AECOM

# London Borough of Camden Section 19 Flood Investigation Report

Flood Incidents on the 12th and 25th July 2021

Project number: 60672596

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## Quality information

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## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
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# Table of Contents

# Figures



# Tables

# Non-Technical Executive Summary

**Introduction**

As the Lead Local Flood Authority, the London Borough of Camden Council has a responsibility to record and investigate flood incidents, in accordance with Section 19 of the Flood and Water Management Act (2010).

Section 19 of the Flood and Water Management Act states:

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

This Section 19 Flood Investigation has been prepared for the flood events of the 12$^{th}$ July 2021 and the 25th July 2021.

**Flood Investigation**

Consultation has been undertaken with the relevant local authorities, agencies and local residents to determine the causes of the 12$^{th}$ and 25$^{th}$ July 2021 flooding. As part of the data collection exercise, site visits of each area were undertaken to assess potential flood mechanisms and to obtain information from residents and stakeholders affected by the flood events. This has informed the understanding of flood mechanisms for the 12$^{th}$ and 25$^{th}$ July 2021 flood event and is supported by anecdotal evidence from online sources.

**Weather Conditions**

Extreme and highly localised rainfall fell across the Camden Borough on the 12$^{th}$ and 25$^{th}$ July 2021. The extreme rainfall was preceded by the fifth wettest three-month period on record since 1891. The prolonged wet weather resulted in saturated ground that reduced the ability of the soils to absorb further rainfall, worsening the impact of the flooding from surface water and sewers.

**Flooding Impacts**

The impact on property was greater on the 12$^{th}$ July 2021, as shown by the total number of properties affected and reports of internal flooding. Reported incidents received by the London Borough of Camden and Thames Water indicate 103 properties flooded on the 12$^{th}$ July, of which 32 properties experienced internal flooding. Only 3 properties are reported to have flooded on the 25$^{th}$ July 2021 and there are no reports of internal flooding.

The impact of the flood events on 12$^{th}$ and 25$^{th}$ July varied according to the area studied. For the majority of sites investigated as part of this report, the total number of reported incidents were ≤12 properties per event. For two of the five sites studied, the total reported incidents >25 properties (12$^{th}$ July); the impact was concentrated to areas of low elevation within the site. A small number of commercial properties were impacted on the 12$^{th}$ July, including: restaurants, retail stores, a Community Centre and Transport for London Underground Stations. This caused a high level of disruption to residents and commuters.

The impact is a result of surface water sources and surcharge of drainage assets. The mechanisms are interlinked, resulting in a larger and more widespread impact. The volume and rate of surface water conveyed via roads and footpaths increases the likelihood of exceeded drainage capacity, preventing surface water from being subsumed into the sewer network, and surcharge of drainage assets contributes to flows and the risk of ponding.

**Risk Management Authority Response**

All of the Risk Management Authorities (RMA) and Emergency Services within the Camden Borough played a part in the incident response to the 12th and 25th July 2021 flood event. All agencies and authorities were proactive in their response to the incident, however the following issues are considered to have impacted the effectiveness of the response:

- There was limited (if any) warning before the flooding occurred;
- When flooding did occur, it was widespread and happened very rapidly. There was little lead time to develop an effective response; and
- The RMA and emergency response during the events was impacted by the gradual exchange of information and availability of resources.

**Lessons Learnt**

The review of the flood incident response and impacts of flooding have been used to identify potential areas for improvement, including the following:

- Communications and Contingency Planning;
- Improving Community Resilience to Repeat Events; and
- Understanding of Integrated Flooding Mechanisms.

Further assessment of the incident response and lessons learnt are outlined in **Section 5** of this report.

**Action Plan**

Following this Section 19 Flood Investigation, several actions have been identified to assist with ongoing flood risk management within the Camden Borough. Many of the actions should be undertaken by the London Borough of Camden Council and Thames Water. The recommended next steps are outlined within **Section 9** of this report.

Recommendations centre upon improved communication within the London Borough of Camden and with other stakeholder groups, such as Thames Water and local residents. Sharing of information is considered key to improving the emergency response and development of flood mitigation strategies, in addition to increasing resilience of the local community. Sustainable Urban Drainage Systems and revision of the gully clearance regime is also recommended.

The majority of actions recommended as part of this report are non-statutory. Although there are benefits to their introduction, there are no legal requirements to implement the actions. There is one statutory action, which states the findings of the report must be published and made available to the public. This is detailed in **Section 9.1**.

# 1. Introduction

## 1.1 Background

Section 19 of the Flood and Water Management Act (FWMA) published in 2010[1] places a duty on Lead Local Flood Authorities (LLFA), such as the London Borough of Camden (LBC), to investigate flood incidents from surface water, groundwater and ordinary watercourses, where it is considered 'necessary and appropriate'.

The FWMA (Section 3(19)) describes the role of Local Authority Investigations, noting:

1. On becoming aware of a flood in its area, a LLFA must, to the extent that it considers it necessary or appropriate, investigate—
    a) which Risk Management Authorities (RMAs) have relevant flood risk management functions, and
    b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
2. Where an authority carries out an investigation under subsection (1) it must—
    a) publish the results of its investigation, and
    b) notify any relevant RMAs.

The FWMA (Section 6 (13)) states RMAs within England to be:

a) the Environment Agency (EA);
b) a LLFA (such as LBC);
c) a district council for an area for which there is no unitary authority;
d) an internal drainage board;
e) a water company (such as Thames Water (TW)); and
f) a highway authority (such as Transport for London (TfL) and LBC).

## 1.2 Criteria for Investigation Flooding Incidents

As the LLFA, LBC has a statutory duty to investigate flooding under Section 19 of the FWMA in instances where a flood event is deemed 'significant'. The LBC Flood Risk Management Strategy (FRMS)[2] states an event is significant if it meets the following criteria:

- The incident resulted in internal flooding of a property; and
- There is ambiguity surrounding the source or responsibility of the flood.

Investigations include consultation with relevant stakeholders, private organisations and residents, to produce a report of the flood events. The report collates all useful information together, to provide a description of the possible cause. It also highlights the potential long-term solutions and suggests recommendations for flood risk management action. The reports are published on the LBC website once finalised. Following the above set of criteria, it was deemed necessary to complete a Flood Investigation due to the large numbers of flood incidents reported across the Camden Borough on 12th and 25th July 2021. The incidents reported sewer and surface water flooding, which affected local highways and properties in several areas of the Borough.

[1] GOV.UK, Flood and Water Management Act 2010. Available: https://www.legislation.gov.uk/ukpga/2010/29/contents [Accessed: 01/02/22]
[2] LBC, Flood Risk Management Strategy 2013. Available: https://www.camden.gov.uk/documents/20142/1458280/Camden_Flood_Risk_Management_Strategy.pdf/9e739029-02e5-59c7-e9a4-64d3622f2475 [Accessed: 01/02/22]

## 1.3 Risk Management Authority Duties and Responsibilities

The legal framework for management of flood risk and events lies with several agencies; the key responsibilities of each agency are outlined in the section below. The LBC FRMS document identifies LBC, the EA, TW and TfL as the RMAs for the area.

### 1.3.1 LBC (LLFA)

As the LLFA, LBC have a strategic role in the management of flood risk from surface water, groundwater and Ordinary Watercourses. LBC are tasked with investigating flood incidents from these sources, where it is considered necessary and appropriate.

The FWMA states the LLFA have powers to designate structures and features that affect flooding, to safeguard assets that are relied upon for the flood risk management. Once designated, the owner must seek consent from the authority to alter, remove or replace the asset or feature (FWMA Schedule 1)[3].

LBC are also the Highway Authority for the Camden Borough, with a duty to maintain adopted highways within the administrative region under Section 41 of the Highways Act 1980[4]. This includes maintenance of road drainage networks, such as gullies.

LBC are a Category 1 Responder under the Civil Contingencies Act 2004[5], therefore have a duty to develop emergency plans and assess local risks, to improve the emergency response. Information relating to civil protection matters must be made available to warn and advise the public in the event of an emergency.

### 1.3.2 Environment Agency

The EA hold a strategic role and responsibility to investigate flooding from Main Rivers and the sea. Under Section 165 of the Water Resources Act (1991), the EA have permissive powers to conduct emergency or maintenance work on Main Rivers[6].

It is important to note that flood risk from Ordinary Watercourses and surface water is not under the jurisdiction of the EA and instead, is the statutory responsibility of the LLFA. There are no Main Rivers within the LBC administrative boundary, therefore the EA are not responsible for the investigation of the July 2021 flood events within the Borough.

### 1.3.3 Thames Water

TW is responsible for the supply and drainage of water in the Camden Borough, including their respective surface water, foul and/or combined sewer systems. Under the Water Industry Act (1991)[7], TW must maintain and operate systems of public sewers, undertake capacity improvements to mitigate flood risk from sewer sources and must respond to flood incidents which involve their assets.

It is important to note TW does not have responsibility for highway or land drainage, until it reaches the sewer network, and does not have statutory responsibility for drainage within the property boundary and serving one property.

Sewerage systems are not designed to accommodate flows resulting from exceptionally severe weather events. Modern sewers developed by TW are typically designed to attenuate a 1 in 30 year storm event, plus allowance for climate change to comply with British Standards[8]. Larger, more intense storms would therefore be expected to result in surcharge of the sewer network.

[3] GOV.UK, Flood and Water Management Act 2010 Schedule 1. Available https://www.legislation.gov.uk/ukpga/2010/29/schedule/1 [Accessed: 01/02/22]
[4] GOV.UK, Highways Act 1980. Available: https://www.legislation.gov.uk/ukpga/1980/66/section/41 [Accessed: 01/02/22]
[5] GOV.UK, Civil Contingencies Act 2004. Available: http://www.legislation.gov.uk/ukpga/2004/36/pdfs/ukpga_20040036_en.pdf [Accessed: 01/02/22]
[6] GOV.UK, Water Resources 1991 Section 165. Available: https://www.legislation.gov.uk/ukpga/1991/57/section/165 [Accessed: 01/02/22]
[7] GOV.UK, Water Industry Act 1991. Available: https://www.legislation.gov.uk/ukpga/1991/56/contents [Accessed: 01/02/22]
[8] Thames Water, Funding Application Guidance. Available: https://www.thameswater.co.uk/media-library/home/about-us/responsibility/surface-water-management-programme/swmp-funding-application-guidance.pdf [Accessed: 01/02/22]

## 1.4 Other Stakeholder Duties and Responsibilities

### 1.4.1 City of London Corporation

The City of London Corporation (CLC) is responsible for managing Hampstead Heath and the ponds found within this area. This includes two chains of earth banked reservoirs and ponds, named the Hampstead ponds and Highgate ponds.

Both chains are managed in accordance with the Reservoirs Act (1975)[9] and have undergone construction works as part of the Ponds Project; the purpose of the project is to reduce the possibility of a dam breach, erosion and the potential failure of the structures[10]. Spillways have been incorporated into the design, to allow for the safe transfer of exceedance flows to areas that are purposely reinforced for these conditions.

The Ponds Project is not intended as a scheme to prevent surface water flooding. However, considerations were made for the potential benefit to surface water flood mitigation.

### 1.4.2 Transport for London

TfL are an integrated transport authority responsible for the daily operation of London's transport network, including roads and public transport routes.

TfL have a dedicated research function, to identify improvements which may help to reduce the impact of severe weather events on operations and asset condition. The TfL Sustainability Report indicates that considerations are being made for increases in severe weather events, including the impact of floods and subsequent damage to assets[11].

### 1.4.3 London Fire Brigade

The London Fire Brigade (LFB) are a Category 1 Responder under the Civil Contingencies Act 2004, therefore have a duty to develop emergency plans and assess local risks to inform emergency planning.

### 1.4.4 Local Residents

Residents who are aware they are at risk of flooding should take action to ensure they and their properties are protected. Residents should report flooding incidents or potential problems (such as blocked drains) to the LLFA or appropriate organisation, if known.

### 1.4.5 Flood Action Groups

The South Hampstead Flood Action Group (FAG) is a voluntary group of residents, who work on behalf of the local community to reduce the impact of flooding within the South Hampstead area.

The South Hampstead FAG promote awareness of flood risk within the local community and can contribute to the overall understanding of an event. Through anecdotal evidence and continued observation of the local area over an extended period of time, the group can provide detail of potential flood mechanisms.

The South Hampstead FAG proactively participate in discussions relating to local flood risk issues and through this, aide the development of potential mitigation measures.

[9] GOV.UK, Reservoirs Act 1975. Available: https://www.legislation.gov.uk/ukpga/1975/23 [Accessed: 01/02/22]
[10] City of London, Detailed Design Hampstead Heath Ponds Project. Available: http://democracy.cityoflondon.gov.uk/documents/s35824/Gateway%204c%20Detailed%20Design%20Hampstead%20Heath%20Ponds%20Project.pdf [Accessed: 01/02/22]
[11] Transport for London, Sustainability Report 2021. Available: https://content.tfl.gov.uk/tfl-sustainability-report-29-september-2021-acc.pdf [Accessed: 01/02/22]

## 1.5 Site Description

The Camden Borough is located within Greater London, north of the River Thames Main River. It is divided into 18 wards, which comprises of approximately 22km$^2$ of land; the location and names of each ward is presented in **Figure 1-1**. The Camden Borough is densely populated and has an estimated population of 279,500 in mid-2020. It is considered to have the second highest number of businesses in London and third highest number of businesses within the UK[12].

There are several commercial centres within the Camden Borough, consisting of small and large commercial properties. Residential properties form around the commercial centres and are connected through an extensive highway network and public footpaths. The main roads include the A5, A41, A502, B518 and A400. Although areas of greenspace are limited due to urban development, Hampstead Heath provides approximately 3.2km$^2$ of public greenspace and woodland, to the north east of the Camden Borough. It is the largest area of greenspace within the Camden Borough.

There are no Main Rivers present as an open channel within the LBC administrative area. However, the River Fleet is present as a subterranean river beneath urban areas within the Borough. The River Fleet has its headwaters at two streams on Hampstead Heath and is subsequently conveyed beneath ground, in a southerly direction, to discharge into the River Thames[13]. The River Fleet has historically drained the Camden Borough area and is incorporated into the sewer network.

At its headwaters, the River Fleet has been dammed to create the Hampstead pond chain and Highgate pond chain; this is presented in **Figure 1-2**. The Hampstead pond and Highgate pond chain discharge to the TW sewer network via an outfall located at the downstream pond, named Hampstead Number 1 Pond and Highgate Number 1 Pond, respectively. Discharge into the sewer network is restricted by the capacity of the outfall pipe from the two pond chains[14].

### 1.5.1 Critical Drainage Areas and Watershed

For the purposes of this Flood Investigation the Camden Borough has been divided into sub-regions, to focus the investigation and account for any differences that may arise between each area. The sub-regions have been split into the four Critical Drainage Areas (CDAs) and one separate catchment.

CDAs referenced within this Section 19 Report were originally defined within the LBC Surface Water Management Plan (SWMP)[13]. The CDAs represent a discrete geographic area where multiple sources of flood risk are interlinked, such as surface water, sewer and groundwater sources. The flood sources interact with one another, to impact flood risk within one or more Local Flood Risk Zones (LFRZs).

The separate catchment has been named as the Heath Watershed by LBC. At the time of writing, the area was not defined as a CDA. The names of the CDA and catchment are listed in **Table 1-1** (overleaf) and presented in **Figure 1-3**.

[12] LBC, Camden Profile 2022. Available: https://opendata.camden.gov.uk/download/9m7e-5qyt/application/pdf [Accessed: 02/02/22]
[13] LBC, Surface Water Management Plan for LBC 2011. Available: https://www.camden.gov.uk/documents/20142/1458280/SWMP_Halcrow_Report_for_Camden.pdf/2a8fbf03-cbd7-e808-3bb4-e75b62756b0a [Accessed: 02/02/22]
[14] URS, LBC SFRA 2014. Available: https://geosmartinfo.co.uk/wp-content/uploads/2020/03/London-Borough-of-Camden-Strategic-Flood-Risk-Assessment.pdf [Accessed: 02/02/22]

**Table 1-1: CDA and Watershed Location**

| Name | Type | Location within the Camden Borough |
|---|---|---|
| Dartmouth Park | CDA | North East |
| Heath Watershed | Watershed | North Central |
| Maitland Park Kentish Town | CDA | Central |
| Belsize Park Swiss Cottage | CDA | Central West |
| Hampstead Kingsgate | CDA | West |

### 1.5.2 Flooding Hotspots

Through assessment of properties and highways affected by the flood event of the 12$^{th}$ and 25$^{th}$ July 2021, six flooding 'hotspots' were identified by the LBC and have been taken forward for the purposes of this Section 19 Flood Investigation; they are highlighted in **Figure 1-4**.

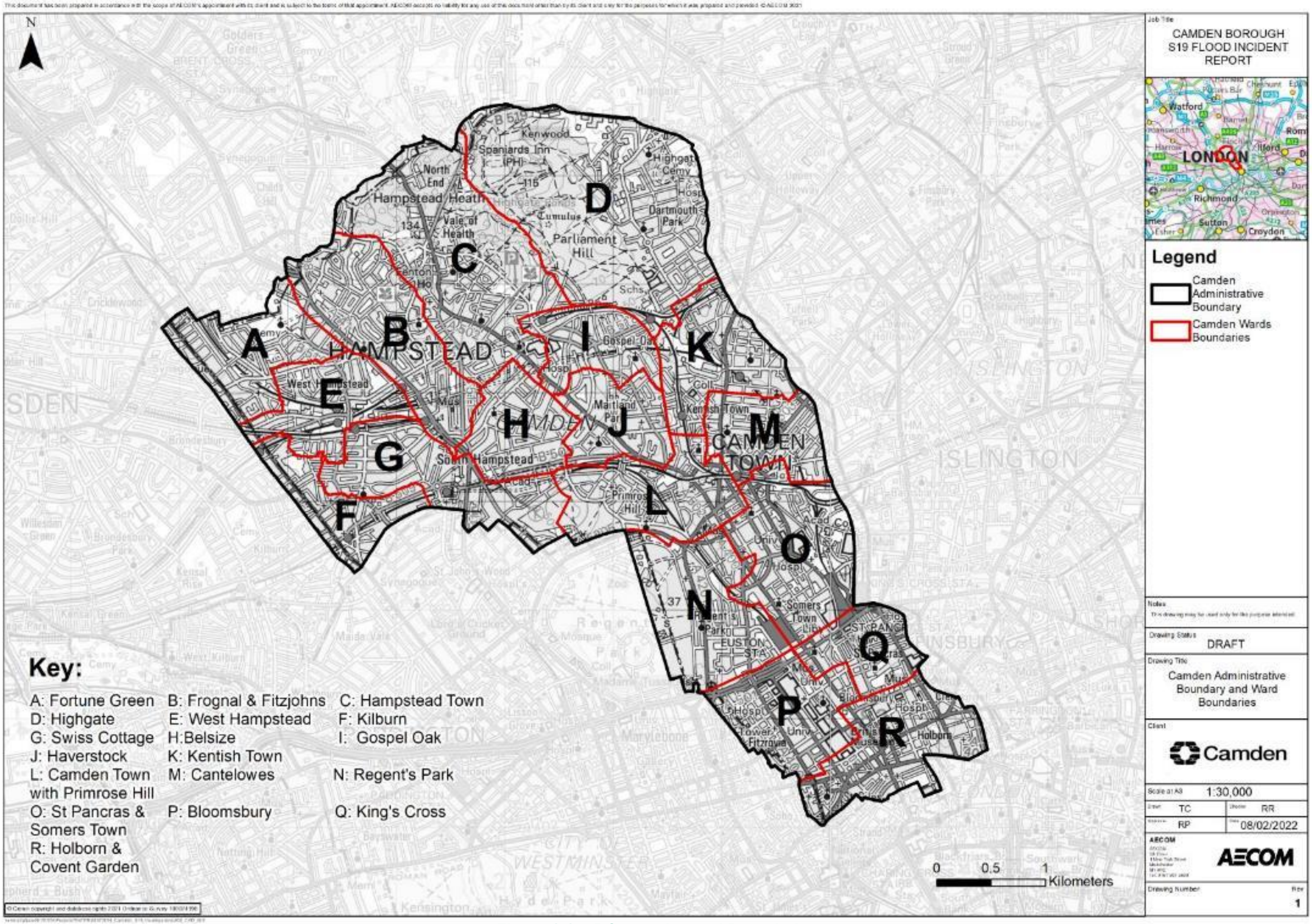

Figure 1-1: LBC Location and Boundaries

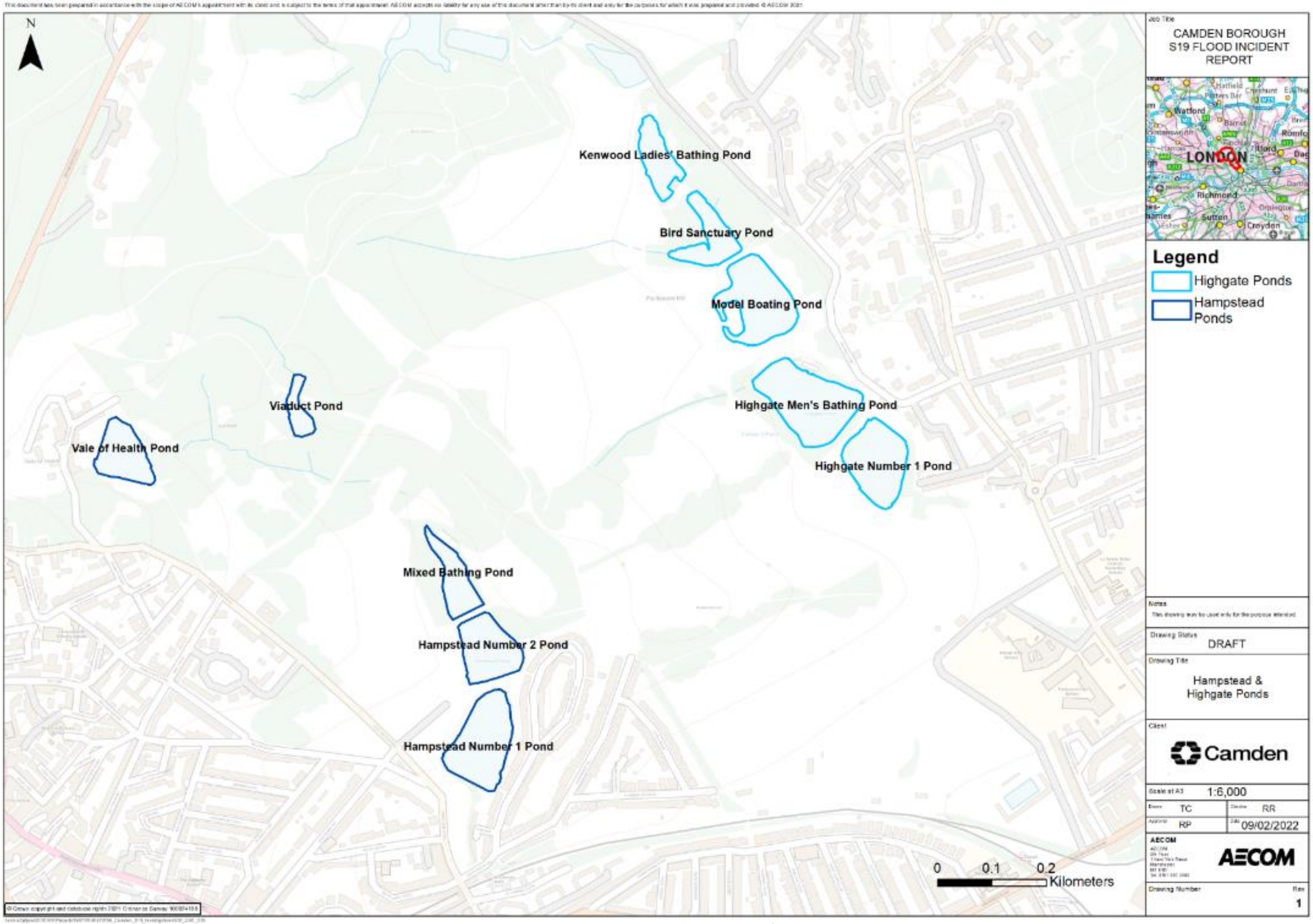


**Figure 1-2: Hampstead Heath Pond Chains**

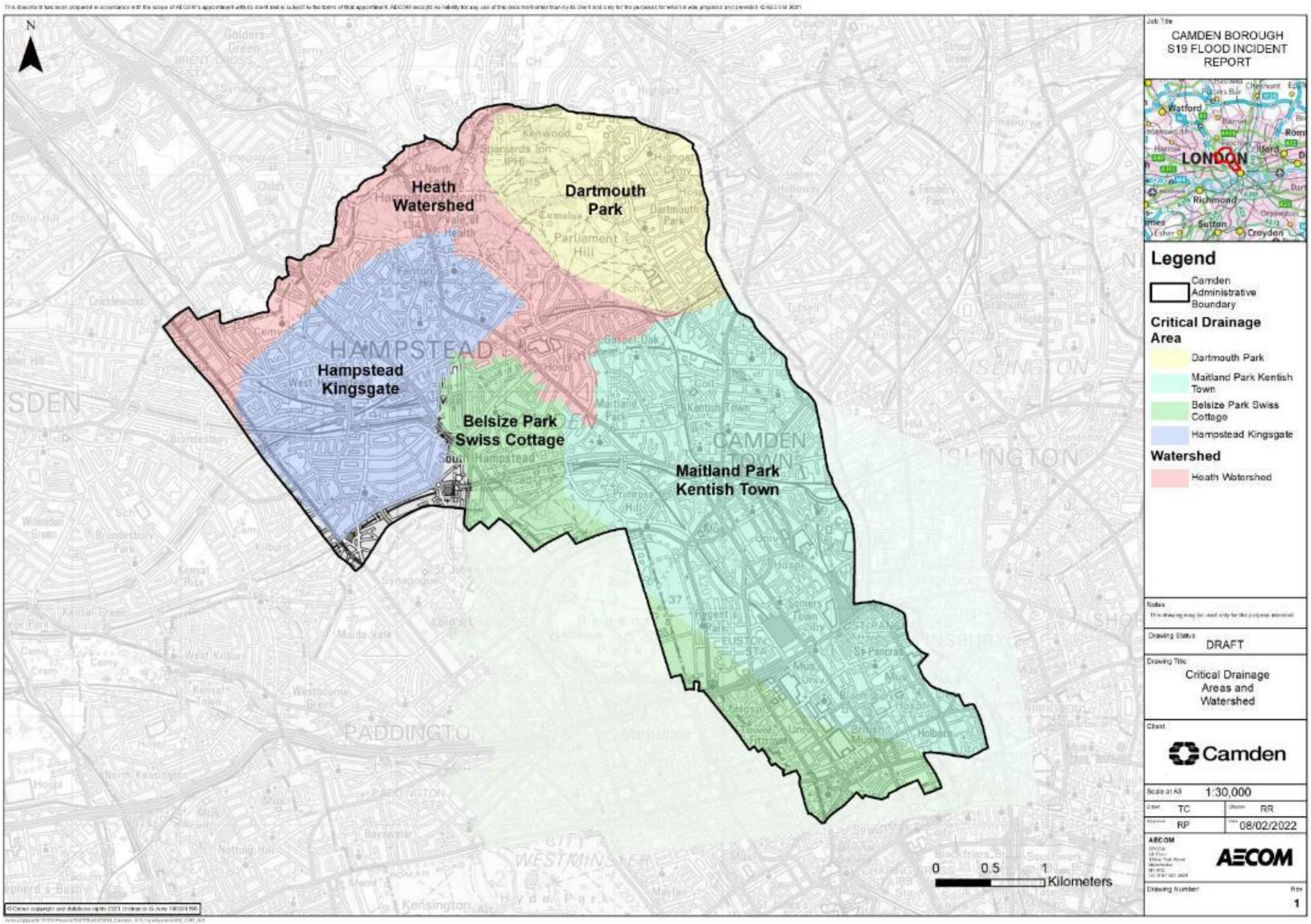


**Figure 1-3: Critical Drainage Areas and Watershed**

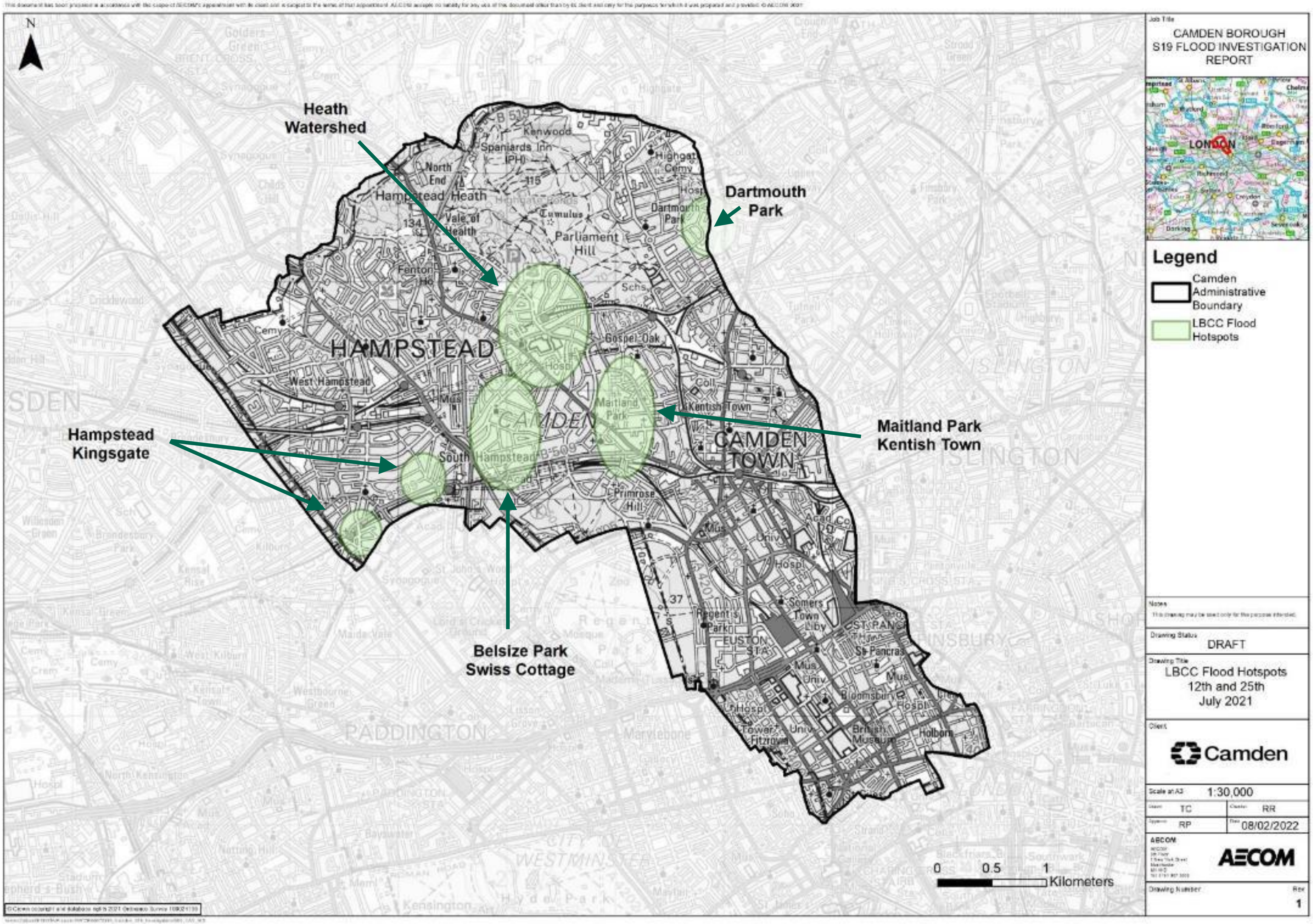


Figure 1-4: LBC Flood Event Hotspots

# 2. Data Collection

## 2.1 Consultation

Investigation of the flooding within the Camden Borough on 12th July 2021 to 25th July 2021 has been undertaken in consultation with key stakeholders and RMAs. LBC held a Flood Response Plan (FRP) meeting with TW on the 22nd July 2021 and on the 4th November 2021, to discuss the July 2021 flood events.

A workshop was hosted by TW on the 28th August 2021 to set out the independent review, which will establish what happened during the event, how the assets performed and to identify key recommendations for managing assets. The workshop also outlined the findings of the rapid internal review conducted by TW, which assessed the incident response and customer communications during the flood events.

Following the appointment, AECOM commenced the production of the Section 19 Flood Investigation Report. This began with the collection of data from RMAs, Emergency Responders and other stakeholders who were involved by the flood events of the 12th and 25th July 2021.

Consultation with the following parties has been undertaken to support the development of the report:

- London Borough of Camden
- Thames Water
- Environment Agency
- City of London Corporation
- Transport for London
- London Fire Brigade

Through the consultation process, the parties listed above have provided information on historic flooding and have clarified the operational response during the events.

Site visits were undertaken on the 27th and 28th January 2022 as part of the consultation process, to establish flooding mechanisms for the worst affected areas. Information was also gathered directly from residents and members of the South Hampstead FAG, who were invited to the site visit.

## 2.2 Data Review

The data collected as part of the consultation process was used to identify which areas of the Camden Borough experienced flooding on 12th July 2021 and 25th July 2021. The LBC identified six hotspots to be investigated for the purposes of this report. All data has been reviewed against the hotspots identified, to focus the report and ensure all relevant information is captured.

During the consultation process, various forms of flooding records and data were provided by the consultees listed above. **Table 2-1** provides an overview of the data provided to AECOM for use in this Section 19 Flood Investigation.

**Table 2-1: Data Register**

| Consultee | Data Item |
|---|---|
| LBC Council | • Record of flood incidents for 12th and 25th July 2021<br>• Record of hotspots identified across the Camden Borough<br>• Multi Agency Flood Plan March 2019 and September 2021<br>• Post Incident Debrief Report for 12th July 2021<br>• Emergency Response and Recovery Plan<br>• Record of street cleansing (from Veolia)<br>• Flood Asset Register<br>• Evidence of drainage response<br>• Residential and commercial property insurance claim data<br>• Photographs and video evidence<br>• Anecdotal evidence from LBC staff members and stakeholder communications<br>• Anecdotal evidence of local residents |
| Thames Water | • Model of the sewer network for the Camden Borough<br>• Record of flood incident events for 12th and 25th July 2021<br>• Record of historic flood events within the Camden Borough<br>• Details of the maintenance regime and key outfalls |
| Environment Agency | • National Receptor Database<br>• Rainfall gauge data (15 minute interval data) for June – August 2021 |
| City of London Corporation | • Detail of the operational condition for the Hampstead and Highgate pond chain<br>• Photographs<br>• Anecdotal evidence |
| Transport for London | • Pan-TfL Flooding Review (July 2021) |
| London Fire Brigade | • Record of flood incident calls for 12th and 25th July 2021<br>• Summary of call out type for 12th and 25th July 2021 |
| South Hampstead Flood Action Group | • Photographs and video evidence<br>• Anecdotal evidence |

## 2.3 Key Statistics

The flood incident data provided by LBC and TW can be summarised in terms of date (12th, 25th and unconfirmed) and type (internal property flooding, external flooding or unconfirmed). A breakdown of these key statistics is presented in **Table 2-2**. It should be noted that due to the variety of sources considered and the quality of data, it has not been possible in all instances to verify the date or type of flooding record. The totals presented in **Table 2-2** represent properties within the hotspots only.

**Table 2-2: Reports of Flooded Properties**

| Source | Type | 12th July 2021 | 25th July 2021 | Unknown Date |
|---|---|---|---|---|
| LBC Records | Internal & External Flooding | 32 | 0 | 0 |
| | External Flooding Only | 32 | 1 | 4 |
| TW Records | Flooding Reported | 39 | 2 | 0 |
| **Total Reports of Property Flooding** | | **103** | **3** | **4** |

# 3. Meteorological Conditions

## 3.1 Overview

On 12th July 2021, localities in the north, west and centre of the Camden Borough experienced severe rainfall, surface water and sewer flooding. This caused disruption to streets, lasting damage to 100+ properties, and several emergency re-accommodations in the Camden Borough[15].

Independent estimates by TW[15] of the rainfall on the 12th July indicate magnitudes exceeding the 1:100 years return event in parts of Camden, or 1:1,000 years including tidal locking effects which reached as far north of the Thames at Belsize Park. On 25th July, a smaller area experienced severe rainfall and flooding of lower magnitudes, up to the 1:30 year return event. It should be noted that it is unclear from the reporting provided what data and methods have been used to determine these TW estimates, therefore in context of this report they should be treated with caution.

## 3.2 Antecedent Conditions

According to the EA Monthly Water Situation Report[16] the three-month cumulative rainfall totals ending in July were classed as exceptionally high across south east England; as presented in **Figure 3-1.** The rainfall totals for south east England represent the fifth wettest three-month combined May-June-July rainfall totals on record (records since 1891).

At the end of July soil moisture deficit (SMD) values were less than the Long Term Average (LTA) for the period 1961-1990 for the time of year across South east England (soils were wetter than the LTA). The SMD for mid-July was approximately 40mm, much wetter than the average (by approximately 50mm) for this time of year; as presented in **Figure 3-2**.

[15] LBC, July 2021 Flood investigation and Report: Consultancy Brief and Invitation to Tender (8th Oct, 2021)
[16] EA Water Situation report, England July 2021, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1010038/Water_situation_report_for_England_July_2021.pdf

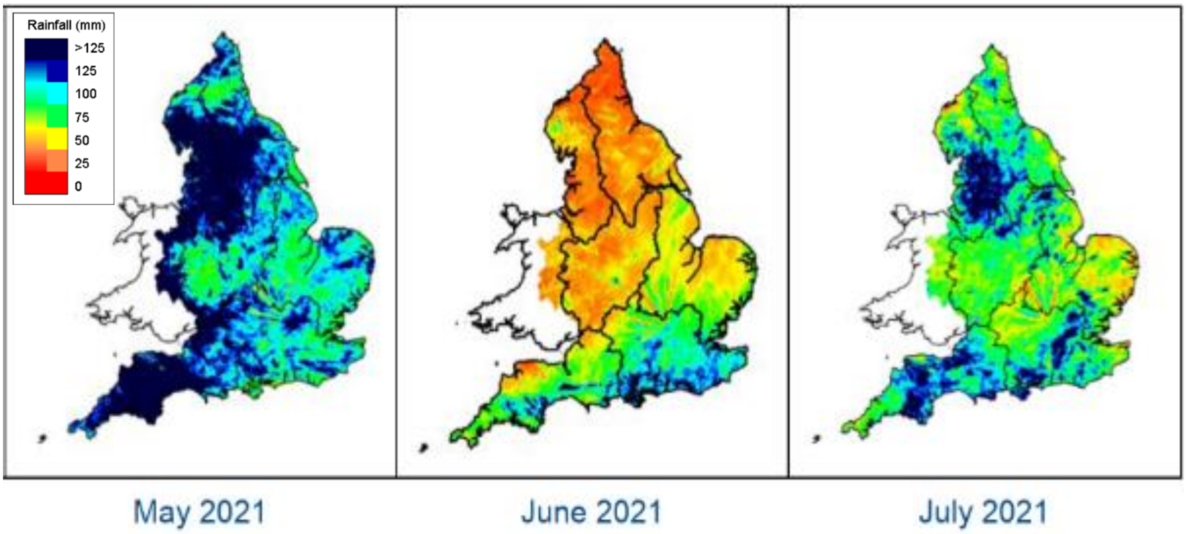


**Figure 3-1: Extract from the EA Monthly Water Situation Report: July 2021**

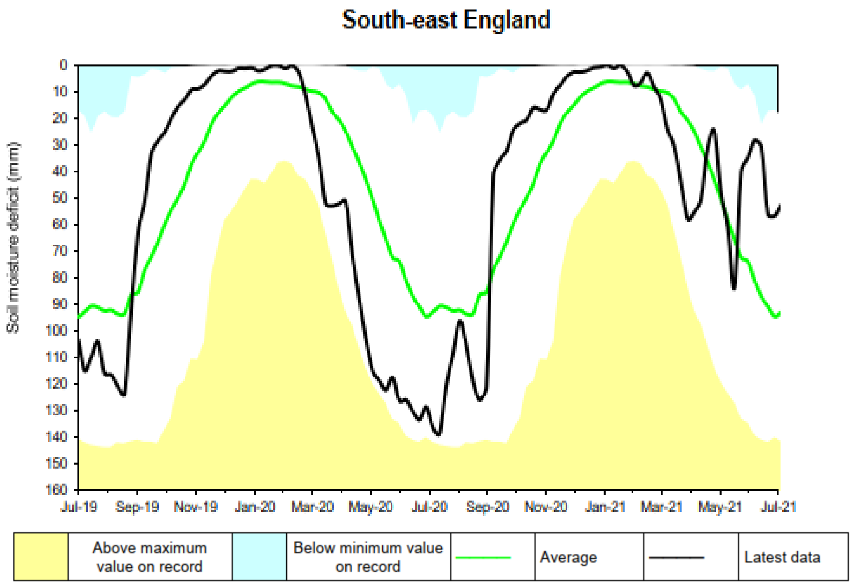


**Figure 3-2: Soil Moisture Deficit for South East England**

*compared to the maximum and minimum, and 1961 to 90 long term average*

The Hertfordshire and North London Area as a whole received 158% of the LTA rainfall for July[17]; as presented in **Figure 3-3**. For the summer period (April-July) the Hertfordshire and North London area received 123% of the LTA rainfall[17].

The North London catchment (where Camden is located) received 167% LTA for July (above normal), which was preceded by 3 months of exceptionally high rainfall (156% LTA).

[17] EA Monthly Water Situation report, Hertfordshire and North London, July 2021, https://webarchive.nationalarchives.gov.uk/ukgwa/20210901235503mp_/https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1010150/Hertfordshire_and_North_London_Water_Situation_Report_July_2021.pdf (accessed January 2022).

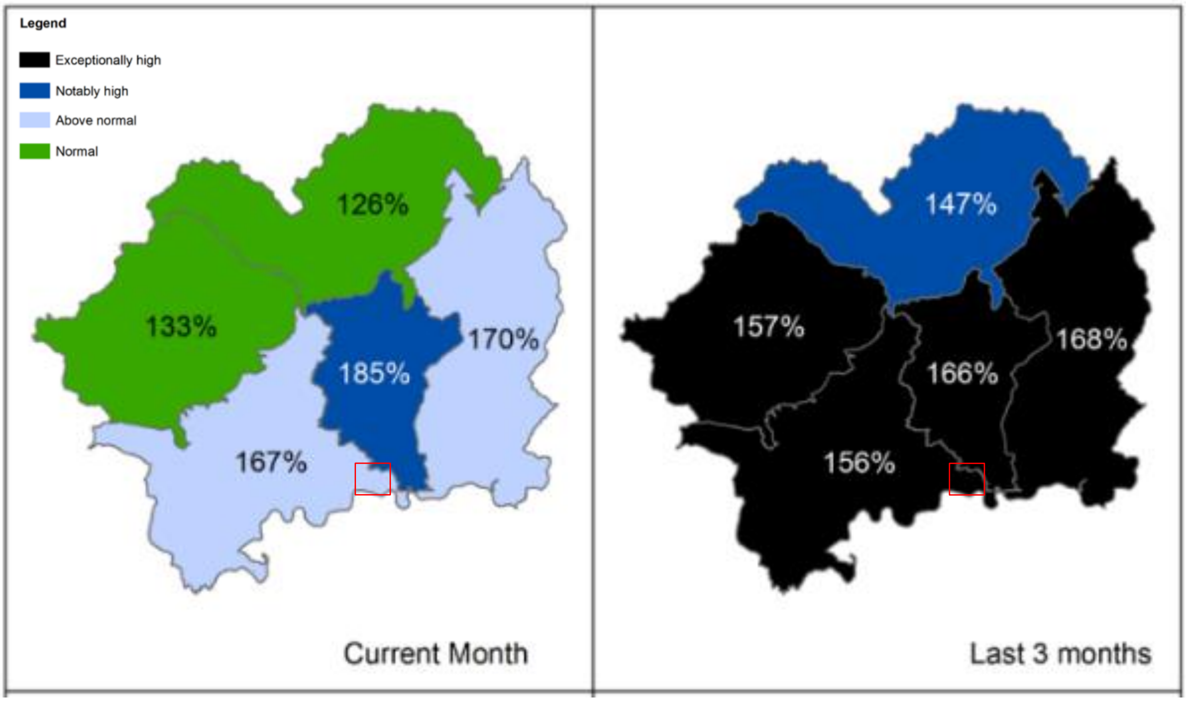


**Figure 3-3: Total Rainfall in July across Hertfordshire and the North London Area**

There is a lack of suitable groundwater data near Camden to enable a direct analysis of the groundwater state during this event. The nearest groundwater level site is Lilley Bottom (recorded as above normal level for the end of July), near Luton which is approximately 40km north of Camden, and has different bedrock geology of Chalk, opposed to the London Clay of Camden.

Geology and soil mapping shows an area of Secondary A aquifer north of Camden, which has a high vulnerability to groundwater flooding. Reports of flooding have been recorded in this area, as shown through the flooded street data, as presented in **Figure 3-4**. Sewer mapping provided by TW confirms the gravity sewer network in this area follows the street layout.

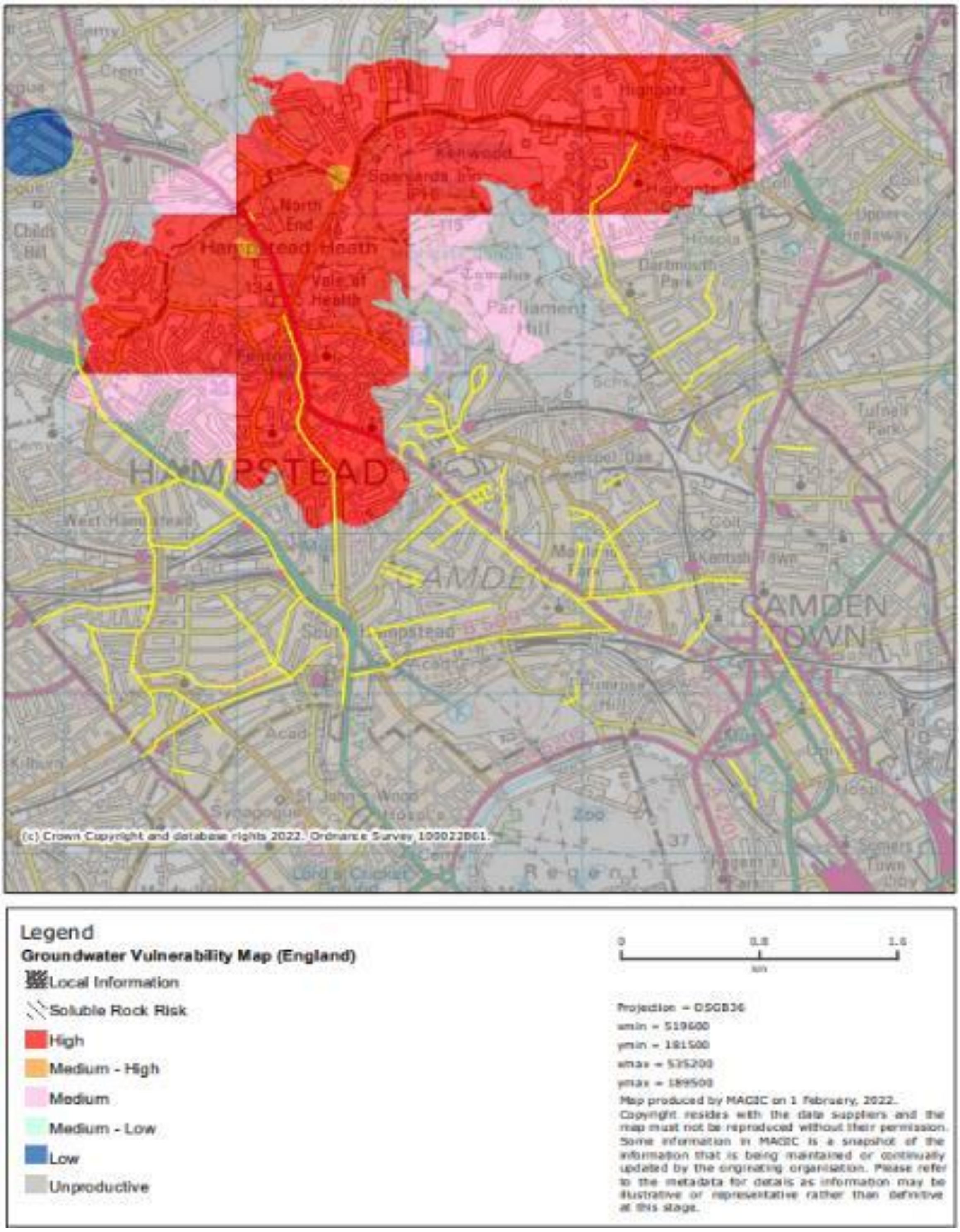


**Figure 3-4: Groundwater Vulnerability Map and Flooded Street Locations**

## 3.3 Recorded Rainfall

The EA water situation report illustrates that July 2021 was a wet month for this area with multiple intense thunderstorms, which led to high daily rainfall totals. Rainfall on both the 12th and 25th of over 60 mm was observed in several locations in North London and the surrounding catchments[17].

## 3.4 Rain Gauge Data

There are five EA tipping bucket rain gauges near Camden, as presented in **Figure 3-5**. The rain gauges are located at:

- Brent Reservoir (15-minute) (National Grid Reference (NGR) 520836, 187013);
- Wanstead (15-minute) (NGR 541544, 188234);
- Hornsey (15-minute) (NGR 530557, 189795);
- Holland Park (15-minute) (NGR 524658, 179586); and
- Deptford (daily) (NGR 53763 177163).

The largest observed daily total (cumulative 15 min rainfall data) of 68.4 mm was recorded at Holland Park on the 12th July, while Wanstead recorded a daily total of 54 mm on the 25th July. The other nearby rain gauges recorded lower totals highlighting the spatial variation of the rainfall experienced during this event. The daily rain gauge at Deptford recorded very little rainfall on the 12th July and a low return period total on the 25th July events and has therefore not been included in the analysis.

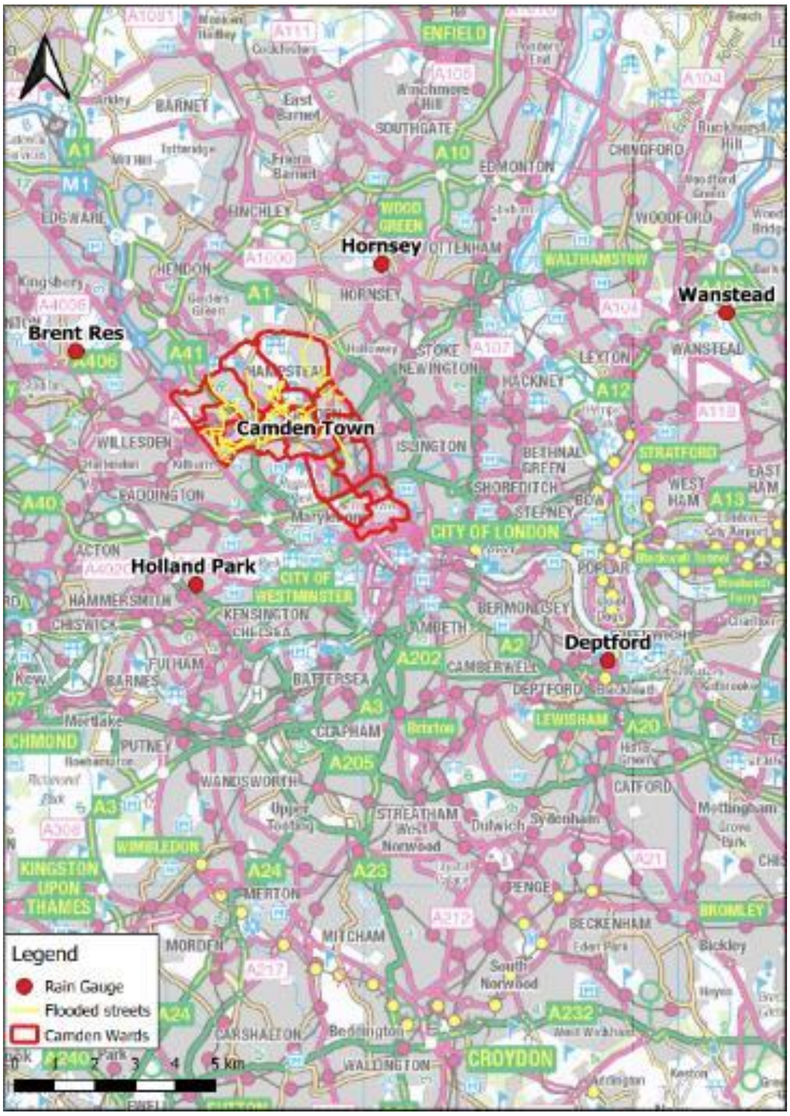


**Figure 3-5: Rain Gauge Location Map**

**Table 3-1: Rain Gauge Data for 12th July 2021**

| Rain Gauge | Total event rainfall (mm) | Total rainfall duration (hr) | Total rainfall return period (yr) | Peak rainfall (mm) | Peak rainfall duration (hr) | Peak rainfall return period (yr) | Data quality flag |
|---|---|---|---|---|---|---|---|
| Holland Park | 68.4 | 17 | 1 in 23 | - | - | - | Suspect |
| Brent reservoir | 10.4 | 6 | NA | - | - | - | Good |
| Hornsey | 14 | 12 | NA | - | - | - | Suspect |
| Wanstead | 15.8 | 15 | NA | - | - | - | Good |

**- = peak rainfall return period is less than total event return period. NA = outside of lower calculated range*

**Table 3-2: Rain Gauge Data for 25th July 2021**

| Rain Gauge | Total event rainfall (mm) | Total rainfall duration (hr) | Total rainfall return period (yr) | Peak rainfall (mm) | Peak rainfall duration (hr) | Peak rainfall return period (yr) | Data quality flag |
|---|---|---|---|---|---|---|---|
| Holland Park | 30 | 20 | 1 in 2 | - | - | - | Good |
| Brent reservoir | 7.4 | 9 | NA | - | - | - | Good |
| Hornsey | 22.8 | 7 | 1 in 2 | 15.4 | 1 | 1 in 3 | Good |
| Wanstead | 54 | 6 | 1 in 21 | 50.8 | 2 | 1 in 53 | Good |

**- = peak rainfall return period is less than total event return period. NA = outside of lower calculated range*

The data for Holland Park on the 12th July is flagged by the EA as suspect as the totals are 8% lower than the check gauge at this site. The Hornsey rainfall data on the 12th July is also flagged as suspect, recording 21% below the check gauge and it is noted that both gauges were blocked when checked. It is uncertain when the discrepancies between gauges occurred during the rainfall event, however a conservative approach has been adopted by adding the percentage difference to the peak rainfall totals. For Holland Park this correction results in a peak of 73.9 mm over 17 hours with a return period of 1 in 31 years, and for Hornsey a peak of 16.9mm over 12 hours which is below the lower range of return periods.

## 3.5 Rainfall Radar

Thames Water has provided mapping of their own independently calculated rainfall-radar return period analysis, the 12th July 2021 is presented in **Figure 3-6** and the 25th July is presented **Figure 3-7**.

**Figure 3-6** highlights the spatially variable nature of the rainfall during the 12th July event, with the highest return period rainfall occuring in a narrow band stretching from the eastern wards of Camden Town, towards the north western corner over Hampstead. The Holland Park rain gauge overlaps with this band of heavy rain, however the return period estimate based on the rain-radar image is much higher (139 year) than that observed at the rain gauge (17 years observed, 31 years corrected). The radar image has a resolution of 1km$^2$ so it is possible that the actual rainfall distrubution within this grid square missed the Holland Park rain gauge.

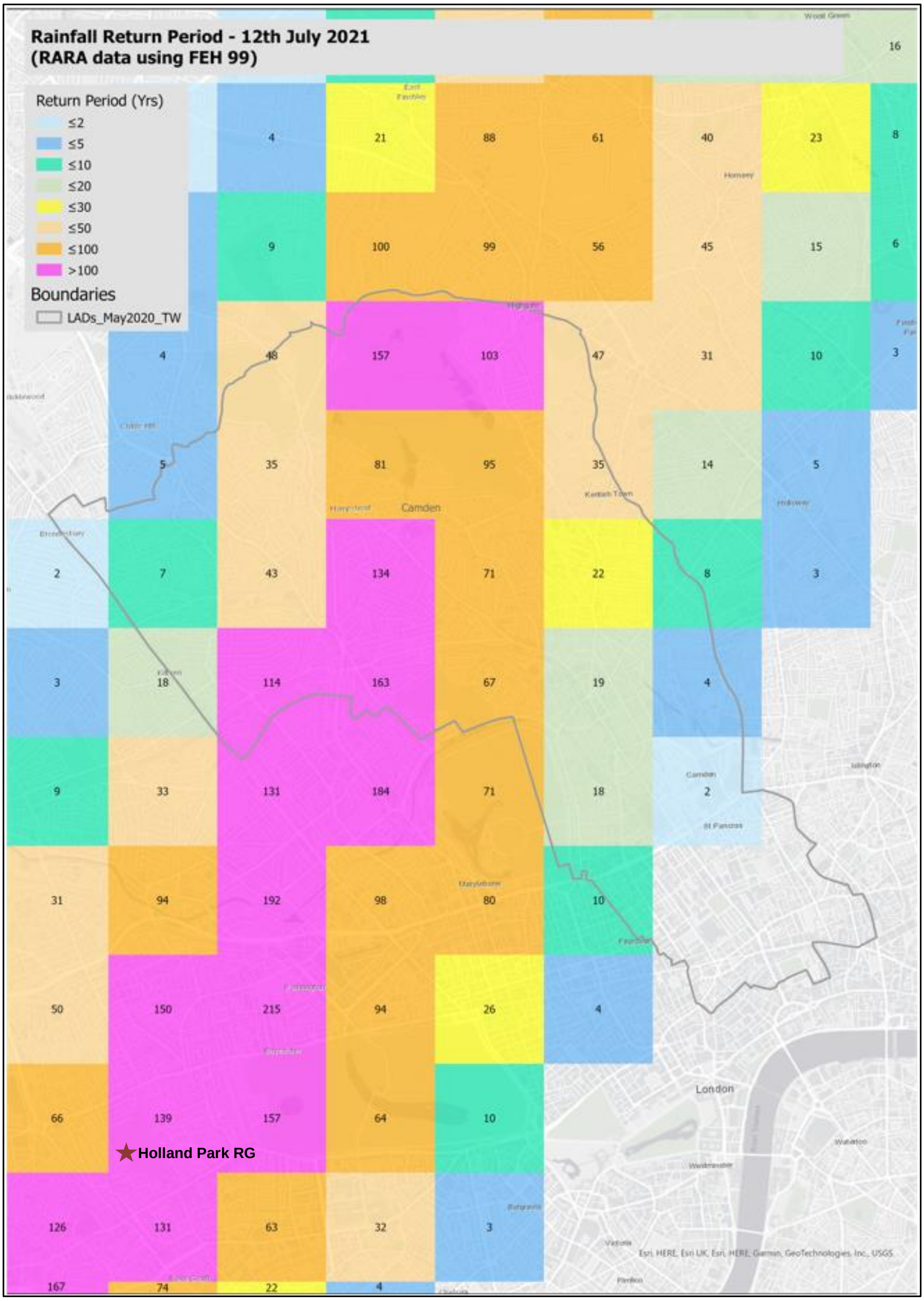


**Figure 3-6: Thames Water Rainfall-Radar Return Period Analysis (12th July 2021)**

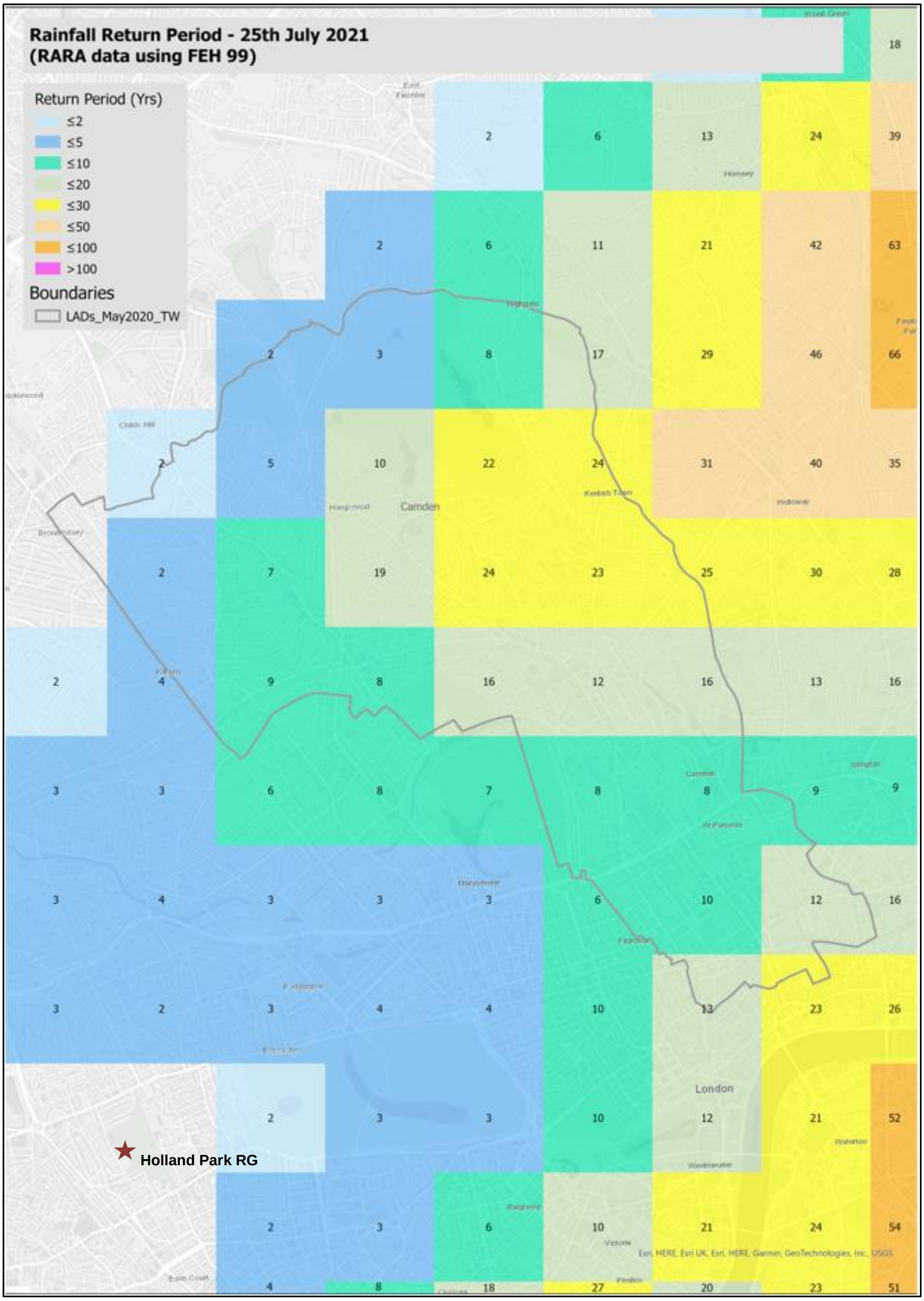


**Figure 3-7: Thames Water Rainfall-Radar Return Period Analysis (25th July 2021)**

Without access to the rainfall-radar data it is not possible to independantly confirm the return period estimates provided above, or assess the methods used (i.e. choice of using FEH99 when FEH13 would be the most up to date dataset). However the above mapping is useful to illustrate the spatial variation and highly localised nature of the rainfall over Camden during the 12th July event. The 25th July mapping supports the lower rainfall totals observed near to Camden during this event. A check was carried out using the Holland Park observed rainfall assessing the difference in return period estimation using the FEH99 and FEH13 rainfall datasets. The comparison resulted in a 2 year difference in return period estimate, therefore the influence on return period of using either dataset in this area should be marginal.

## 3.6 Event Rarity

The method outlined in The Flood Estimation Handbook[18] and the FEH webservice have been used to determine the corresponding likelihood of probability for the rainfall event from the rain gauge data. The EA tipping bucket rain gauge recorded rainfall equivalent to a 1 in 23 year return period (1 in 31 years with check gauge correction) event at Holland Park on the 12th July 2021, and a peak rainfall of 1 in 53 year return period at Wanstead on the 25th July 2021.

From the datasets discussed above, it is clear from the observed rain gauge data that there was a high degree of spatial variation in rainfall during these events, with significant rainfall only occurring over one rain gauge per event. These events were thunderstorms which can be characterised by highly localised intense rainfall, and therefore it is possible that the rain gauges missed the peak rainfall intensity, particularly if this was localised entirely over Camden Town where there are no rain gauges. This assumption is supported by the rainfall-radar analysis, which illustrates the spatial variation over the study area, with the highest return period rainfall occurring in a band stretching from the eastern Camden wards, towards the north western corner covering Hampstead. Return period estimates are highest in this area ranging from 67 to 163 years.

## 3.7 Summary

Several months of exceptionally high rainfall followed by above normal rainfall in July 2021 led to a high level of catchment saturation in the North London catchment as indicated by the low SMD data and high rainfall averages. Such high catchment saturation levels would result in a reduction in catchment infiltration capacity causing greater surface water runoff, and potential for groundwater ingress into the sewer drainage system reducing conveyance capacity. To the north of Camden Town, the geology mapping shows that the raised area around Hampstead Heath has a high vulnerability to groundwater flooding, therefore ingress into the sewer system in these areas would be possible which would then feed through the gravity sewer system to the lower catchment (connectivity confirmed from TW sewer mapping). These catchment and sewer conditions, when combined with the high rainfall totals observed on the 12th and 25th July 2021 would result in significant localised urban surface water flooding, as experienced in Camden. This would predominantly be caused by surface water runoff accumulating in depressions in the urban area (over hard/over saturated ground surfaces) where the capacity of the drainage network has been exceeded.

The return period analysis discussed above was determined using FEH methods and observed rain gauge data (1 in 23 years for 12th July and 1 in 50 years for the 25th) is much less than that reported by TW which shows rainfall-radar return periods exceeding the 1:100 year in Camden on the 12th July. It is likely that the localised nature of this rainfall event resulted in the highest rainfall intensities missing the physical rain gauges. The rainfall-radar analysis indicates that the highest return period rainfall occurred in a band stretching from the eastern Camden wards, towards the north western corner covering Hampstead (with a range of 67 – 163 year rainfall return period), this band of rainfall corresponds with the areas that experienced the most flooding, indicating that these high rainfalls return period estimates are accurate.

It is important to note that this whilst this report has focused upon rainfall intensity and rarity, it is not within the scope of this study to undertake a detailed analysis of hydraulic sewer capacity at each hotspot. When cross-referenced with the findings of the rainfall analysis, data relating to sewer capacity could further develop the understanding of the flooding mechanisms at the affected locations.

[18] Centre for Ecology & Hydrology, Flood Estimation Handbook Vol 2. Available: https://www.ceh.ac.uk/sites/default/files/2021-11/Flood-Estimation-Handbook-2-Rainfall-Frequency-Estimation-Duncan%20Faulkner_2-9-21.pdf [02/02/22]

# 4. Flooding Impacts & Mechanisms

The following section summaries the flood mechanisms investigated for each hotspot, which is identified as being affected on the 12th July 2021 and 25th July 2021. For each site, an overview of the environment and topography is provided, in addition to an assessment of flooding mechanisms and impacts. This has formed the basis for recommendations, which are presented in **Section 9**. The majority of this section focuses upon flooding on the 12th July 2021, given the significant impact to people, property and the large volume of data which was captured for this event.

The location of the flooding ‘hotspots’ and other relevant information gathered during the consultation process, was reviewed to determine the potential flooding mechanisms and to identify areas which may benefit from a site walkover in accordance with the project brief. The site visits were undertaken on the 27th and 28th January 2022. The scope, extent and timing of the site visit was agreed with LBC prior to undertaking work on site. The objective of the site work was to:

- Identify and appraise historic flooding mechanisms, including source pathway, receptor; and
- Engage with local residents and relevant stakeholders, to capture anecdotal evidence of the July 2021 flood events

The following sites were targeted for the walkover, as part of the agreed scope:

1. **Dartmouth Park, including areas around:**
   - Dartmouth Park Hill, Dartmouth Park Road, York Rise, Croftdown Road, Swain’s Lane
2. **Heath Watershed, including areas around:**
   - Hampstead Heath Ponds (Number 1 and Number 2), South Hill Park Gardens, South Hill Park, South End Road, Heath Hurst Road, Keats Grove, Downshire Hill, Rosslyn Hill, Hampstead Hill Gardens, Aspern Grove and Russell Place
3. **Maitland Park Kentish Town, including areas around:**
   - Quadrant Grove, Maitland Park Villas, Maitland Park Road, Prince of Wales Road, Malden Road
4. **Belsize Park Swiss Cottage, including areas around:**
   - Belsize Avenue, Glenloch Road, Belsize Park Gardens, Eton Avenue, Winchester Road, Ornan Road, Belsize Lane
5. **Hampstead Kingsgate, including areas around:**
   - Belsize Road, Goldhurst Terrace, Fairhazel Gardens

Stakeholder engagement was pre-arranged and co-ordinated by LBC and AECOM in advance of the site work. Local residents and members of the South Hampstead FAG were invited to attend the walkover and encouraged to share their knowledge of the flood event and condition of the local environment. Members of the LBC Highways Team, Parks Team and an Area Engineer were involved in the site visit, to provide further insight into the areas affected, response to the flood events and maintenance of each area.

## 4.1 Dartmouth Park

### 4.1.1 Site Overview

As presented in **Figure 1-4**, the Dartmouth Park site hotspot is located north east of the Camden Borough. It is important to note, the western region of the hotspot is within the LBC administrative area and has been investigated for the purposes of this report. The eastern region of the hotspot is located within the Islington Council administrative boundary, therefore has not been investigated with the exception of Dartmouth Park Hill, which is connected to sites of interest.

The Dartmouth Park site is densely populated, consisting mostly of residential property. There are a few commercial properties and public buildings within the site, yet no large commercial centres. The properties are connected through a series of local roads and public footpaths. Greenspace comprises mostly of private gardens and is small, relative to the size of the urban area.

The Dartmouth Park greenspace is located east of the hotspot, which houses the Maiden Lane Reservoir. At the time of writing, Maiden Lane Reservoir was undergoing repairs to protect the structure and create new drainage paths.

The site is underlain by a combined sewer network, which conveys sewer and surface water flows in a southerly direction. Wastewater from the Camden Borough is processed at the Beckton Sewage Works[19] located approximately 16 km south east of the administrative boundary. A storm sewer is found within vicinity to the Dartmouth Park hotspot, conveying surface water flows south and away from the site.

Key sites of interest within, and in vicinity to, the Dartmouth Park hotspot is presented in **Figure 4-1**.

### 4.1.2 Flooding Impacts

Records indicate two properties were affected by the flood event on the 12th July and no properties were affected by the flood event on the 25th July. The total number of properties affected is presented in **Table 4-1**;

Within the hotspot, as defined by LBC, a property on Dartmouth Park Hill was reported to have experienced internal flooding on 12th July. Records also indicate a property on Croftdown Road flooded on 12th July, yet the occurrence of internal flooding is unknown;

**Table 4-1: Dartmouth Park Hotspot – Reports of Flooding**

| Source | Date of Event | Total Number of Properties Reporting Flooding | Total Number of Properties Reporting Internal Flooding |
|---|---|---|---|
| LBC Records | 12th July 2021 | 2 | 1 |
| | 25th July 2021 | 0 | 0 |
| TW Records | 12th July 2021 | 0 | 0 |
| | 25th July 2021 | 0 | 0 |

- In vicinity to the hotspot, yet outside of the boundary, five properties reported flooding on 12th July. Four of these properties experienced internal flooding, including a property in the western section of Dartmouth Park Road;

[19] URS, Camden Infrastructure Study Update (2012). Available: https://www.eustonareaplan.info/wp-content/uploads/2014/04/CED10-Camden_Infrastructure_Study_Update-July-2012.pdf [Accessed: 21/02/2022]

- Records suggest one insurance claim was submitted for a property affected by the event on Winscombe Street (12th July). This location does not correspond with recorded incidents of flooding; and
- Data provided by the LFB indicates there were no flood calls received on the 12th July and two flood calls in the nearby vicinity of the hotspot on the 25th July; this is presented in **Figure 4-2** and **Figure 4-3**, respectively.

**There is no photographic evidence relating to roads affected by the flooding, therefore it has not been possible to identify specific damage to property. When considered alongside LFB flood call data, the impact of flooding on the Dartmouth Park hotspot is considered to be low.**

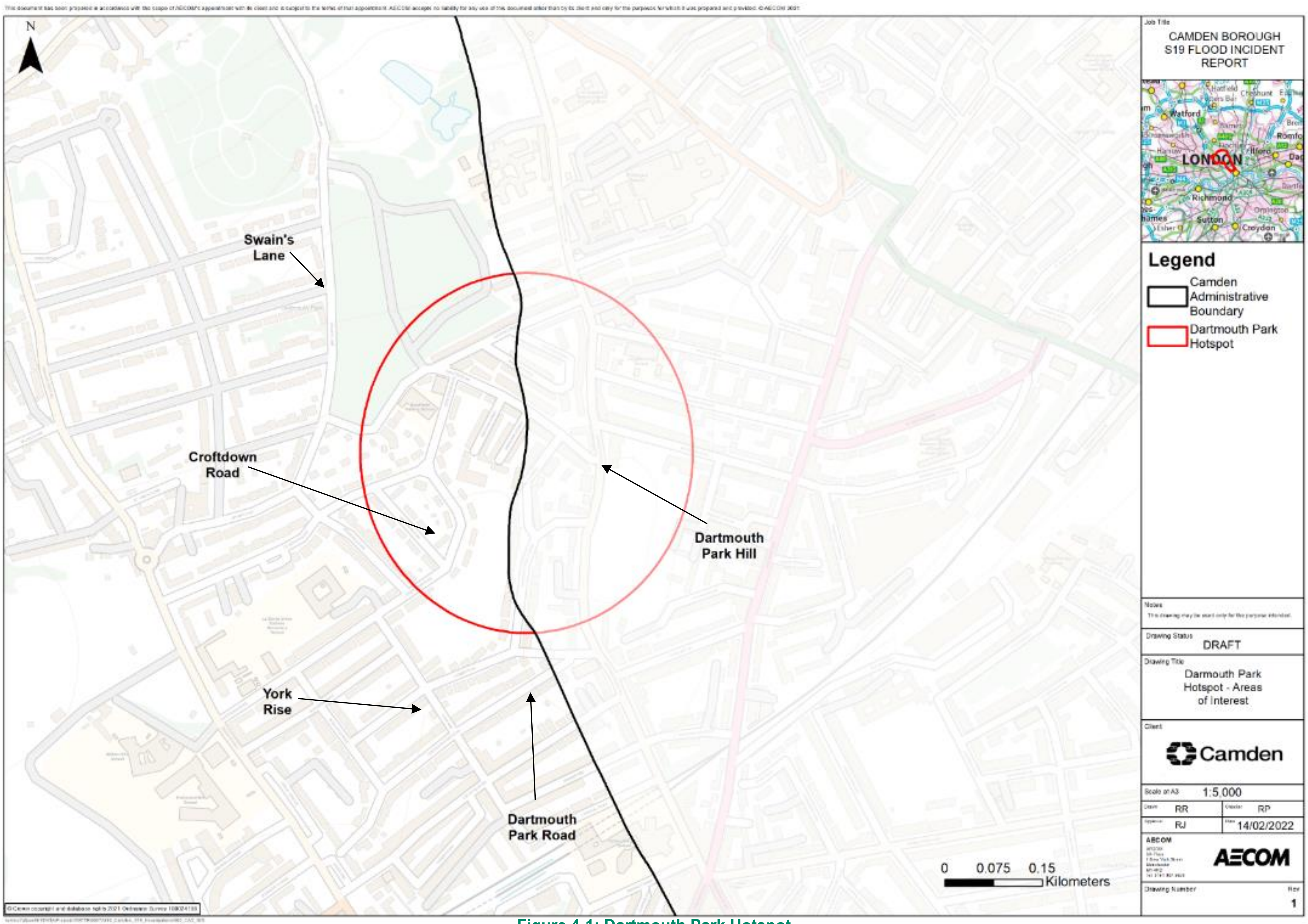


**Figure 4-1: Dartmouth Park Hotspot**

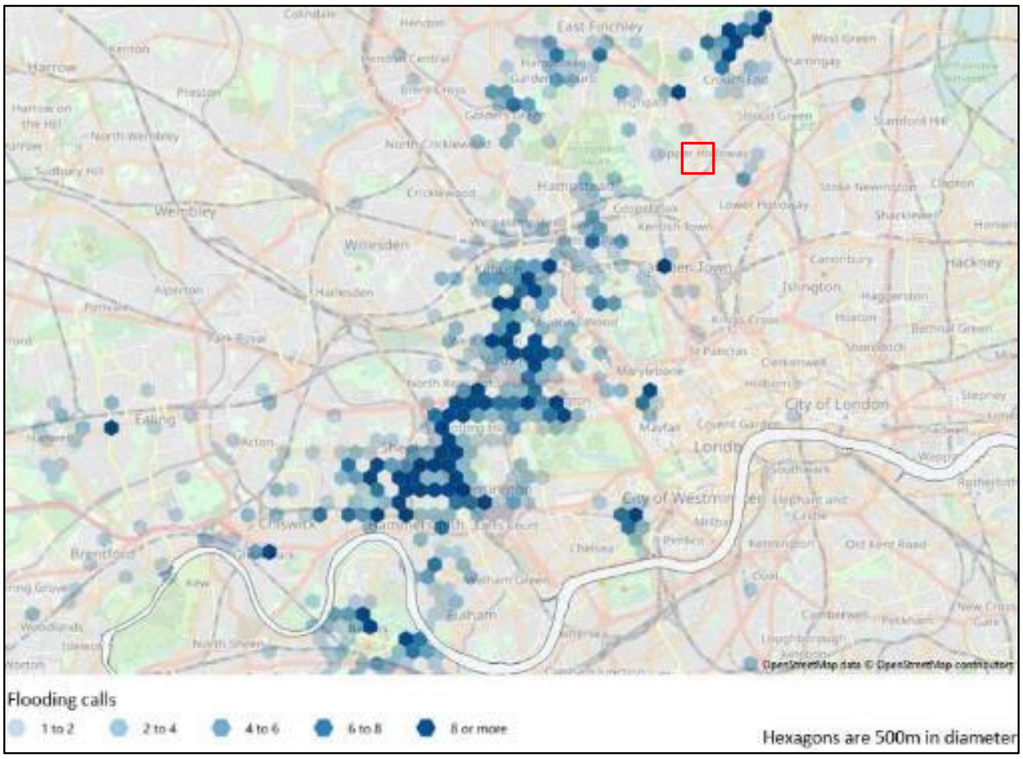


Figure 4-2: LFB Incident Reports Dartmouth Park Hotspot (12th July)

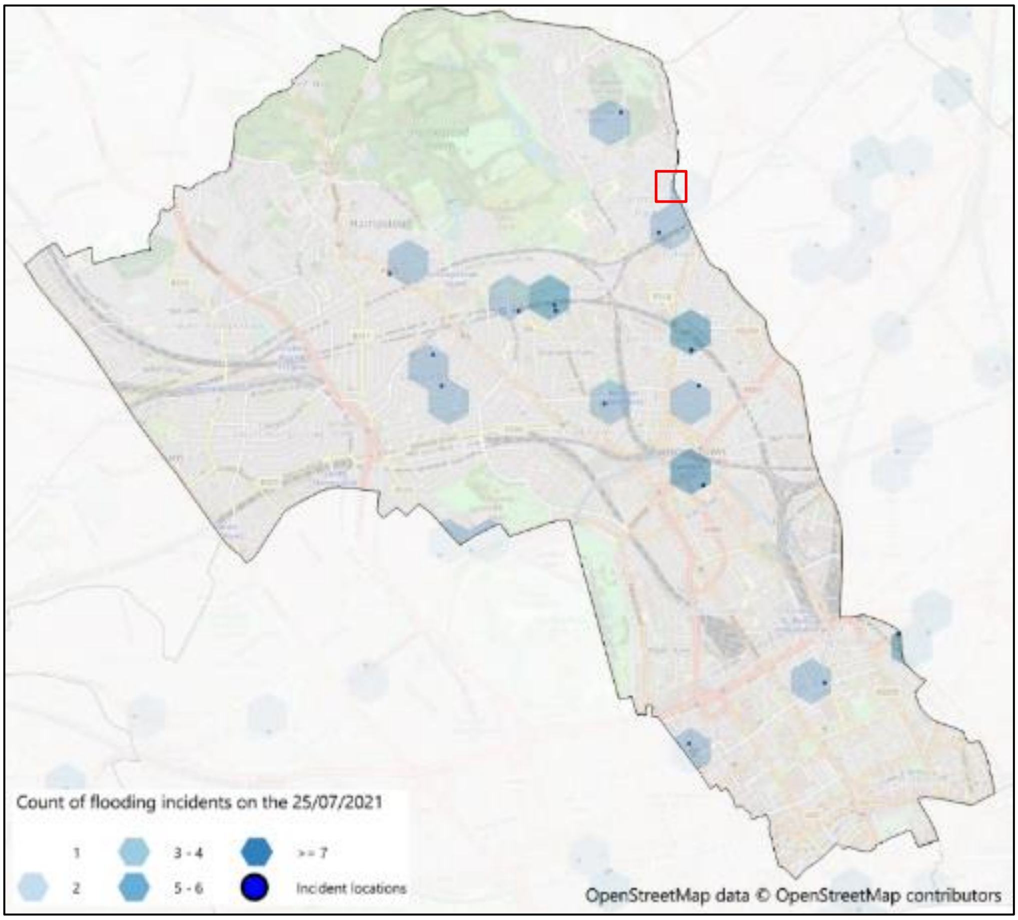


Figure 4-3: LFB Incident Reports Dartmouth Park Hotspot (25th July)

### 4.1.3 Site Observations

**Dartmouth Park Hill**

Dartmouth Park Hill is one of the widest and longest roads present within the Dartmouth Park hotspot, providing a continuous impermeable surface. The road is characterised by a steep slope, which declines to the south; this is presented within **Photograph 1**. The steep and impermeable terrain allows for the conveyance of surface water, to areas of low elevation in the south.

The kerb height along Dartmouth Park Hill varies, to allow for pedestrian and vehicle access; this is presented in **Photograph 2**. Low kerb heights could enable the transfer of water onto the footpath, during periods of high rainfall. As highlighted in **Photograph 3**, there are several speed bumps located on the road, which may direct and channel surface water on the road, to increase the speed of flow.

There are several junctions onto Dartmouth Park Hill, which connect to adjacent roads. Dartmouth Park Hill is located at a higher elevation than these roads, creating a decline in slope to the west. This allows for the conveyance of surface water to the adjacent roads, such as Dartmouth Park Road.

Photograph 1

Photograph 2

Photograph 3

**Dartmouth Park Road**

Dartmouth Park Road has a steep gradient which declines to the south west; the surface water velocity is expected to increase as a result of the topography, which may lead to ponding or exceeded sewer drainage capacity at the lower elevations.

Although the road is narrow, it is bordered by parking spaces on both sides, creating a large impermeable surface area. As presented in **Photograph 4**, the footpath adjacent to the road is wide and greenspace is limited. The capacity for infiltration is therefore low, increasing the volume of surface water which may be conveyed to the lower elevations and the risk of ponding.

As presented in **Photograph 5**, several speed bumps are located on Dartmouth Park Road. The raised bumps are separated, creating narrow channels which can direct surface water flows to the side of the road. By channelling the flow, the speed bumps may increase the water level and result in the kerb heigh being exceeded. This could lead to ponding on the footpath and conveyance toward property thresholds.

Several sections of the road are divided by small areas of pavement, which are raised above the road surface; this is presented in **Photograph 6** and **Photograph 7**. The pavement is likely to intercept flows, directing surface water to the side of the road. This may result in transfer of water to the footpath and to nearby property. At these locations, the height of the kerb is typically <100mm and, during a high intensity rainfall event, could be exceeded.

The curve of Dartmouth Park Road declines to the footpath, which may contribute to surface water ponding at the side of the road. This could result in transfer of water to the footpath.

Photograph 4

Photograph 5

Photograph 6

Photograph 7

**York Rise**

York Rise is situated in an area of low elevation and is west of steep roads, such as Dartmouth Park Road. For this reason, surface water flows are conveyed toward York Rise, from several pathways. During the site visit, the drains contained a high volume leaves and debris, which indicate the presence of flows to York Rise; this is presented in **Photograph 8**.

The topography of York Rise is relatively level, with no defined slope direction. As the road is located in an area of low elevation relative to its surroundings, it is likely that ponding will occur due to the flat terrain. As presented in **Photograph 9**, speed bumps are found on York Rise. The speed bumps are raised and form a continuous line across the road, which could therefore intercept flows and result in a build-up of surface water.

The road surface curves toward the footpaths which border York Rise; this may lead to ponding and could increase the volume of water entering the sewer network. The road surface is heavily eroded at the edge of the road, which may be an indicator of frequent surface water pooling or emergence of flow pathways down York Rise.

Photograph 8

Photograph 9

**Croftdown Road**

The eastern section of Croftdown Road is characterised by a steep slope, which declines to the west. This is presented in **Photograph 10**. Surface water is likely to be conveyed downslope toward the western section of the road, which is located in an area of low elevation relative to its surroundings.

As presented in **Photograph 11**, the width of Croftdown Road and adjacent footpath creates a large impermeable surface, which may reduce the capacity for infiltration of surface water, during high intensity rainfall events. The greenspace provided by private gardens is limited, relative to the total area of the road. When considered alongside the topography of the road, it is likely that high volumes of surface water are conveyed to the lower elevations, such as York Rise.

The kerb height is typically raised to a height of approximately 100mm, however several sections are at road level to allow for access to property. At these locations, it is likely that surface water can transfer to the footpath.

The footpath is approximately 2m wide and most properties are set back from the pavement. This may reduce risk from flooding, in the event of surface water flows on Croftdown Road. A small number of properties on Croftdown Road are located below kerb height, which could increase risk of flooding in the event of surface water pooling on the footpath.

Photograph 10

Photograph 11

**Swain's Lane**

As presented in **Photograph 12**, the topography of Swain's Lane is steep, with a decline in slope to the south. This is likely to increase the rate and volume of surface water conveyed on Swain's Lane, to areas of lower elevation. Roads such as York Rise and Croftdown Road are located south of Swain's Lane and in an area of lower elevation. The extensive road network may facilitate conveyance of flows to York Rise and Croftdown Road, resulting in greater volumes of surface water at these locations.

Although there is some capacity for infiltration, due to private gardens and the cemetery located immediately east it is likely that large volumes of surface water are conveyed downslope, due to the large impermeable surface area provided by Swain's Lane. As presented in **Photograph 13** the road is wide, which increases potential for flow conveyance.

Photograph 12

Photograph 13

### 4.1.4 Flooding Mechanisms

Following a review of the data, stakeholder consultation and site walkover it is concluded that the flooding within the Dartmouth Park hotspot was a result of the following:

- Steep topography of roads such as Dartmouth Park Hill, Dartmouth Park Road, Croftdown Road and Swain's Lane, increased the velocity and conveyance of surface water to the lower elevations. This created several pathways and enabled the accumulation of surface water. This corresponds with a review conducted by LBC, which recorded a blocked gully on Swain's Lane on 20th July. This follows the 12th July flood, indicating the gully was blocked as a result of the surface water pathways emerging from flood event;
- Structures on the road, such as speed bumps and sections of pavement, encouraged surface water to pond at the side of the road and exceed the kerb height. This allowed for surface water to transfer onto the footpath and to approach property thresholds;
- The large impermeable surface area of the site and reduced infiltration capacity, resulted in greater volumes of surface water to be conveyed downslope and to pond in localised areas;
- Asset data provided by LBC suggests a gully was blocked on Dartmouth Park Hill, as a result of fast flowing water. The gully was blocked in the southern sections of Dartmouth Park Hill, at the base of the hill and south of the hotspot. The capacity to transport debris and cause a blockage indicate the rate and volume of flows were significant;
- There are no TW incident reports in the area to indicate blocked drains or surcharging sewers;
- When assessing the LBC reported flood incidents, most are attributed to an unknown cause of flooding. As there are no reported TW incidents in this area, it is considered likely that these properties have been affected by surface water; and

- Surface water is assessed to be the predominant flood mechanism, due to the steep topography, impermeable surface area and lack of TW incident reports.
- A visual representation of the flood mechanisms is presented in **Figure 4-4.**

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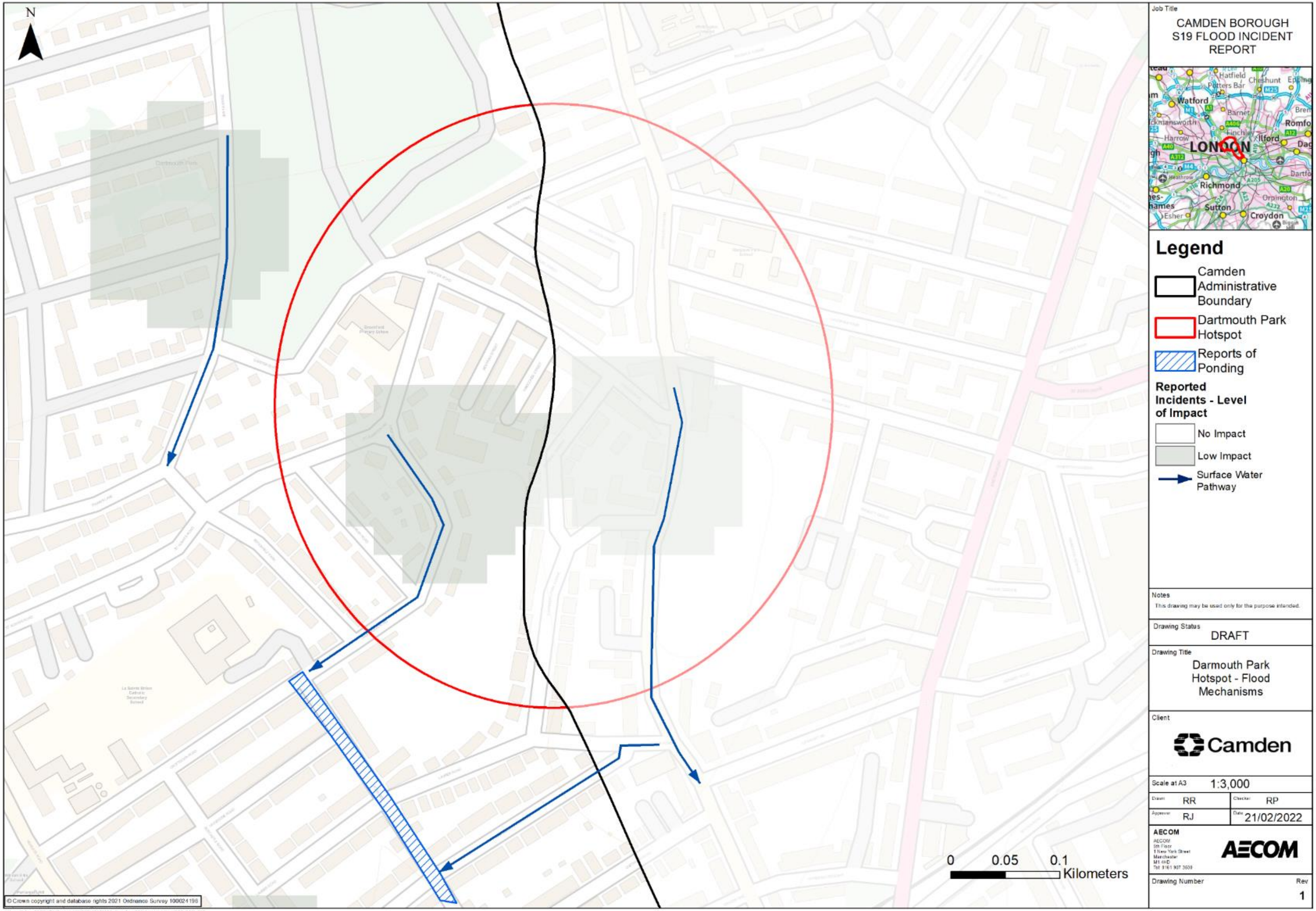



**Figure 4-4: Dartmouth Park Hotspot - Flood Mechanisms**

# 4.2 Heath Watershed

## 4.2.1 Site Overview

The Heath Watershed hotspot is located to the north and central area of the Camden Borough, as presented in **Figure 1-4**. The centre of the hotspot consists of several local businesses and Hampstead Overground Station. The remaining area comprises of residential properties, which are connected by several local roads and key access roads, including the B511 an A502. A large proportion of the residential area is built up of large, terraced and semi-detached properties.

Hampstead Heath is the largest area of greenspace within the hotspot and is located immediately north of the urban area. The land borders the gardens of several properties located on South Hill Park and South Hill Park Gardens. Greenspace within the hotspot is otherwise limited to private gardens.

The site is predominantly underlain by a combined sewer network, to convey sewer and surface water flows; the flows are typically conveyed in a southerly and easterly direction, to be processed at the Beckton Sewage Works[19]. A storm sewer is found in the northern region of the hotspot and is connected to the combined network on South End Road and Keats Grove. The storm sewer conveys flows in an easterly direction, away from the Heath Watershed site.

Key sites of interest within the Heath Watershed hotspot are presented in **Figure 4-5**: Heath Watershed Hotspot.

## 4.2.2 Flooding Impacts

LBC records indicate 25 properties were affected by the flood event on the 12th July, which resulted in 7 reports of internal flooding. In contrast, there were no reports of flooding to LBC on the 25th July. TW records confirm there was one report of flooding on the 12th and 25th July. The incidents did not occur at the same location and are independent from another. The total number of properties reported to be affected by flooding are presented in **Table 4-2**.

**Table 4-2: Heath Watershed Hotspot – Reports of Flooding**

| Source | Date of Event | Total Number of Properties Reporting Flooding | Total Number of Properties Reporting Internal Flooding |
|---|---|---|---|
| LBC Records | 12th July 2021 | 25 | 7 |
| | 25th July 2021 | 0 | 0 |
| TW Records | 12th July 2021 | 1 | 0 |
| | 25th July 2021 | 1 | 0 |

- All reports of internal flooding occurred on 12th July 2021. The areas of interest affected include: South End Road, Keats Grove, Hampstead Hill Gardens, Russell Place and the Hampstead Heath Underground station at the South Hill Park Gardens junction;
- Evidence of water ingress to a commercial property on South End Road is presented in **Photograph 14**. The impact on commercial property is likely to have a long-term impact and will affect the wider community, due to closure of the facilities;

- As presented in **Photograph 15**[20] and **Photograph 16**[21], South End Road was flooded on the 12th and 25th, respectively. The high level of disruption is clear from photographic evidence of both events, which shows queuing traffic and debris in the road;
- Anecdotal evidence provided by residents indicate significant external flooding of properties on Hampstead Hill Gardens on the 12th July. A reported incident to LBC suggests the water level reached approximately 150 mm in a private garden. Residents also note flooding of basements on Hampstead Hill Gardens, with a water level depth of approximately 30 mm.
- Records suggest no insurance claims have been submitted for a residential or commercial property within the Heath Watershed hotspot;
- Data provided by the LFB indicates there were multiple flood calls received on the 12th July; this is presented in **Figure 4-6**;
- The calls form a cluster around South End Road and Rosslyn Road, and range between 2 to 4 calls and 4 to 6 calls per 500m area. On the 25th July, two flood incidents are reported within the LFB dataset, near to the junction of Downshire Hill and Rosslyn Road; this is presented in **Figure 4-7**. This suggests there was a greater level of disruption and impact to property on the 12th July 2021; and

**Upon review of the anecdotal evidence, news articles and data supplied, the impact of flooding on the Heath Watershed hotspot was high.**

[20] Ham & High, News Article: Flash Flooding Hits Hampstead and Highgate. Available: https://www.hamhigh.co.uk/news/weather/flash-flooding-south-end-green-hampstead-8139756 [15/02/22]
[21] Ham & High, News Article: Review of London Flash Floods Begins. Available: https://www.hamhigh.co.uk/news/weather/thames-water-launches-london-flood-review-8586198 [15/02/22]


**Photograph 14**

*Source: Twitter [Online], Twitter entry for the July 2021 Flood Event*

**Photograph 15**

*Source: Camden New Journal [Online], News Article Published 12th July 2021*

**Photograph 16**

*Source: Ham & High [Online], News Article Published December 24th 2021*

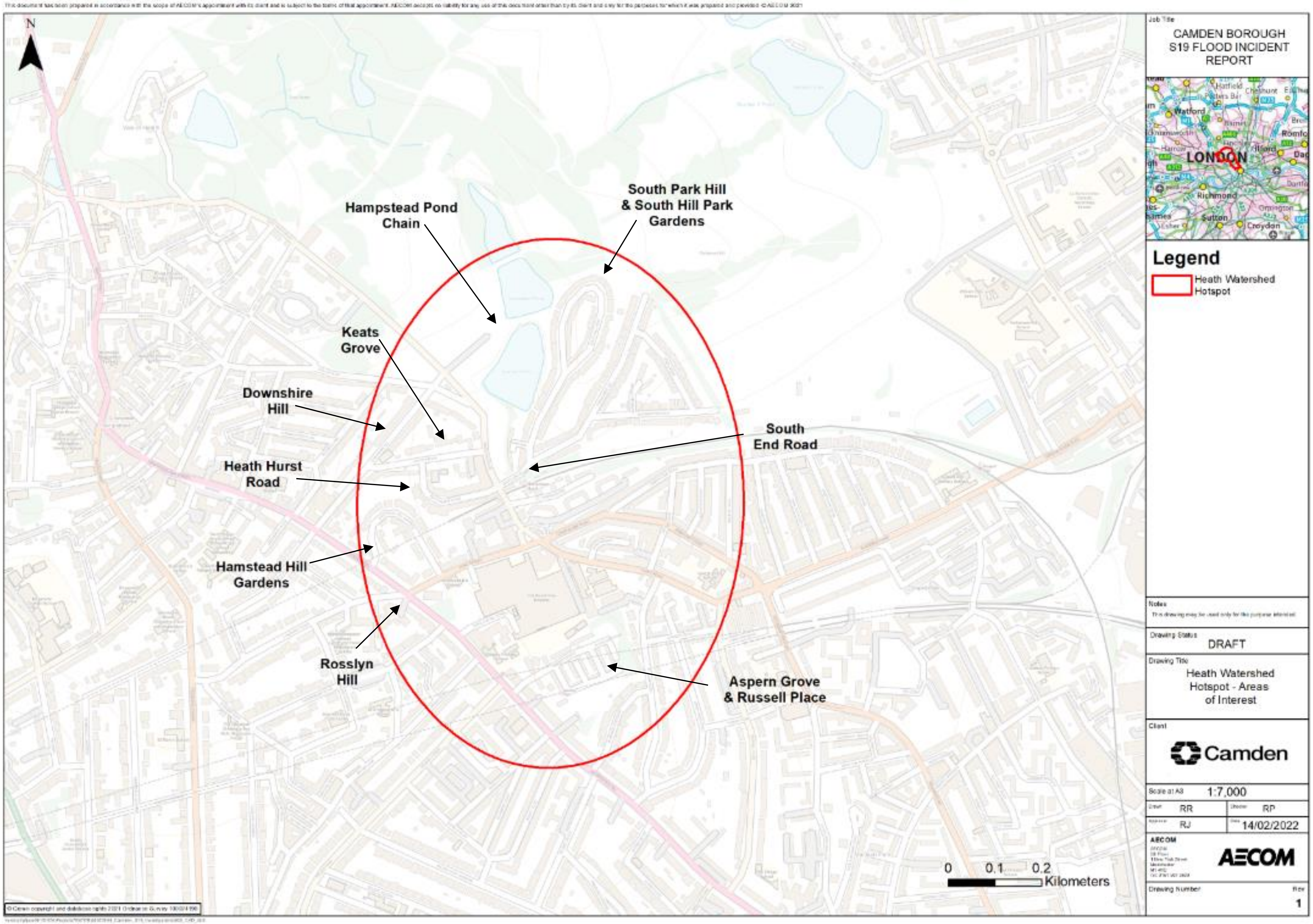



**Figure 4-5: Heath Watershed Hotspot**

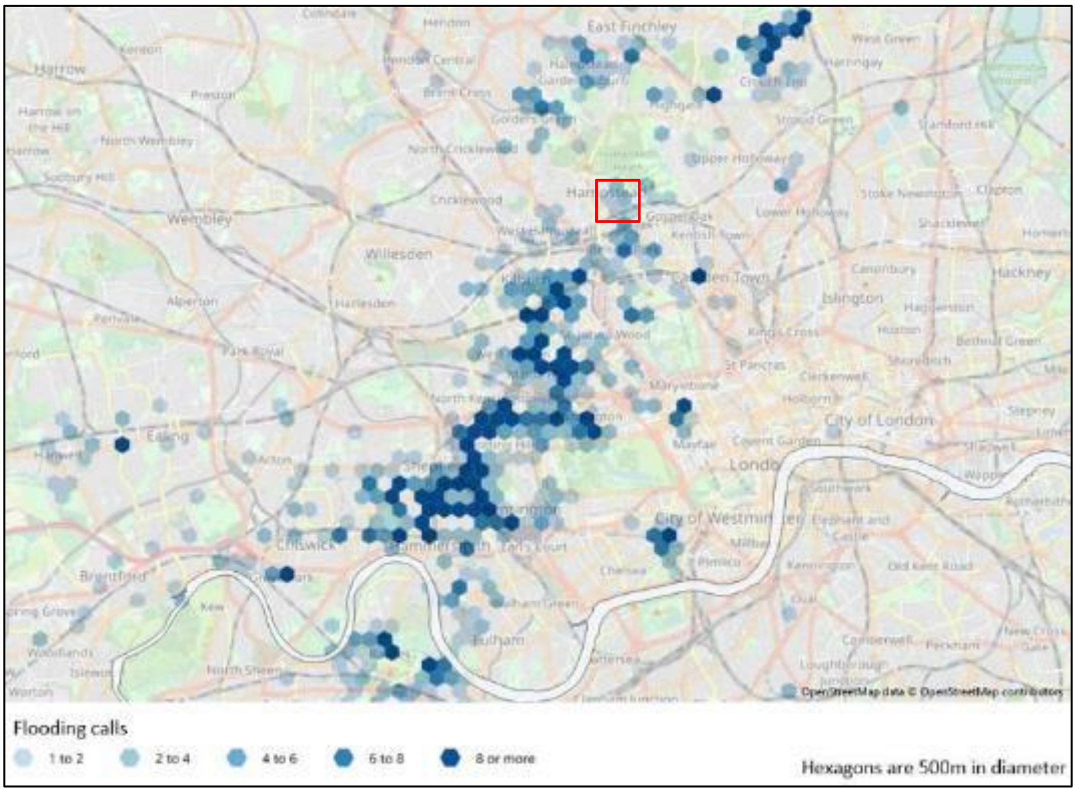



**Figure 4-6: LFB Incident Reports Heath Watershed (12th July)**

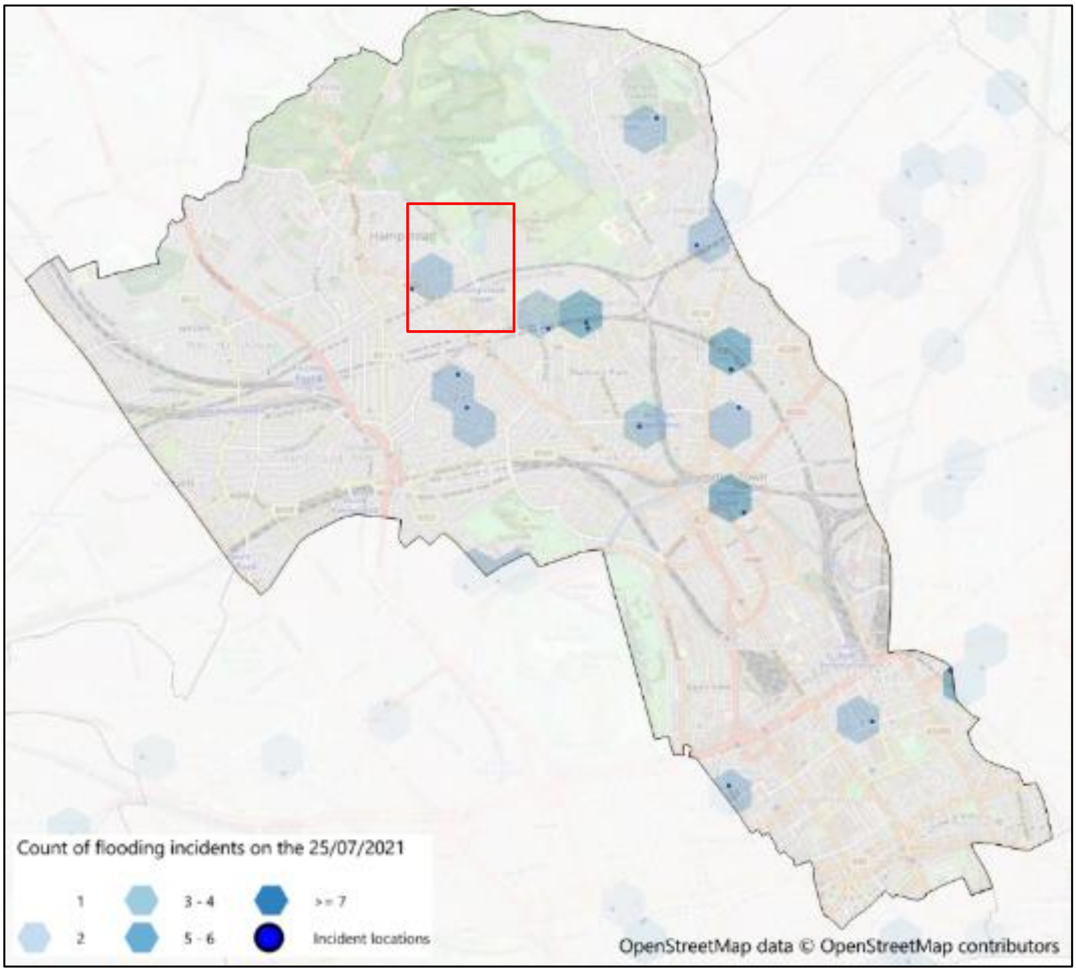



**Figure 4-7: LFB Incident Reports Heath Watershed (25th July)**

### 4.2.3 Site Observations

**Hampstead Heath Ponds & Hampstead Heath**

The Hampstead Pond chain is situated west of the Hampstead Heath greenspace, north of the Heath Watershed hotspot. Hampstead Pond Number 1 and Number 2 were assessed as part of the Section 19 Flood Investigations; the location of each pond is presented in **Figure 1-2**.

As presented in **Photograph 17**, the pond chain is separated by artificial dams and public footpaths; this provides structural security and allows for pedestrian access to other areas of Hampstead Heath. Records of the Ponds Project indicate the outfall of Hampstead Number 2 is located in the south west corner, which outflows to the north west corner of Hampstead Number 1[22]. Records from TW indicate the outfall of Hampstead Pond Number 1 discharges to the combined sewer network, located at Ordnance Survey National Grid Reference (OS NGR) TQ 27179 85811 on South End Road. As presented in **Photograph 18**, structures such as trash screens are used to maintain the condition of the pond.

Photograph 17

Photograph 18

The Hampstead Pond chain is located in an area of gentle terrain, with small slopes which decline toward the banks of each pond. Surface water from Hampstead Heath will be conveyed toward the ponds during a high intensity rainfall event. Although this may increase the water level, overtopping and risk of flooding is highly unlikely due to the design and maintenance of the ponds.  The pond chains are carefully managed by CLC and in 2016, were strengthened and upgraded to address the concern of dam failure and overtopping[23].

East of the Hampstead Pond chain, the topography increases significantly, creating a steep slope that inclines east toward the Parliament Hill Viewpoint; this is presented in **Photograph 19**. At the base of the hill, there are several drains and a culvert to convey surface water toward the Hampstead pond chain; this is presented in **Photograph 20** and **Photograph 21**. During the site visit, there was evidence of leaves and debris build up near the drains and the area around the culvert was waterlogged; this suggests flows conveyed downslope are strong enough to transport material, whilst highlighting the potential for surface water ponding in this area.

At the base of the hill, a brick wall acts as a border between Hampstead Heath and private gardens of homes located on South Hill Park Gardens and South Hill Park; this is presented in **Photograph 22**. In the event of surface water ponding and high flow, there is potential for water to cross the wall threshold and underneath doorways, which could result in flooding of private properties located on South Hill Park Gardens and South Hill Park.

As presented in **Photograph 23** and **Photograph 24**, there is evidence of informal flood risk measures, such as use of timber and a railway sleeper, being used to direct flows away from the wall and doorways;

[22] Hampstead Heath Ponds Project Blog, Work Starts at Hampstead No.2 (2015). Available: https://hampsteadheathpondsproject.wordpress.com/2015/07/08/work-starts-at-hampstead-no-2/ [Accessed: 02/02/22]
[23] City of London Corporation, Gateway 4c – Detailed Design: Hampstead Heath Ponds Project. Available: https://democracy.cityoflondon.gov.uk/documents/s35824/Gateway%204c%20Detailed%20Design%20Hampstead%20Heath%20Ponds%20Project.pdf [Accessed: 02/02/22]

this suggests surface water flows conveyed downslope have impacted private property previously. It is important to note that this does not confirm the occurrence of internal flooding yet does indicate the presence of a pathway near the property boundary.

There are several footpaths within Hampstead Heath that provide access to varying areas of the greenspace. The footpaths are formed of impermeable material which act as an artificial channel and could increase the volume and rate of surface water conveyed downslope. The likelihood of surface water flows on the footpath is dependent on the infiltration capacity of the surrounding greenspace. Following a period of intense rainfall, saturated ground conditions reduce infiltration and increase the volume of surface water conveyed via the footpath.

Photograph 19

Photograph 20

Photograph 21

Photograph 22

Photograph 23

Photograph 24

**South Hill Park Gardens & South Hill Park**

South Hill Park Gardens and South Hill Park has a steep gradient which declines south west, as presented in **Photograph 25**. Surface water flow rate is expected to increase as a result of the topography, which may lead to ponding or exceeded sewer drainage capacity at the lower elevations.

As presented in **Photograph 26**, the allocated parking spaces border the road on both sides and the footpath is approximately 2m wide; the total impermeable area reduces capacity for infiltration, increasing the volume and rate of surface water flows. As presented in **Photograph 27**, South Hill Park Gardens meets at a midpoint on South Hill Park; this allows for the confluence of flows and contributes to the volume of surface water conveyed downslope.

Although a large proportion of the property thresholds and doorways are raised above road height, many of these buildings have a ground floor below the road level; this is presented in **Photograph 28**. Should surface water transfer to the footpath, the ground floor of a property may be susceptible to water ingress, as flows are conveyed to localised areas of low elevation.

Photograph 25

Photograph 26

Photograph 27

Photograph 28

**South End Road**

South End Road is located in an area of low elevation, relative to the immediate surroundings. South Hill Park, Heath Hurst Road, Keats Grove and Downshire Hill decline in slope, to meet with South End Road; examples of the slope of South Hill Park and Heath Hurst Road is presented in **Photograph 29** and **Photograph 30**, respectively. Pathways originating from these roads are expected to convey surface water to South End Road, resulting in an accumulation of large volumes of surface water at this location.

The northern section of South End Road is characterised by a steep slope, which declines south. This increases the rate and volume of surface water conveyed downslope and the risk of sewer surcharge.

At the junction of South Hill Park and Heath Hurst Road the road surface is uneven and undulates, creating a localised depression in topography; this is presented in **Photograph 31**. Large volumes of surface water are expected to accumulate at this location, due to the road surface and the surrounding slopes which decline to this location.

At the junction, several kerbs have been dropped to allow for pedestrian access. This may allow for the transfer of surface water onto the footpaths and toward property thresholds on the roadside. As presented in **Photograph 32**, commercial buildings located on South End Road have property thresholds at kerb height, which increases the risk of water ingress in the event of surface water on the footpath.

As presented in **Photograph 33**, Hampstead Heath Overground station is located at the junction of South End Road and South Hill Park, with an area of low elevation relative to the surroundings. Although the entrance of the station is raised above road level, the kerb has been dropped to allow for access. If surface water height exceeds that of the road level, it is likely the station will be affected.

Immediately east of South End Road, there is an area of greenspace which is approximately 35-50m in width. The greenspace inclines toward Hampstead Heath, creating a gradual slope to its entrance. As presented in **Photograph 34**, a footpath extends across the greenspace, ending at the junction of South End Road and South Hill Park. A surface water pathway is likely to emerge from this area, due to the slope and impermeable surface of the footpath, contributing to the volume of surface water conveyed to South End Road.

Although the capacity for infiltration is provided by the adjacent greenspace, this is limited relative to the surroundings. South End Road is a key access route for those visiting Hampstead Heath, therefore it is connected through a series of footpaths, roads and public transport services. This increases the total impermeable surface area, reducing capacity for infiltration and increasing the volume of surface water conveyed through the Heath Watershed hotspot.

Photograph 29

Photograph 30

Photograph 31

Photograph 32

Photograph 33

Photograph 34

### Heath Hurst Road

As presented in **Photograph 30**, the topography of Heath Hurst Road is steep, with a decline in slope to the east. This is likely to increase the rate and volume of surface water conveyed downslope, to areas such as South End Road. This may result in ponding or exceeded drainage capacity at the lower elevations.

Although the road is narrow, it is bordered by parking spaces and a footpath of approximately 2m in width on both sides. The total impermeable surface area is high, which reduces the capacity for infiltration and may therefore increase the volume of surface water conveyed to lower elevations, such as South End Road.

### Keats Grove

The topography of Keats Grove is steep, with a decline in slope to the east; this is presented in **Photograph 35**. Keats Grove follows a straight line toward South End Road. For this reason, surface water flows are likely to be conveyed directly to South End Road, contributing to pooling and volume of water entering the sewer system at this location.

The private gardens adjacent to Keats Grove may offer the capacity for infiltration of surface water, however the total area of greenspace is small, relative to the surroundings. Properties are typically bordered by a wall or fence, which directs flow downslope toward the lower elevations, rather than dispersal into gardens. This may reduce risk of water ingress on Keats Grove, yet contribute to surface water flows at the lower elevations.

At the junction of Downshire Hill the road and footpath curves toward Keats Grove, creating a decline in slope toward Keats Grove; as presented in **Photograph 36**. It is likely that higher volumes of surface water will be directed to Keats Grove. In addition, the kerb height of the footpath at the junction is level with the road, therefore surface water flows are expected to overspill onto the footpath.

Photograph 35

Photograph 36

### Downshire Hill

As presented in **Photograph 37**, Downshire Hill has a steep slope which declines to the north east, toward South End Road. The road is unobstructed, providing a continuous impermeable surface toward the lower elevations. Although the carriageway is narrow, Downshire Hill is bordered by parking and a footpath of 1m – 2m width, on both sides of the road. The slope and large impermeable surface increases the volume of surface water conveyed to the low elevations, such as South End Road.

The kerb height of Downshire Hill varies, yet typically raised ≥100mm from road level. A large proportion of properties are set back ≥3m from the road and are bordered by a wall, which may reduce the likelihood of water ingress in the event that flows exceed kerb height. Toward the south western sections of Downshire Hill, there are a small number of properties with a ground floor below road level; this is presented in **Photograph 38**. These properties may be more susceptible to ingress in the event of water levels exceeding kerb height.

Photograph 37

Photograph 38

**Rosslyn Hill and Haverstock Hill (A502)**

As presented in **Photograph 39**, Rosslyn Hill is characterised by a gentle slope, which declines to the south east. Although gradual, the elevation changes significantly due to the length of the road. The emergence of surface water pathways are expected, due to the decline in elevation and length of Rosslyn Hill. Rosslyn Hill forms a section of the A502, providing key access to areas within the Heath Watershed hotspot. The road provides a large impermeable surface area, due to the width of the carriageway, bus stops and parking spaces available. Both sides of the road are bordered by a footpath, with widths of 2m – 4m. There is limited capacity for infiltration, which is likely to increase the volume of surface water conveyed downslope.

The residential and commercial properties on Rosslyn Hill are typically set back ≥10m from the road. As such, the likelihood of water ingress is considered low. It is important to note that Rosslyn Hill connects to Haverstock Hill, which continually declines in slope toward the Maitland Park Kentish Town hotspot. This creates an unobstructed pathway, which may result in surface water conveyance from the high elevations of the Heath Watershed toward other hotspots within the Camden Borough.

Photograph 39

### Hampstead Hill Gardens

At the junction of Rosslyn Hill and Hampstead Hill Gardens, the road surface curves north east and creates a gradual decline in slope toward Hampstead Hill Gardens. The junction is wide and the kerb has been dropped to allow for access. It is likely that surface water flows from the A502 overspill onto the footpath and continue down the slope of Hampstead Hill Gardens.

Although a large proportion of properties have a ground floor which is below road level, water ingress is considered unlikely as properties are typically bordered by a wall or fence. A property located near to the junction of Rosslyn Hill and Hampstead Hill Gardens is set back from the road yet located on a small slope; this is presented in **Photograph 40**. Water ingress at this property may occur, should surface water flows on Hampstead Hill Gardens be conveyed downslope toward the property threshold.

Photograph 40

### Aspern Grove & Russell Place

Aspern Grove and Russell Place are located in an area of low elevation, relative to the areas of interest within the Heath Watershed hotspot. As presented in **Photograph 41**, Aspern Grove is characterised by a steep slope, which declines to the east. At the junction of Aspern Grove and the A502, the kerb has been dropped to road level. Surface water pathways conveyed via the A502 may overspill onto the footpath and continue downslope, toward Aspern Grove. As presented in **Photograph 42**, there are a number of small speed bumps located on the road, which may obstruct any surface water flows and could result in ponding.

Photograph 41

Photograph 42

Photograph 43

Russell Place is situated off Aspern Grove, toward the base of the slope. As presented in **Photograph 43**, Russell Place is perpendicular to Aspern Grove. There is no kerb separating the roads, meaning the conveyance of surface water to Russell Place is unobstructed; in the event of ponding, surface water may approach property thresholds. However, the risk of water ingress is reduced as property thresholds at this location are raised approximately 200mm above road level.

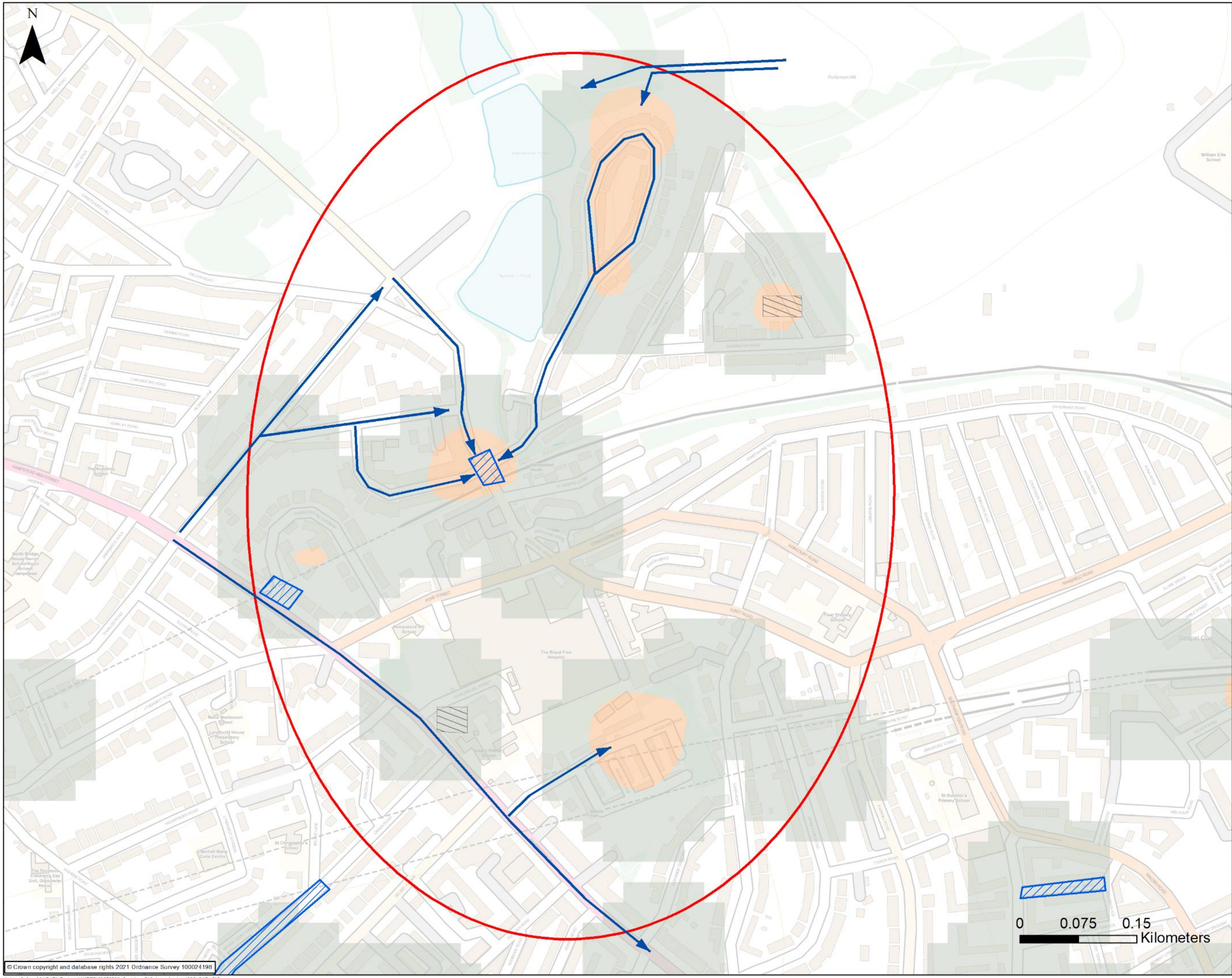
### 4.2.4 Flooding Mechanisms

Following a review of the data, stakeholder consultation and site walkover it is concluded that the flooding within the Heath Watershed hotspot was a result of the following:

- Antecedent conditions led to saturated ground within the Hampstead Heath greenspace. This increased surface water runoff to the Hampstead Pond Chain and adjacent roads, including South End Road and South Hill Park Gardens. Overland flow from Hampstead Heath is a key mechanism for flooding in the hotspot. This corresponds with the findings of an asset review, conducted by LBC.
- Anecdotal evidence from local residents note a small stream was once conveyed water overland, behind the gardens of South Hill Park toward the Hampstead Number 2 Pond. This has since been replaced by a drain. Site observations of Hampstead Heath confirmed the likelihood of a flow pathway behind the wall of the gardens, due to informal flood prevention measures (**Photograph 23** and **Photograph 24**).
- Records from CLC indicate the Hampstead Heath Pond chain did not overtop or fail, despite increases in the water level noted on 12$^{th}$ July. This is due to the structural design and storage capacity of the Ponds. Therefore, overspill from the ponds did not contribute to overland flow.
- TW records indicate the Hampstead Number 1 Pond outfalls to the combined sewer system on South End Road. As noted by CLC, the water levels of both Hampstead Number 1 and Number 2 Pond were raised significantly during the event on the 12$^{th}$ July, yet back to overflow level by 22$^{nd}$ July. This indicates large volumes of water entered the sewer network during this period, reducing drainage capacity in the urban area.
- Several roads within the Heath Watershed hotspot decline toward South End Road, including South Hill Park Gardens, Heath Hurst Road, Keats Grove and Downshire Hill. This resulted in the emergence of multiple flow pathways, increasing the rate and volume of surface water conveyed to South End Road. South End Road is therefore a key pathway within the Heath Watershed hotspot. This corresponds with the findings of asset review and hydraulic model review conducted by LBC.
- Anecdotal evidence from residents suggests the conveyance of flow from Keats Grove and Downshire Hill was similar to that observed in November 2019 when a water main burst in the local area. Flows were directed downslope and were reported to have caused internal flooding.
- A review of asset data conducted by LBC states gullies between South End Road and Heath Hurst Road were found in a critical condition. The poor condition of the gullies suggests an increased risk of blockages and reduced effectiveness of drainage in this area.
- The length, width and slope of Rosslyn Hill creates a key surface water pathway. As part of the A502, Rosslyn Hill connects to Haverstock Hill. This forms a continuous and unobstructed pathway toward other hotspots within the Camden Borough.
- Large volumes of surface water were conveyed via the A502, increasing the risk of flooding to adjacent roads, such as Aspern Grove and Hampstead Hill Gardens. With the exception of Hampstead Heath, there is little capacity for infiltration within the Heath Watershed hotspot, due to the extensive road network and wide footpaths.
- The uneven surface of roads, such as South End Road and Hampstead Hill Gardens, led to ponding; this corresponds with findings of a data asset review conducted by LBC. Ponding at these locations allowed for overspill onto the footpath and approach of surface water to property thresholds.
- Anecdotal evidence from residents suggest a potential surface water pathway between properties on Hampstead Hill Gardens on 12$^{th}$ July. A household located opposite a flooded

garden reported the conveyance of surface water toward their property and internal flooding. It was not possible to confirm the likelihood of a flow pathway through site observations, due to private land and access.

- Site observations and anecdotal evidence indicate surface water is the predominant driver for flooding on the 12$^{th}$ and 25$^{th}$ July. However, TW records indicate there were reports of surcharging drainage assets on Haverstock Hill (25$^{th}$ July) and east of the areas of interest (12$^{th}$ July). This indicates the drainage capacity was exceeded due the rarity of the rainfall, leading to surcharge of drainage assets. A visual representation of the flood mechanisms is presented in **Figure 4-8**.




Job Title

CAMDEN BOROUGH S19 FLOOD INCIDENT REPORT

## Legend

- Heath Watershed Hotspot
- Reports of Ponding
- Reports of Surcharge

**Reported Incidents - Level of Impact**

- No Impact
- Low Impact
- Medium Impact
- Surface Water Pathway

Notes

This drawing may be used only for the purpose intended.

Drawing Status: DRAFT

Drawing Title: Heath Watershed Hotspot - Flood Mechanisms

Client: Camden

| | | | |
|---|---|---|---|
| Scale at A3 | 1:4,500 | | |
| Drawn | RR | Checker | RP |
| Approver | RJ | Date | 21/02/2022 |

AECOM
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Drawing Number | Rev 1

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**Figure 4-8: Heath Watershed Hotspot - Flood Mechanisms**

## 4.3 Maitland Park Kentish Town

### 4.3.1 Site Overview

As presented in **Figure 1-4**, the Maitland Park Kentish Town hotspot is located in the centre of the Camden Borough. The hotspot is predominantly residential, consisting of consisting several large apartment buildings and terraced properties. A number of commercial properties are located on Malden Road, east of the hotspot, and south of the hotspot along Chalk Farm Road and Adelaide Road.

There are several large access roads within the Maitland Park Kentish Town hotspot, including the B517 and A502. Chalk Farm Underground station is located in the southernmost region of the hotspot. Greenspace is limited, due to the large number of residential properties and apartment buildings. A playground to the west of Maitland Park Road provides the largest area of greenspace, however it is small relative to the size of the hotspot. The site is underlain by a combined sewer network, which conveys sewer and surface water flows in a southerly and easterly direction. The flows are processed at the Beckton Sewage Works[19]. Key sites of interest within the Maitland Park Kentish Town hotspot are presented in **Figure 4-9**.

### 4.3.2 Flooding Impacts

LBC records indicate 11 properties were affected by the flood event on the 12th July, which resulted in 5 reports of internal flooding. In contrast, there were no reports of flooding to LBC on the 25th July. TW records suggest there was one report of flooding associated with surcharge of sewer drainage assets on the 12th July 2021. The total number of properties affected is presented in **Table 4-3**.

**Table 4-3: Maitland Park Kentish Town Hotspot – Reports of Flooding**

| Source | Date of Event | Total Number of Properties Reporting Flooding | Total Number of Properties Reporting Internal Flooding |
|---|---|---|---|
| LBC Records | 12th July 2021 | 11 | 5 |
| | 25th July 2021 | 0 | 0 |
| TW Records | 12th July 2021 | 1 | 0 |
| | 25th July 2021 | 0 | 0 |

- All reports of internal flooding occurred on 12th July 2021. The areas of interest affected include: Quadrant Grove, Queens Crescent and Chalk Farm Underground station at the junction of Adelaide Road. Flooding at Chalk Farm Underground station corresponds with detail noted in online news articles. This caused significant disruption to travel;
- Records indicate there are no insurance claims submitted for residential or commercial properties within the hotspot. Although flood waters may have impacted property, the low number of insurance claims suggests that any damage to property was minimal;
- Data provided by LFB indicate there were no flood calls received from areas of interest within the Maitland Park Kentish Town hotspot on the 12th July; this is presented in **Figure 4-10**.
- On the 25th July, a flood call was received south of the Malden Road and Prince of Wales Road junction; this is presented in **Figure 4-11**. Although not directly within the hotspot, the call was received from an area downslope of Malden Road. This supports evidence of a flow pathway on Malden Road, yet indicates the impact within the hotspot was not significant; and

**There is no photographic or anecdotal evidence relating to roads affected by the flooding, therefore it has not been possible to identify specific damage to property. When considered alongside LFB flood call data and claims submitted, the impact of flooding on the Maitland Park Kentish Town hotspot was low.**

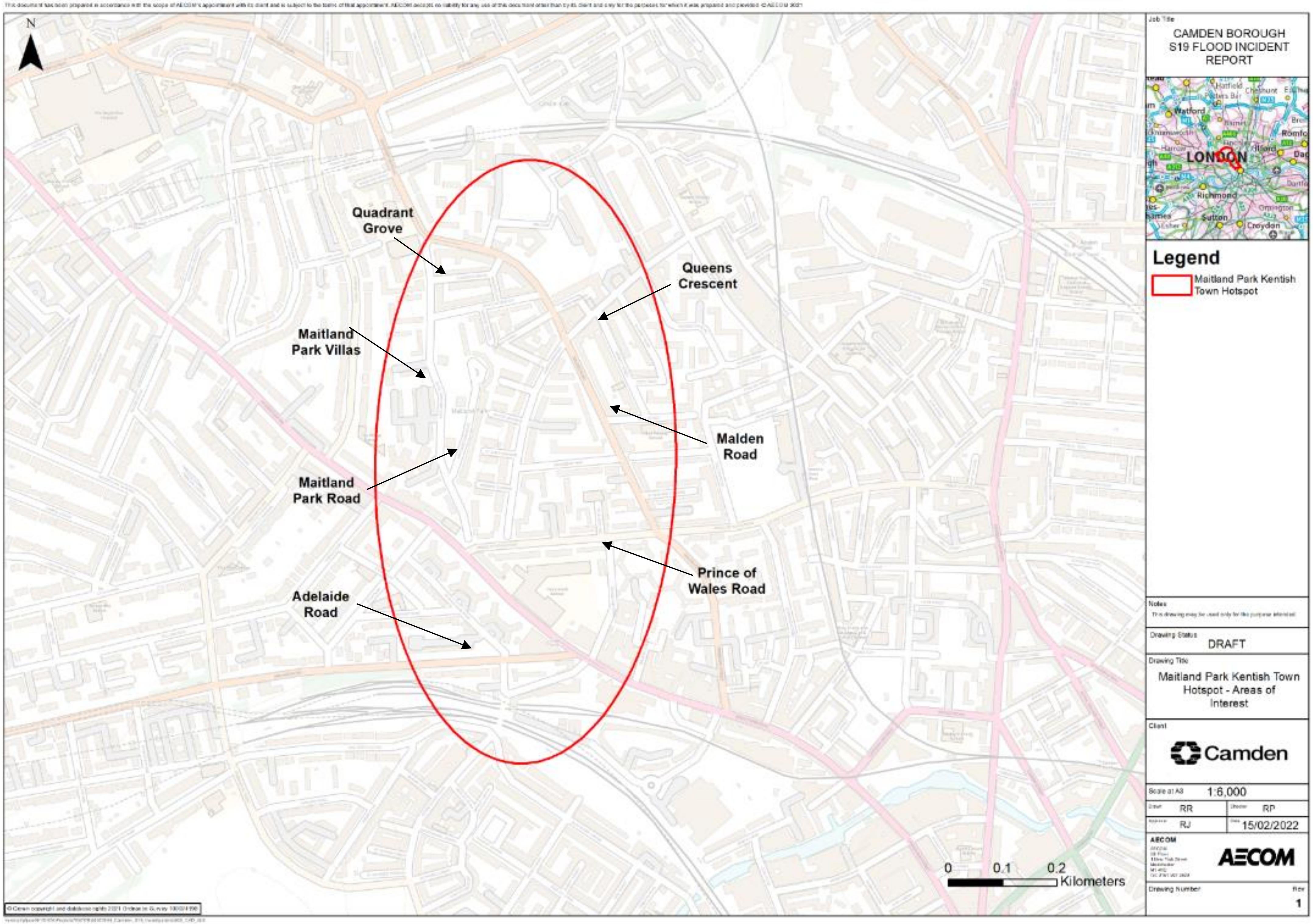



Figure 4-9: Maitland Park Kentish Town Hotspot

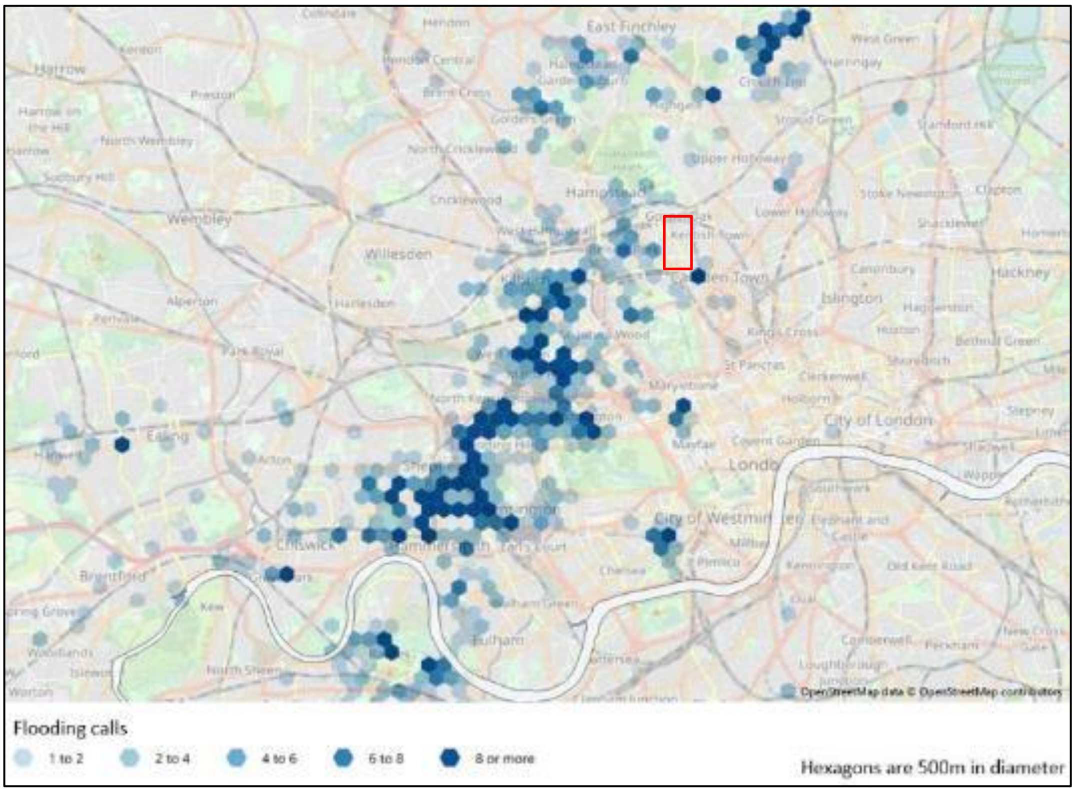



**Figure 4-10: LFB Incident Reports Maitland Park Kentish Town Hotspot (12th July)**

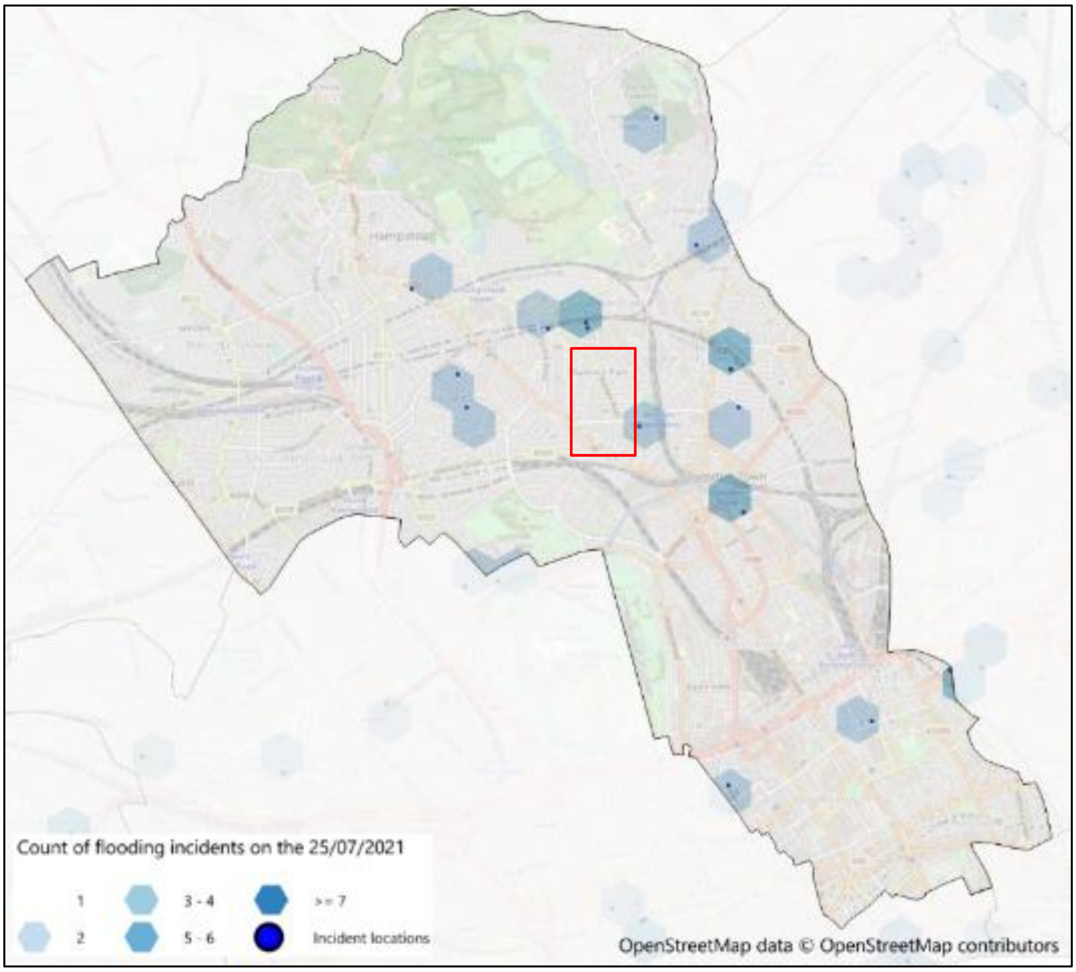



**Figure 4-11: LFB Incident Reports Maitland Park Kentish Town Hotspot (25th July)**

### 4.3.3 Site Observations

**Quadrant Grove**

Quadrant Grove is located in an area of high elevation, relative to of key areas of interest within the Maitland Park Kentish Town hotspot. Therefore, it is unlikely that high volumes of surface water are conveyed to the area.

As presented in **Photograph 44**, Quadrant Grove is a level road surface. Although there is a decline in slope to the east, the gradient is small and so is unlikely to convey large volumes of surface water to the east, such as Malden Road. Ponding is considered likely due to the level surface and low number of drains found on Quadrant Grove.

The kerb height varies, with sections of the kerb at road level; this is presented in **Photograph 45**. At these locations, surface water is likely to transfer to the footpath. A large proportion of property thresholds are level with the kerb height, therefore there is potential for surface water to approach the threshold. However, several of the properties are bounded by a wall, which may act as a barrier and reduce risk.

Photograph 44

Photograph 45

**Maitland Park Villas**

As presented in **Photograph 46**, Maitland Park Villas is characterised by a gentle slope, which declines south. Although gradual, the elevation is significantly lower in the southern section of Maitland Park Villas, compared to the north; this is due to the length of the road, which extends over a large area. Flow pathways are likely to form, due to the decline in elevation and road length. Surface water is expected to be conveyed toward the Prince of Wales Road, located at the base of the slope.

Maitland Park Villas has a large impermeable surface area, due to its length and the adjacent footpath, which borders both sides of the road and measures approximately 2m in width. This reduces capacity for infiltration, with the potential to increase the volume of surface water and size of the flow pathway.

There are several speed bumps located on Maitland Park Villas, which extend across the width of the road. The speed bump may act as a barrier to flow, causing surface water to pond; this could increase the water level and may result in the transfer of surface water onto the footpath.

A large proportion of the properties are bounded by a wall or are set back >5m from the road. Therefore, the likelihood of surface water approaching property thresholds is considered low.

East of Maitland Park Villas, an area of greenspace gently slopes to the east toward Maitland Park Road. The greenspace is bordered by a wall <500mm in height and small sections of the wall are removed, to allow for public access; this is presented in **Photograph 47**. at these locations, the surface water on the footpath may be conveyed downslope, toward the Apartment Buildings which are located on Maitland Park Road.

Photograph 46

Photograph 47

**Maitland Park Road**

Maitland Park Road is connected to the southern section of Maitland Park Villas. At the junction, the road surface curves north, creating small decline in slope toward Maitland Park Road and a localised area of low elevation. Therefore, it is considered likely that surface water flows originating from Maitland Park Villas, are conveyed toward Maitland Park Road.

As presented in **Photograph 48**, the slope Maitland Park Road gradually increases north, from the junction. For this reason, it is likely that surface water ponds at the junction or is conveyed immediately east, to the adjacent driveway. Several properties at this location are situated below the road level yet are set back approximately 5m from the road and separated by a wall or grass verge. This may act as an obstacle to flow, to reduce the likelihood of surface water approaching the property threshold.

Photograph 48

**Prince of Wales Road**

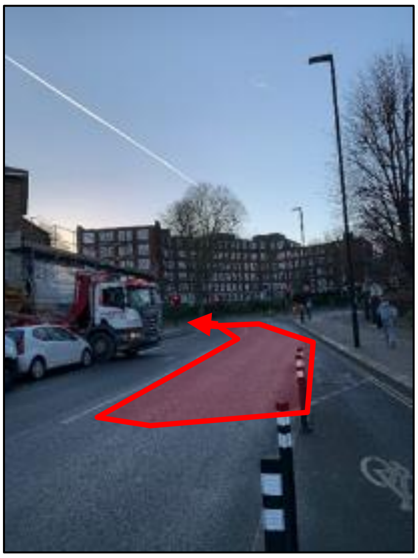
The Prince of Wales Road is connected to Maitland Park Villas, Queens Crescent and Malden Road, at the base of each road. It is located within an area low elevation, relative to the adjoining roads. For this reason, it is likely several surface water flow paths are conveyed toward Prince of Wales Road, resulting in the accumulation of surface water.

As presented in **Photograph 49**, the surface of the Prince of Wales Road is level. The road is bordered by a cycle lane and footpath of approximately 3m on both sides, creating a large impermeable surface area; this is presented in **Photograph 50**. The capacity for infiltration is therefore low and could result in surface water ponding on the road surface.

Although the majority of the road is level, with no distinguishable slope direction, there is a small slope where the Prince of Wales Road connects to Haverstock Hill, and where it joins with Malden Road; the decline in slope is to the south west and to the south east, respectively. The slope observed at the junction of Haverstock Hill is presented in **Photograph 51**, and the junction of Malden Road is presented in **Photograph 52**. Surface water on the Prince of Wales Road may follow the slope and affect the adjoining roads or may accumulate in these areas. Despite the likelihood of ponding at this location, the likelihood of water ingress is low as properties are set ≥5m from the road and are typically bordered by a wall.

**Photograph 49**

**Photograph 50**



**Photograph 51**

**Photograph 52**

**Malden Road (B517)**

As presented in **Photograph 53**, Malden Road is characterised by a gentle slope, which inclines to the north. Although gradual, the elevation is significantly lower to the south of Malden Road, compared to the northern sections of the road; this is due to the length of Malden Road, which extends over a large area. The steady decline in elevation and road length creates a direct surface water pathway to the base of the slope and the Prince of Wales Road.

Malden Road forms part of the B517 and has been developed to cater for a large number of vehicles. As a result, the road is wide and provides cycle routes, bus stops and areas for car parking; this is presented in **Photograph 54**. This creates a large impermeable area, which reduces the capacity for infiltration and is expected to increase the volume of surface water conveyed downslope.

There are several sections of Malden Road where the kerb height is level with the road surface, allowing for access. This may result in the transfer of surface water to the footpath, which may subsequently approach property thresholds. Residential properties are typically set back >3m from Malden Road or have raised thresholds, therefore are not considered to be at risk. However, a small number of properties on Malden Road have a ground floor which is located below road level and several commercial properties have a threshold which is equal to the footpath; these properties may be at greater risk from flooding as a result.

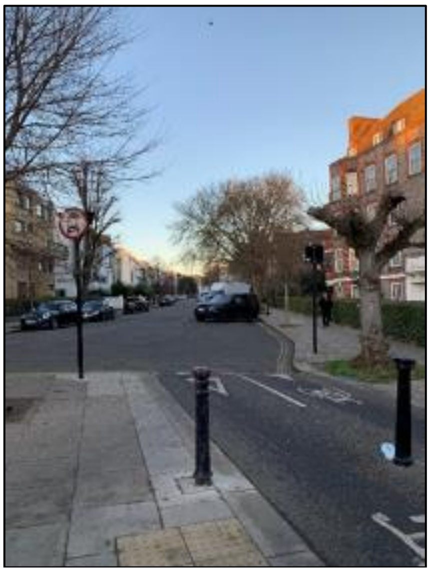
**Photograph 53**

**Photograph 54**

**Queens Crescent**

The north eastern section of Queens Crescent is located in an area of high elevation, relative to its surroundings. The road crosses Malden Road and extends south west, where it gradually declines in slope; this is presented in **Photograph 55**. At the base of the slope, Queens Crescent connects to the Prince of Wales Road via a cycle path; this is presented in **Photograph 56**. The elevation is significantly lower at this location, whilst the cycle path is at road level. For this reason, surface water flows from Queens Crescent are expected to accumulate on the Prince of Wales Road.

**Photograph 55**



**Photograph 56**

**Adelaide Road (B509)**

Adelaide Road is located south of all key areas within the hotspot, situated in an area of low elevation. It is located at the base of Haverstock Hill, which is a key flow pathway originating in the Heath Watershed hotspot. As such, high volumes of surface water are conveyed toward Adelaide Road, which may result in ponding or sewer surcharge, in the event of exceeded drainage capacity.

The eastern section of Adelaide Road, located within the Maitland Park Kentish Town hotspot, is level and there is no distinguishable slope. As such, it is likely that ponding will occur on the road surface.

Chalk Farm Underground Station is located at the base of Haverstock Hill and junction of Adelaide Road. The kerb heights at this location are lowered to road level, to allow for access. Surface water accumulating in this area, due to the level terrain of Adelaide Road, may result in overspill onto the footpath. This poses a potential flood risk to the station.

### 4.3.4 Flooding Mechanisms

Following a review of the data, stakeholder consultation and site walkover it is concluded that flooding within the Maitland Park Kentish Town hotspot was a result of the following:

- The gradual slope and length of roads, such as Maitland Park Villas, Malden Road and Queens Crescent, enabled the emergence of multiple surface water pathways within the hotspot. These roads decline to the Prince of Wales Road, resulting in the accumulation of surface water at this location;
- The majority of flows are conveyed via roads, forming a direct pathway toward the lower elevations. A single pathway emerged on the greenspace located between Maitland Park Villas and Maitland Park Road, due to the declining slope and removed sections of the boundary wall;
- The large impermeable surface area of the site and reduced infiltration capacity, resulted in greater volumes of surface water to be conveyed downslope and to pond in localised areas of level terrain, such as Adelaide Road. This corresponds with anecdotal evidence from news articles which state Chalk Farm Underground station flooded (12$^{th}$ July)[24], situated at the Adelaide Road junction;
- Data provided by LBC indicates that reported incidents were isolated and did not occur within a specific area. Where surface water accumulates in the lower elevations, properties are set back ≥5m from the road and are typically bordered by a wall. This reduces the likelihood of water ingress, despite the potential for ponding at this location;
- There is one incident reported by TW, which indicates flooding as a result of surcharge of sewer drainage assets. This occurred near to the base of Haverstock Hill; and
- Within the LBC dataset, flooding is largely attributed to unknown causes. A small number of properties attribute flooding to drain overflow and surcharge. When considered alongside the TW dataset, flooding within the hotspot is considered a result of surface water and surcharge of drainage assets.
- A visual representation of the flood mechanisms is presented within **Figure 4-12**.

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[24] Mirror, News Article: Severe Flooding Sparks Rail Chaos Leaving 3 Stations including Euston Lines Shut. Available: https://www.mirror.co.uk/news/uk-news/london-flooding-sparks-rail-chaos-24520531 [Accessed: 15/02/22]

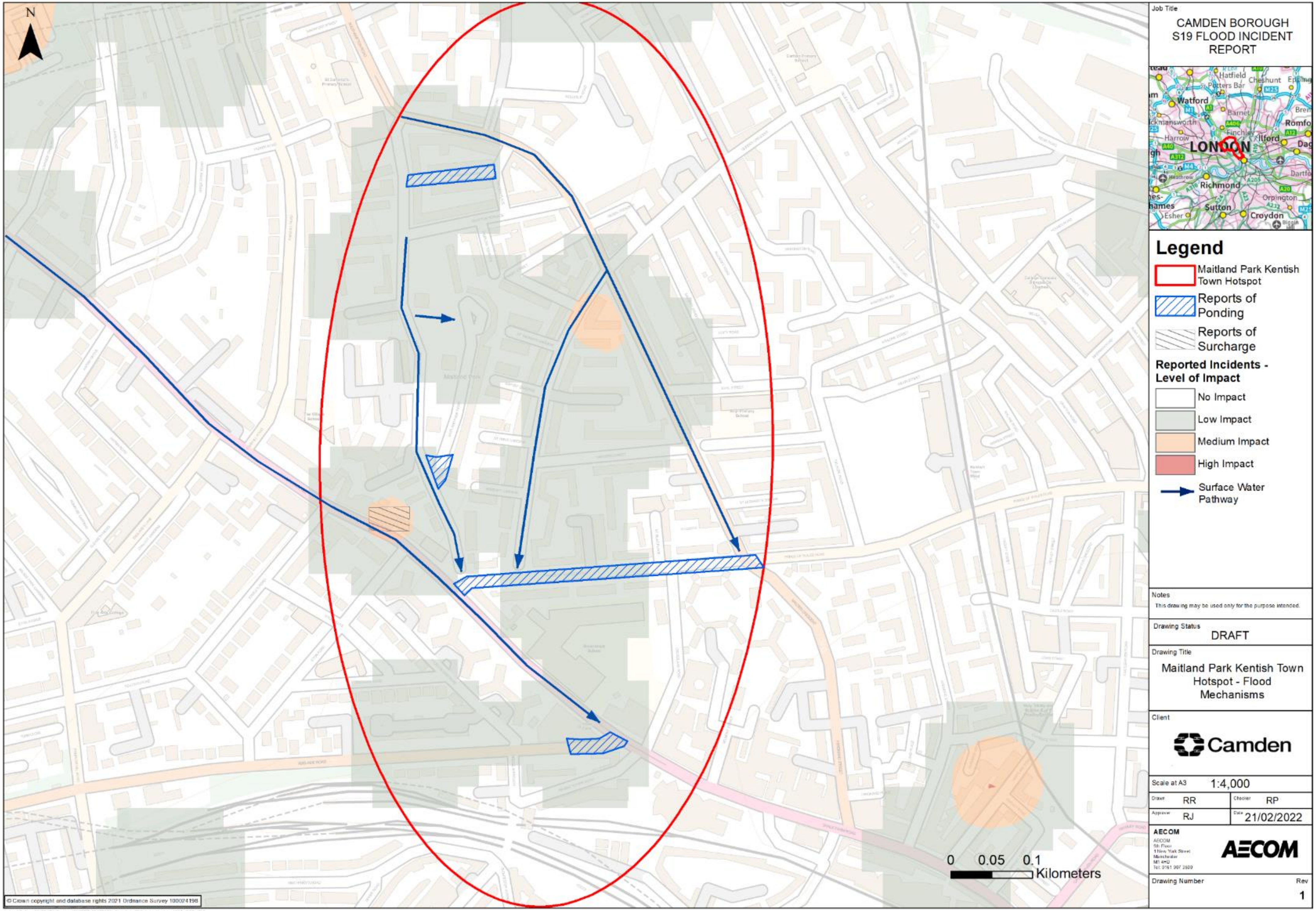



**Figure 4-12: Maitland Park Kentish Town Hotspot – Flood Mechanisms**

## 4.4 Belsize Park Swiss Cottage

### 4.4.1 Site Overview

The Belsize Park Swiss Cottage hotspot is located to the west and central area of the Camden Borough, as presented in **Figure 1-4**. The hotspot is largely formed of residential properties, which are connected through an extensive network of local access roads. A commercial centre is located south west of the hotspot, comprising of several retail outlets, healthcare services and community spaces, such as The Tavistock and Portman NHS Foundation Trust and The Winch Community Hub. The A41 borders the western boundary of the Belsize Park Swiss Cottage hotspot, to connect with the B509 in the southern region of the hotspot.

There are no large areas of public greenspace, due to the road network, commercial centre and number of properties within the hotspot, however there is a small area of greenspace located west of Winchester Road. All other greenspace in the area is limited to private gardens.

The site is underlain by a combined sewer network, which typically conveys sewer and surface water flows in a southerly direction, to be processed at the Beckton Sewage Works[19].

Key sites of interest within the Belsize Park Swiss Cottage hotspot are presented in **Figure 4-13**.

### 4.4.2 Flooding Impacts

LBC records eight properties were affected by the flood event on the 12th July, which resulted in 4 reports of internal flooding. There are three reports of flooding which are associated with an unknown date. In contrast, there were no reports of flooding to LBC on the 25th July. TW records suggest there were three reports of flooding on the 12th July and no reports on the 25th July. The total number of properties affected is presented in **Table 4-4**.

**Table 4-4: Belsize Park Swiss Cottage Hotspot – Reports of Flooding**

| Source | Date of Event | Total Number of Properties Reporting Flooding | Total Number of Properties Reporting Internal Flooding |
|---|---|---|---|
| LBC Records | 12th July 2021 | 8 | 4 |
| | 25th July 2021 | 0 | 0 |
| TW Records | 12th July 2021 | 3 | 0 |
| | 25th July 2021 | 0 | 0 |

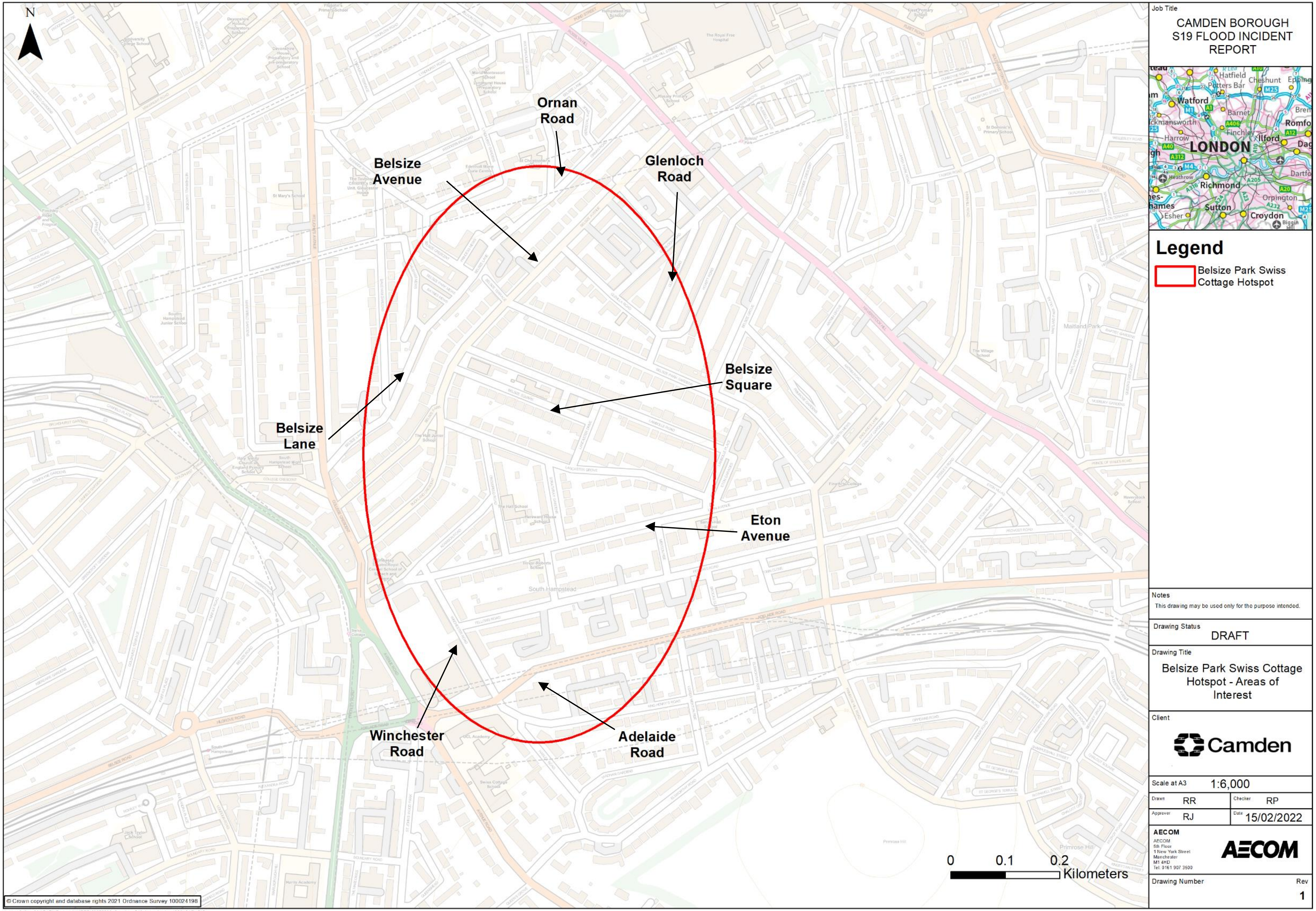



**Figure 4-13: Belsize Park Swiss Cottage Hotspot**

- All reports of internal flooding occurred on 12th July 2021. The areas of interest affected include Belsize Avenue, Adelaide Road, Glenloch Road and Winchester Road;
- Anecdotal evidence indicates exceedance of sewer drainage capacity on Ornan Road, located north east of Belsize Lane. The resident noted water ingress on the 12th July, with an affect on the lower ground floor property;
- As presented in **Photograph 57** and **Photograph 58**, The Winch Community Hub was subject to water ingress and resulted in damage to the facility, deposited silt and debris. News articles highlight the disruption caused by the flood on the 12th July event and imply the need for fundraising, in order to repair the level of damage;
- Anecdotal evidence indicates the Mora Burnet Care Home, Winchester Road experienced internal flooding. The incident notes damage to the pharmacy and medical clinic as a result of drain water, although the source of flooding is not specified. Reports to LBC suggest an estimated £100,000 of remedial works and disruption to the business;
- Anecdotal evidence from residents indicates a water accumulation in the gardens of multiple properties located on Belsize Square, however water ingress is not noted. Although the water level was significant, property thresholds offered a level of protection against ingress at this location;
- Records state two insurance claims were submitted for commercial properties on Winchester Road. Damage caused to commercial buildings had an impact on the wider community, due to its function. One insurance claim was submitted for a residential property on Glenloch Road, which is indicative of overspill and a direct impact on residents;
- Data provided by the LFB indicates there were multiple flood calls received on the 12th July; this is presented in **Figure 4-14**. The calls form a cluster around Belsize Avenue, Glenloch Road, Belsize Square, Belsize Park Gardens and Winchester Road. The reports range between 2 to 4 calls and 6 to 8 calls per 500m area;
- On the 25th July, two flood incidents are reported to the LFB on Glenloch Road and south of Belsize Park Gardens; this is presented in **Figure 4-15**. This implies the 12th and 25th July flood had an impact on similar areas within the hotspot, yet a greater level of disruption and impact to property on the 12th July; and

**Upon review of the anecdotal evidence, news articles and data supplied, the impact of flooding on the Belsize Park Swiss Cottage hotspot is considered to be high.**

**Photograph 57**

**Photograph 58**

*Source: Camden New Journal [Online], News Article Published 13th July 2021*

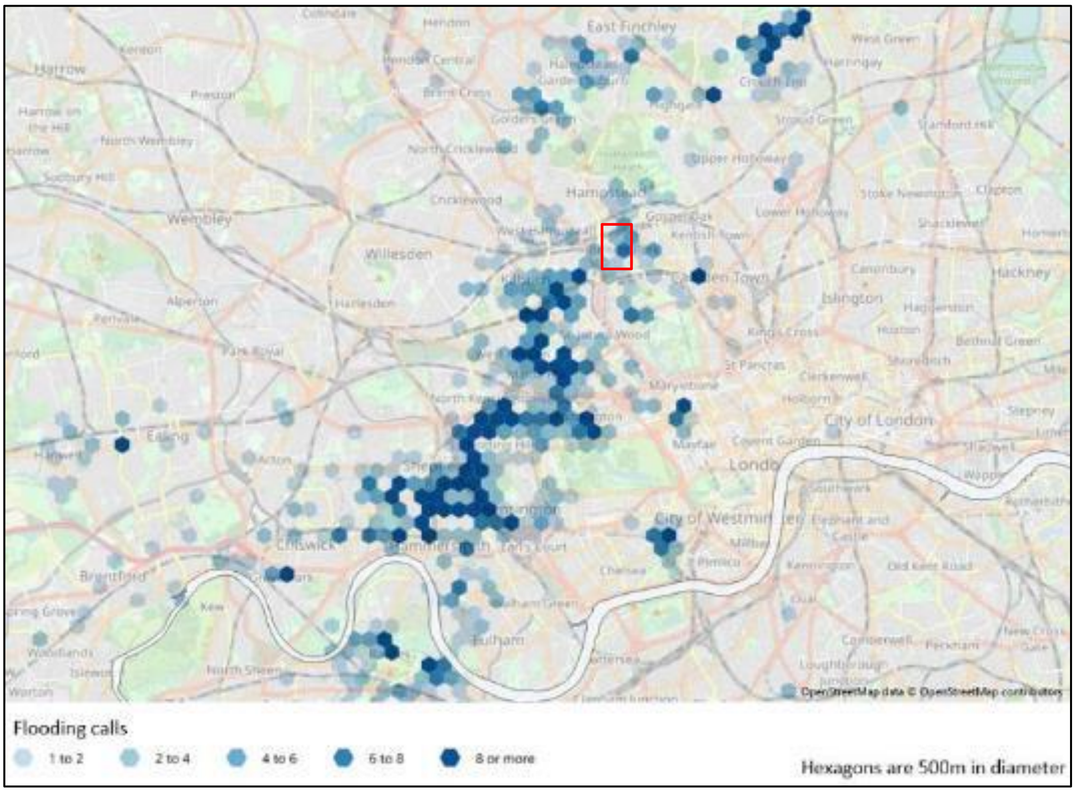



**Figure 4-14: LFB Incident Reports Belsize Park Swiss Cottage Hotspot (12th July)**

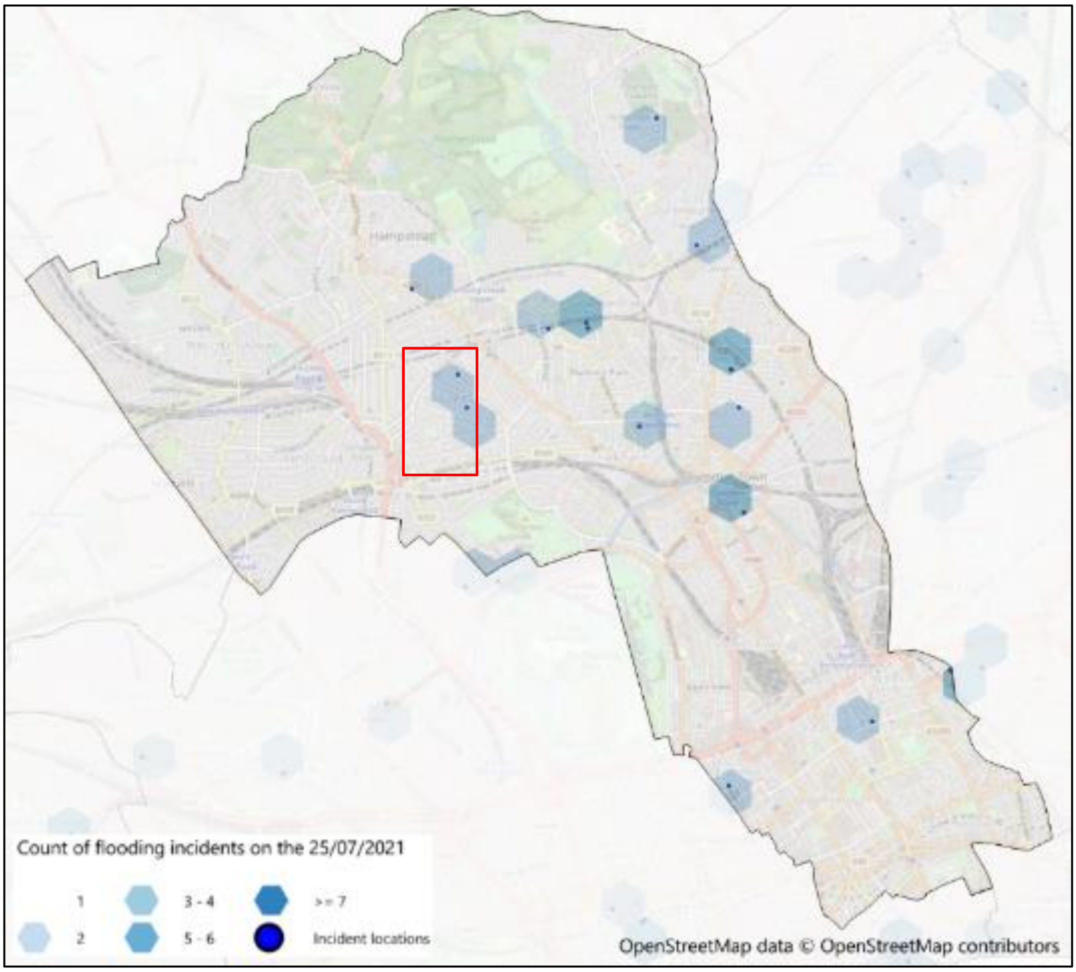



**Figure 4-15: LFB Incident Reports Belsize Park Swiss Cottage Hotspot (25th July)**

### 4.4.3 Site Observations

**Belsize Avenue**

Belsize Avenue is 500m in length and is one of the longest roads within the hotspot. As presented in **Photograph 59**, Belsize Avenue is characterised by a gentle slope, which facilitates the conveyance of flows south, toward roads situated within a low elevation; this includes Belsize Park and Buckland Crescent.

Belsize Avenue is connected to the A502, at the Haverstock Hill junction. Surface water flows from Haverstock Hill are likely to be conveyed toward Belsize Avenue, as a result of the decline in slope. As presented in **Photograph 60**, the junction is bordered by a wall which reduces overspill, thus increasing the volume of surface water conveyed on the road surface.

Belsize Avenue provides a large impermeable surface area, due to the road length and footpaths. However, there is some capacity for infiltration due to the greenspace of the area; approximately 2m of greenspace are found between the footpath and the properties on Belsize Avenue, which may increase infiltration. This may reduce the volume of surface water conveyed downslope, decreasing the likelihood and scale of ponding. The properties are typically set back ≥5m from the road and the property thresholds are raised above ground, reducing the risk of water ingress.

Photograph 59

Photograph 60

**Glenloch Road**

As presented in **Photograph 61**, Glenloch Road has a steep slope which declines south west. The road provides an unobstructed, direct impermeable surface to the lower elevations of the road. This will increase the rate of surface water flows down Glenloch Road.

Glenroch Road is connected to Haverstock Hill to the north east; Haverstock Hill is a key surface water pathway and flows may be conveyed toward Glenloch Road, as a result of the steep slope, increasing the volume of surface water on the road surface.

At the time of the site visit, the drains at the base of the slope consisted of leaves and debris; the condition of the drains is presented in **Photograph 62**. This indicates surface water flows occur frequently or are strong enough to transport large volumes of debris downslope, increasing the risk of sewer surcharge.

A large number of properties have a ground floor below road level. Should surface water flows on Glenloch Road exceed kerb height, there is a potential risk of water ingress. However, many of these properties are bordered by a wall, which offers a small level of protection.

Photograph 61

Photograph 62

**Belsize Square & Belsize Park Gardens**

As presented in **Photograph 63**, Belsize Square is a level road with no distinguishable slope and is situated in an area of low elevation relative to its surroundings. Belsize Park Gardens exhibits a similar topography, with no distinguishable slope.

Belsize Square and Belsize Park Gardens are located downslope of Belsize Avenue and may therefore be affected by flows. However, the junction of both Belsize Square and Belsize Park Gardens are raised by a road calming measure; this is presented in **Photograph 64**. The raised level acts as an obstruction to flow and reduces the likelihood of ponding. Transfer of surface water across the road calming measure is possible during high flow.

The majority of properties have a ground floor below the road level. In the event of surface water levels exceeding the kerb height, these properties may be at risk from flooding. However, the properties are typically bordered by a wall or fence, acting as a barrier to surface water and reducing the likelihood of water ingress.

Photograph 63

Photograph 64

### Eton Avenue

As presented in **Photograph 65**, Eton Avenue provides a level terrain with no distinguishable slope. For this reason, the emergence of a surface water pathway on Eton Avenue is considered unlikely.

Although Eton Avenue is located in an area of low elevation relative to other areas of interest in the hotspot, it is not directly connected via the road network. Surface water flows arising in other areas of the Belsize Park Swiss Cottage hotspot are therefore unlikely to impact Eton Avenue, despite its low elevation. Properties on Eton Avenue are typically set back ≥5m from the road and are bordered by a wall. This offers protection against surface water, should ponding or sewer surcharge occur.

**Photograph 65**

### Belsize Lane

Belsize Lane is one of the longest roads within the Belsize Park Swiss Cottage hotspot, extending from Haverstock Hill in the east, to Fitzjohn's Avenue in the west. The slope of the road varies greatly between the western and eastern sections of the road. As presented in **Photograph 66**, there is no distinguishable slope in the western and central sections of Belsize Lane. In contrast, the eastern section of the road, at the junction of Belsize Lane and Ornan Road, is characterised by a steep slope rising north, to meet Haverstock Hill.

The impermeable surface area of Belsize Lane is large, due to the length of the road. There is limited greenspace due to the footpaths, parking spaces and driveways on the roadside, therefore the capacity for infiltration is low. The topography and impermeable surface area of Belsize Lane is likely to result in ponding, which may increase the risk of exceeded sewer drainage capacity and surcharge of these assets.

The Tavistock and Portman NHS Foundation Trust is adjacent to the junction of Fitzjohn's Avenue and Belsize Lane. Although a large proportion of the site is raised above road level, an access point to the rear of the building is provided via a steep slope; as presented in **Photograph 67**. Should surface water pond on site, or transfer from Belsize Lane, surface water will be conveyed downslope and could impact the rear of the building. It was not possible to access this area, as it is located on private property.

Photograph 66


Photograph 67

**Winchester Road**

Winchester Road is characterised by a steep slope which declines south, toward Adelaide Road (B509); this is presented in **Photograph 68**. The road is straight and wide, due to the width of the carriageway and roadside parking. Winchester Road therefore provides a direct, impermeable surface toward the lower elevations; this is likely to increase the rate and volume of surface water conveyed downslope, which could increase risk of exceeded sewer drainage capacity.

The Fellows Road junction is located at the mid-point of Winchester Road. As presented in **Photograph 69**, Fellows Road gradually declines in slope toward the junction; this is likely to contribute to surface water flows on Winchester Road.

At the junction, the road surface is slightly raised due to the design of a road calming measure; this is presented in **Photograph 70**. The measure is likely to obstruct or slow flows, resulting in ponding at this location. As indicated in **Photograph 71**, the kerb heights at this location are equal to road level, facilitating the transfer of surface water to the footpaths and toward nearby properties, increasing the risk of water ingress.

The road surface at the junction undulates, creating an uneven terrain which declines west, toward the footpath and property; as presented in **Photograph 70**. The slope, condition of the road surface and kerb height, are highly likely to result in the accumulation of surface water at this location and the conveyance of flows toward properties on the western side of Winchester Road.

As presented in **Photograph 72**, there are several commercial properties located west of the junction of Fellows Road, including The Winch Community Hub. The threshold of these properties reaches approximately 100mm. Although the threshold is raised above road level and may offer a level of protection against water ingress, the risk of water ingress is high due to the kerb height and road surface, which declines to the footpath.

Behind the properties on Winchester Road, there is an area of landscaped greenspace. As presented in **Photograph 73**, the greenspace has a gradual slope which declines east toward the rear entrance of properties on Winchester Road. There is a wide footpath from the greenspace to Winchester Road, that borders the western boundary of The Winch; as presented in **Photograph 74**. The footpath provides an impermeable surface, to convey surface water downslope, from the greenspace toward Winchester Road. This creates an additional pathway, increasing the volume of surface water conveyed toward Winchester Road, thus increasing the risk of flooding and exceeded sewer drainage capacity.


Photograph 68


Photograph 69


Photograph 70


Photograph 71


Photograph 72


Photograph 73


Photograph 74

**Adelaide Road (B509)**

The western section of Adelaide Road is located at the base of Winchester Road, in an area of low elevation. Adelaide Road has a gentle slope which declines to the west, toward Winchester Road junction. It forms part of the B509, providing key access to the A41; to accommodate for the volume of traffic, the road is designed as a dual carriageway and has a large impermeable surface area. The slope and width of Adelaide Road, and the connectivity with Winchester Road, increases the volume of surface water conveyed to the lower elevations.

Properties at this location consist of apartments and commercial buildings, which are set back ≥5m from the road, or are bordered by a wall. In the event of ponding and surface water flows, it is considered unlikely that properties will be affected due to the distance from Adelaide Road.

### 4.4.4 Flooding Mechanisms

Following a review of the data, stakeholder consultation and site walkover it is concluded that the flooding within the Belsize Park Swiss Cottage hotspot was a result of the following:

- The slope and width of roads, such as Belsize Avenue and Winchester Road, resulted in the emergence of two key pathways within the hotspot. The flows conveyed large volumes of surface water to connecting roads. This corresponds with a review conducted by LBC, which found a blocked gully on Belsize Park, and evidence of internal flooding on Winchester Road. The blocked gully was recorded on the 26th July, following the flood event. Therefore, it is considered likely the blockage occurred as a result of debris conveyed by surface water pathways during the 25th July flood event;
- Smaller surface water pathways emerged on Glenloch Road and the north eastern section of Belsize Lane, due to the steep slope. This contributed to the volume of surface water conveyed to the lower elevations;
- Communications between residents and LBC indicate exceeded drainage capacity on Belsize Lane, resulting in surcharge of drainage assets;
- The large impermeable surface area of the site and reduced infiltration capacity, led to ponding in areas of level terrain, such as Belsize Square and Belsize Park Gardens. A review conducted by LBC states the presence of blocked gullies on Belsize Park Gardens, which is indicative of ponding. The blocked gully was recorded on the 13th and 16th July, following the 12th July flood. This suggests the blockage occurred as a result of debris conveyed during the event;
- Although greenspace adjacent to Belsize Avenue and Winchester Road may offer some capacity for infiltration, the antecedent conditions resulted in saturated ground on the 12th and 25th July. This is likely to have prevented infiltration, resulting in larger flows;
- The road design and low kerb heights of Winchester Road and the Fellows Road junction, combined with the low threshold of commercial properties at this location, renders the properties susceptible to water ingress. This is exacerbated by the landscaping of the adjacent greenspace, which slopes toward the rear of the properties; and
- TW data indicate three properties were affected by sewer surcharge (12th July) within the Belsize Park Swiss Cottage hotspot. All are located west of the hotspot, in areas of low elevation and are underlain by a combined sewer network. Evidence of sewer surcharge is supported by news articles, which state water flowed up from plugholes and appeared from pipes at The Winch Community Hub (12th July)[25]. Flood mechanisms at this location are therefore associated with surface water and surcharge of sewer drainage assets.
- A visual representation of the flood mechanisms is presented in **Figure 4-16**.

[25] Camden New Journal, News Article: The Winch Counts Cost of Damage After Flooding Nightmare. Available: https://www.camdennewjournal.co.uk/article/the-winch-counts-cost-of-damage-after-flooding-nightmare [Accessed: 15/02/22]

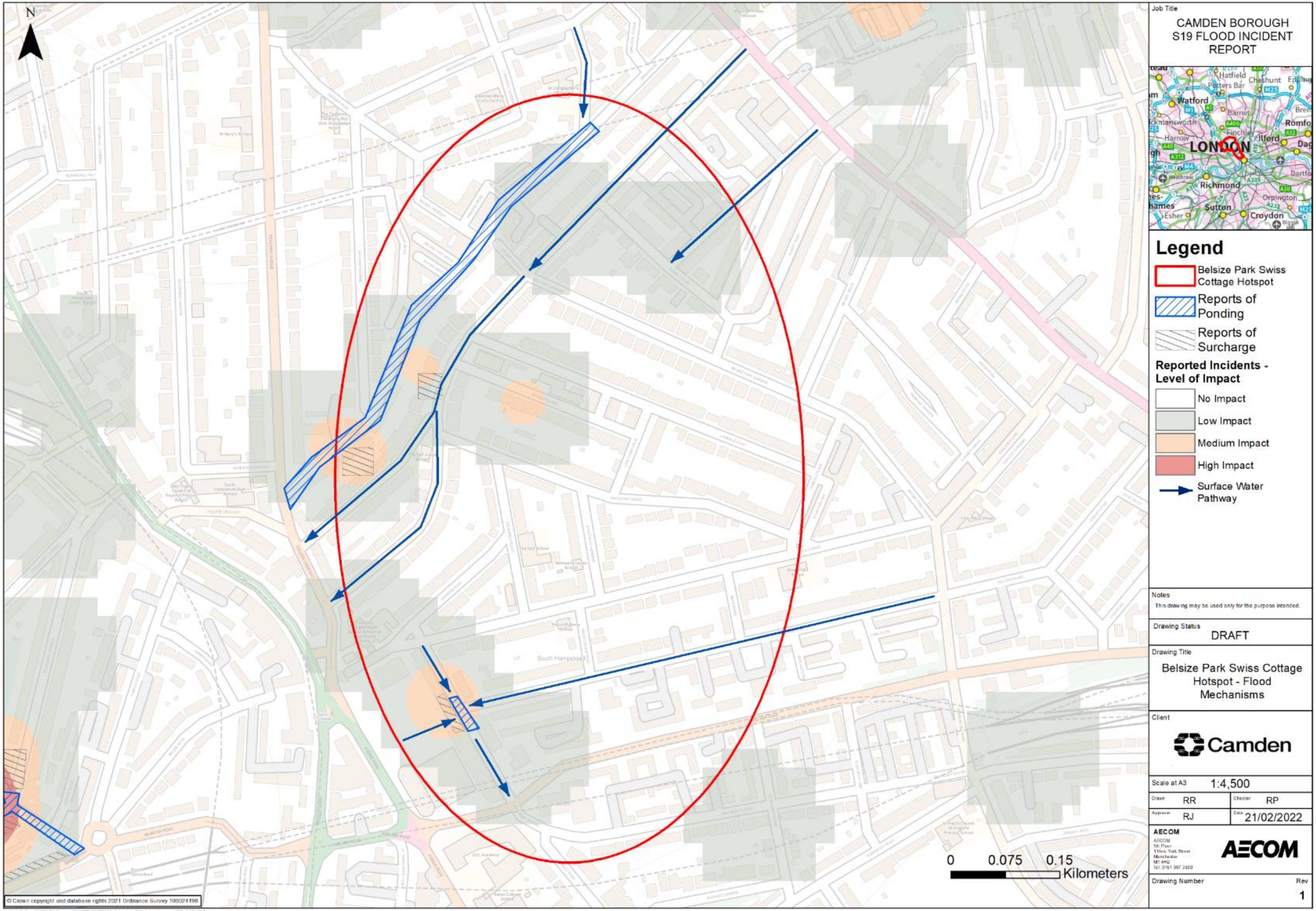



Figure 4-16: Belsize Park Swiss Cottage Hotspot - Flood Mechanisms

## 4.5 Hampstead Kingsgate

### 4.5.1 Site Overview

As presented in **Figure 1-4**, the Hampstead Kingsgate hotspot comprises of two sites located west of the Camden Borough. The sites have been grouped for the purposes of this Section 19 Flood Investigation due to the size of area covered and proximity.

The Hampstead Kingsgate hotspot is predominantly residential, consisting of terraced housing and apartment buildings. A number of small commercial properties are located within the hotspot. The area is densely populated and connected through a series of local roads and the B509 (Belsize Road). For this reason, there is no identifiable public greenspace within the hotspot. All greenspace is limited to private property.

There are two underground stations found in the Hampstead Kingsgate hotspot, including South Hampstead and Kilburn High Road Underground station; these stations are found to the south east and south west of the hotspot, respectively.

The site is predominantly underlain by a combined sewer network, which conveys sewer and surface water flows in a south westerly direction, to be processed at the Beckton Sewage Works[19]. As presented in **Figure 4-17**, a storm relief sewer named the North West Storm Relief Sewer (NWSR) underlies a small section of Belsize Road[14], conveying water in a southerly direction. Findings within the SFRA (2014) indicate the NWSR was designed to accommodate a 1 in 10 year Annual Exceedance Probability (AEP) storm event.

Key sites of interest within the Hampstead Kingsgate hotspot are presented in **Figure 4-18**.

### 4.5.2 Flooding Impacts

LBC records indicate 18 properties were affected by the flood event on the 12th July, which resulted in 15 exports of internal flooding. There was one report of flooding to LBC on the 25th July and one report associated with an unknown date. TW records suggest there were 34 reports of flooding on the 12th July and one report on the 25th July. Anecdotal evidence indicates the properties experienced internal flooding, yet the specific number is not confirmed. The total number of properties affected is presented in **Table 4-5**.

The records of flooded properties provided by LBC and TW differ from local perception; anecdotal evidence provided by the South Hampstead FAG suggest >100 properties were affected by the flooding on the 12th July. The difference may be a result of poor community awareness, which could reduce the total number of reports successfully shared with LBC. This is explored further in **Section 5.2.2**;

**Table 4-5: Hampstead Kingsgate Hotspot – Reports of Flooding**

| Source | Date of Event | Total Number of Properties Reporting Flooding | Total Number of Properties Reporting Internal Flooding |
|---|---|---|---|
| LBC Records | 12th July 2021 | 18 | 15 |
| | 25th July 2021 | 1 | 0 |
| TW Records | 12th July 2021 | 34 | 0 |
| | 25th July 2021 | 1 | 0 |

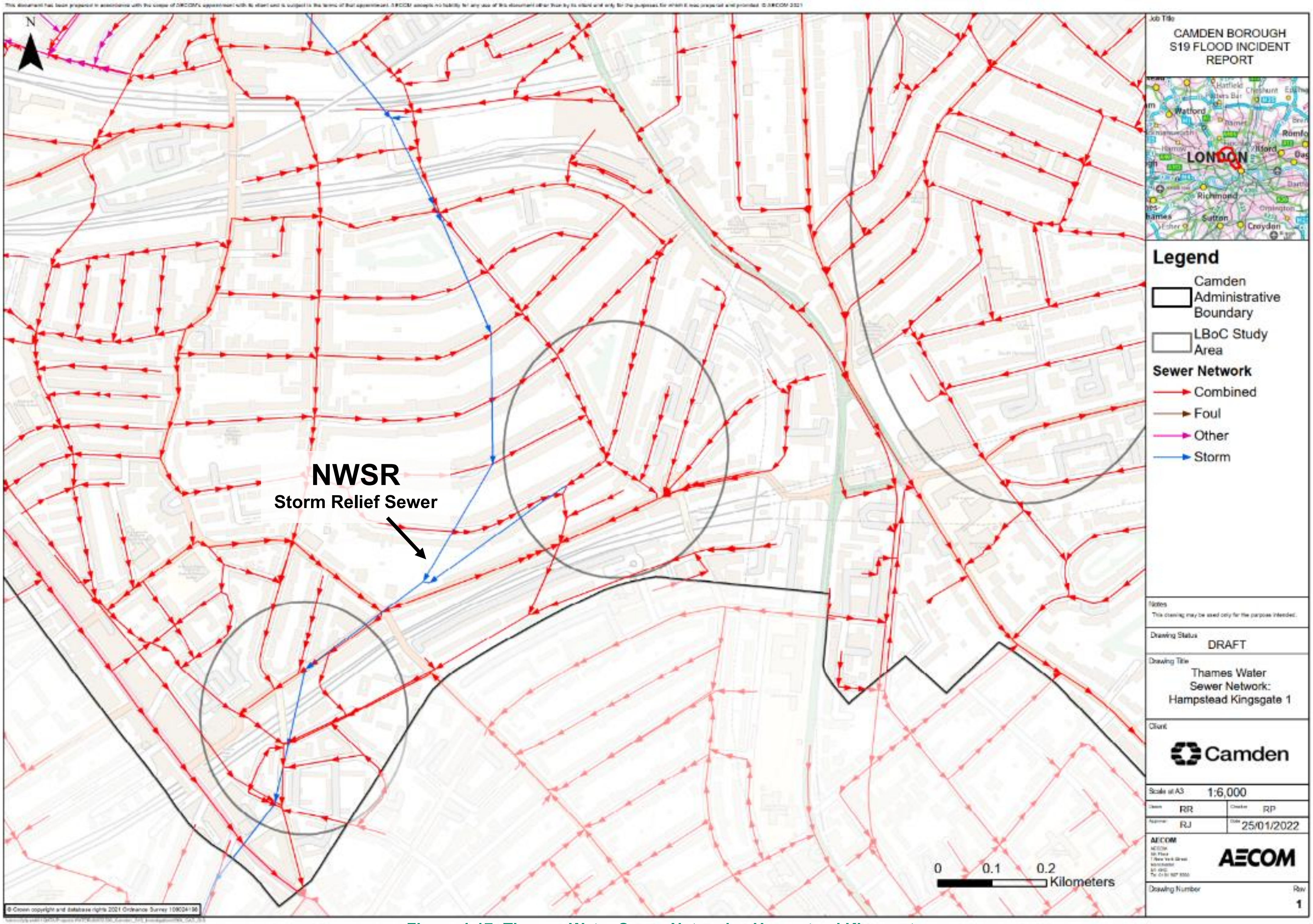



Figure 4-17: Thames Water Sewer Network – Hampstead Kingsgate

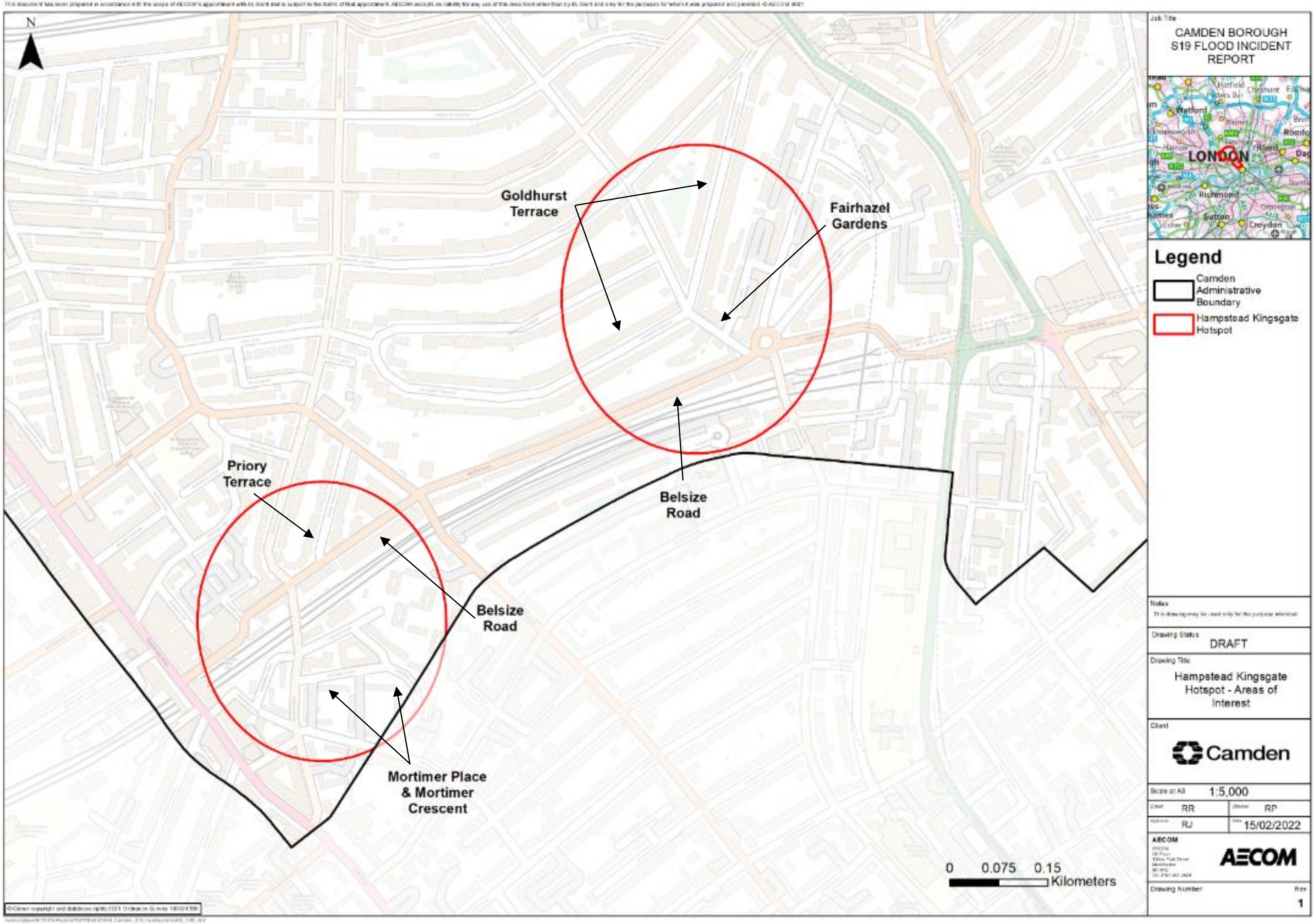



Figure 4-18: Hampstead Kingsgate Hotspots

- Internal flooding was observed on the 12th July, affecting several properties on Belsize Road. As presented in **Photograph 75** the water level was observed to reach approximately 1m above ground level in one of the properties affected;
- There are several instances on Belsize Road, whereby the water level exceeded the height of basement windows (12th July). This is presented in **Photograph 76**;
- As presented in **Photograph 77**, a manhole on Belsize Road surcharged, as a result of the high flows. This contributed to the water level height, which reached approximately 300 mm. It is not possible to determine whether this represents the peak height of the water level;
- Anecdotal evidence states a lift within an apartment building on Belsize Road were inaccessible for 29 days, limiting access to 119 apartments within the building. The detail highlights the distress experienced by residents, with particular reference to members of the vulnerable community;
- As presented in **Photograph 78**, a manhole cover on Goldhurst Terrace was surcharging onto the road, contributing to the water level height. As presented in **Photograph 79**, the water level reached approximately 200mm. It is not possible to determine whether this represents the peak height of the water level;
- Anecdotal evidence indicates long term water damage to basement walls of properties located on Goldhurst Terrace; **Photograph 80** presents the water damage to a basement wall, six months after the 12th July event.
- Anecdotal evidence indicates the water level exceeded the height of car doors on Goldhurst Terrace, resulting in water pooling in the footwell; this is presented in **Photograph** 81. Detail provided by the South Hampstead FAG states two cars were written off, due to the water level within an underground car park on Belsize Road;
- Local residents state the commercial properties located to the south of Fairhazel Gardens were flooded, including a restaurant, dry cleaners and newsagent. Damage caused to commercial buildings had an impact on the wider community, due to its function;
- As indicated within the TW dataset, properties at the base of Priory Terrace and Priory Road reported flood incidents associated with surcharge of sewer drainage assets (12th July). On this date, highways data provided by LBC also note a burst main on Priory Terrace. It is considered likely the two events occurred at this location, due to exceeded capacity of the highway drainage system and sewer networks;
- Anecdotal evidence states local residents were responsible for assisting a vulnerable individual out of their ground floor apartment on Priory Road, on 12th July;
- Data provided by LFB indicates multiple flood calls were received by the LFB on the 12th July. The calls are reported in all areas of the Hampstead Kingsgate hotspot; this is presented in **Figure 4-19**;
- On the 25th July, there were not flood calls was received by LFB within the hotspot; this is presented in **Figure 4-20**.
- Records indicates several insurance claims have been submitted for residential properties, including: Belsize Road, Goldhurst Terrace and Fairhazel Gardens. There is one record of an insurance claim for a commercial property within the hotspot, located on Belsize Road. The claim data corresponds with anecdotal, indicating a significant level of damage has been caused; and

**Upon review of the anecdotal evidence, news articles and data supplied, the impact of flooding on the Hampstead Kingsgate hotspot is considered to be high due to the number of properties affected, impact on commercial buildings and damage to possessions.**

**Photograph 75**

**Photograph 76**

**Photograph 77**

**Photograph 78**

**Photograph 79**

**Photograph 80**

**Photograph 81**

*Photographs 75-81*
*Source: South Hampstead FAG*

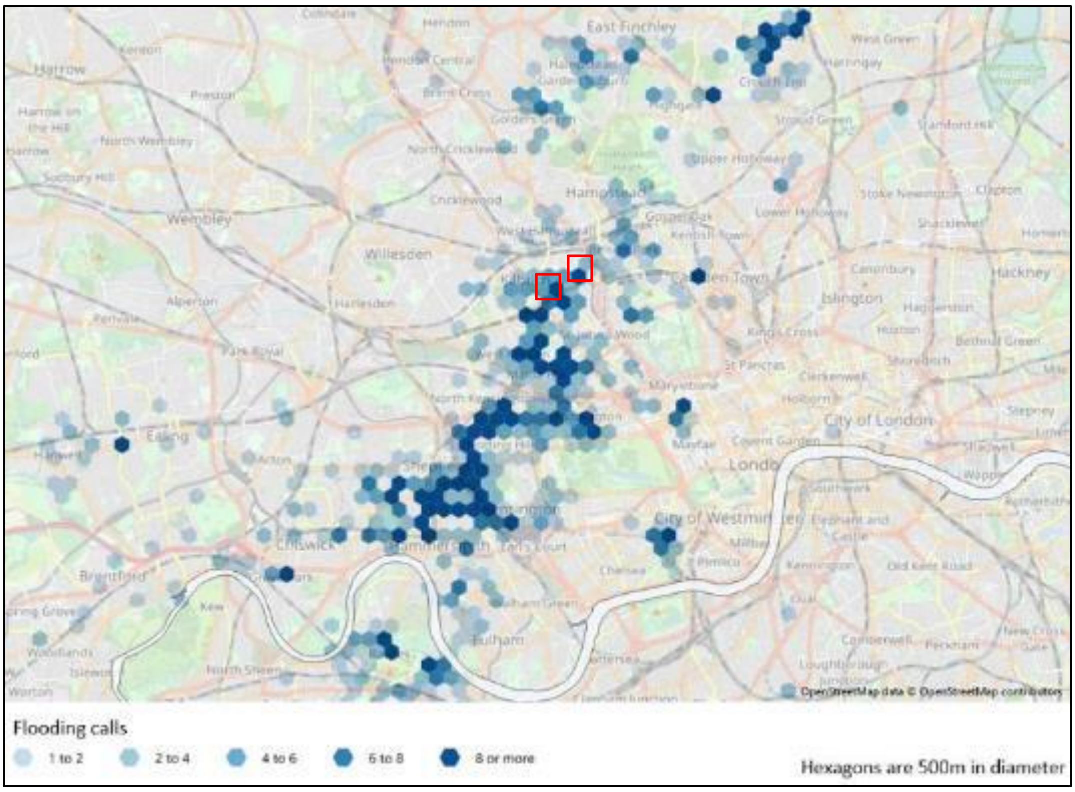



**Figure 4-19: LFB Incident Reports Hampstead Kingsgate Hotspot (12th July)**

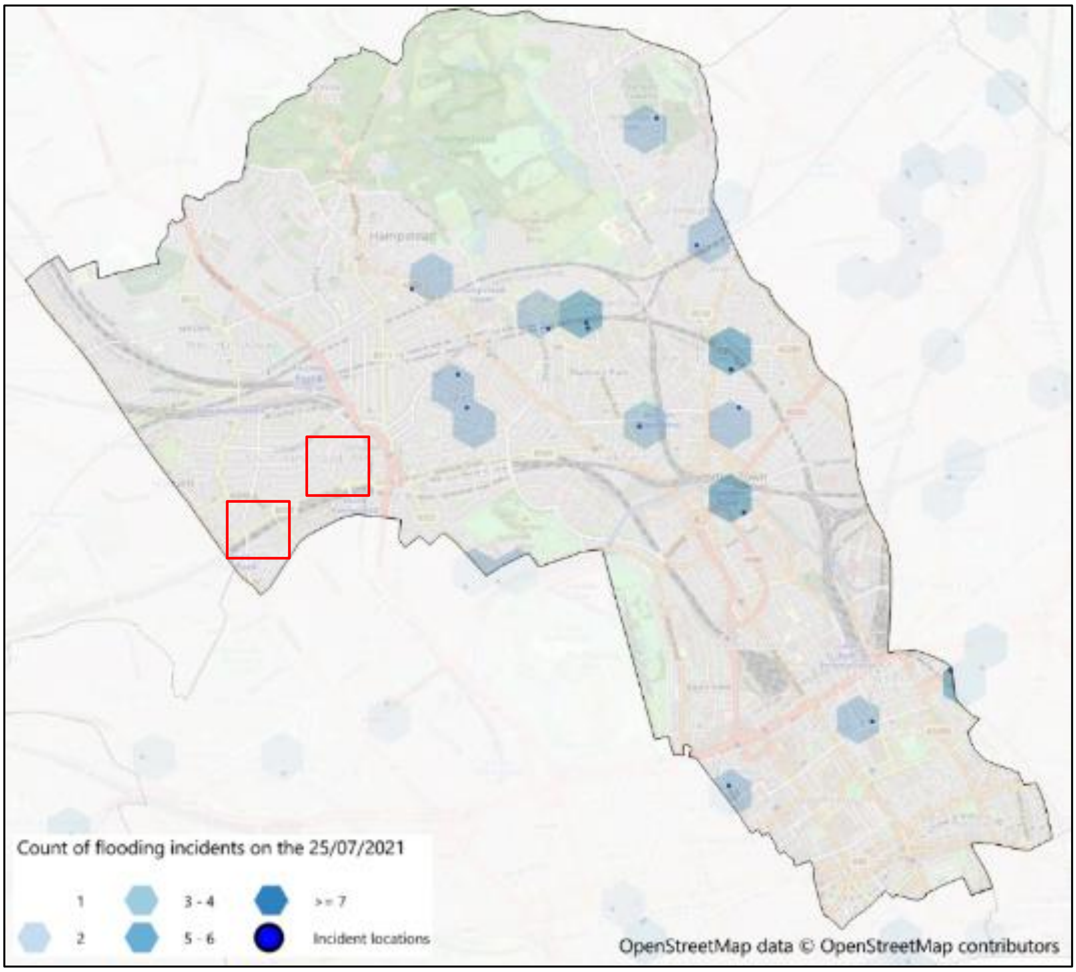



**Figure 4-20: LFB Incident Reports Hampstead Kingsgate Hotspot (25th July)**

### 4.5.3 Site Observations

**Goldhurst Terrace**

As presented in **Photograph 82**, the eastern section of Goldhurst Terrace is characterised by a steep slope which declines to the south west, toward the junction of Fairhazel Gardens. The steep gradient is expected to increase the rate and volume of surface water conveyed downslope, toward the junction and the western section of Goldhurst Terrace.

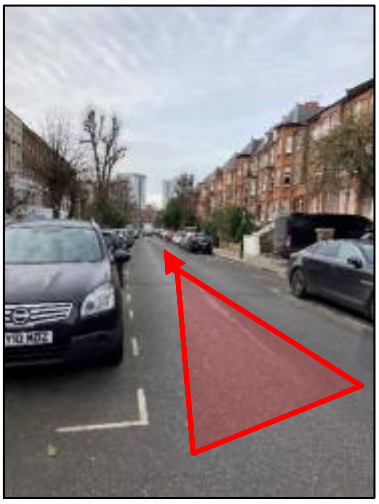
The slope becomes level at the junction, creating an area of low elevation. As such, surface water is expected to accumulate at this location. As presented in **Photograph 83**, the kerb heights are level with the road. This could result in the transfer of surface water to the footpath and conveyance of flow to property thresholds.

From the junction and in the western sections of Goldhurst Terrace, the slope gradually declines to the west; this is presented in **Photograph 84**. This creates a continuous pathway from the north eastern section of the road, increasing the volume of surface water conveyed to the lower elevations. The gradual slope is likely to reduce the flow rate, resulting in the accumulation of surface water in the western sections of the road.

There are several speed bumps on Goldhurst Terrace, extending across the width of the road. This may obstruct flows, causing a build-up of surface water which may subsequently overspill onto the footpath. A large proportion of properties have a ground floor lower than road level. Should surface water transfer to the footpath, the ground floor of a property would be susceptible to water ingress.

Photograph 82

Photograph 83



Photograph 84

**Fairhazel Gardens**

The northern section of Fairhazel Gardens is characterised by a steep slope, which declines south to the junction of Goldhurst Terrace. South of the junction, there is no distinguishable slope of Fairhazel Gardens; as presented in **Photograph 85**. This results in the accumulation of surface water at the junction and may result in ponding on the southern sections of the road surface.

There are several commercial properties located south of Fairhazel Gardens. The threshold of properties at this location are typically equal to the footpath; an example of this is presented in **Photograph 86**. Should surface water transfer to the footpath, the properties are susceptible to water ingress due to the low threshold.

Photograph 85

Photograph 86

**Belsize Road (B509)**

The north eastern section of Belsize Road is characterised by a steep slope, which declines to the south west, toward the junction of Fairhazel Gardens. The steep gradient is likely to increase the volume and rate of surface water flows conveyed to the lower elevations.

As presented in **Photograph 87**, the western section of Belsize Road is characterised by a gentle slope, which declines south west toward Priory Terrace and Kilburn High Road.

Although the gradient is small, Belsize Road forms part of the B509 and is the widest and longest road within the Hampstead Kingsgate hotspots. There is a significant difference in elevation between the eastern and western section of the road, which is likely to increase the rate and volume of surface water conveyed to the lower elevations.

The wide carriageway is bordered by a footpath on both sides, which ranges in width between 1m – 4m. In addition to this, eastern sections of Belsize Road are bordered by parking spaces; this is presented in **Photograph 88**. This creates a large impermeable surface area and reduces capacity for infiltration, increasing the volume of surface water conveyed downslope. A park is situated north of Belsize Road and may offer the potential for infiltration. However, the size of the greenspace is small relative to the surroundings, thus will provide little benefit the reduction of surface water volume or flow rate.

A large proportion of properties on Belsize Road have a ground floor located below road level. Should surface water transfer onto the footpath, the ground floor of a property may be susceptible to water ingress. Despite this, the majority of the properties are bordered by walls, which may reduce the likelihood of surface water approaching the threshold and could offer a level of protection against water ingress.

Photograph 87

Photograph 88

**Priory Terrace and Priory Road**

Priory Terrace is characterised as a steep slope, which declines south west and curves toward Belsize Road; as presented in **Photograph 89**. The difference in elevation is likely to result in the conveyance of surface water to Belszie Road, contributing to the volume of surface water in this area.

As presented in **Photograph 90**, a speed bump is situated at the junction of Priory Terrace and Belsize Road, at the base of the slope. This may obstruct flows and could lead to ponding and/or surcharge of assets at this location, in the event of exceeded sewer drainage capacity.

Priory Road is situated west of Priory Terrace and exhibits a similar topography, with a steep slope that declines toward Belsize Road. A large number of properties on Priory Terrace have a ground floor located below road level, which increases the risk of flooding in the event of overspill onto the footpath. Properties located at the base of Priory Road and Belsize Road are at greatest risk, due to the conveyance of surface water to the lower elevations. An example of a ground floor apartment set 2m below ground level is presented in **Photograph 91**.

Photograph 89

Photograph 90

Photograph 91

**Mortimer Place & Mortimer Crescent**

Mortimer Place has a gentle slope which inclines west, toward the junction of Mortimer Crescent; this is presented in **Photograph 92**. Mortimer Crescent has a gentle slope which peaks at the junction; the northern and southern section of Mortimer Crescent gradually declines from the peak and toward Greville Road.

The slope of both Mortimer Place and Mortimer Crescent is likely increase the rate and volume of surface water conveyed on the road surface. A solid wall outlines the grounds of the apartment buildings which face onto the road, providing a barrier to flow and a level of protection against water ingress.

As presented in **Photograph 93**, an access road is situated between the apartment buildings; this is characterised by a steep slope, which declines north toward Mortimer Place. Although the access road may increase the risk to nearby properties, due to its proximity, the ground floor apartments are bordered by greenspace which offers the capacity for infiltration. This may slow any emerging flows, thus reducing the risk of water ingress.

Photograph 92

Photograph 93

### 4.5.4 Flooding Mechanisms

Upon review of the flood incident data, anecdotal evidence and site work conducted, it was concluded that the flooding within the Hampstead Kingsgate area was a result of the following:

- The rate and volume of surface water flows within the hotspot was increased by the steep topography of roads, including Goldhurst Terrace, Fairhazel Gardens, Priory Road and the north eastern section of Belsize Road. This led to the emergence of several key pathways, which is supported by anecdotal evidence and a review conducted by LBC which identified blocked gullies;
- LBC reports indicate the Fairhazel Gardens gully blockage was recorded on 22nd July. This follows the 12th July flood event and could be a result of debris conveyed by surface water pathways. Three incidents of blocked gullies were reported at the junction of Priory Road, recorded on the 7th, 16th and 27th July. It is likely the incidents recorded on the 16th and 27th were a result of the 12th and 25th flood event, respectively. The incident recorded on the 7th July occurred prior to the flood events and may therefore have contributed to reduced drainage capacity;
- The gentle slope, length and width of the western section of Belsize Road enabled the emergence of a key flooding pathway, to convey large volumes of surface water in a westerly direction. This corresponds with a review conducted by LBC, which found gullies and drains were blocked as a result of high flows, following the 12th and 25th July event;
- The accumulation of surface water occurred at the base of slopes, where the road levelled out to a flat surface; this includes Goldhurst Terrace, Priory Terrace and Priory Road. At these locations, TW data confirm there were numerous flood incidents relating to sewer surcharge on the 12th July and one incident on the 25th July. This suggests the intensity of the rainfall exceeded the design standard of the drainage network and that this was a predominant driver of flooding within several areas of the Hampstead Kingsgate hotspot;
- Speed bumps and road calming structures obstructed flows and resulted in pooling on the roads. This increased the water level and allowed for surface water to approach properties. This corresponds with anecdotal evidence of ponding near to the speed bump on Priory Road;
- Anecdotal evidence provided by local residents indicate that gullies and drains were blocked in the Hampstead Kingsgate hotspot on the 12th July. The blocked gullies are thought to have affected drainage efficiency, resulting in ponding. Discussions with residents suggest the gullies were cleared two weeks prior to the event, yet became blocked during the flood. Residents were taking action to clear gullies before the flood event on the 25th July, to mitigate the impact;
- The presence of a foul and surface water network increases the risk of flooding from multiple sources within the hotspot;
- The large impermeable surface area of the site and reduced infiltration capacity, resulted in greater volumes of surface water to be conveyed downslope and to pond in localised areas;
- A visual representation of the flood mechanisms is presented in **Figure 4-21.**


Figure 4-21: Hampstead Kingsgate Hotspot - Flood Mechanisms

## 4.6 Other Affected Areas

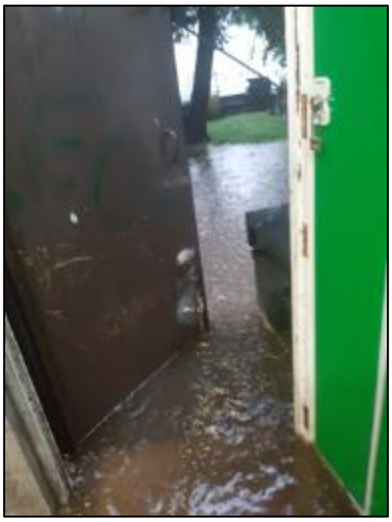
**Kilburn Grange Park**

Kilburn Grange Park is located west of the Camden Borough and is north of the Hampstead Kingsgate hotspot. The location of the park relative to the hotspots is presented in **Figure 4-22**.

As presented in **Photograph 94** and **Photograph 95**, a large area of the playground was flooded and there was evidence of water ingress in the Attendant's Building, adjacent to the play area; the area affected is highlighted in **Figure 4-22**. The flooding occurred on the 12th July.

It was observed from the site visit that the playground and Attendant's Building is situated within a localised area of low elevation, at the base of several small slopes found within the within the Kilburn Grange Park greenspace. Surface water flows are likely to be conveyed to the low elevation and accumulate on the playground, which is partly formed of impermeable material. There are no incident records to indicate the neighbouring Primary School flooded on the 12th or 25th July 2021.

**Photograph 94**



**Photograph 95**

*Source: LBC Records of the July 2021 Flood Event*

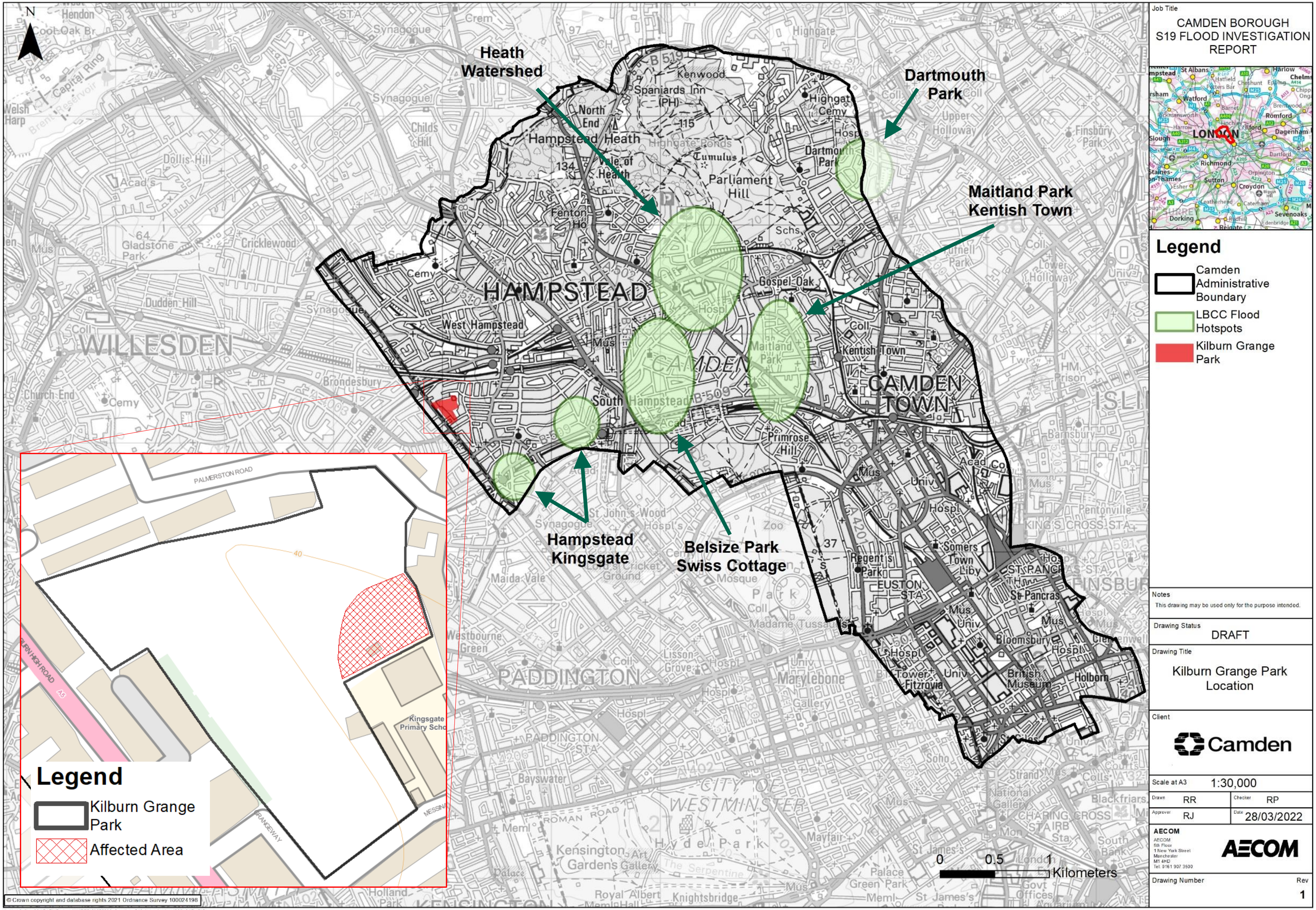



**Figure 4-22: Site Location – Kilburn Grange Park**

# 5. RMA Response to the Flooding

## 5.1 Flood Incident Response – Core Themes

The following themes characterise the flood event and incident response that occurred on the 12th and 25th July 2021:

- There was limited (if any) warning before the flooding occurred;
- When flooding did occur, it was widespread and happened very rapidly. There was little lead time to develop an effective response; and
- The RMA and emergency response was impacted by the gradual exchange of information and availability of resources.

The core themes are explored further in the sub-headings below.

### 5.1.1 Limited Warning

As discussed in **Section 3**, the antecedent conditions represented the fifth wettest three month combined rainfall total (May-July). Despite this, there was limited warning in the days preceding the July 2021 flood events, due to the densely populated urban landscape and the nature of rainfall.

The large impermeable surface area of each hotspot creates a flashy response to rainfall, meaning the onset of a flood event occurs quickly and can be difficult to predict. The rainfall was highly localised, as indicated through the high degree of spatial variation between gauge readings.

The localised nature of rainfall may have resulted in discrepancies within the gauge readings, impacting the capacity to predict a flood event and provide sufficient warning.

The historic record of warnings issued by the Met Office[26] indicate a National Severe Weather Warning Service (NSWWS) of rain was released on the 11th July 2021 and a NSWWS of thunderstorms on the 26th July 2021. No NSWWS is listed for the 12th July. The record does not list a local weather warning for the 12th and 26th July, and LBC note there was no local storm warning for the London region. The limited warning is considered to have impacted the capacity to develop an effective response to the flood events.

### 5.1.2 Rapid Onset

As the majority of flooding occurred on the 12th July resulted from surface water, there was very little lead time between the first signs of flooding and effect on property. This impacted the capacity for RMAs and emergency responders to effectively mobilise resources, contact the relevant authorities and identify areas at greatest risk.

In addition, the flood event of the 12th and 25th July occurred in short succession, meaning there was little opportunity to investigate reasons for the flooding, nor time to review all areas and properties affected. Therefore, any lessons learnt from the 12th July flood event could not be applied to the subsequent event.

### 5.1.3 Exchange of Information

Given the lack of flood warnings and limited lead time that preceded the flood event, RMAs involved were initially unaware of the scale and severity of the flood event. In addition, the short succession of events did not allow for stakeholders to regroup and discuss any lessons learnt in full detail.

Review of the affected properties within the Hampstead Kingsgate hotspot illustrated differences between the reported incidents to LBC and the perception of the South Hampstead FAG. It was found that the FAG recorded more properties were affected on the 12th July, than stated within the formal LBC record. The record has been informed by reports of flooding from residents within the area, therefore

[26] Met Office, National Meteorological Library and Archive [online]. Available: https://library.metoffice.gov.uk/Portal/Default/en-GB/SearchResults [Accessed: 05/04/2022]

the difference suggests many who were impacted by the event were unsure how to report flooding and/or did not know which authority to contact.

### 5.1.4 Resource Availability

LBC had limited resources available with which to support residents on site, during the flood event. This was in part due to the scale of the event, which affected various areas across the Camden Borough. LBC mobilised resources to aide in the recovery of the event, however resource availability remained stretched due to the scale of the flooding.

### 5.1.5 Positive Observations

There were several actions and interactions between stakeholders, which improved the response to the flood event and helped to mitigate the impact. The positive observations are as follows:

- The LBC response was proactive. The team sought to engage multiple stakeholders, including RMAs and the general public, in order to collate information and better understand the event and its impacts;
- The South Hampstead FAG and local residents took an active role during the flood event. This includes clearance of gullies and assistance to vulnerable members of the community;
- All RMA's have been proactive in undertaking site specific post-event investigations;
- TW have commissioned an independent report to understand the flood mechanisms and impact of the July 2021 events on the drainage systems and local area.

## 5.2 Lessons Learnt and Moving Forwards

Following a review of the information supplied by the RMA's, relevant stakeholders and data collected from the site walkover, the following strategic areas have been identified as potential areas for improvement:

- Communications and Contingency Planning;
- Improving Community Resilience to Repeat Events; and
- Understanding of Integrated Flooding Mechanisms.

### 5.2.1 Communication and Multi-Agency Flood Planning

Following the July 2021 flood events, the RMAs and relevant authorities identified a need for more clearly defined channels of communication during a flood event, and the rapid internal review conducted by TW identified need for improved flow of information between each group.

Review of the existing Multi Agency Flood Plan will help to address the complex nature of flooding within the area and improve the response to any future events. LBC have already developed the Flood Plan, as a framework for response activities. It is important that the LBC consider contributions from all relevant internal departments, such as Emergency Planning, Highways, Drainage, Social Services and Environmental Health, in addition to other relevant authorities such as TW and the EA.

All RMAs should review procedures and processes for data collection during and after a flood event. Reports of flood should capture data in a manner which can be shared rapidly amongst the relevant stakeholders and easily documented.

### 5.2.2 Community Resilience

Community resilience is key to the preparedness of a flood event, in addition to the mitigation of damage caused by potential flood events. Through awareness, the local community can introduce measures to protect their property and possessions.

Although the benefit of these measures are typically limited to a single property, if the level of awareness is high across a community, it is expected that several households will implement flood risk measures; this increases the overall capacity of a community to protect property within the wider area, with potential to reduce impact and disruption following a flood event.

Furthermore, an awareness of the relevant authorities will enable communication prior to, during and after a flood event. Regular contact between the local community and relevant authority allows for the identification of issues which may exacerbate the impact of a flood. Contact with the most appropriate authority will also enable authorities to respond effectively.

Local authorities, such as LBC, should initiate discussions within the community to drive awareness and direct individuals to the relevant contacts; this will allow for members of the community to communicate issues to the most appropriate authority or organisation prior to, during and after a flood event.

To develop community resilience, it is critical that the local community take ownership for monitoring the local environment, reporting issues and for implementing measures that will protect their properties. Consistent engagement within the local community increases the level of resilience and helps to drive adaptability to flood events over a longer period of time, compared to a community which is not aware of the potential ways to mitigate flood risk.

### 5.2.3 Understanding Integral Flooding Mechanisms

Assessment of the flood mechanisms within each hotspot indicate a combination of surface water and sewer surcharge. The mechanisms are closely linked and can contribute to the severity and frequency of damage, for example: insufficient drainage capacity can prevent surface water from being subsumed into the network, resulting in ponding and larger flow pathways on the road surface, whilst greater volumes of surface water entering the sewer network at multiple locations can result in surcharge of sewer drainage assets at the low elevations.

It is important to understand the interactions between different flood mechanisms, to determine the most effective solution; a solution which addresses multiple flood mechanism will typically provide longer term benefit and significantly reduce the impact of a flood, compared to a solution which addresses a single cause. Given the criticality of the linked flood mechanisms, it is recommended that RMAs consider the development of a fully integrated catchment model (i.e. one that links sewers, surface water and any sub-surface watercourses) to further improve understanding of flood risk within the Camden Borough.

### 5.2.4 Sustainable Urban Drainage Systems

Sustainable Drainage Systems (SuDS) solutions should be implemented, as part of a long-term approach to flood risk alleviation. Solutions should seek to relieve pressure on the sewer network and target areas where surface water flooding is known to occur.

In the case of the July 2021 flood events, SuDS solutions were likely to have had only localised benefit. This is due to the large scale of AEP event, which exceeded sewer drainage capacity, and as a result of the saturated ground conditions that preceded the flood events.

Solutions developed should account for the scale and placement of SuDS, in order to increase the potential benefits.

# 6. Flood Investigations Outcomes

This section of the Flood Investigation Report outlines a summary of the responses from each of the RMA's which operate within the LBC administrative area and presents suggestions for further management of flood risk.

## 6.1 London Borough of Camden

### 6.1.1 London Borough of Camden as LLFA

As the LLFA, LBC have conducted this Section 19 Flood Investigation Report in response to the flood incidents of the 12th and 25th July 2021. The report has been compiled through collaboration with relevant RMAs and stakeholders and is to be published in the public domain. LBC will coordinate with RMAs for further work and any future investigations, whilst working collaboratively with local communities to address flood issues.

### 6.1.2 London Borough of Camden as Highways Authority

LBC as the Highways Authority is responsible for maintenance of highways within the Camden Borough. During the flood events on the 12th and 25th July, the LBC Highways team mobilised resource quickly, to investigate reports of blocked gullies and drains. Records provided indicate incidents were attended within two hours of the reported blockage. A contractor was mobilised on the 12th July to aide the distribution of sandbags.

### 6.1.3 London Borough of Camden as Category 1 Responder

As a Category 1 Responder, LBC has produced a Multi-Agency Flood Plan (MAFP) for flooding and severe weather. The plan been informed by knowledge gained through previous flood events, including but not limited to: communications, temporary emergency accommodation, road closures and assistance to the vulnerable community. There are multiple versions of the MAFP and the document has been updated following the July 2021 flood events, to account for any new information that may help to inform the response.

## 6.2 Thames Water

Following the 12th and 25th July 2021 flood events, TW have investigated incidents directly reported to them and have produced a high-level overview of the meteorological conditions, flood mechanisms and clean up actions for several London Boroughs, including Camden Borough.

Blockages were resolved and a rapid internal review was conducted, to assess the incident response and performance of the customer call centre during the event. Longer-term concerns were recorded by TW and prioritised for future investment; bids for funding were submitted by TW following the July 2021 flood events in support of this.

At the time of writing this report, TW were in the process of conducting their own independent investigation into the July 2021 flood event. This is being investigated under the London Flood Review (further detail is provided in **Section 7**). A strategic stakeholder panel was developed as part of this process, including: the Greater London Authority, TfL, London Councils, the London Drainage Engineers Group, EA, Consumer Council for Water and the Thames Regional Flood and Coastal Committee (RFCC). Ofwat will join the panel, to oversee the process. The findings of the TW investigation will be considered as part of the Section 19 Flood Investigation Report, to ensure there is an aligned understanding of the flood events.

Following the July 2021 flood events, TW are also funding 20 nature-based schemes to address flood risk in London and the wider Thames Valley. Local authorities were invited to bid for a proportion of £1.8 million, which would support SuDS scheme development. A further £1.5 million was allocated in February 2022, for additional projects. At the time of writing, the total funding equates to over £3 million[27].

[27] Thames Water, 'Less Concrete, More Jungle: Over £3 Million of Funding for Nature Schemes to Tackle Flooding'. Available: https://www.thameswater.co.uk/about-us/newsroom/latest-news/2022/feb/sustainable-drainage-funding [Accessed: 10/06/2022]

# 7. Flood Questionnaire Responses

To supplement the Section 19 Flood Investigation Report, a questionnaire was developed and shared with local residents online, to collect data from those affected by the July 2021 flood events. The questionnaire was used to inform the flood incident response and determine the level of community awareness. Questions centred upon community preparedness, assistance during the flood incident and impact of the event.

At the time of writing, fifteen responses had been completed by residents within the Camden Borough. The key findings are presented in **Figure 7-1** (overleaf).

From the questionnaire responses submitted, all respondents were impacted by the 12$^{th}$ July flood event. No respondent reported flooding of their property on the 25$^{th}$ July. Of those impacted, 80% reported internal flooding. This suggests the water level exceeded property threshold. It is considered likely that this caused damage to property and/or possessions. More than half of the respondents noted they had adequate insurance, covering re-accommodation and disruption.

The results suggest 73% of the respondents had not been affected by flooding previously. This suggests the scale of the July 2021 flood was significant. It is possible the property had been affected by flooding previously yet was not known to the current owner. The questionnaire indicated no respondents were aware of any flood alerts, which may reflect the rapid onset of the event.

87% of the respondents did not know how to report a flood. This could be associated with the number of respondents who had not been affected by flooding previously, thus were unlikely to have prior first-hand experience of reporting a flood within the Camden Borough. Similarly, 80% of respondents did not know where to find more information about flooding. It is unclear from the questionnaire whether the respondents have since developed their understanding. Engagement with the community is key to building local awareness and preparedness.

73% of respondents stated they did not know how to improve the property's flood protection, and 93% did not know which organisation was responsible for managing the different sources of flood risk. This suggests it is important to engage with the residents, in order to highlight responsibilities of the relevant RMAs and to provide high level detail of what measures can be introduced by a household, to reduce risk of flooding to their property.

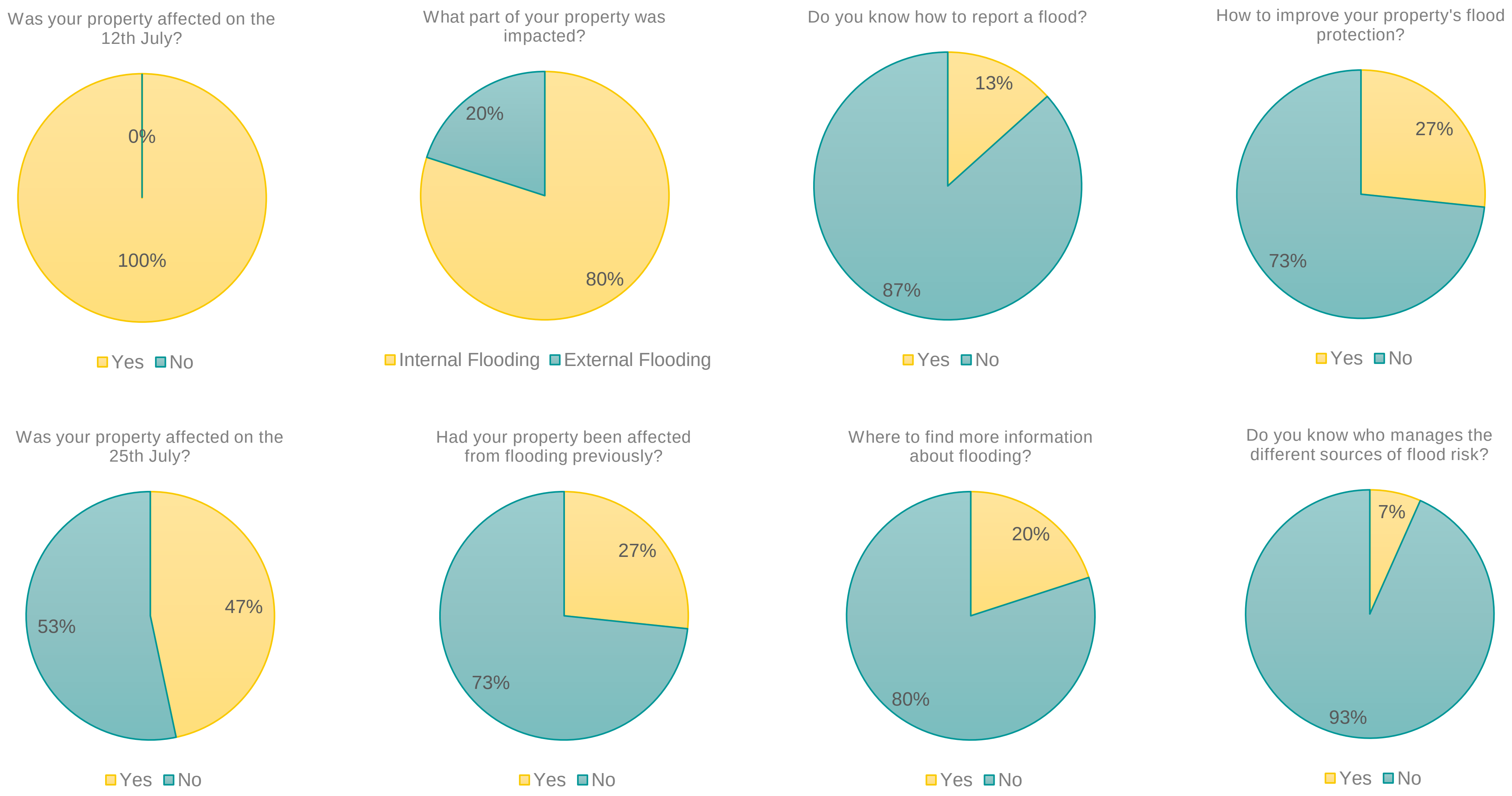



**Figure 7-1: Flood Questionnaire Responses**

# 8. London Flood Review

## 8.1 Overview

TW has commissioned the London Flood Review[28], to assess the extent and cause of the July 2021 floods across London. The objective of the review is to assess the performance of the sewerage system and present recommendations to mitigate the risk of future flood events.

The London Flood Review is led by an independent expert group (IEG) of external specialists and is divided into four stages. The stages are as follows:

- **Stage 1:** An objective review of the available data relating to the flooding on 12 and 25 July 2021
- **Stage 2:** An investigation into the flooding mechanisms and contributory factors that led to flooding on 12th and 25th July 2021
- **Stage 3:** An assessment of how well Thames Water's assets, including flooding alleviation schemes, critical pumping stations and the overall sewer network, performed on 12 and 25 July 2021
- **Stage 4:** Recommendations to improve current flood mitigation processes and improve resilience to future flooding events

At the time of writing, the report for Stage 1[29], Stage 2[30] and Stage 3[31] had been produced by Mott MacDonald. The document provides an overview of the sources data that will be used to investigate the flooding and inform the subsequent appraisal and recommendations. Multiple data sources were used to produce the report, including TW, TfL, Met Office, EA and Local Authorities.

It is important to note the London Flood Review adopts a strategic view, accounting for high level information. The review captures detail on a London-wide scale and uses secondary sources of data. In contrast, this Section 19 Flood Investigation Report focuses on site specific details relating to the July 2021 flood events occurring in Camden Borough. It uses multiple sources of information, including site observations and anecdotal evidence, to assess potential flood mechanisms and impact.

## 8.2 Stage 1 Report: Findings

### 8.2.1 General Findings

The location and number of reported flooded properties on the 12th and 25th July 2021 are presented in Appendix A.1 and A.3 of the London Flood Review, respectively. The findings confirm that the number of reported flooded properties in the Camden Borough was significantly higher on the 12th July relative to the 25th July. On the 12th July, the reported flooded properties form a cluster in the Camden Borough and adjacent areas. There is a large concentration of reported incidents near to the western boundary of the Camden Borough. This is indicative of highly localised rainfall on the 12th July.

In contrast, the reported flooded properties are dispersed across London on the 25th July. The findings do not show a concentration of reported flooded properties within the Camden Borough.

### 8.2.2 Rainfall Event Analysis

Radar rainfall data provided by TW (originally the Met Office) consists of two months of observed rainfall intensities in mm per hour, covering June and July 2021 at five-minute intervals. Rainfall data was also

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[28] The London Flood Review [online]. Available: https://londonfloodreview.co.uk/ [Accessed 30/03/2021]
[29] Mott MacDonald, London Flooding Review: Data Discovery and Initial Analysis (February 2022). Available: https://londonfloodreview.co.uk/wp-content/uploads/2022/03/Data-Discovery-and-Initial-Analysis-Report-RevD-Clean-1.pdf [Accessed 30/03/2021]
[30] Mott MacDonald, London Flooding Review: Root Cause Assessment and Outcomes from Sensitivity Testing (April 2022). Available: https://londonfloodreview.co.uk/wp-content/uploads/2022/04/TW-Flood-Review-_Stage-2-Report_E.pdf [Accessed: 16/06/2022]
[31] Mott MacDonald, London Flooding Review: Performance of Schemes and Hotspot Areas (May 2022). Available: https://londonfloodreview.co.uk/wp-content/uploads/2022/05/Stage-3-Report-Final.pdf [Accessed: 16/06/2022]

obtained from the EA for rain gauges; it is important to note, the locations of the rain gauges did not coincide with areas of most intense rainfall.

It was concluded that the flood event occurring on the 12th July was more severe than the 25th July, because of higher return periods of rainfall, occurring for shorter durations in specific locations; the rainfall was highly localised in time and space on the 12th July. The total rainfall of London was greater on the 25th July, occurring over a longer period.

The 12th and 25th July events were significant in terms of depth and intensity of rainfall; this resulted in the AEP of both events being greater than the design standard for drainage systems.

### 8.2.3 Tidal Event Analysis

River level data provided by TW formed the basis for the tidal event analysis, covering six locations across London. Camden Borough was not a targeted location of the analysis and it is noted that areas in north London, such as Walthamstow, were unaffected by the tidal levels, due to the distance inland.

Initial reports indicate the tide levels were high during the July 2021 flood events. It is stated within the Stage 1 Report that this may have resulted in tide-locking at a number of sewerage outfalls, preventing exceedance flows from spilling from the sewer system into the tidal or river basin.

### 8.2.4 Model Analysis

Model data was received from the TW Systems Modelling, for the Beckton catchment and Crossness catchment, representing several locations across London. Camden Borough is located within the Beckton catchment only.

The model-predicted depths were found to be generally higher than the observed depths on the 12th July. There was limited correlation against the reported flood events on the 25th July, with the model predicted extent being greater than the reported flooding.

The report concluded the model is over-predicting the number of properties with basement sewer flooding and may be under-representing the volume of water surcharging the manholes. Findings also indicate the model is not representing overland surface water run-off and overland flow paths. Sensitivity runs and testing of model scenarios are proposed, to further investigate the cause of the flood events in the following stages of the reporting.

### 8.2.5 Conclusion

There are similarities between the findings outlined within the Stage 1 Report and the Section 19 Flood Investigation. The similarities are as follows:

- The number of properties with reports of flooding were greater on the 12th July, compared to the 25th July;
- On the 12th July, clusters of properties with reported flooding are formed within the Camden Borough. This is largely concentrated to western areas of the Borough, which aligns with the large number of flooding reports in the Hampstead Kingsgate hotspot;
- The 12th July rainfall event was highly localised in time and space; and
- The 12th and 25th July rainfall events were greater than the design standard for drainage systems.

## 8.3 Stage 2 Report: Findings

The Stage 2 Report investigates the catchment response and potential flood mechanisms, through a number of sensitivity scenarios which were simulated in catchment models provided by TW. The scenarios were compared against baseline model results, to determine differences in top water levels, predicted flooding volumes and observed depth monitor data. Any relevant information of known flooding mechanisms were extracted from SWMP documentation.

Two areas were assessed in Hampstead, within the Camden Borough. The report noted a historical sewer flooding issue during the 2002 flood event, stating several properties were affected by raw sewerage. The report notes that high volumes of surface water were conveyed to Belsize Road during the 2002 flood event. At this location, surface water was not able to enter the sewer network due to the intensity of the event. This corresponds with findings from the Section 19 Flood Investigation, which identified Belsize Road as a key surface water pathway and evidence of sewer surcharge on Priory Road. The Stage 2 Report notes the two areas assessed were not considered to be influenced by tide levels or pump failure.

## 8.4 Stage 3 Report: Findings

The Stage 3 Report explores the performance of TW assets and how they performed during the July 2021 flood events. The report provides a commentary and analysis on the following: design standard of sewer systems and return periods of flooding and rainfall events, performance of critical assets during the events, performance of recent and possible future TW flood schemes and interaction between multiple flooding assets.

Data presented within the report suggest there are no key pumping stations within the Camden Borough, as all are located on the River Thames. There is no specific mention of Camden within the document.

It is noted that new sewer systems are typically designed up to 1 in 30 year return period. However, older systems often have a lower capacity than a 1 in 30 year design standard, due to the requirements at the time of construction. The findings confirmed the scale of the July 2021 event exceeded design standards for sewer systems. The report acknowledges it may not be economical to implement schemes which eliminate risk for any potential future events of a similar scale. TW continue to upgrade the sewer network where performance issues have been identified.

# 9. Next Steps

As LLFA, LBC are responsible for the coordination of flood risk management strategies and actions, within the administrative boundary. It is suggested that the recommendations listed within this Section 19 report are incorporated into an Action Plan, to be produced by the relevant RMAs. This Action Plan should be monitored and discussed at future operational flood group meetings.

Following a review of this Section 19 Report and liaison with RMAs, should flood risk be considered unacceptable at a hotspot, LBC should investigate potential capital schemes which could provide flood alleviation.

## 9.1 Strategic Recommendations

Through the assessment of flood mechanisms and impact of the July 2021 flood events, several recommendations for improvement have been identified; this is presented in **Table 9-1**.

Recommendations have been categorised as statutory or non-statutory. Statutory recommendations are a legal requirement and must be implemented as part of the Section 19 Flood Investigation. It is important to identify the statutory recommendations, to ensure appropriate action is taken. Non-statutory recommendations are not required under law yet are considered to be of benefit to the management of flood risk within the area.

The strategic recommendations require the involvement of several stakeholder groups and can be adopted across the Camden Borough.

**Table 9-1: Strategic Recommendations**

| Recommendation | Owner | Statutory or Non-Statutory |
|---|---|---|
| LBC is to publish the findings of the Section 19 Flood Investigation Report. The published report will aid the development of flood mitigation strategies and provide vital information for RMAs | **LBC** | **Statutory** |
| An Action Plan should be created by LBC, which aims to outline timescales and milestones for delivery of site specific and strategic recommendations presented within this report | **LBC** | **Non-Statutory** |
| LBC should continue to develop the MAFP, with sustained input from the RMAs involved, including the EA, TW, TfL and other relevant stakeholders, such as the CLC, LFB, Met Office, Metropolitan Police, Canal and Rivers Trust, Network Rail and NHS England (London) | **LBC, TW, TfL, EA** | **Non-Statutory** |
| Communication with local communities should be proactive and seek to improve awareness for flood events. Discussions should emphasise the importance of preparing for a flood event before an incident occurs.<br>Residents should be frequently directed to the useful contacts and be encouraged to report potential issues at the earliest possible opportunity | **LBC** | **Non-Statutory** |
| Members of the local community have expressed concern about the flood event and there is a desire for changes to be made, in order to reduce or mitigate the impact of any future event. It is recommended that public consultation forms part of any scheme development | **LBC & Local Residents** | **Non-Statutory** |

| Recommendation | Owner | Statutory or Non-Statutory |
|---|---|---|
| exercise, to engage residents and obtain buy-in to flood alleviation proposals | | |
| Ongoing communication and partnership working with TW and RMAs is required to develop holistic solutions, which are suitable for surface water flooding and does not have a negative impact on the sewer system | **LBC, TW** | **Non-Statutory** |
| Revision of the gully clearance regime is recommended, to ensure the maintenance and clearance is frequent enough to prevent build-up of leaves and debris. It is recommended that the importance of clear gullies and drains is communicated to residents, to increase awareness and promote local action. If residents take an active role in monitoring and reporting the gully condition, this could improve the effectiveness of drainage within the area | **LBC & Local Residents** | **Non-Statutory** |
| LBC have commissioned consultants to undertake studies of high-risk areas and of the sewer and gully capacities. Findings from the study will contribute to the understanding of what measures could be implemented, such as additional gullies, SuDS or other alternatives which may help to alleviate flood risk. LBC should discuss the findings with relevant stakeholder groups and seek to implement, as appropriate | **LBC** | **Non-Statutory** |
| Hampstead Heath may offer opportunities to increase storage capacity or to reduce surface water flow rate to the affected areas, such as South End Road. CLC could review this potential and seek to develop measures to mitigate flood risk, as appropriate | **CLC** | **Non-Statutory** |
| TW should review the capacity of the sewer system in areas affected by the flooding, to ascertain whether there is any scope to invest and prioritise construction at these locations | **TW** | **Non-Statutory** |
| TW may consider new and/or improved ways of engaging with the local residents, in order to identify and remove misconnections and to promote key information, such as how to report incidents. This could improve the reporting of issues, with a subsequent improvement to managing potential flood risks | **TW** | **Non-Statutory** |
| Each stage of The London Flood Review will be published, once completed. It is recommended that discussions are held between TW and LBC, to align understanding and account for new information which may emerge from the London Flood Review | **TW** | **Non-Statutory** |
| As described within this report, the South Hampstead FAG has taken an active role in promoting awareness of flooding in the local area. There would be a benefit to having several FAG within the Camden Borough, as a means of contributing to the understanding of local flood risk, sharing contact details and engaging the wider community. Residents should consider forming a FAG for their local area | **Local Residents** | **Non-Statutory** |

| Recommendation | Owner | Statutory or Non-Statutory |
| --- | --- | --- |
| Local residents and businesses could consider community level projects, which are intended to mitigate the effects of flooding. This may require support from relevant RMAs and FAG to implement | **Local Residents** | **Non-Statutory** |
| The local community should consider Property Flood Resilience (PFR) measures, to reduce the potential impact of a flood event. They should continually familiarise themselves with the key contact information and report events via the appropriate channels, to help mitigate risk | **Local Residents** | **Non-Statutory** |

## 9.2 Actions – Site Specific

Below are recommendations for site specific actions, which are intended to alleviate potential flood risk within a localised area.

- LBC and TW should consider undertaking a further appraisal of areas found to be most impacted by flooding. Appraisals conducted by LBC should be used to explore potential solutions which will reduce flood risk, such as improvements to drainage systems and the attenuation of surface water through SuDS. Appraisals undertaken by TW will be limited to assessment of sewer capacity and efficiencies, in line with their responsibilities (as outlined in **Section 1.3.3**). All appraisals should consider the possibility of securing Flood Defence Grant-in-Aid funding to deliver solutions.

  The following locations should be prioritised for further appraisal:

  - South End Road (Heath Watershed);
  - Winchester Road (Belsize Park Swiss Cottage); and
  - Goldhurst Terrace and Belszie Road (Hampstead Kingsgate).
- Properties which are located downslope and/or have a ground floor which is below road level should use temporary and easily accessible property resilience measures to reduce water ingress;
- LBC should continue to liaise with residents and active groups, such as the South Hampstead FAG, to track progress made toward flood resilience measures and to monitor local awareness of flood risk;
- TW should consider conducting a review of road drainage infrastructure within the Hampstead Kingsgate hotspot, with particular attention paid to Goldhurst Terrace, Farihazel Gardens, Priory Road and Priory Terrace. If sewer capacity cannot be increased, changes to the road design may reduce risk of water ingress and property damage; potential changes could include raised kerb heights and permeable paving.

## 9.3 Actions – Quick Wins

Through the development of this Section 19 Flood Investigation, the following actions have been identified as those which can be achieved quickly:

- Provision of PFR surveys for residents affected by flooding;
- Promoting an awareness of flood risk and improving the community understanding of what to do and who to contact in the event of a flood. This can be achieved through the development of personal emergency plans and disseminating information via leaflets and websites;
- Development of a flood toolkit, which will empower local communities;
- Training volunteer community ‘flood wardens’ and developing knowledge of FAG; and
- Hosting an event in a community space, to inform and empower local communities on the topic of flooding.

The actions listed above fall under the responsibility of LBC, although may require input from relevant RMAs.

# 10. Useful Contacts

**Flooding from Public Sewer**

**THAMES WATER**

- Report sewer flooding — **0800 316 9800**
- https://www.thameswater.co.uk/help/emergencies/flooding

**Flooding from a Burst Water Mains**

**THAMES WATER**

- Report a leak or burst pipe — **0800 316 9800 / 0800 714 614**
- https://www.thameswater.co.uk/help/emergencies/frozen-or-burst-pipes

**Flooding from the Public Highway or Drains**

**LONDON BOROUGH OF CAMDEN COUNCIL**

- Council switchboard — **020 7974 4444 (Mon-Fri, 8am – 5pm)**
- To report a flooding emergency — **020 7974 4444 (Mon-Fri, 8am – 5pm)**
  **020 7974 4444 (out of hours)**

**Flooding from a Main River**

**ENVIRONMENT AGENCY**

- General enquiries — **03708 506 506 (Mon-Fri, 8am – 6pm)**
- Incident hotline — **0800 80 70 60 (24hour service)**
- Flood line — **0345 988 1188 (24 hour service)**
- General enquiries email — **enquiries@environment–agency.gov.uk**

**USEFUL WEB RESOURCES**

The following web links contain useful information about being prepared, understanding flood risk and reporting drainage issues to LBC Council.

| **Being Prepared** |
|---|
| Prepare for a flood and get help during and after:<br>**https://www.gov.uk/prepare-for-a-flood/get-help-after-a-flood**<br>Be ready for flooding:<br>**https://nationalfloodforum.org.uk/wp-content/uploads/2016/12/Ready-For-Flooding-26-11-14.pdf**<br>Make a personal flood plan:<br>**https://www.gov.uk/government/publications/personal-flood-plan**<br>Prepare your property for flooding:<br>**https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/451622/LIT_4284.pdf** |
| **Understanding Flood Risk and Flood Warnings** |
| Check current flood warnings and river levels:<br>**https://www.gov.uk/check-if-youre-at-risk-of-flooding**<br>Sign up for flood warnings:<br>**https://www.gov.uk/sign-up-for-flood-warnings** |
| **Reporting a Flood** |
| Report flooding from a public highway to LBC Council:<br>**https://www.camden.gov.uk/flooding#ygac**<br>Report a problem with a drain or a grid (also known as a gully):<br>**https://forms.camden.gov.uk/cus/servlet/auth.Login?auth=0** |