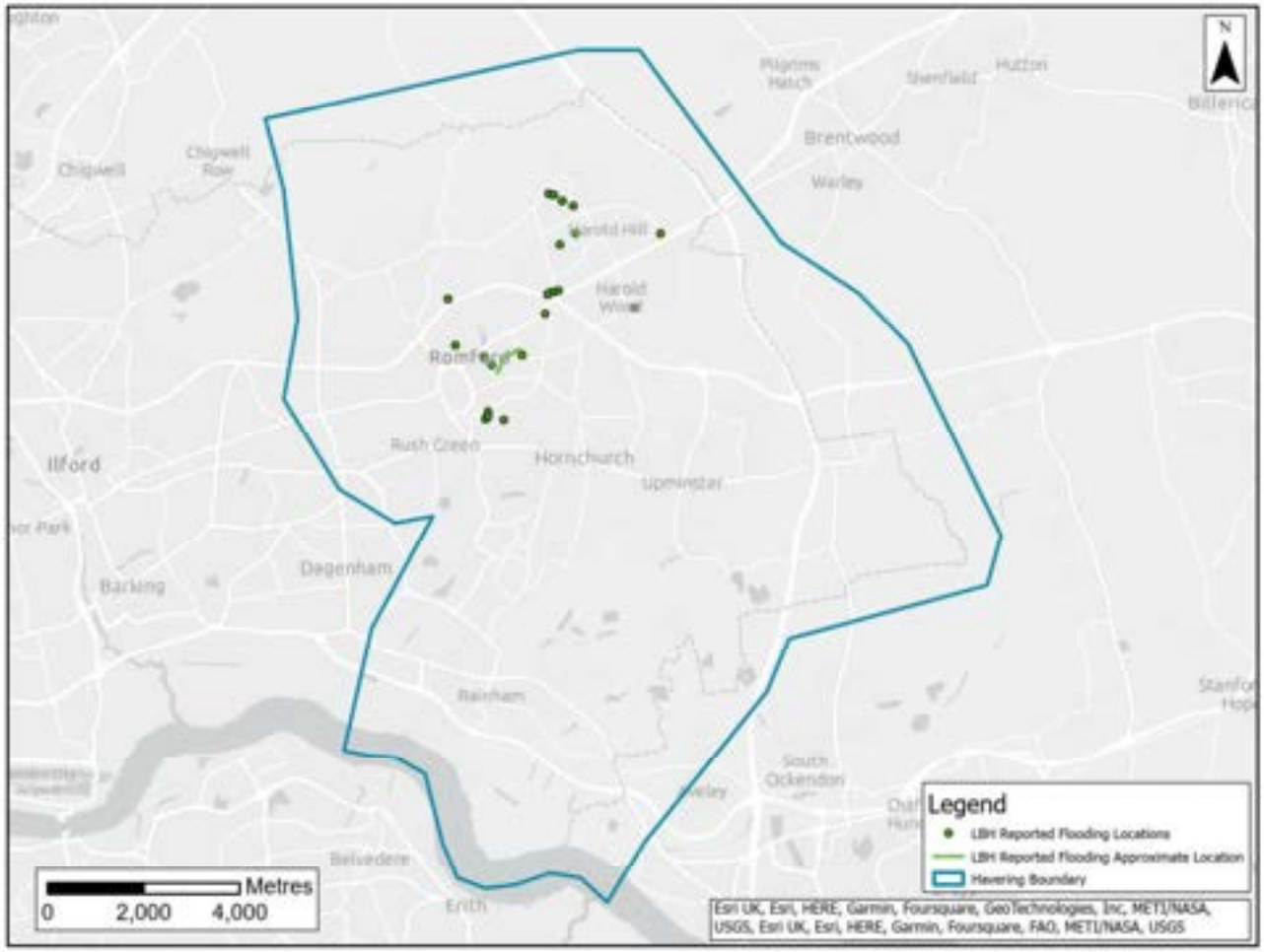


Figure 2.3: Map of flooded properties within the London Borough of Havering

2.5 Predicted Flood Risk

To assist with addressing the likely cause of flooding in each of the identified locations, an assessment of predicted flood risk from the two most likely sources of flooding, fluvial and surface water, was undertaken.

2.5.1 Environment Agency Flood Zones

The EA Flood map for planning (Environment Agency, 2023) identifies the areas that are at risk of flooding from rivers or the sea. The different flood zones are stated below:

- Flood Zone 1: areas that are not at risk of flooding from rivers or the sea in an event greater than 0.1% (1 in 1000) Annual Exceedance Probability (AEP).
- Flood Zone 2: areas at risk of flooding from fluvial sources from an event with between 1% (1 in 100) and 0.1 (1 In 1000) AEP.
- Flood Zone 3: area at risk of flooding from fluvial sources, from an event with greater than 1% (1 in 100) AEP.

The investigated flooding locations are not located within the EA Flood Zones 2 and 3. It should be noted that the flood map for planning does not include fluvial flood risk from small watercourses (generally those with a catchment of less than 3km^2 would not be anticipated to be included) and therefore other areas may be at risk of fluvial flooding. Flooding from minor watercourses not included on the flood map for planning is often better represented on EA Risk of Flooding from Surface Water (RoFSW) mapping (see section 2.5.2).

In this instance, the observed flooding is not believed to have been caused by fluvial flooding given flooding was observed in discrete locations as opposed to across a greater geographical extent in line with Flood Zone extents or alongside small watercourses. There were also no anecdotal reports of fluvial flooding received. It has not been possible based on the information received from Flood Risk Management Authorities to identify

if high river levels blocked outfalls and therefore contributed to flooding upstream as a result of drainage systems surcharging.

2.5.2 Environment Agency Risk of Flooding from Surface Water Mapping

The Environment Agency RoFSW (Environment Agency, 2023) mapping indicates the extent of flooding likely to be observed for:

- Low risk: Between 0.1% (1 in 1000) and 1% (1 in 100) AEP event;
- Medium risk: Between 1% (1 in 100) and 3.3% (1 in 30) AEP event.
- High risk: Greater than 3.3% (1 in 30) AEP event.

Three of the reported flooded properties are located in areas at high risk of surface water flooding. 20 of the reported flooded properties are in areas at medium risk of surface water flooding. Given the uncertainties inherent in the high level RoFSW mapping, properties within five metres of the high RoFSW extent were also noted. There were 28 properties that are within five metres of areas shown as being at high risk of surface water flooding.

A comparison of the reported flood events with the RoFSW mapping extent for the grouped locations can be found in table 2.4, the comparison shows there are areas of both good and poor agreement between the predicted and reported flood extents for locations assessed. It should be noted that the RoFSW mapping is not intended or considered suitable for identifying individual properties at risk but gives an indication of areas of risk around a property. While many of the properties with reported internal flooding are not located within the high risk RoFSW extent, instead they were in the medium and low risk flood extents.

One of the limitations of the mapping, as caveated by the EA, is that often the mapping shows flooding only adjacent to a property, where the property itself could be at risk of internal flooding. It should also be noted that poor correlation with the mapping may mean that the flooding was caused by an alternative source of flooding.

Table 2.4: Comparison of observed and predicted flood extents

Location	Observed flood extent	EA RoFSW extent	Comparison
1. North Hill	Internal damage reported due to flooding on North Hill Drive (1 property), and along multiple properties on Taunton Road (4 properties) and Hitchin Close (7 properties).	Three of the five properties along Taunton Road lie within the high RoFSW extent. Properties along Hitchin Close lie within the medium RoFSW extent. There is low risk of surface water flooding along the northern part of North Hill Drive, reported property is within this extent.	Properties within high RoFSW extent reported internal flooding, indicating good correlation on Taunton Road and Hitchin Close. North Hill Drive property is not covered by any RoFSW but reported internal damage, indicating poor correlation with mapping.
2. Gallow's Corner	Reported flooding but no internal damage in property on Launceston Close.	All properties along Ramsay Gardens and Shenstone Gardens are within the medium RoFSW extent. Launceston Close is located within 15m of high and	Launceston Close and Links Avenue reported internal flooding but are not in high or medium RoFSW but are within the low RoFSW extent. Other properties within medium RoFSW extent and all

Location	Observed flood extent	EA RoFSW extent	Comparison
	Reported internal damage from multiple properties along Shenstone Gardens (4) Ramsay Gardens (6) and Marlowe Gardens (4).	medium RoFSW extent. The properties along Links Avenue are located within 10m of high and medium RoFSW extent. Both roads are in the low RoFSW extent.	reported internal damage, indicating good correlation, although level of risk may be higher than shown on mapping.
3. Balgores Lane	Reported internal flood damage at seven properties on Balgores Lane.	There is low risk of surface water flooding on Balgores Lane. The properties were not specified so unable to comment whether they are within the RoFSW extents.	In area of low RoFSW but reported internal damage for all properties in an event anticipated to be of lower magnitude.
4. Francess Bardley School	Flooding reported along Douglas Road but no internal damage. Reported internal flood damage in two properties along Park Lane, one property along Globe Road.	The affected properties are located within the medium RoFSW extent on Douglas Road and Park Lane. Property along Globe Road is not located within area at risk of surface water flooding.	Globe Road not covered by any RoFSW extents but reported internal damage.
5. Stanley Avenue	Reported internal flood damage at five properties along Stanley Avenue.	There is a low risk of surface water flooding along Stanley Avenue. The properties were not specified so unable to comment whether they are within the flood extent.	In area of low RoFSW but reported internal damage in an event anticipated to be of lower magnitude.
6. Hulse Avenue	Reported internal flood damage at two properties along Hulse Avenue.	There is low – high risk of surface water flooding along Hulse Avenue. The affected properties were not specified so unable to comment on whether they are within the flood extent.	In area of low RoFSW but reported internal damage in an event anticipated to be of lower magnitude.
7. Squirrels Heath Road	Reported highway flooding, manhole cover collapse, no internal flood damage reported.	There is low – high risk of surface water flooding along Squirrels Heath Road. All three flood extents cover the main road.	Highway issue covered by all RoFSW extents
8. Pettits Lane North	Reported manhole cover collapse and internal flood damage at one property.	There is low – high risk of surface water flooding along Pettits Lane North. All three flood extents cover the main road. Impacted property is in low – medium RoFSW extents.	Reported internal damage in area of medium surface water flood risk. Highway issue covered by all RoFSW extents

2.5.3 Other Sources of Flood Risk

The nature of the flooding, coming as it did during a large rainfall event and generally being of short duration, means that it is highly unlikely to have been caused by groundwater flooding. There are no reports/evidence suggesting that the flooding was caused by failure of water supply infrastructure.

2.6 Flood Incidents

The LBH Strategic Flood Risk Assessment (SFRA) (2016) compiled a list of historic flooding across the Borough from various sources. In the last 100 years, there have been 11 notable flood events (excluding the August 2020 event, which happened after the SFRA had been published). The type of flooding is predominantly fluvial, with one recorded tidal event.

The LBH SFRA states that it is the southern area of the borough that is at most risk of flooding, as it is within the vicinity of the Thames and the valleys of the Rivers Beam and Ingrebourne and their tributaries.

The two most recent events (excluding the August 2020 event) in 2007 and 2016 are attributed to sewer flooding, and surface water and fluvial flooding, respectively. The 2007 event caused flooding across the Romford and Hornchurch area. Fluvial impacts of the 2016 event were caused by flooding of the River Rom and the surface water flooding was recorded across numerous locations in the Borough. No specific location for the recorded surface water flood events was provided within the SFRA. The 2016 event is understood to be as a result of intense rainfall onto already saturated ground, the cause of the 2007 event is also understood to be significant rainfall.

Previous Section 19 reports detail locations from their respective flood events. The most recent flood events in the borough for which Section 19 reports have been compiled are from June 2016 and August 2020. The recorded flood locations from the June 2021 flood event have been compared the two locations in the Give previous Section 19 reports to see whether there are any overlaps in the reported flood locations and subsequent regular flood spots. The previous Section 19 reports detail the road names of properties who reported flooding. Although these reports used location groups names that are used in this report, the list of properties with reported flooding were used to make a comparison.

Both the 2021 and 2016 flood events caused flooding in Hitchen Close. No other locations overlapped from previous Section 19 reports during the June 2021flood event.

3. Organisational Responses

This section includes key actions undertaken by responsible authorities before, during and after the June 2021 flood event.

This report was commissioned over a year after the June 2021 flood event and as such requests for information to responsible RMAs were delayed. The time gap may have hindered the organisational responses, as the information received is, in some cases, incomplete or insufficient for inclusion in this report, or in other cases unavailable.

3.1 London Borough of Havering

As the lead local flood authority, LBH was contacted to request data they have recorded from the event that will aid the section 19 investigation. The response received consisted of a list of properties that had been damaged in the 25th June 2021 flood event. A further response was received including details of an additional location that had been flooded, including photographs that can be found in the appendix of this report.

It would be beneficial for future flood events for LBH to provide additional records, including identifying the communications made between risk management authorities and any actions undertaken by the council in advance of and in response to the flood event (both immediately and in the following days and weeks). More comprehensive and consistent recording of flood reports is also recommended, although it is recognised that this is not always possible given the reliance on third parties for information. Use of a standard reporting form, to be completed by any council staff receiving reports of flooding, could help drive greater consistency and ensure more information is obtained in any future flood events.

3.1.1 Councillor Correspondence

Anecdotal evidence of potential causes of the flooding was provided by the then leader of Havering Council, Councillor Damian White. In correspondence with residents sent on the 26th June 2021, Councillor White stated that:

"Unfortunately, we were not able to predict the ferocity of last night's storm. Indeed, the Met Office only issued their yellow warning for rain and flooding for our area at 8.43pm by which time most of the damage had already occurred.

However, even if we had been advised hours in advance of the rain and hailstones falling, drains and gullies became blocked due to the sheer volume of water falling in a short space of time, and the debris, leaves, and litter that was then swept into them."

3.2 Environment Agency

The Environment Agency provided information on their response to the flood event. It stated that there were no flood warnings or alerts issued for the location around the 25th June. The EA incident line received four reports related to flooding in Havering on the evening of the 25th June, and three retrospective reports on 26th June.

Two reports related to TW assets (one relating to sewage, one a TW pond), in which case the issues were reported to TW and advised the callers to also contact TW. One reported sewage flooding near Heath Park and the other related to flooding from a pond near Harrow Lodge Park.

Five reports were also received by the EA about flooding or blockages on the Ravensbourne in the Hornchurch area. Four of them related to the Ravensbourne in or near Harrow Lodge Park, and one about a blockage on Black's Brook in Heath Park area. EA field teams were sent to the area and attended various sites on the Ravensbourne, but were not able to take much action, as the water levels were very high due to high rainfall over a short period of time. A field team cleared the Local Authority-owned trash screen at TQ5189988911 on Black's Brook on 27th June, and a confined space team cleared another blockage around TQ 53422 87538 on the Ravensbourne on the 2nd July 2021.

3.3 Thames Water

Thames Water were contacted to provide an overview of their response during the June 2021 flood event. There was no response. TW could not provide any sewer depth monitoring data or flooding records for the period and did not provide an overview of their response to the flood event as a FRMA. Thames Water also declined the request for any time-based monitoring data.

3.4 London Fire Brigade

London Fire Brigade (LFB) provided an overview of their response during the June 2021 flood event, including a log of the calls that were made to the Fire Service across the evening of the flood. There were over 150 incidents recorded across the borough, with most reports coming from the central wards. LBF pumped flood waters out of five properties, three of which were located on Barnstaple Road, and one property on Taunton Road needed evacuating. Other actions described within the logs include the 'making safe' of properties, providing advice and standing by for action.

3.5 Metropolitan Police

The Metropolitan Police were contacted to provide an overview of their response during the June 2021 flood event. The Metropolitan Police responded saying that they were unable to disclose any information on the event.

3.6 Transport for London

Transport for London (TfL) were contacted, as the major A12/A217 roundabout is a TfL red route. TfL did not respond.

3.7 Summary

Table 3.1 provides a summary of the responses received from the FRMAs and identifies which RMA responses are considered sufficient for the purposes of this report.

Table 3.1: Responses received to request for information from FRMAs

Source	Response received	Sufficient evidence to allow for completion of this report
London Borough of Havering	• List of impacted properties which did not include full details for every property. • Could not comment regarding their highway responsibilities due to lack of records	N
Environment Agency	• Rain gauge data • River gauging station data • Overview of event	Y
Thames Water	• Responded stating they're unable to provide information	N
Metropolitan Police	• Responded stating they're unable to provide information	N
London Fire Brigade	• Flooding incident record	Y
Transport for London	• Did not respond	N

4. Likely Causes of Flood Incident

A combination of factors are considered likely to have contributed to the flooding on 25th June, including:

- Depth and intensity of rainfall experienced over the 3 hours on 25th June;
- Drainage capacity;
- Antecedent conditions.

4.1 Primary Causes

The primary contributing factor to the flooding observed in June 2021 is considered to be the intensity and depth of the rainfall that fell across the borough. It is estimated that a third of one month's average rainfall fell across the borough over 3 hours. The Havering Bower rain gauge recorded 26.29mm of rainfall over the course of the 25th June 2021. This was approximately a third of the monthly rainfall recorded in the Thames region.

4.2 Contributing Factors

It is anticipated that flooding observed at the assessed locations was predominantly a result of rainfall exceeding sewer capacity and/or blocked gullies. However, due to the lack of information available, it cannot be confirmed to what extent these factors impacted the flood event. Despite the rainfall event being a flash flood, with significant rainfall in a short period of time, the sewer infrastructure would generally be anticipated to have been designed to handle rainfall events of such magnitude, 20% (1 in 5) AEP event. This would infer that the elements of the drainage network, were either already under capacity due to failures/blockages, or became blocked during the course of the storm event.

A number of the reported flooded locations show good correlation between the observed flooding and the EA RoFSW mapping extents (see section 2.5). Whilst three of the reported properties were within the 3.3% (1 in 30) AEP extent, most locations that had reported flooding were found to be in or adjacent to areas at risk of surface water flooding in 1% (1 in 100) AEP events. It may be that blocked gullies and drains are the reason that areas shown in the mapping to only flood in more significant rainfall events flooded in June 2021, however it is not possible to confirm this based on the information available.

As discussed in section 2.2, June 2021 saw above average rainfall recorded across South-East England. The monthly rainfall for the Thames region was 72mm which was 142% above the long-term average. This may have contributed to reduced storage capacity in rivers and in the ground, potentially increasing runoff and reducing discharge to watercourses.

Blockages of trash screens may also have contributed to high river levels, further reducing the ability of sewers to outfall to watercourses. The shortage of evidence provided as to actions taken by some risk management authorities before, during and after the flood event means that there is limited evidence as to if this is likely to have been the case. The only reported action in relation to trash screens came from the Environment Agency, which reported that following the flooding its site teams cleared a trash screen on Blacks Brook, a few hundred metres downstream of two of the reported flood sites. No further details are available to identify if any blockage at this location was a contributing factor to the flooding that occurred. No other evidence of the condition of other trash screens in the vicinity of areas that flooded has been made available.

4.3 Uncertainties

Limited information has been provided from FRMAs to inform the production of this report. Consequently, it has not been possible to confirm whether the cause of the flood event was due to sewer conditions, gully blockages, sheer volume of water or a combination of these and other factors. However, it is considered likely that a combination of these factors is the most likely cause of the flooding at the locations considered within this report.

Further evidence of events on the day of the flood event or modelling of the flood event that is beyond the scope of this study, would be required to identify the causes with any level of confidence.

5. Conclusions and Recommended Actions

5.1 Conclusions

The primary cause of the flooding experienced on 25th June 2021 was the volume and intensity of the rainfall experienced. It is estimated that a third of one month's rainfall fell across the borough over 3 hours. There is potential for other factors and mechanisms to have contributed to flooding within most of the reported grouped flooded areas. The flooding appeared to be localised, with reports of flooding only in the northern and central areas of Havering.

In accordance with the Flood and Water Management Act, LBH is the LLFA within the Borough. Section 19 of the Act includes regulations relating to flood investigations within an LLFA's jurisdiction. LBH have adhered to these regulations by:

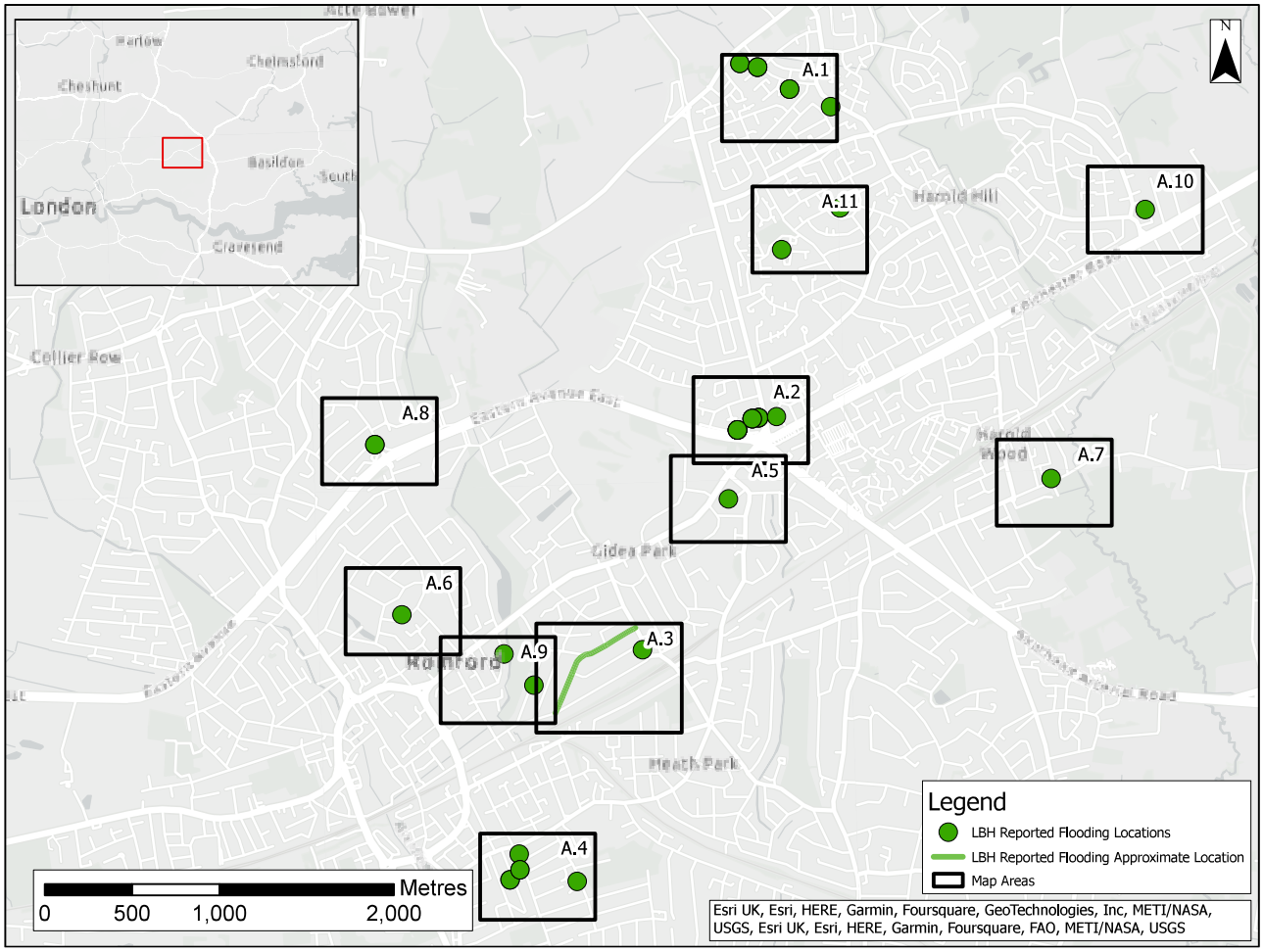
- Maintaining a register of properties flooded during the June 2021 flood;
- Investigating the factions of FRMAs during the June 2021 flood event;
- Devising a list of recommended actions for FRMAs to ensure a more effective response is achieved if a similar event should occur in the future.

5.2 Recommended Actions

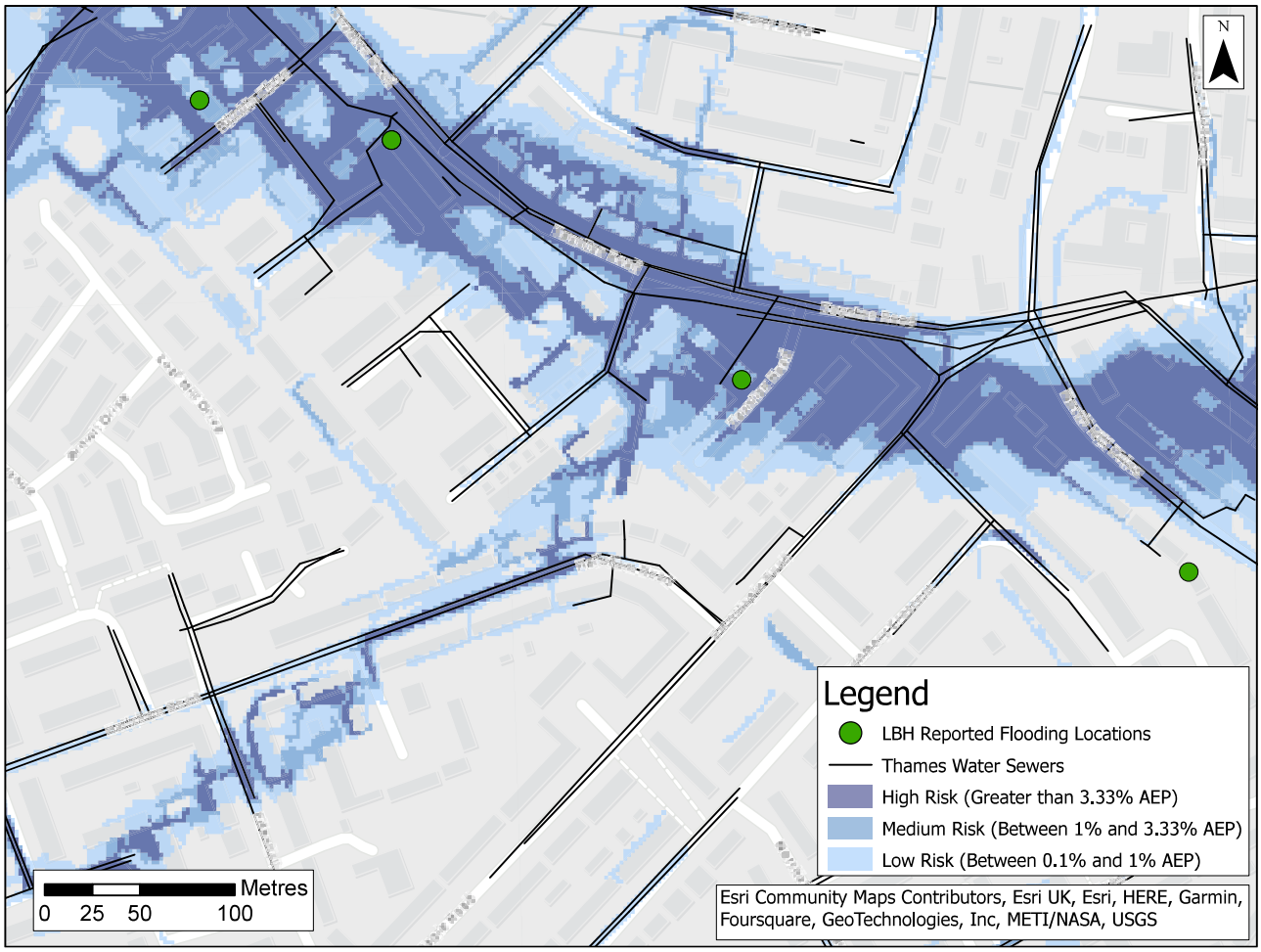
- This Section 19 investigation was commissioned in October 2022, over 12 months after the flood event. It is recommended that any future reports be commissioned for completion as soon as possible following the flood event. This allows for collection of evidence in a timely fashion and for site walkovers to assess conditions closer to the event. Consideration could also be made of requests for information being made prior to commissioning of investigations, particularly given that the information required is generally standardised for investigations of this type.
- It has been recommended in previous Section 19 reports that a more refined, detailed and consistent reporting system be applied across the FRMAs, as some reports would only include a record of a post code without a type of flooding attributed to it, or any specific location provided, which had not been resolved for this report. Therefore, it is recommended that a more detailed and consistent reporting and record keeping system for all FRMAs be considered. This would assist improved lessons learnt and identification of potential mitigation following flood events. Consistent and joined up reporting may also assist responders and members of the public. In addition, it is recommended that reporting ensures it is confirmed when recommended actions associated with recorded flooding incidents are carried out.
- The two most recent flood events (2020 and 2016) within the borough were due to the exceedance of sewer capacity and blocked gullies. This report identifies drainage conditions as a possible contributing factor to the flooding on June 25th, 2021. It is recommended that Thames Water ensure they keep records of actions undertaken in flood events and provide them to any future investigations. It is also recommended that Thames Water and LBH consider if any of the flooded areas have substandard drainage that may be causing flooding even in low magnitude flood events.
- The Environment Agency reported that following the flooding, its site team cleared a blocked trash screen a few hundred metres away of two of the reported flood sites, but no further details were available to identify whether this was a contributing factor. However, given that blocked trash screens are likely to increase flood risk, it is recommended that with increased monitoring and clearance of screens is considered near to regular flood locations.
- It is possible that some areas within the borough experienced higher magnitude rainfall events on a local scale that went unrecorded due to the small number of operational rain gauges in the borough. Consideration should also be made of if additional rain gauges could be installed to allow for better understanding of local rainfall conditions.

Appendix A. Flooding Locations

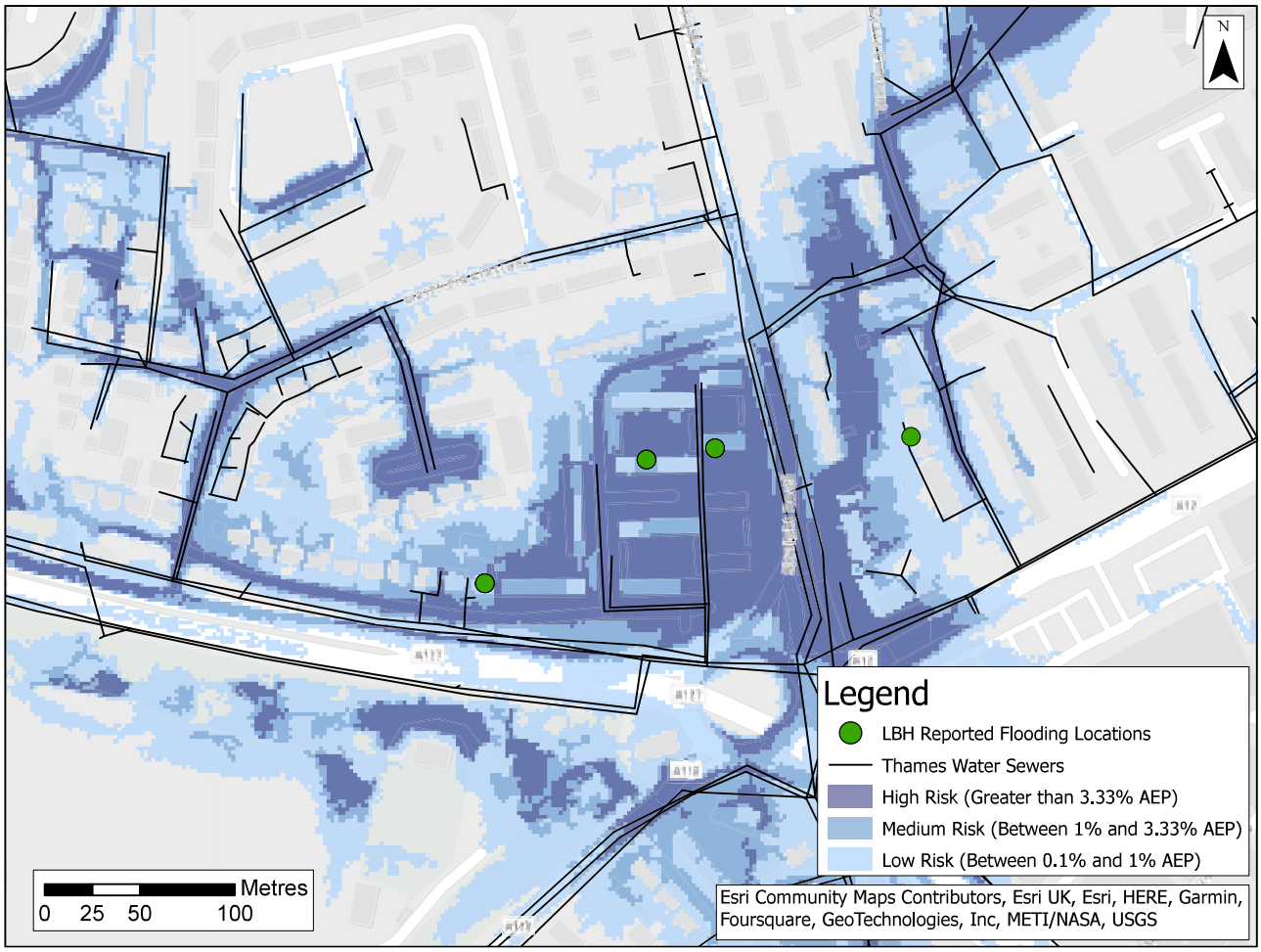
A. Location Plan



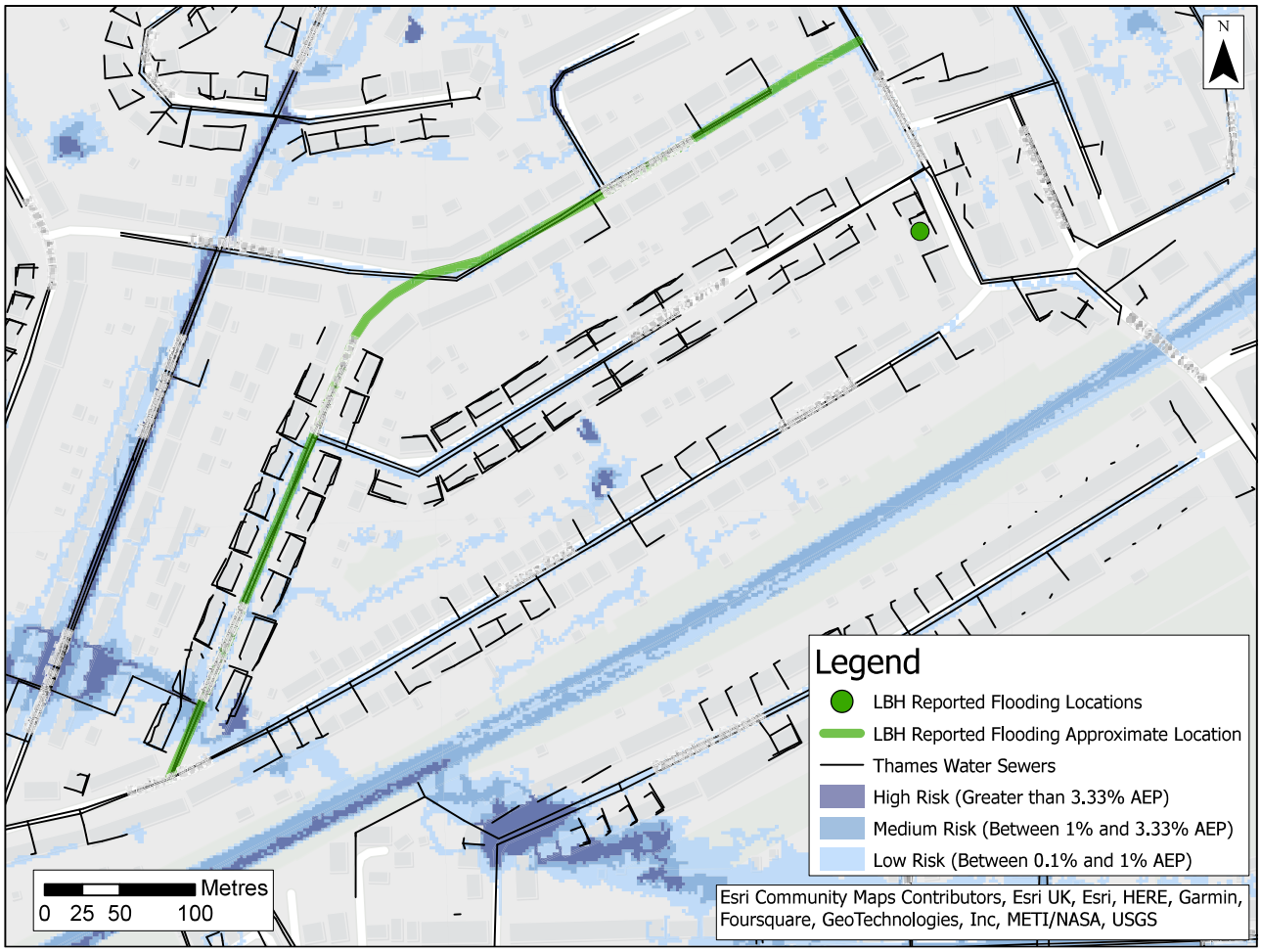
A.1 North Hill



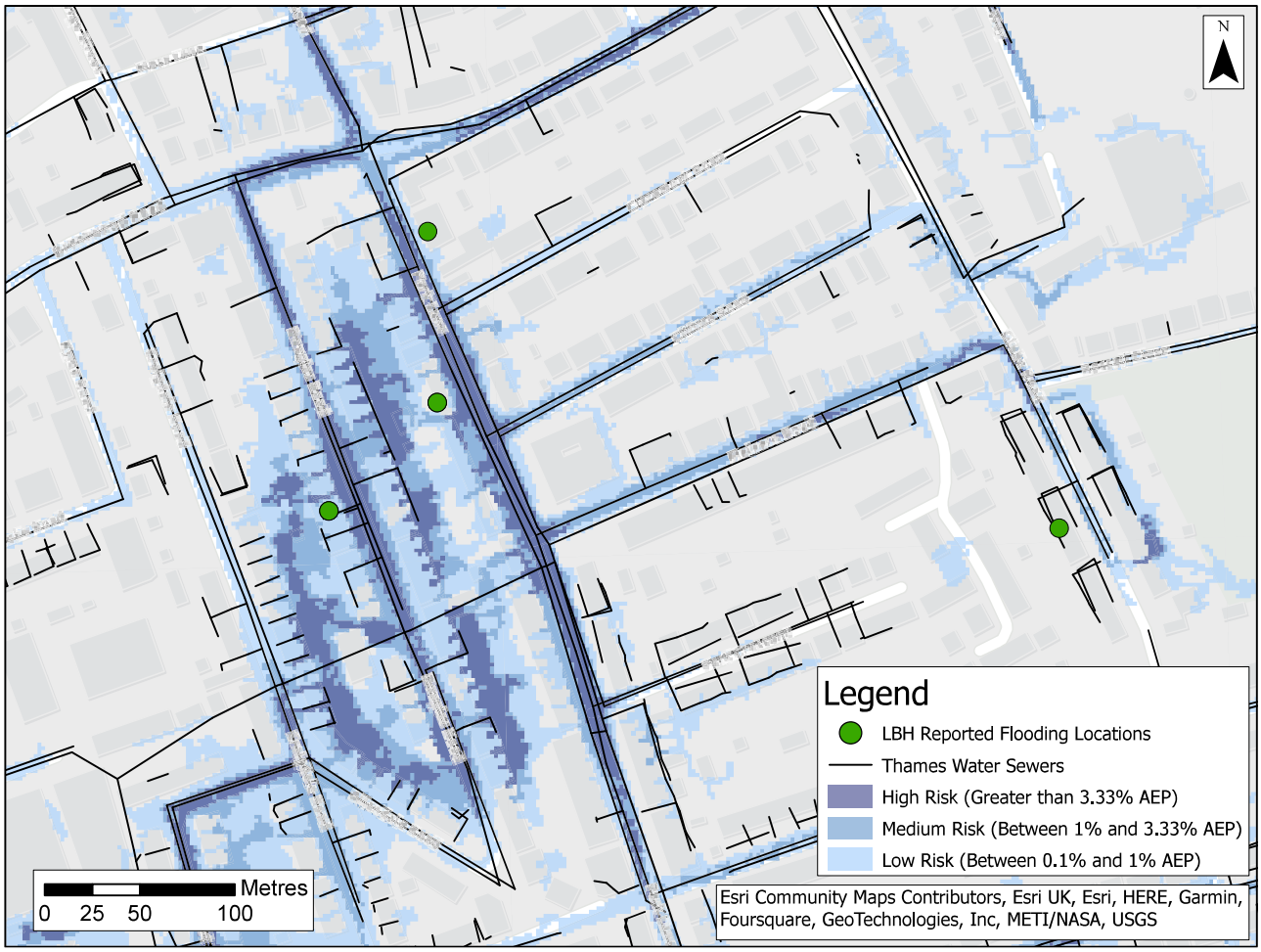
A.2 Gallows Corner



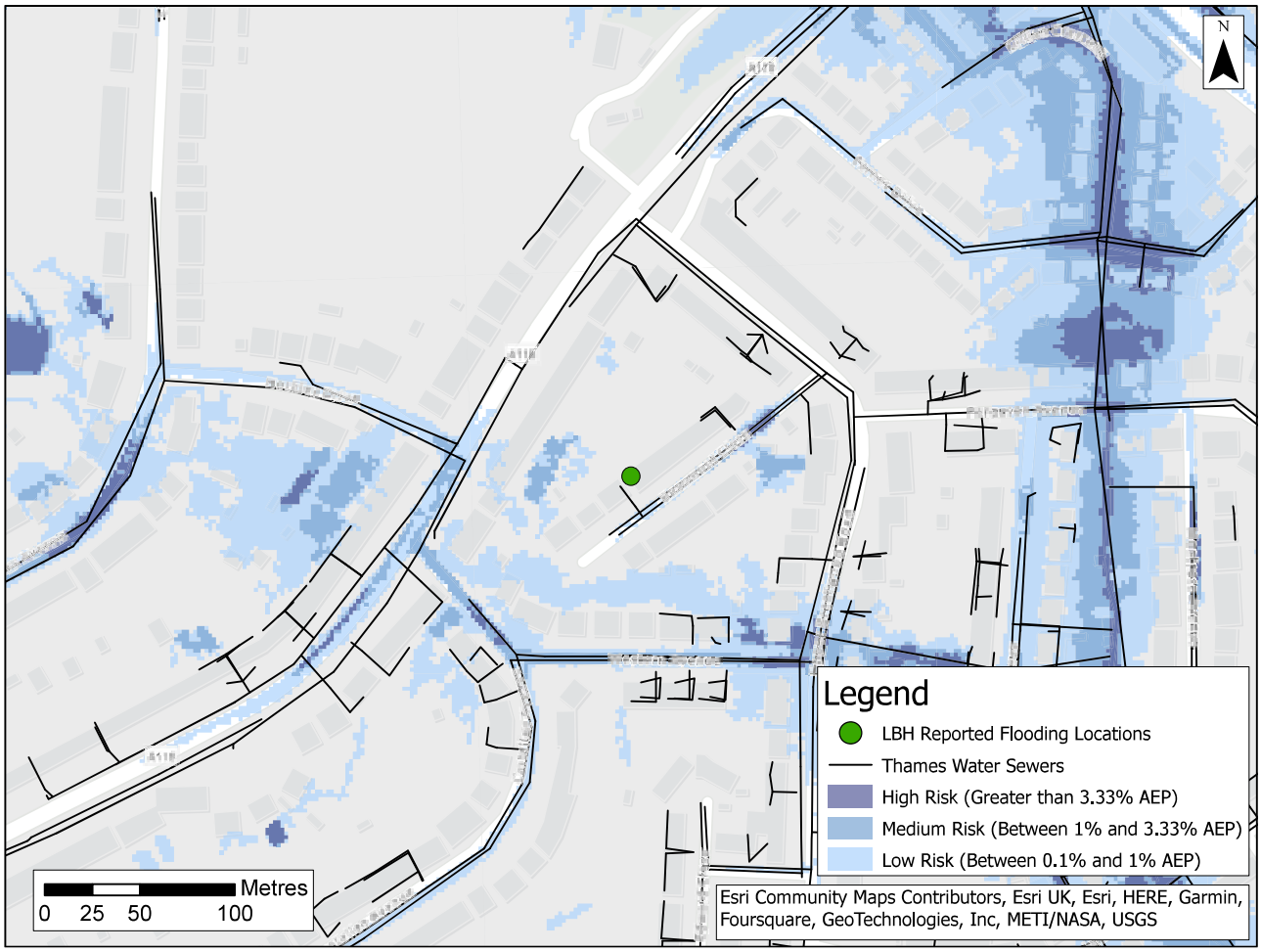
A.3 Balgores Lane



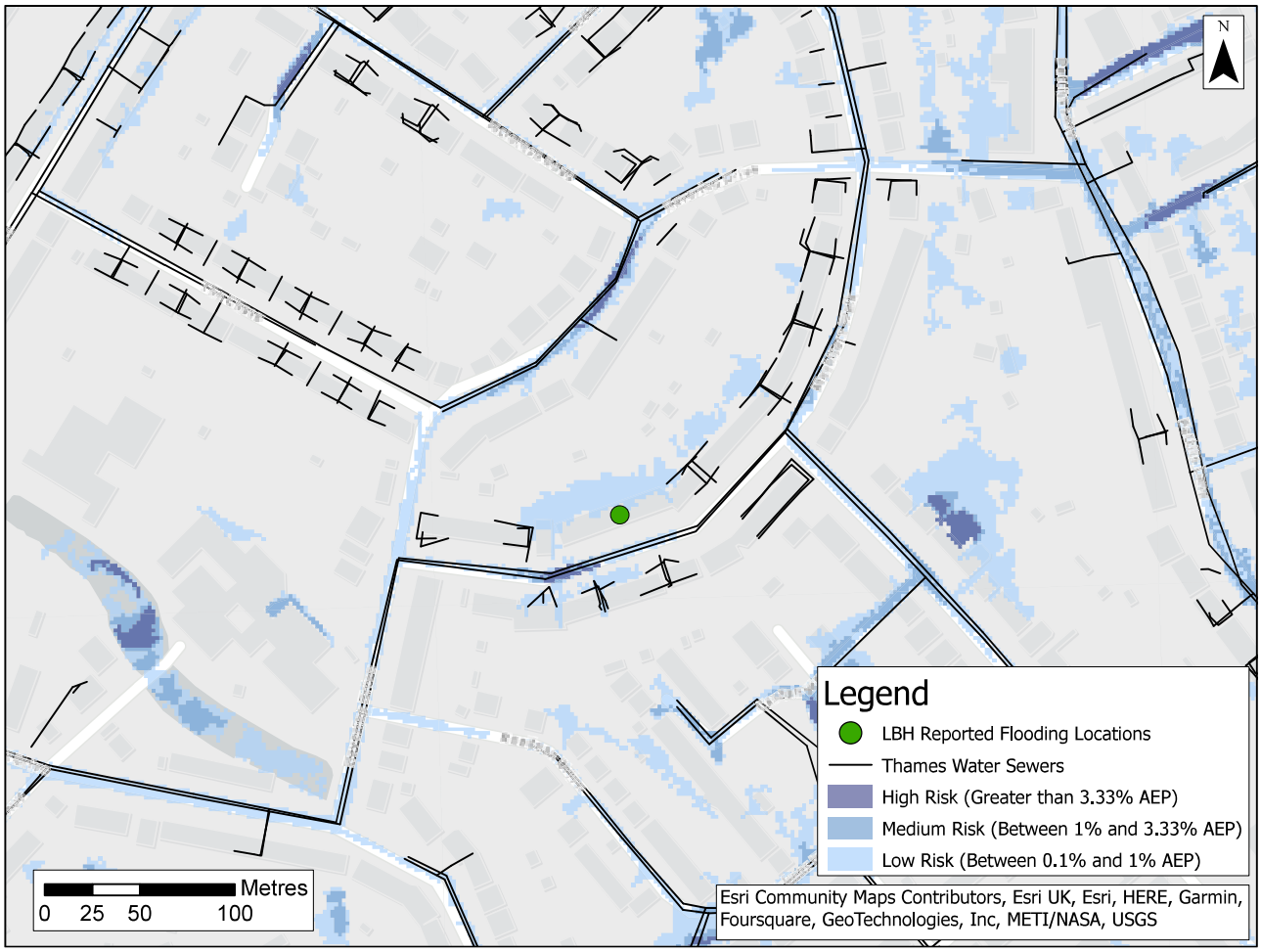
A.4 Frances Bardsley School



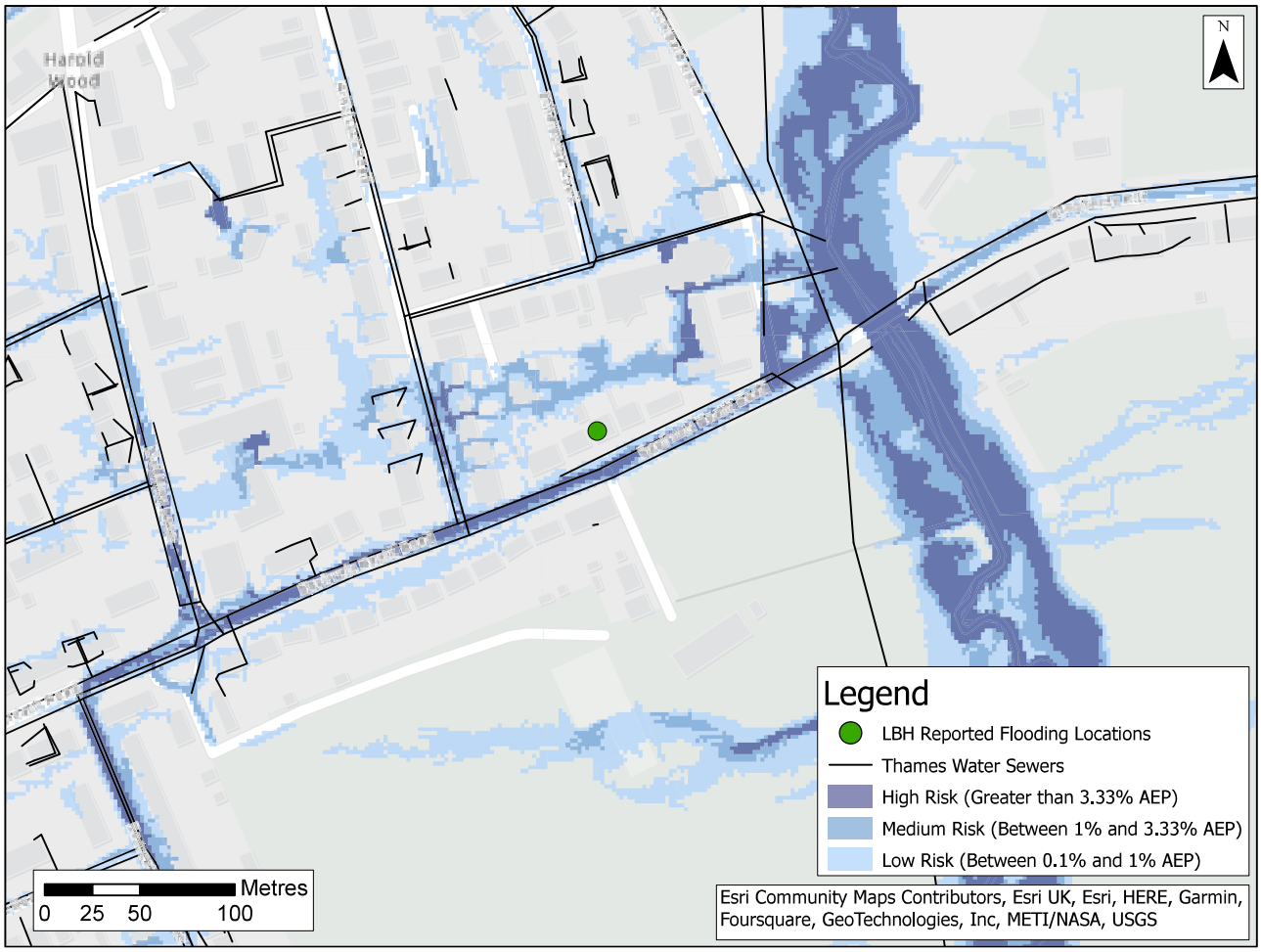
A.5 Beaumont Close



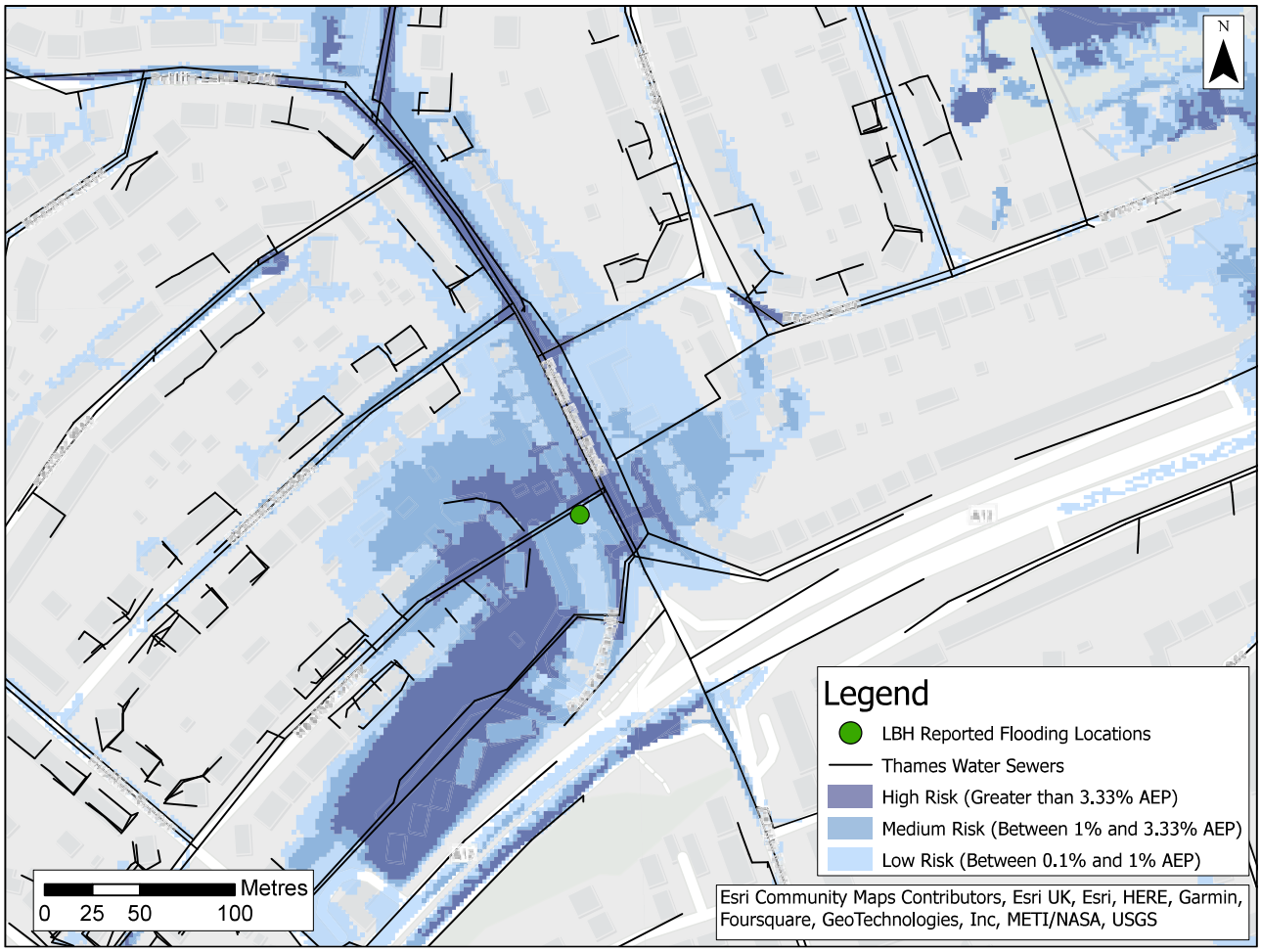
A.6 Mashiters Walk



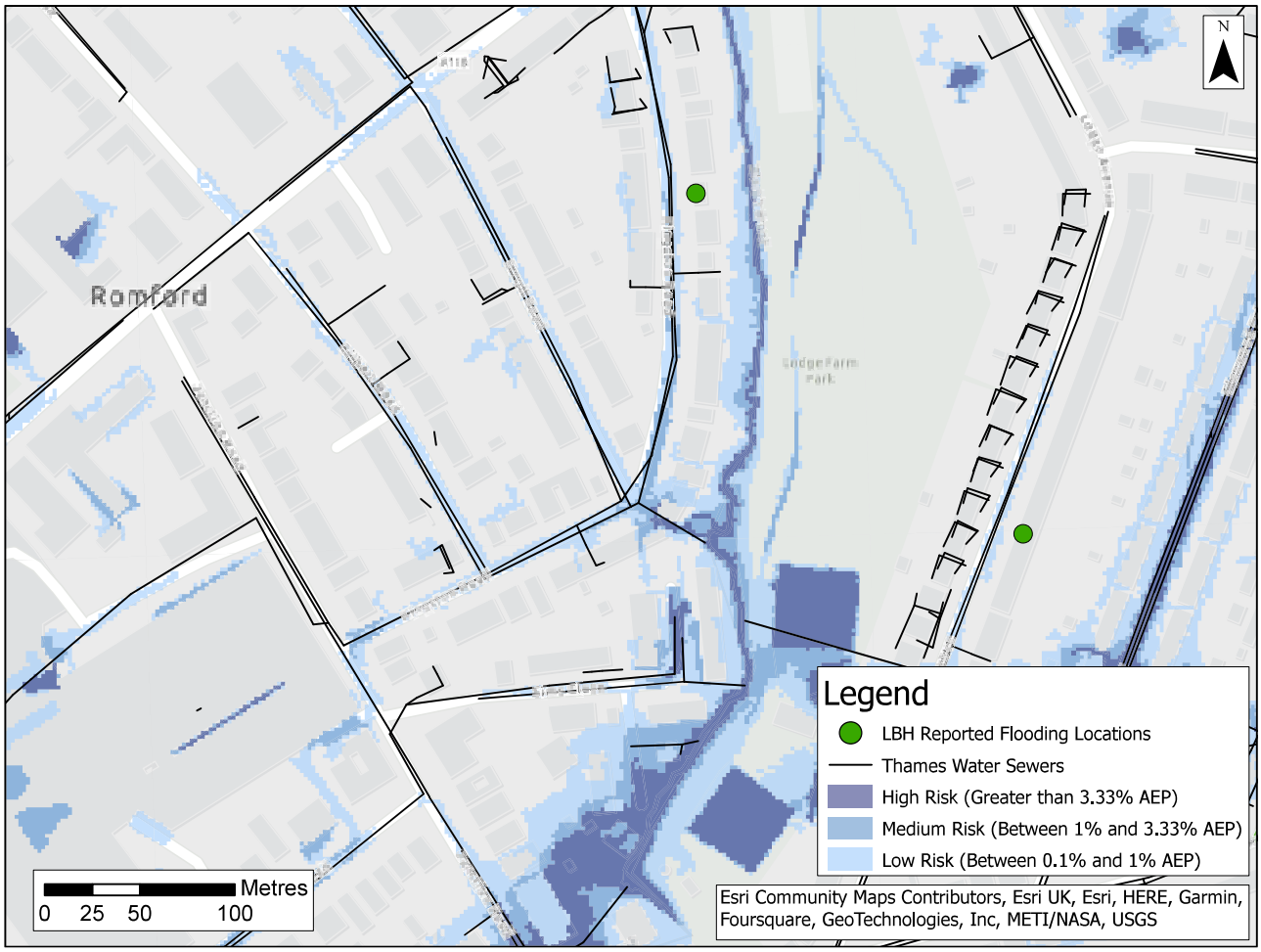
A.7 Squirrels Heath Road



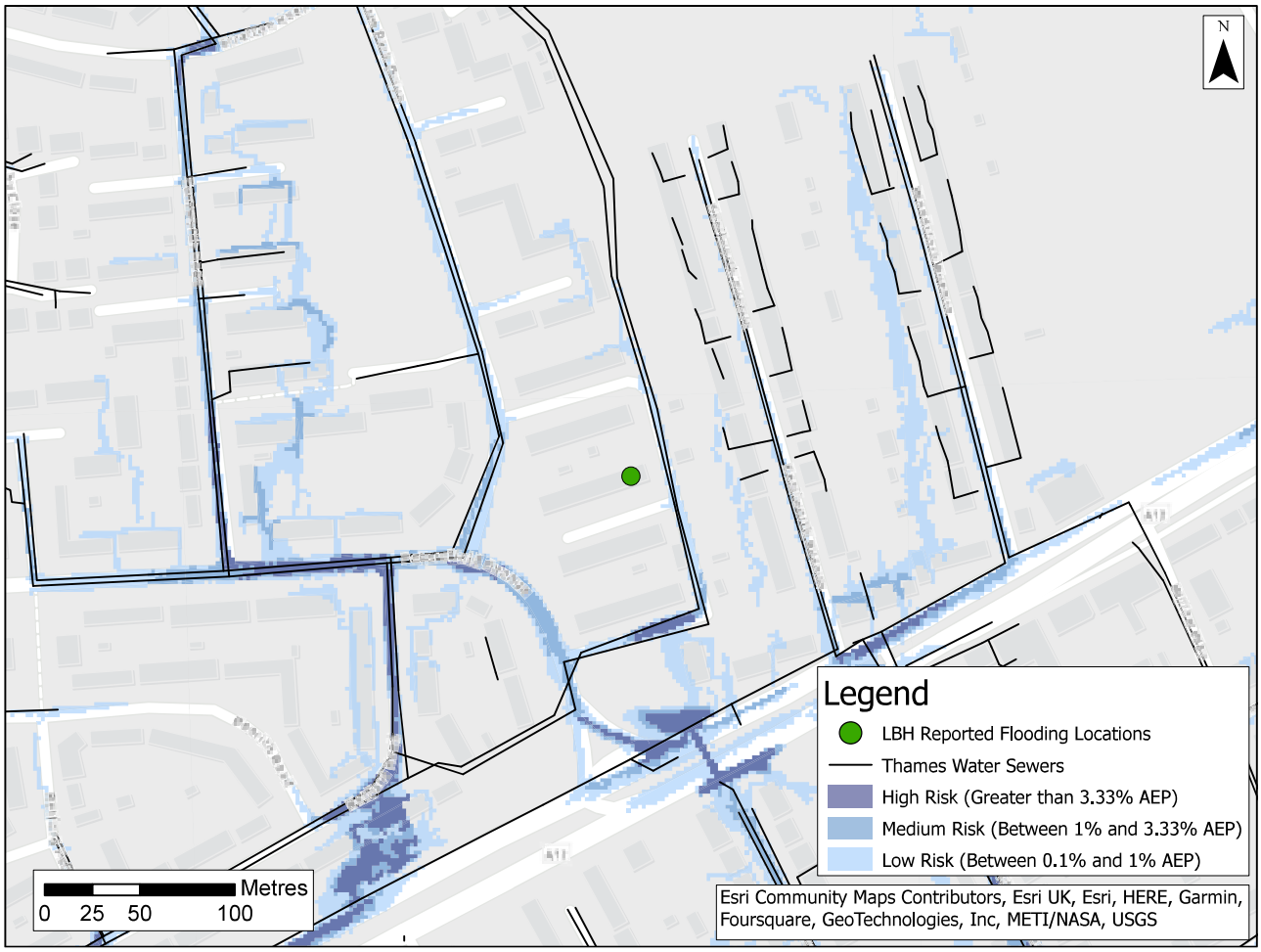
A.8 Petits Lane North



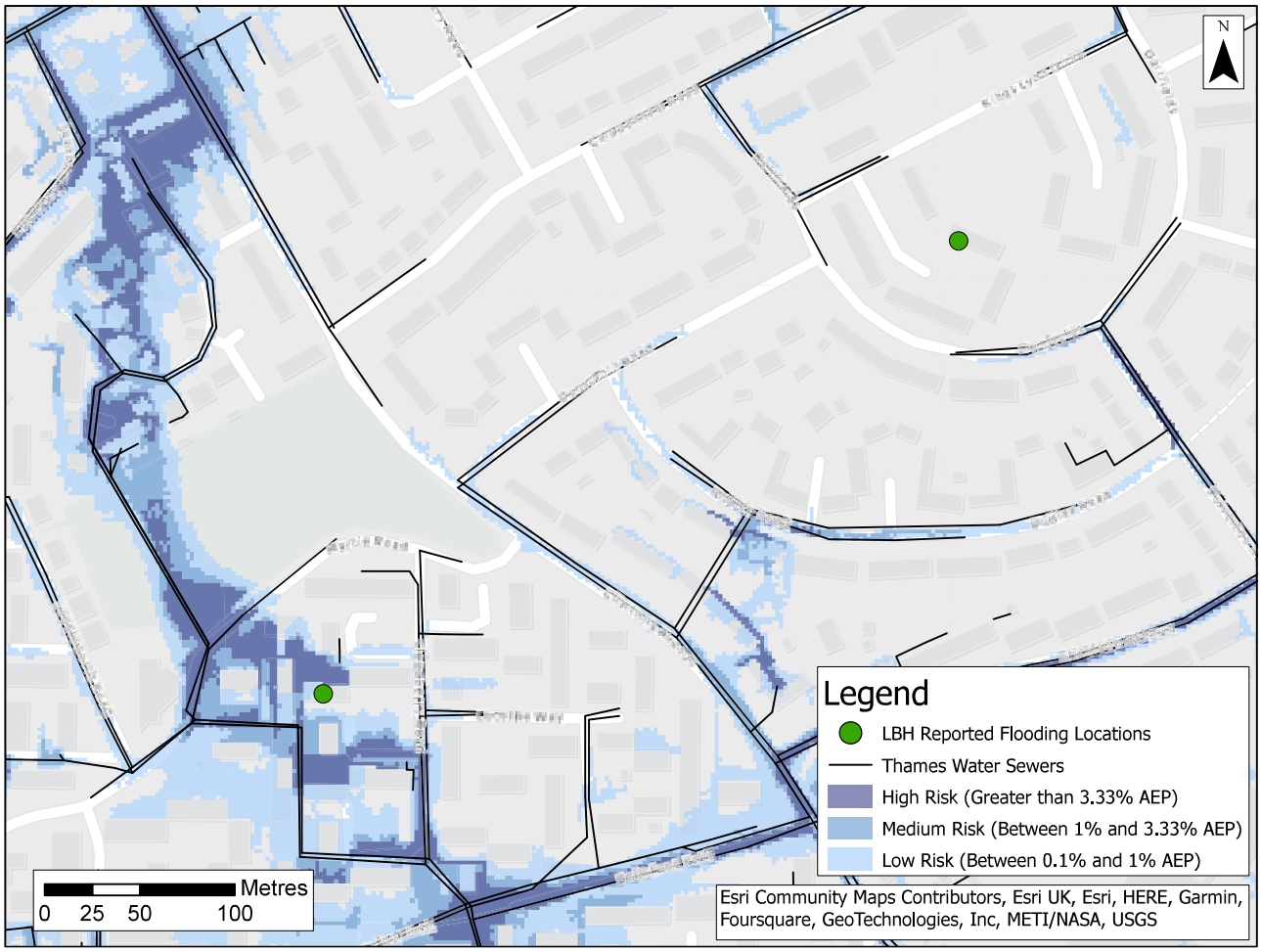
A.9 Lodge Avenue and Kingston Road



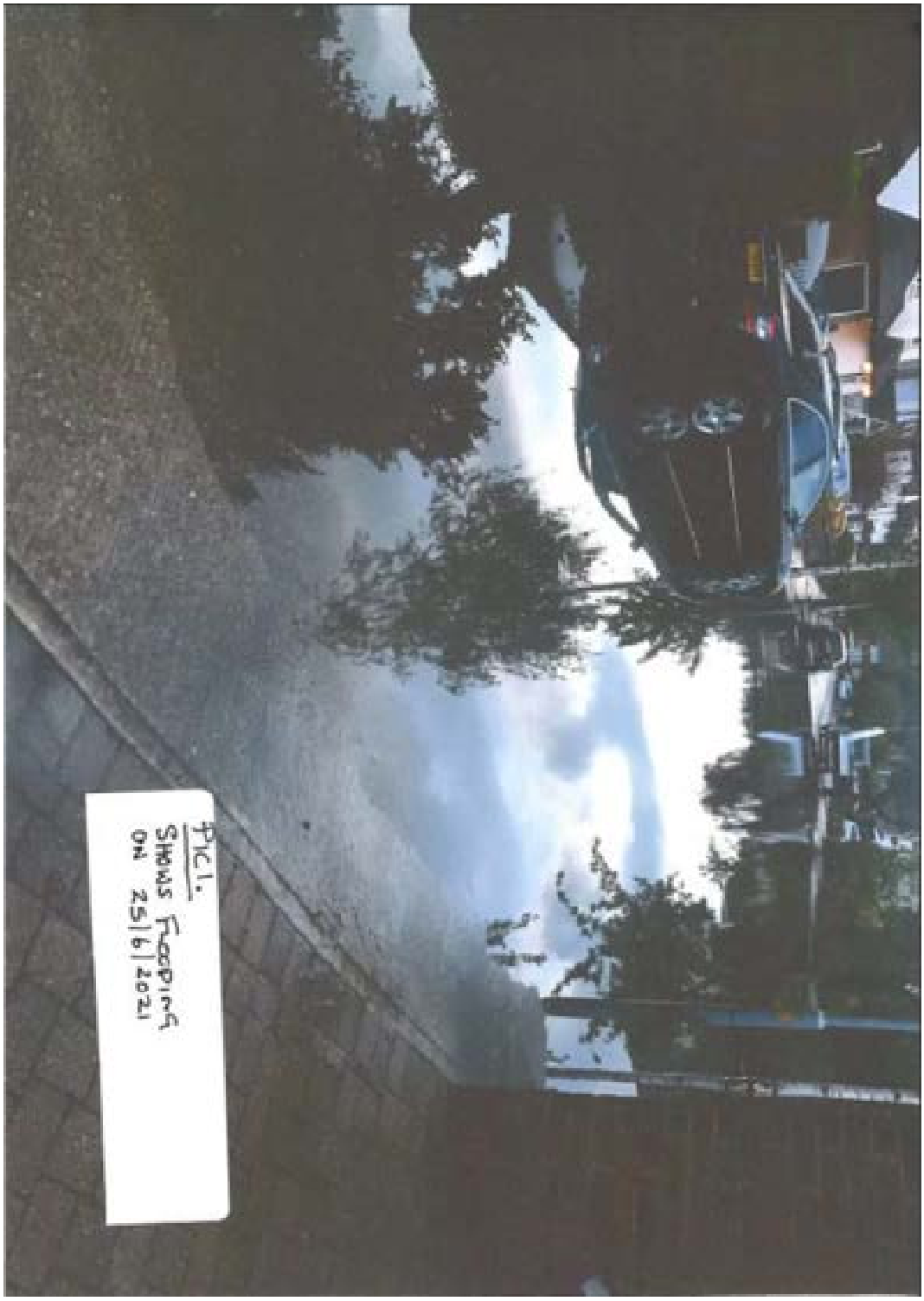
A.10 Fairford Way

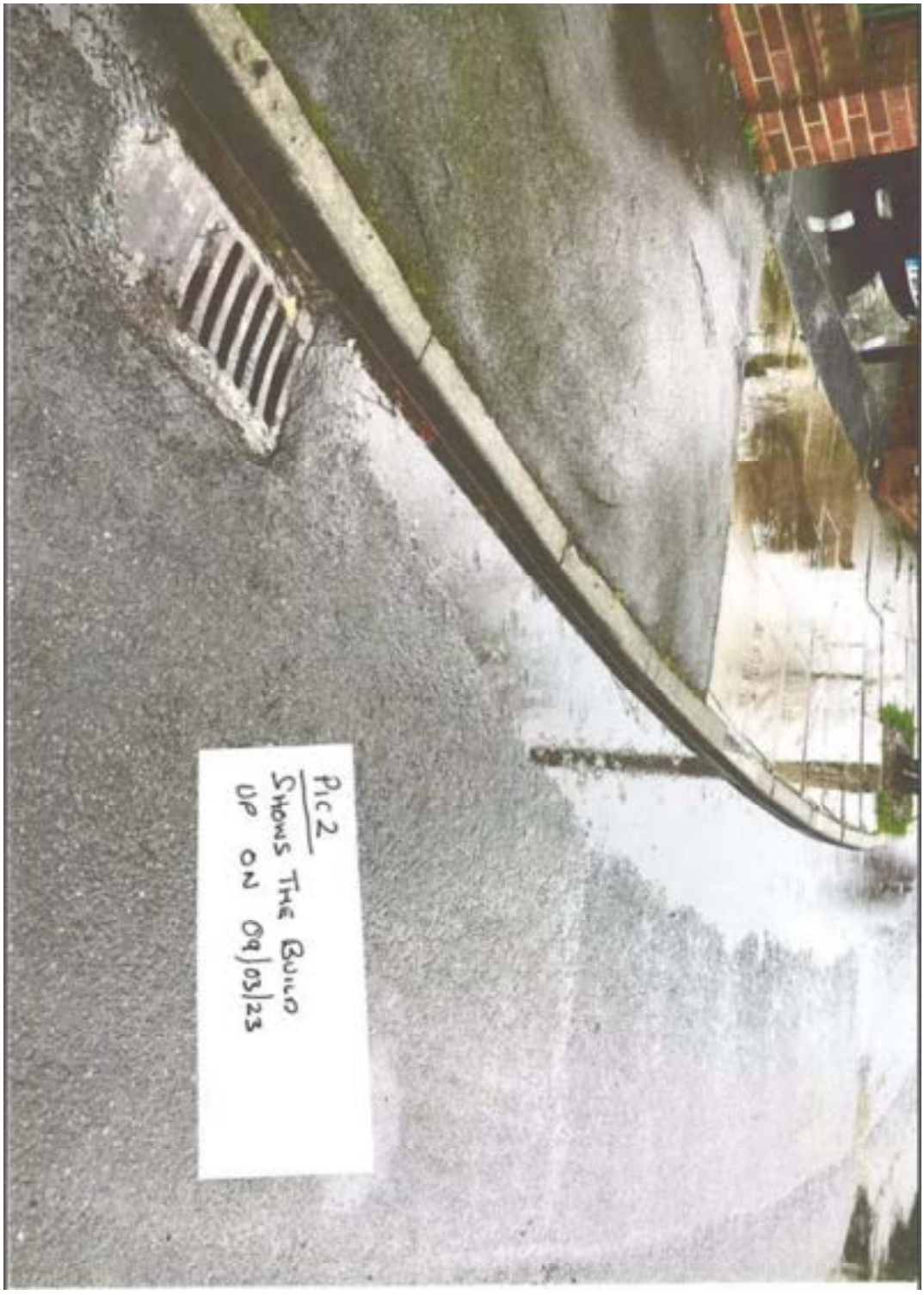


A.11 Kings Lynn Drive and Honeysuckle Close



Appendix B. Pictures sent from Havering Residents.




PIC 2
SHOWS THE BUILD
UP ON 09/03/23


Links Ave
Links Ave
Links Ave
Einsteins
APPROX AREA OF FLOODING
98 Flooded
96 Flooded
93
96
APPROX POSITION OF DRAINS
Pic 3
DIAGRAM SHOWING AREA OF FLOODING 25/6/21.

Appendix C. Hydrology Analysis Report

Jacobs

Havering Flood Investigation

February 2023

London Borough of Havering

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	Feb 2023	Draft	MMcD	KB		

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Contents

1. Introduction

1.1 Description of work

Jacobs have been commissioned by the London Borough of Havering to undertake a study into the flooding that occurred during the 25th of June 2021. A flood Incident Report is to be produced and this hydrological analysis is required to inform the report of the likely rarity of the rainfall event. A similar study at the London Borough of Havering was undertaken by Jacobs for the flood event of 14th – 16th August 2-20, and the findings are reported in March 2021[8]. Some of the information reported here are also based on the Jacobs (2021) report.

1.2 Location Plan

Havering London Borough is located in East London and its administrative boundary covers an area of 111.4km^2. Over 70% of the Borough is urbanised. The main communities are Romford located to the north, Hornchurch, Upminster in the centre and Rainham located to the south of the borough.

The main watercourses flowing within the borough are the River Ingrebourne, River Mardyke, River Ravensbourne, River Rom and River Beam, which are tributaries of the River Thames.

Jacobs have received data for two intensity rainfall gauges for the period between the 24th of June 2021 and the
26th of June 2021, which are located in close proximity to the study area. These are Nag's Head Lane and Havering Bower.Figure 1 - There are also two river level gauges, one at Gaynes Park on the River Ingrebourne and the second at Elm Park (Bretons Farm) on the River Beam. Additionally, there are also three surface water level gauges at Romford on the River Tom, Collier Row on the River Tom, Harold Park on the Ingreborne River, and two temporary surface water level gauges at New Road and Hornchurch park. The location of rainfall gauges and the river water level gauges within the Havering study area are shown in Figure 1.

[8] Havering Section 19 Flood Investigation Appendix C @ Rainfall event return period analysis.

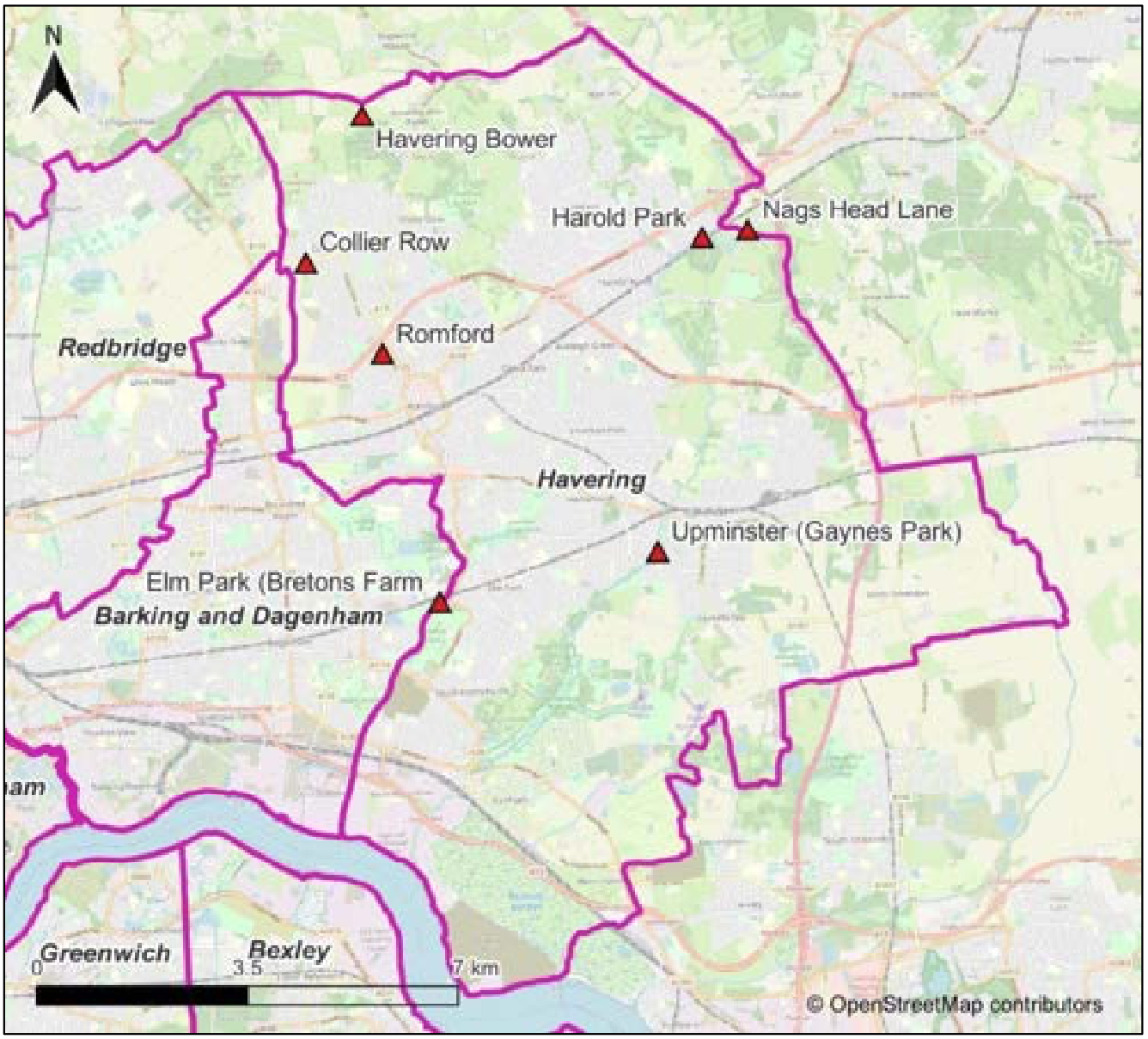

Figure 1 - Rainfall and Hydrometric gauges in Havering Borough

1.3 Methodology

- Fifteen-minute rainfall data for the event were plotted against time at each of the two rain gauges for which the rainfall data is available, in order to establish the most intense rainfall period and overall storm durations.
- Total rainfall depths over differing storm durations were calculated from the recorded data at each of the two rain gauges.
- Long term rainfall depth-duration-frequency statistics at each of the rain gauge locations were downloaded from the Flood Estimation Handbook (FEH) web service[9]. The FEH long

[9] FEH Web Service. Accessed at https://fehweb.ceh.ac.uk/

term statistics were compared with the recorded rainfall data at each of the rain gauge locations to derive the rarity of the 25th of June 2021 extreme rainfall event.

- The rarity of the river flow data was estimated from the statistical analysis of the available AMAX data at the two gauges and comparing the peak flows (derived from the peak stage and available ratings) on 25th June 2021.

1.4 Data received

The details of data received for this study are presented in Tables 1 – 3 below. Table 1- Data received from Rain Gauges

Rain Gauge	NGR	Data Received	Period of Record	Comments
Havering Bower	TQ5024093425	15 minute time series (rainfall depths, in mm)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Good data quality.
Nags Head Lane	TQ5666491532	15 minute time series (rainfall depths, in mm)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Good data quality.

Table 2- Data received from River Gauges

River Gauge	NGR	Data Received	Period of Record	Comments
Elm Park (Bretons Farm)	TQ5153385330	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Good data quality. Peak flow rated Station # 37019

Upminster (Gaynes Park)	TQ5516386177	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Good data quality. Peak flow rated Station # 37018

Table 3- Data received from Surface Water Level Gauges

Surface Water Level Gauge	NGR	Data Received	Period of Record	Comments
Romford (River Rom)	TQ5058089460	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Station 7382. Good data quality. On the Gov.uk Check for Flooding Service, it
				notes that Low lying land flooding is possible above 0.7m.
Collier Row (River Rom)	TQ4930890978	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Station 9282. Good data quality. Normal range is between 0.27m to 1.5m.
Harold Park (Beam River)	TQ5590091400	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Station 7384. Good data quality.
New Road (temp) (Ingrebourne River)	TQ5234182600	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Temporary gauge. Linear transformation due to sensor drift 0mm at start 29mm at end.

Hornchurch park (temp)	GlobalX: 553750 GlobalY: 184278	15 minute time series (river stage, in m)	24/06/2021 00:00:00 to 26/06/2021 23:45:00	Temporary gauge. Listed as: 5553TH

The rainfall data for the 26th of June 2021 event is plotted in Figure 2 and Figure 3 for the two rainfall gauges.

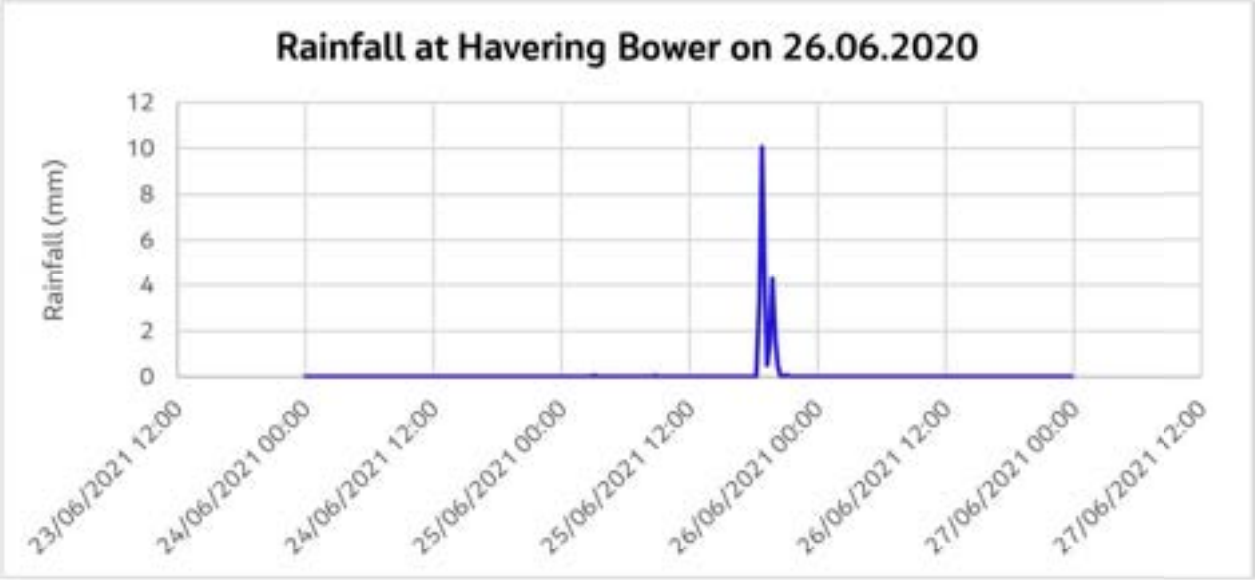

Figure 2- Rainfall at Havering Bower on 26.06.2020

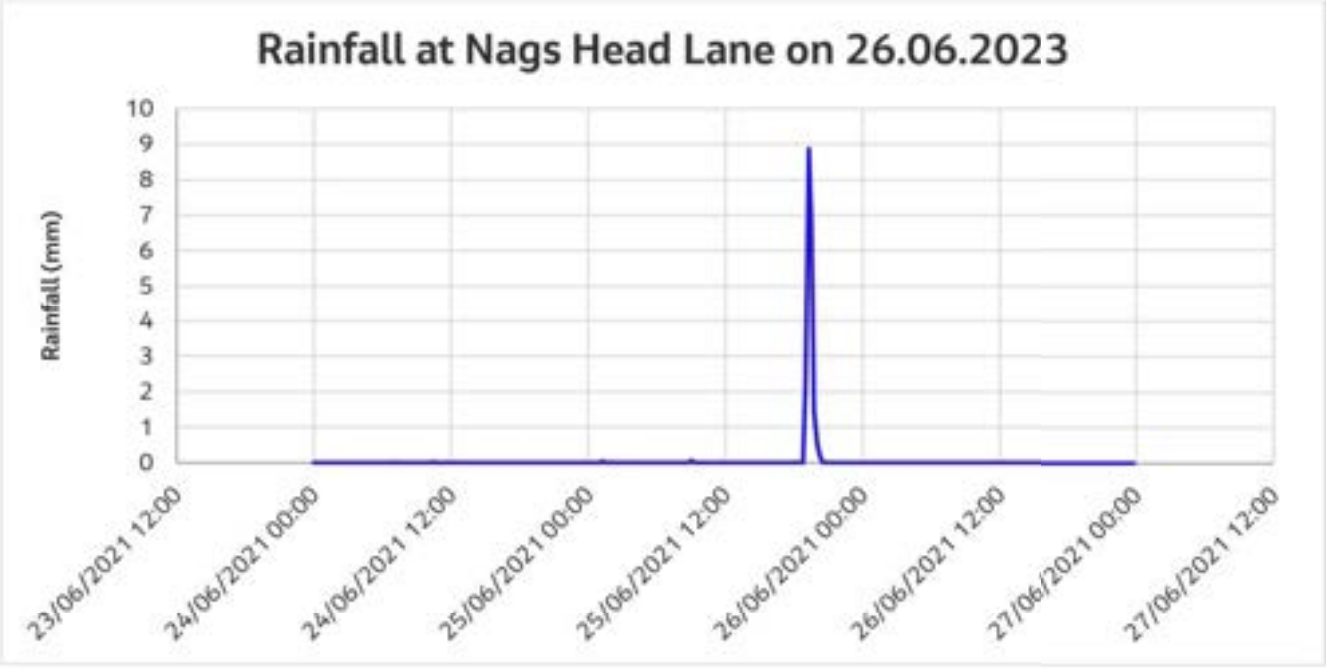

Figure 3- Rainfall at Nags Head Lane on 26.06.2023

1.5 Results

The return period associated with the maximum depths during the 25th of June 2021 flood event are shown below.

5.2.1 Rarity of rainfall events

Table 4- Estimation of rarity of the rainfall events at: (a) Havering Bower; (b) Nags Head Lane

At Havering Bower rainfall gauge				
Duration	Period		Maximum Depth (mm)	Return Period (years)
	From	To		
15 minute	25/06/2021 18:30	25/06/2021 18:45	10.06	3.09
30 minute	25/06/2021 18:30	25/06/2021 19:00	14.53	4.00
1 hour	25/06/2021 18:15	25/06/2021 19:15	18.41	4.37
1 hour 30 min	**25/06/2021 18:15**	**25/06/2021 19:45**	**24.10**	**5.49**
2 hour	25/06/2021 18:15	25/06/2021 20:15	26.09	4.75
3 hour	25/06/2021 18:15	25/06/2021 21:15	26.29	3.29
3 hour 15 min	25/06/2021 18:15	25/06/2021 21:30	26.30	3.09

At Nags Head Lane rainfall gauge				
Duration	Period		Maximum Depth (mm)	Return Period (years)
	From	To		

15 minute	25/06/2021 19:00	25/06/2021 19:15	8.87	2.34
30 minute	25/06/2021 19:00	25/06/2021 19:30	15.65	4.28
45 minute	**25/06/2021 18:45**	**25/06/2021 19:30**	**17.97**	**4.49**
1 hour	**25/06/2021 18:45**	**25/06/2021 19:45**	**19.44**	**4.49**
1 hour 15 min	25/06/2021 18:45	25/06/2021 20:00	19.99	3.90
1 hour 30 min	25/06/2021 18:45	25/06/2021 20:15	20.20	3.33
2 hour 15 min	25/06/2021 18:00	25/06/2021 20:15	20.21	2.30

Tables 4 (a) and (b) show that the rarity of the 25th June 2021 rainfall event was approximately 1 in 5 years (ranging from 1 in 4.5years to 1 in 5.5 years).

5.2.2 Rarity of flow river flooding events

All surface water gauges were plotted to find a local flooding event but could not be compared. However, there are two peak flow rated gauges in the catchment, namely, Beam at Bretons Farm (Station No. 37019) and Ingrebourne at Gaynes Park (Station No. 37018). These gauges provide the information on annual maximum (AMAX) flow data up to the water year 2021 which does not cover the 25th of June 2021 event.

The NRFA website shows the QMED values as 8.48 m^3/s and 6.93m^3/s at the Bretons Farm and Gaynes Park gauges respectively.

The NRFA website also shows live flow data (daily flow) which indicates the peak daily flow values as 5.08m^3/s and 2.9m^3/s at Bretons Farm and Gaynes Park gauges respectively on 25th June 2021 (refer to Figures 4 and 5).

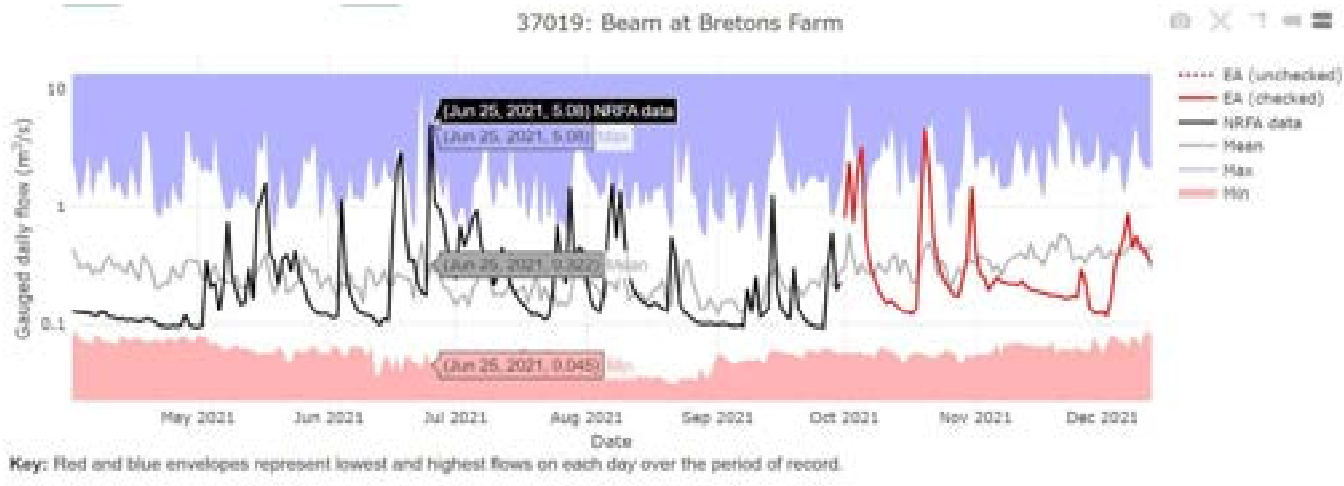

Figure 4-Live Data for the 25th of June 2021, at Beam at Bretons Farm

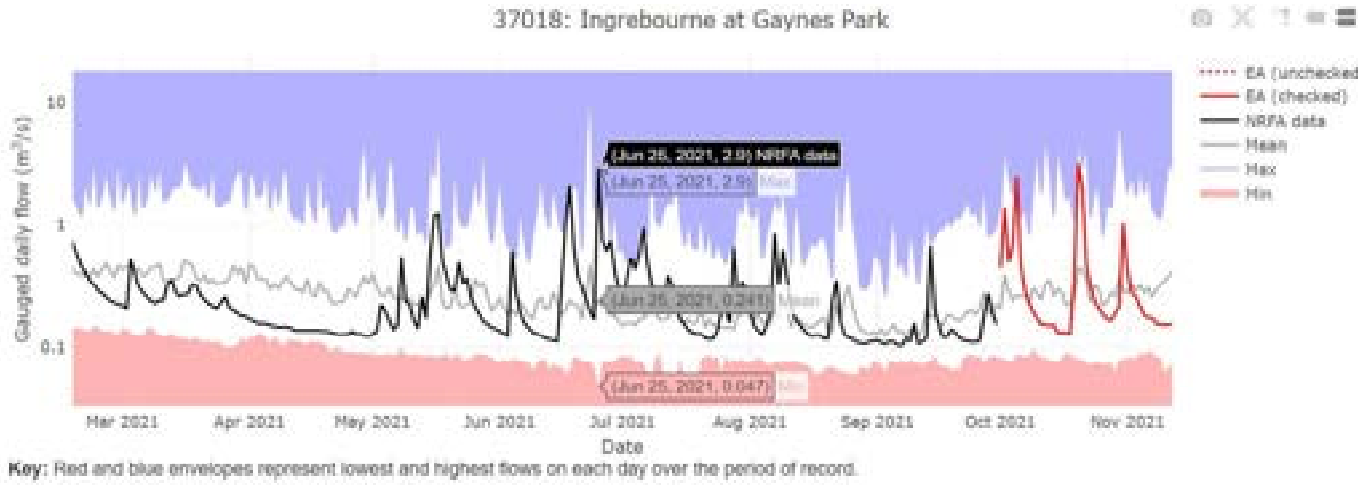

Figure 5- Live Data for the 25th of June 2021, at Ingrebourne at Gaynes Park

The NRFA website shows the ratings for both peak flow gauges, the Gaynes Park gauge having one single rating with four limbs whereas Bretons Farm gauge also has one single rating with three limbs. Using these ratings the maximum stages of 25th June 2021 were converted into the peak flow values as 17.15m^3/s and 13.07m^3/s at Bretons Farm and Gaynes Park gauges respectively.

Single site flood frequency analyses were undertaken in WinFAP5 using the available AMAX data to estimate the rarity of the peak flow at the two gauges. The results of the analysis are presented in the last column of Table 5.

Table 5- Rarity analysis of the river flow data of 25th June 2021 at the two gauges

River Gauge	QMED Flow	NRFA Live Data daily flow (m^3/s)	Maximum stage (m)	Flow from NRFA rating (m^3/s)	Approximate return period (1 in T yrs)*

	(m^{10}/s)				
Bretons Farm (peak flow raged gauging station no. 37019)	8.48	5.08	1.14	17.15	18.9*
Gaynes Park (peak flow rated gauging station no. 37018)	6.93	2.90	1.00	13.07	5.1*

**Calculated directly from WinFAP5 using GLO / L-moment method*

Table 5 shows that the peak flows are much higher (almost 1.8 to 3.7 times) than the daily flow shown by the NRFA Live data. The WinFAP5 single site analysis indicates the rarity of the 25th June 2021 event as 1 in 5.1 years at Gaynes park gauge and 1 in 18.9 years at the Bretons Farm gauge. As there are more than 50yrs of AMAX data at both gauges, the rarity of the event from single site analysis are considered to be reliable. The rarity of the flood event at Gaynes Park (approximately 1 in 5 years) also matches with that from rainfall data rarity analysis at the two rainfall gauges.

1.6 Discussion

Both the Havering Bower and Nags Head Lane gauges show recorded rainfall after 18:00 on the 25th of June 2021. At the Havering Bower gauge, this was recorded between 18:15 and 26:30, totalling three hours and fifteen minutes, with a peak rainfall depth of 10.06mm and a total rainfall depth of 26.29mm. At the Nags Head Lane gauge this was recorded between 18:00 and 20:15, totalling two hours and fifteen minutes, with a peak rainfall depth of 8.87mm and a total rainfall depth of 20.21mm.

At the Havering Bower gauge, the highest return period rainfall event occurs at 1 hour and 30 minute, where the total rainfall depth is 24.1mm, and the return period is 1 in 5.49years.

At the Nags Head Lane gauge, the highest return period rainfall event occurs at both the 45 minute and 1 hour storm durations, where the total rainfall depths are 17.97 and19.44mm and respectively, and the return period is 1 in 4.49 years.

Therefore, it is assumed that the above rainfall totals are from the same singular storm event. This is expected as the gauges are in proximity since the distance between the gauges is less than 7km. It can also be assumed that the January 25th rainfall event was approximately 1 in the 5-year return period range, or an annual exceedance probability of 20%.

According to the Hydrological Summary for the United Kingdom for June 2021[3], "June was generally a settled month with summery conditions but was punctuated by occasional thunderstorms and heavy rainfall, particularly in the south-east of England." The summary also mentions transport disruption in and around London between the 25th and 29th due to heavy rainfall. The monthly rainfall recorded for the Thames region was 72mm which was 142% above

[10] NRFA, 2021. Accessed at: https://nrfa.ceh.ac.uk/sites/default/files/HS_202106.pdf

the long-term average. The monthly rainfall map for June 2021 shows rainfall at Havering to be between 150 to 170% rainfall as % of the 1981-2010 average.

It is noted that during a 3-hour period on the 25th of June, 26.29mm of rainfall was recorded at the Havering Bower gauge, which is just over a third of what the Thames region recorded for the whole month of June in 2021, which was 72mm.

The flood frequency analysis of the Gaynes Park AMAX data shows the rarity of the 25th of June 2021 as approximately 1 in 5 years, which is line with the rarity of the rainfall event at the two rainfall gauges. However, the rarity of the same event at Bretons Farm gauge is much larger (approximately 1 in 19 years). Although both gauges have neighbouring catchments, the reason for the different return periods for the same event could be due to the variability of rainfall in the two catchments or quality of the flow data or a combination of both, further investigation of which is beyond the scope of this study.

1.7 Limitations and Assumption

An assumption is made that the data from the gauges that were used was presumed to be accurate.

1.8 Conclusion

From the analysis above, it seems likely that the flood event in Havering on the 25th of June 2021 was caused by a short rainfall storm event on the same day and the rarity of the event is not less than 1 in 5 years (20%), as suggested by the rarity of rainfall data at two rainfall gauges and flow data at one peak flow rated gauge. However, the flow data at Bretons Farm gauge suggests a slightly higher rarity (up to 1 in 19 year), which could have been caused by variability in the rainfall data or quality of flow data or combination of both. Further investigation of the reasons of this disparity is beyond the scope of this study.