

# WORCESTER PARK SECTION 19 FLOOD INVESTIGATION



PREPARED FOR LONDON BOROUGH OF SUTTON

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## EXECUTIVE SUMMARY

This flood risk investigation report was written as part of the London Borough of Sutton's (LB Sutton) duty as Lead Local Flood Authority (LLFA) under Section 19 of the Flood and Water Management Act (2010). Heavy rainfall events caused significant flooding in the Worcester Park area on four different dates: the 12<sup>th</sup> July, 25<sup>th</sup> July, 7<sup>th</sup> August, and 20<sup>th</sup> October 2021. A total of 59 flooding reports were received. 41 of these were reported as internal flooding, 12 were external flooding, one was highway flooding, and one was received where the specific location of flooding is unconfirmed. These were spread across 14 roads within the area. Four reports of flooding on social media were also collated and analysed in this report. This report has been carried out in response to these significant flooding events and aims to investigate the causes of flooding, as well as the actions of the Risk Management Authorities (RMAs) who have different roles in response to flood events. The RMAs include LB Sutton, the Environment Agency (EA) and Thames Water Utilities Limited (TWUL).

The hydrological catchment area was identified as the upper end of the Beverley Brook catchment and all the reported flooding incidents lie within this catchment. The reported flood incidents were mapped for each separate flooding event. For each event, the flood incident details were analysed, flooding mechanisms and various flood risks were assessed, the actions of RMAs before, during and after the flooding were recorded (where known), and recommendations are given. The Surrey County Council Section 19 report for Worcester Park (2022) has also been reviewed as part of this investigation reflecting incidents reported over the same dates, in order to adopt a catchment-based approach to flood risk management.

Across most of the events, the sewers were inundated with the volume of surface water entering the drainage network. It is likely that the outfalls in the Beverley Brook were submerged, leading to this volume of water being unable to discharge into the channel. The return periods, where known, differ in each of these events. TWUL produced rainfall return period maps for the 12<sup>th</sup> July, 25<sup>th</sup> July, and 7<sup>th</sup> August which provide high level estimates for the return periods in Sutton for each date. The maps show that the estimated return periods for the 12<sup>th</sup> July were between the 1 in 20 and 1 in 100 year events, for the 25<sup>th</sup> July they were between the 1 in 30 and 1 in 100 year events, and for the 7<sup>th</sup> August it was a 1 in 10 year event. TWUL also recorded specific return periods for the 12<sup>th</sup> July on Browning Avenue which was recorded as a 1 in 331 year event, and for the 25<sup>th</sup> July on Browning Avenue and Sandringham Road which was recorded as a 1 in 62 year event. The return periods for the 20<sup>th</sup> October are presently unknown. The first three events occurred in quick succession, which may have raised the groundwater table during the latter flooding events. Other factors such as topography, blockages in the sewer system, and the frequent blockage of a trash screen at the entrance to a culvert in Cuddington Recreation Ground also exacerbated the flooding.

A flood alleviation scheme (FAS) in Cuddington Recreation Ground is currently in the detailed design phase and undergoing stakeholder engagement. This is due to be constructed in 2022 (subject to surveys, stakeholder engagement, planning process and funding release) and aims to address some of the flooding issues in Worcester Park. Specifically, the scheme aims to address the issues concerning the TWUL culvert, and the flooding this contributed to on Sandringham Road and areas surrounding the recreation ground further downstream in the surface water flow path. LB Sutton has installed five new gullies on Sandringham Road following the flooding events to redirect surface water away from the properties and deal with highway profile issues in this location. Further recommendations have been suggested for Worcester Park:

- LB Sutton to investigate whether SuDS or additional highway drainage could be included on the affected roads, specifically at the intersection between Washington Road and Browning Avenue.
- TWUL to work with residents to provide information on the incorrect disposal of waste via the sewer system and encourage communication of any blockages.
- TWUL to conduct a detailed investigation of the surface water sewer network at the intersection between Washington Road and Browning Avenue.
- LB Sutton LLFA to undertake further research into Oaks Avenue and the surrounding area to the south to confirm if the site is vulnerable to groundwater flooding, using strategically placed boreholes.
- LB Sutton LLFA encourage the uptake of property level protection through community engagement.
- LB Sutton Emergency Planning to update the multi-agency flood plan to outline the council's response to future flooding events.
- LB Sutton LLFA to install permanent signage on the underpass on the A2043 Central Road to highlight the deep-water flood risk at this location.
- LB Sutton LLFA, EA, and TWUL to investigate potential issues caused by multiple catchment areas discharging into the Beverley Brook, and to identify new solutions and funding opportunities.
- TWUL to consider increasing the capacity of the sewer network on Oaks Avenue and Dalmeny Road as part of the plans in their updated Drainage and Wastewater Management Plan (DWMP).
- TWUL to survey and identify a potential misconnection in the sewer network on the corner of Oaks Avenue and Dalmeny Road.
- The LB Sutton Highways team to ensure that the road hump that was installed on Sandringham Road following the flooding events is reprofiled, to prevent highway profile issues and surface water pooling.
- TWUL to ensure that they continue to fortnightly check/clear and maintain the culvert and trash screen on Cuddington Recreation Ground, prior to the commencement of the Worcester Park FAS.

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## ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
Cheam PS	Cheam Pumping Station
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
FAS	Flood Alleviation Scheme
FEH	Flood Estimation Handbook
FWMA	<a href="#">Flood and Water Management Act (2010)</a>
GIS	Geographic Information System
Hogsmill STW	Hogsmill Valley Sewage Treatment Works
LALO	Local Authority Liaison Officer
LB Sutton	London Borough of Sutton
LFB	London Fire Brigade
LFRMS	<a href="#">Local Flood Risk Management Strategy</a>
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
MAFP	Multi-Agency Flood Plan
MPS	Metropolitan Police Service
RaRa	Rainfall Radar
RB Kingston	Royal Borough of Kingston upon Thames
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SWMP	<a href="#">Surface Water Management Plan</a>
TWUL	Thames Water Utilities Limited



# 1 INTRODUCTION

## 1.1 Background Policy and Information

This flood risk investigation report has been prepared by Metis Consultants Ltd for the London Borough of Sutton (LB Sutton). As a unitary authority, LB Sutton is a Lead Local Flood Authority (LLFA). LLFAs are defined as a Risk Management Authority (RMA) under Section 6, Part 1, Paragraph 13 of the Flood and Water Management Act 2010 (FWMA). LLFAs are required to investigate significant flood incidents under Section 19 of the FMWA and publish the results. A LLFA must, to the extent that they consider it necessary or appropriate, investigate:

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

LLFAs set out the criteria which defines what flood event should trigger a Section 19 investigation. For LB Sutton, the criteria are outlined in the Local Flood Risk Management Strategy (LFRMS) (2015). This is currently in the process of being updated however the criteria will be staying the same:

- If internal flooding of one property has been experienced on more than one occasion.
- Where internal flooding of five or more properties has been experienced during a single flood incident.
- Where critical infrastructure has been affected by flooding more than once within a 12-month period.

There were four significant flood events that took place in the Worcester Park area of the borough in 2021 which triggered a Section 19 investigation for LB Sutton. These took place in July, August, and October. During these dates there were a total of 41 reports of internal flooding, 12 reports of external flooding, one report of highway flooding, and one report where the specific location of flooding is unconfirmed. These came from 14 different locations within the area (Table 4-2). 50 of these were reported during the 25th July flood event, however there were six reported for the 7th August, two reports for the 20th October events, and one report for the 12th July. Four social media reports were also found for the 25<sup>th</sup> July event, and have been incorporated into this report.

## 1.2 Disclaimer

Only reports which were received by the Sutton Flood Risk officer have been included in this report. This includes reports received through the [Sutton flooding inbox](#) and the [online flood reporting form](#). Reports from other means such as from social media or councillors could only be included where sufficient details were provided. The council is aware there were additional flooding incidents in this area but due to a lack of information (date, specific location, nature flooding) they were not included at this stage. The report will be updated after public consultation so additional flood reports will be included post public consultation.

To report an additional flooding incident from any of the dates in question: Please fill out the [Section 19 Questionnaire](#).

## 1.3 Methodology

To conduct this investigation, data was collected from the relevant RMAs. A list of the data and their sources is compiled below in *Table 1-1*. To supplement the information received from the RMAs, a

search on social media platforms was conducted to gather further information into the flood events that took place. Along with the data collected by the LLFA during and following the flood events, this enabled a better understanding of what happened prior to writing this report.

**Table 1-1: Data sources**

Data	Source
Actions taken before, after or during each event	LB Sutton / TWUL
Assets significant to flood risk	LB Sutton / TWUL
Detailed River Network	EA
Flooding reports	LB Sutton / TWUL
Flood risk mapping	EA / LB Sutton
Gully cleansing history	LB Sutton
Rainfall data	EA / <a href="#">GaugeMap</a>
River level data	EA
Return periods for each flood event	TWUL
Sewer network and cleansing information	TWUL

The available historical, topographical, drainage, and geological data was used to explore all potential flood risk sources throughout the flooded locations. The data from LB Sutton was used to produce maps using a geographic information system (GIS) to show the affected locations. The hydrological catchment area was defined using LB Sutton’s Surface Water Management Plan (SWMP). A site visit was conducted to view the affected locations and collect data to supplement the information already received. The responsibilities of the RMAs for each location for each event were identified. Further information on this can be found in *Section 2*.

There are some limitations associated with the data used in this report. The accuracy of the rainfall data used is limited due to the distance of the rain gauges from the site area. The EA Detailed River Network map does not include the section of the Beverley Brook in Cuddington Recreation Ground as an ordinary watercourse, this has however been added to the mapping using the OS map. Each RMA was consulted on a draft version of this document. Some of the dates for the RMA actions before / during / after each flooding event were not specified at the time of data collection.

The results of the investigation were compiled and are outlined in this report. Recommendations on flood risk mitigation and potential next steps are provided in *Section 7.2*.

## 2 RISK MANAGEMENT AUTHORITIES

There are multiple RMAs who are responsible for managing the risks of flooding, as referred to in *Section 1*. These are shown in *Table 2-1* where they are listed at a borough level. Further information on each RMA can be found in *Sections 2.1 to 2.5*.

**Table 2-1: Borough level Risk Management Authorities**

Risk Management Authority	Borough-specific Authority	Flood risk management responsibilities
Environment Agency (EA)	EA	Main rivers and reservoirs
LLFA	LB Sutton	Surface water, ordinary watercourses, and groundwater
Water and Sewerage Company	Thames Water Utilities Limited (TWUL)	Surface water, foul and combined sewer systems
Highway Authority	LB Sutton	Public highway drainage
Highway Authority	Royal Borough of Kingston upon Thames (RB Kingston)	Public highway drainage at A2043 Central Road underpass

### 2.1 Environment Agency

The EA is responsible for managing flood risk from main rivers, the sea, and reservoirs. They also supervise and work with other RMAs to manage the risk of flooding. The EA has an important role in advising Local Planning Authorities on how development proposals may influence flood risk and issuing consent for works that may be on or near main rivers. They also take part in emergency planning and response to flooding events.

There is one main river within Worcester Park which is the Beverley Brook. Fluvial flooding has been identified as a potential source of flooding for the flooding event of the 25<sup>th</sup> July, therefore, the EA may have direct responsibilities as a RMA from these events.

### 2.2 London Borough of Sutton

LB Sutton has multiple RMA roles, predominantly as a LLFA, but also as a Highway Authority, landowner, and Category One Responder. The **LLFA's** main responsibility is to manage the risk of flooding from surface water, groundwater, and ordinary watercourses. Under the FWMA and [Flood Risk Regulations \(2009\)](#), they are responsible for, amongst other duties:

- Developing, implementing, maintaining, and monitoring a LFRMS.
- Maintaining a register of structures and features that have a significant effect on flood risk.
- Preparing and maintaining preliminary flood risk assessments, flood hazard maps, flood risk maps and flood risk management plans.
- Reviewing and acting as a statutory consultee on surface water drainage proposals for major developments.
- Undertaking flood risk investigations.

Other RMAs have a duty to cooperate with LLFAs where necessary to undertake the above responsibilities. The LLFA can also carry out work to help alleviate surface water, groundwater, and

ordinary watercourse flooding in collaboration with other RMAs. Under the powers granted to them, the LLFA can make by-laws to ensure that flood risk management work is effective.

### 2.2.1 Highway Authority

As a Highway Authority, LB Sutton are responsible for providing and managing public highway assets that are not managed by Transport for London (TfL) or National Highways. LB Sutton is the Highway Authority for most of LB Sutton's public roads, the remainder being the responsibility of TfL. Part of their responsibility includes managing surface water drainage from the highways and minimising flooding on their roads. They are also responsible for the maintenance of roads, the highway gullies and drains that run beneath the road surface, road surfaces, and footpaths. RB Kingston is included as a RMA to adopt a cross-boundary approach to flood risk management. They are the neighbouring LLFA and the Highway Authority for public highway drainage on the Central Road at the Worcester Park underpass. It is important for neighbouring authorities to coordinate their response to flooding to consider the wider catchment area.

### 2.2.2 Landowner

As a landowner, LB Sutton have a responsibility to safeguard their own land and property against flooding. Common law also requires that they do not increase the risk of flooding to a neighbouring property through carrying out tasks such as drain clearing and maintaining any existing flood defences.

### 2.2.3 Category One Responder

As a Category One Responder under the [Civil Contingencies Act \(2004\)](#), LB Sutton plays a lead role in emergency planning and recovery after a flood event. They therefore must have plans in place ready to respond to any emergency, such as a flooding event, and make sure that they can manage or reduce the impact of the event by liaising with relevant stakeholders (including other Category One Responders). These stakeholders are listed in LB Sutton's MAFP (Multi-Agency Flood Plan) which includes: the EA, Metropolitan Police Service (MPS), LB Sutton, London Fire Brigade (LFB), London Ambulance Service, NHS Epsom & St. Helier Trust / NHS England, South West London & St George's Mental Health Trust, TfL, National Grid: gas and electricity distribution & transmission, UK Power Network, British Red Cross, UK Health Security Agency, TWUL, Sutton and Surrey East Water and Sutton Clinical Commissioning Group.

The Worcester Park Flood Alleviation Scheme (FAS) is at the detailed design and stakeholder engagement stage. The scheme will implement a system of wetlands and dry basins on Cuddington Recreation Ground. Construction is aimed for 2022 subject to resource, planning approval, funding release, stakeholder engagement and survey findings. This scheme is being led by LB Sutton, in partnership with the EA and TWUL. This location has been chosen strategically as the culvert entrance within the recreation ground is believed to be one of the causes of flooding. The scheme consists of a wetland area, two dry basins, and a new stretch of open watercourse which will bring back part of the former open channel. The scheme is being designed to provide a total volume of 3400m<sup>3</sup> of flood storage. This FAS aims to address some of the flooding issues in Worcester Park, specifically on Sandringham Road and the areas along the Cuddington Recreation Ground flow path.

## 2.3 Thames Water Utilities Limited

TWUL is the regional water and sewerage company and is the RMA responsible for managing the risk of flooding from public sewers including surface water, foul and combined sewer systems. They must manage and maintain their water supply and sewerage systems and make sure that they are resilient to flooding. They have a duty under Section 94 of the [Water Industry Act \(1991\)](#) to make sure that the area they serve is effectively drained and will continue to be effectively drained in the future. TWUL data has been used in this report to analyse local drainage networks.

TWUL is responsible for various assets in the Worcester Park area, such as the sewer network, manholes and gullies. They are also responsible for the trash screen on the culvert in Cuddington Recreation Ground, which they inherited several years ago from LB Sutton.

## 2.4 Landowners

Landowners have the primary responsibility of safeguarding their own land and property against flooding, this includes private roads. Under common law they are also required to ensure that they do not develop their land or property in a way that increases the risk of flooding to a neighbouring property. Common law also enables landowners to take reasonable measures to protect their property from flooding, provided that the measures do not cause harm to others. Riparian owners are responsible for ensuring that any structure(s) on their land linked to a neighbouring watercourse is kept clear of debris and the watercourse can flow naturally. Typically, they are also responsible for maintaining the banks and bed of an ordinary watercourse or main river as it passes through or adjacent to their land, up to halfway across the watercourse.

## 2.5 Category One Responders

[Schedule 1 of the Civil Contingencies Act \(2004\)](#) categorises all local authorities and all blue light emergency services as Category One Responders. For flood incidents within the borough, the most relevant services are the LFB and the MPS. MPS co-ordinates emergency services and assists with evacuations, and LFB is responsible for saving lives, but may also pump out floodwater.

# 3 FLOOD INCIDENT DETAILS

## 3.1 Rainfall Events

There were four significant rainfall events between July and October 2021 which caused flooding in the Worcester Park area. These occurred on the 12<sup>th</sup> July, 25<sup>th</sup> July, 7<sup>th</sup> August, and 20<sup>th</sup> October. This section outlines the rainfall return periods for each event. A return period of a rainfall event is the average time between events of a given or greater magnitude. A 1 in 100-year event is an event that is estimated to occur once every hundred years. In any given year, there is a 1% chance of an event of this magnitude occurring.

### 3.1.1 12<sup>th</sup> July Rainfall Event

On the 12<sup>th</sup> July there was one report of highway flooding received. There were no reports of internal flooding, however it did cause some disruption on Browning Avenue which meant the road had to be blocked off temporarily. Rainfall return period data for LB Sutton was produced by TWUL for the event (*Figure 3-1*). These were based on Rainfall Radar (RaRa) data using Flood Estimation Handbook (FEH) 99 calculations. *Figure 3-1* provides a high-level estimate for the return periods across Sutton on the 12<sup>th</sup> July 2021. Each grid is coloured based on the average return period experience at that location. It shows that Worcester Park experienced a range of

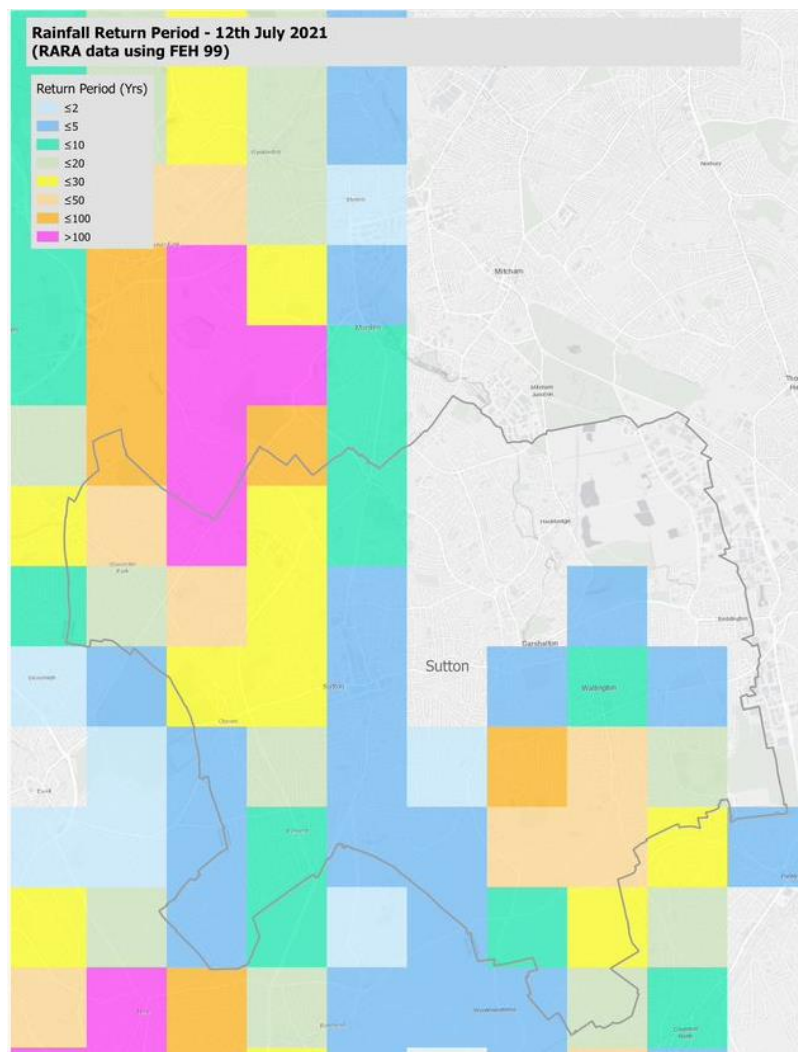


Figure 3-1: Rainfall return period for the 12<sup>th</sup> July (RARA data using FEH 99) (TWUL, 2022)



return periods between the 1 in 20 in the south, 1 in 50 in the centre, and 1 in 100 (or greater) in north and east. TWUL also produced a specific estimate for Browning Avenue, which recorded a 1 in 331 year event. This is higher than the return periods in *Figure 3-1*, however more accurate given that it is specific to a particular road rather than a grid square on the map.

### 3.1.2 25<sup>th</sup> July Rainfall Event

On the 25<sup>th</sup> July several parts of southern England experienced torrential rain, which also affected Worcester Park and led to a number of flood incidents being reported. LB Sutton received 36 reports of internal flooding. There were also 10 reports of external flooding, and four social media reports. 20 residents had to be re-housed and emergency services attended to rescue people from a car stuck within the flood waters on the A2043 Central Road. The incident caused significant disruption to both public (buses) and non-public transport, as there were road closures on both A2043 Central Road and Green Lane. LB Sutton deployed a rapid-response team and organised their contractors to attend the area and support with gully cleansing and traffic

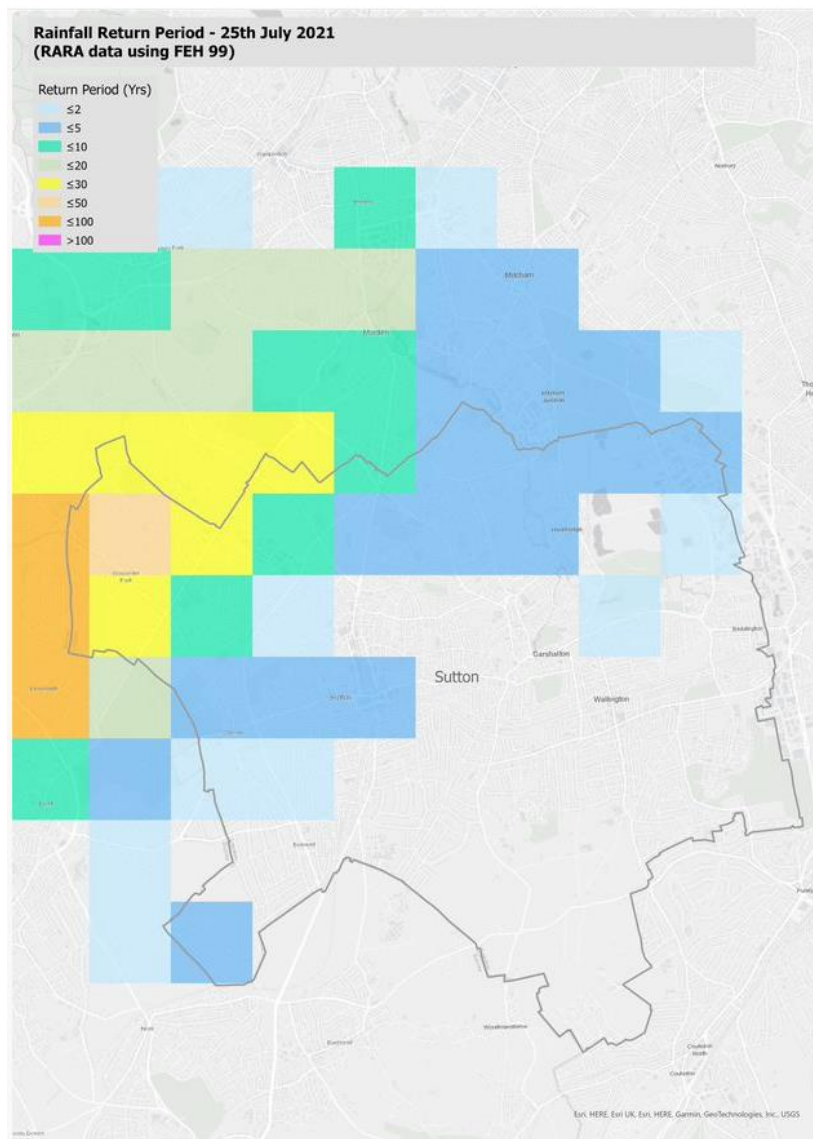


Figure 3-2: Rainfall return period for the 25<sup>th</sup> July (RARA data using FEH 99) (TWUL, 2022)

management. *Figure 3-2* shows the estimated rainfall return period for each across Sutton for this event. This indicates that the majority of Worcester Park experienced rainfall with a return a period of 1 in 50 years, with some areas in the north and east experiencing lower return periods of 1 in 30-year. Higher return periods of 1 in 100-year were estimated for the western boundary of Worcester park. The specific return periods recorded by TWUL for Browning Avenue and Sandringham Road recorded a 1 in 62-year event for both locations, which is an accurate representation for the area and similar to the high-level estimates provided in *Figure 3-2*.

### 3.1.3 7<sup>th</sup> August Rainfall Event

On the 7<sup>th</sup> August another rainfall event occurred and led to five reports of internal flooding, and one where the specific location of flooding is unconfirmed. There were no known traffic disruptions in the area on this date. TWUL attended Oaks Avenue to check the foul and surface water sewers on this date due to reports of flooding. Rainfall return period data was produced by TWUL for the event (*Figure 3-3*). This shows that the return period for the entire Worcester Park on this date was a 1 in 10 year event. This is lower than previous events however flooding was still experienced on this date.

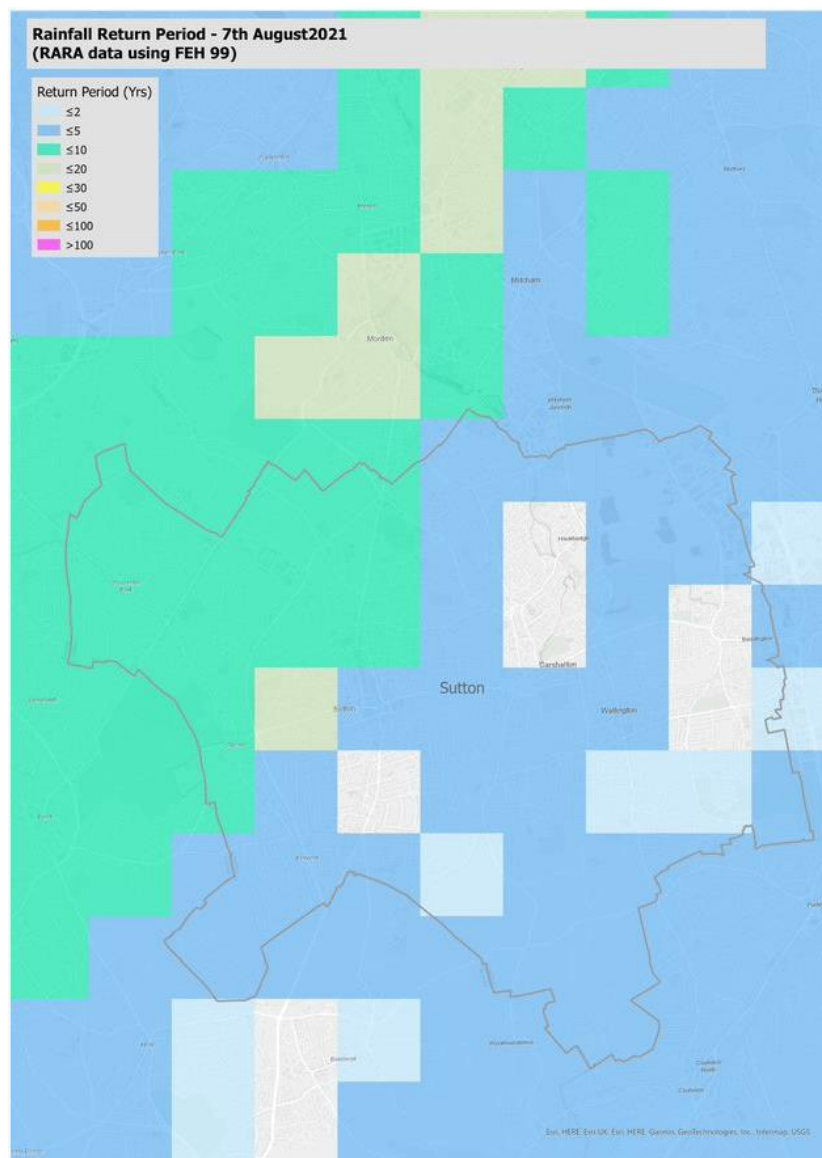


Figure 3-3: Rainfall return period for the 7<sup>th</sup> August (RARA data using FEH 99) (TWUL, 2022)



### 3.1.4 20<sup>th</sup> October Rainfall Event

On the 20<sup>th</sup> October there were two reports of external flooding received. This was a smaller flooding event however it did cause surface water flooding. There was no rainfall return period map produced by TWUL for this date.

## 3.2 Rain Gauge Data

Rainfall data, as recorded by nearby rain gauges has been collated for these rainfall events. The closest rain gauges to the catchment area were found to be Cheam Pumping Station (Cheam PS) and Hogsmill Valley Sewage Treatment Works (Hogsmill STW), as shown in *Figure 3-4*. The measurement recorded by these rain gauges were captured in a Tipping Bucket Rain gauge. The data recorded provides accumulated totals for each 15 minute period. shows the summary of the rainfall events.

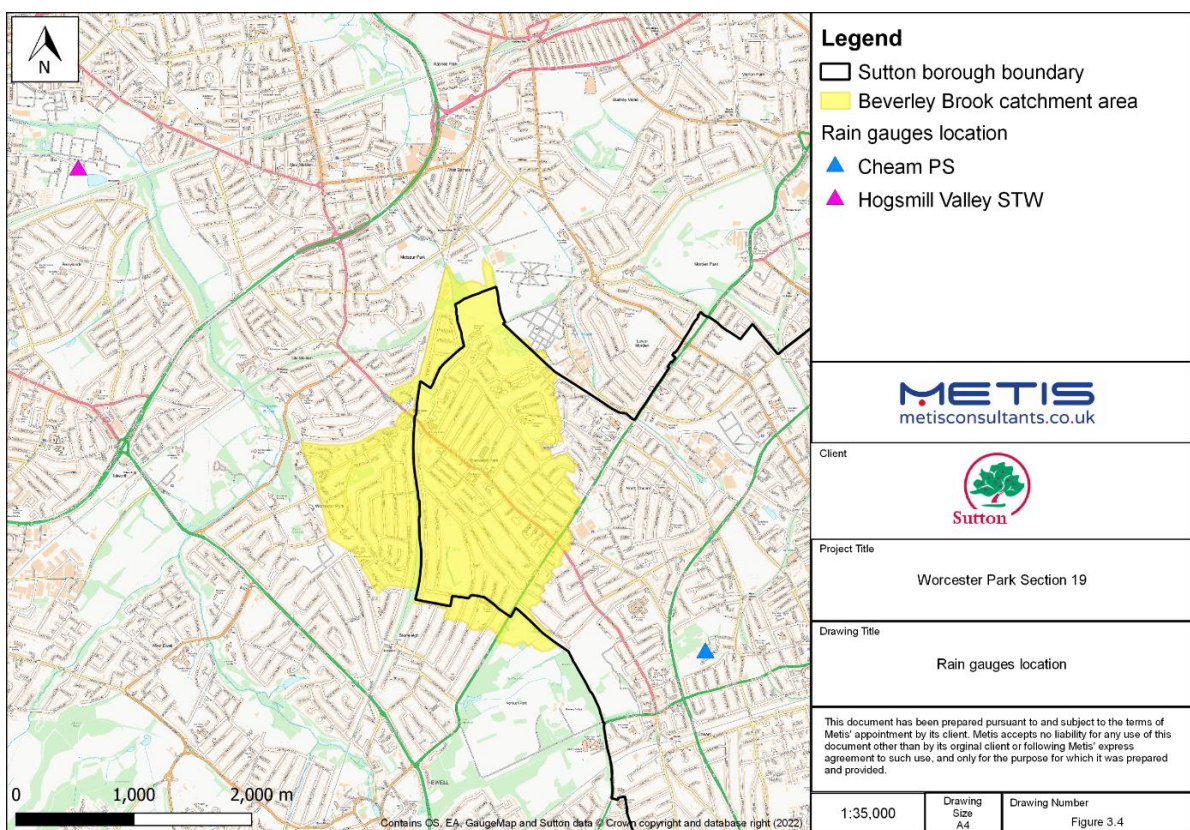
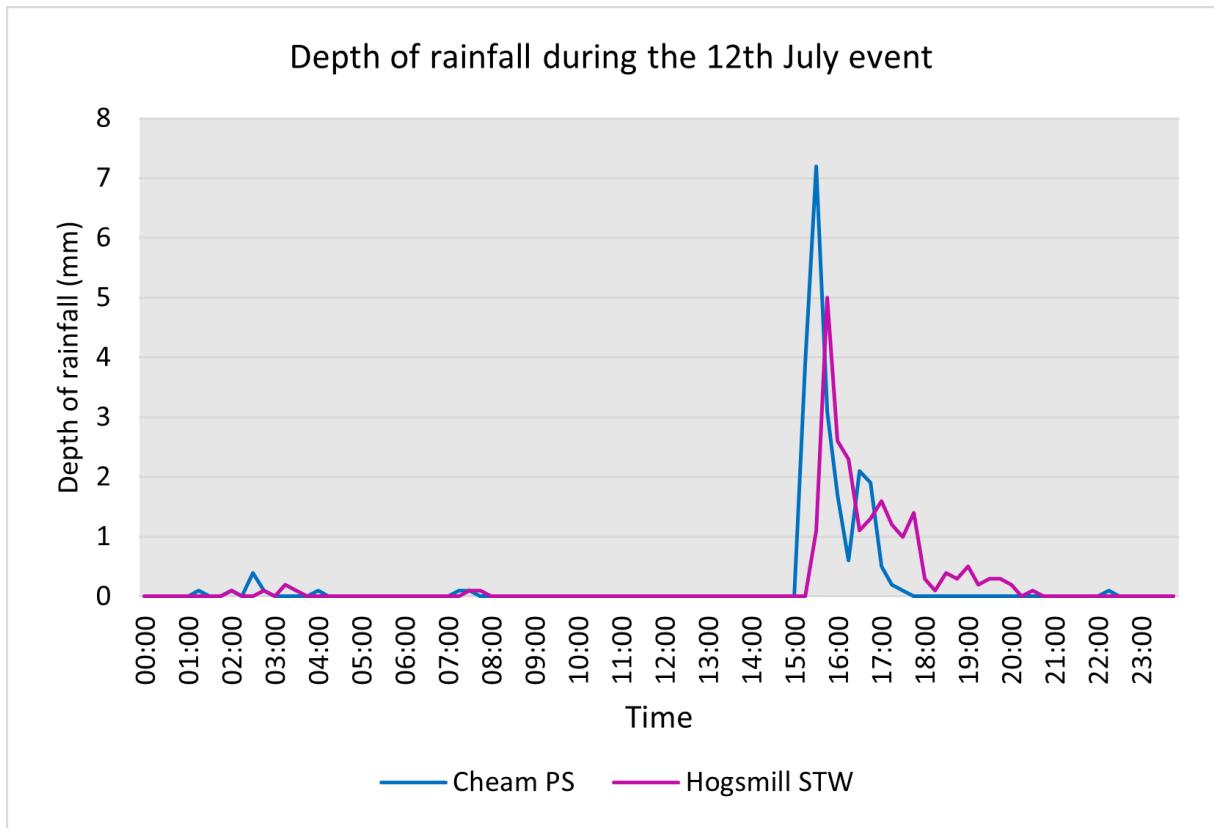


Figure 3-4: Rain gauges location

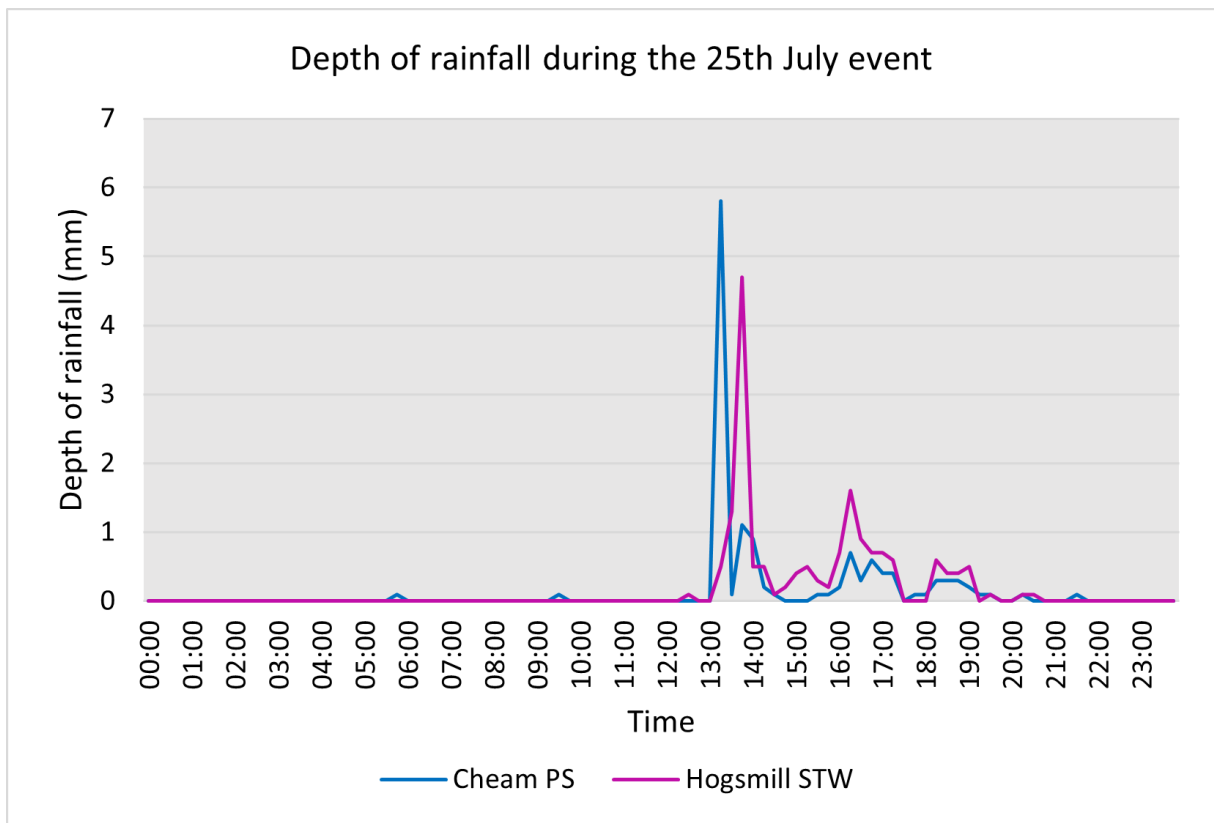
Table 3-1: Summary of rainfall events

Date	Rain gauge	Peak time	Peak rainfall amount
12 <sup>th</sup> July	Cheam PS	15:30	7.2mm
12 <sup>th</sup> July	Hogsmill Valley STW	15:45	5mm
25 <sup>th</sup> July	Cheam PS	13:15	5.8mm
25 <sup>th</sup> July	Hogsmill Valley STW	13:45	4.7mm
7 <sup>th</sup> August	Cheam PS	07:15	5.8mm
7 <sup>th</sup> August	Hogsmill Valley STW	07:00	6.3mm
20 <sup>th</sup> October	Cheam PS	22:00	4.8mm
20 <sup>th</sup> October	Hogsmill Valley STW	11:45	6.4mm

Each rainfall event experienced different peak times and amounts. For both July events, rainfall peaked within one hour in the afternoon (*Figure 3-6* and *Figure 3-5*). For the 7<sup>th</sup> August, the rainfall continued over a period of 4 hours during the morning (*Figure 3-7*), and for the 20<sup>th</sup> October there was one peak recorded by the Hogsmill STW rain gauge at midday and further peaks of rainfall were recorded during the evening by both rain gauges (*Figure 3-8*). Based on the information provided, the peak rainfall is not as high as expected given the nature of these events, particularly for the 12<sup>th</sup> and 25<sup>th</sup> July. The [London Flood Review](#) which was written following the flooding events of the 12<sup>th</sup> July and 25<sup>th</sup> July states that severe flooding occurred across London on these dates, and the flooding witnessed in Worcester Park reflects this. It is likely that the data may not fully describe the events that occurred in Worcester Park given the distance of the rain gauges away from the hydrological catchment area. The rainfall experienced on these dates may have been more localised and given that there are no rain gauges within the hydrological catchment area, it is difficult to provide an accurate representation for peak amounts of rainfall within Worcester Park.



**Figure 3-6: Depth of rainfall during the 12<sup>th</sup> July event**



**Figure 3-5: Depth of rainfall during the 25<sup>th</sup> July event**

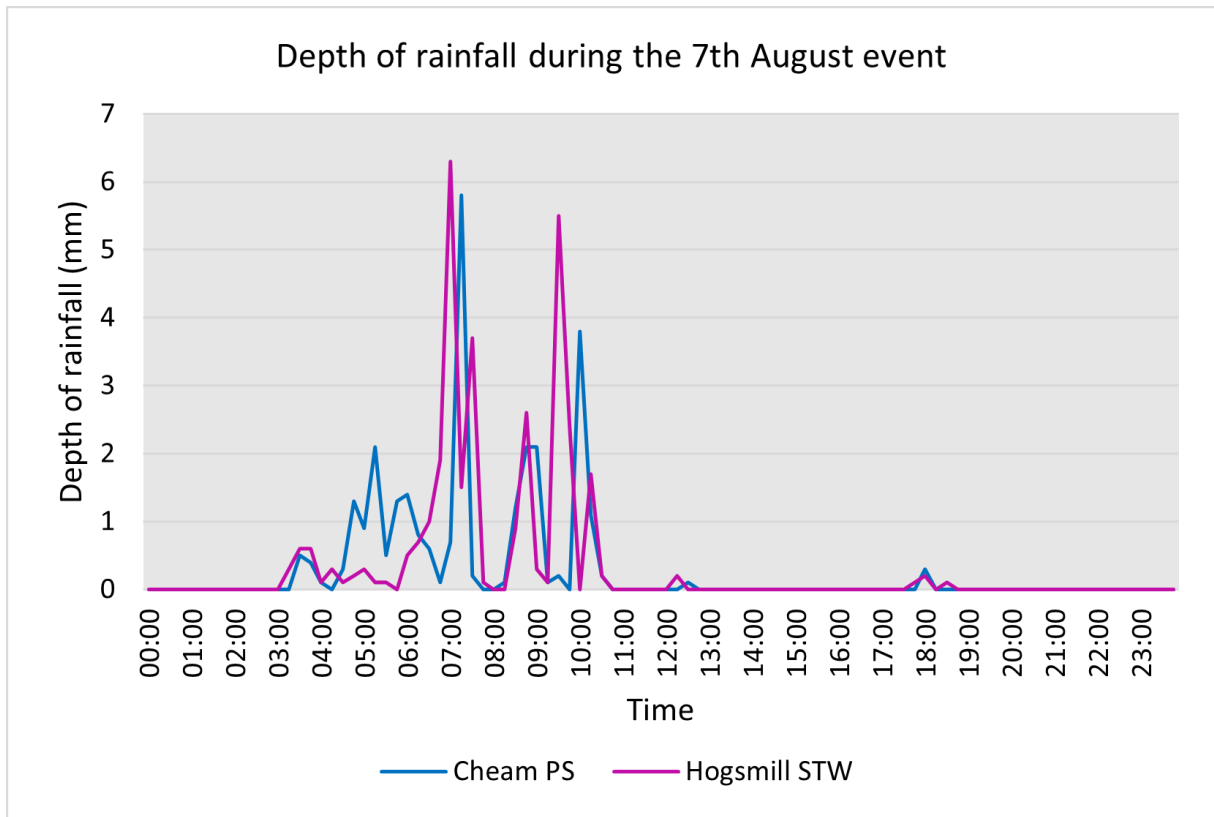


Figure 3-7: Depth of rainfall during the 7<sup>th</sup> August event

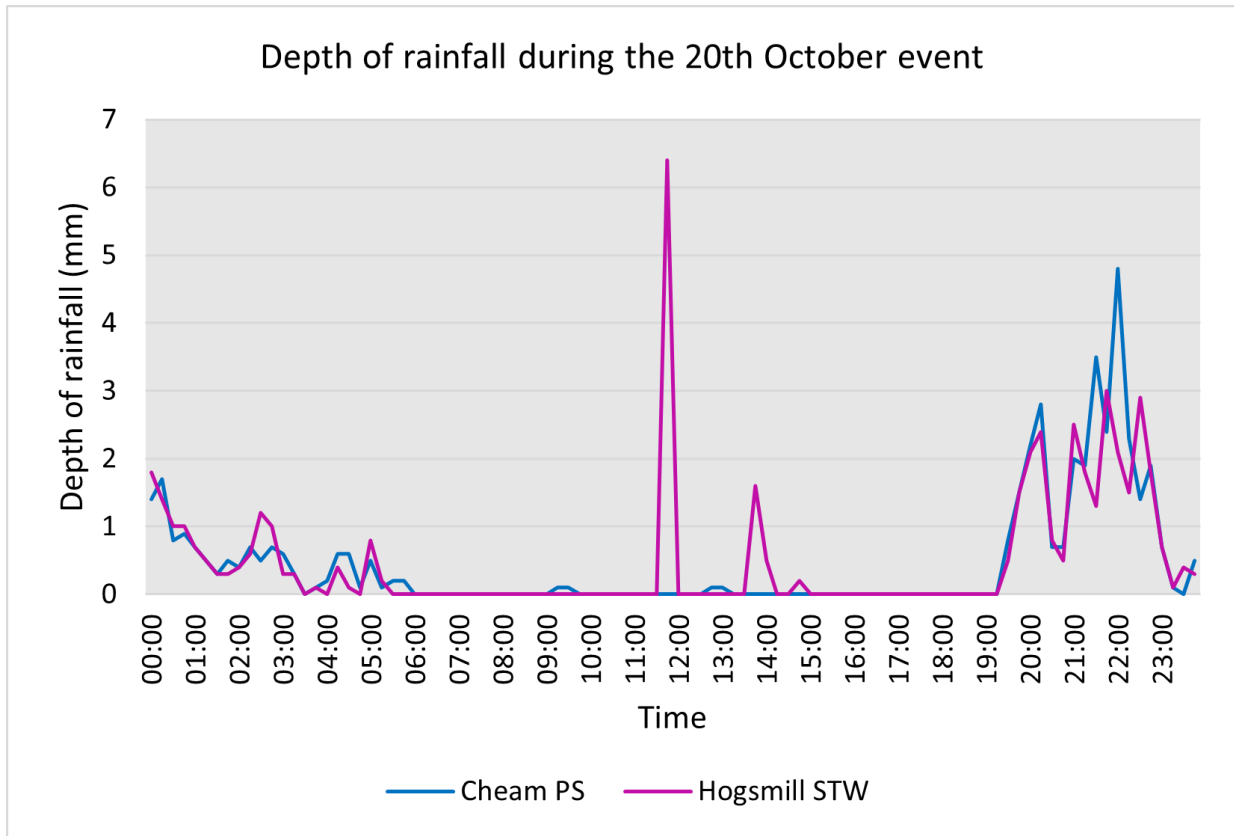


Figure 3-8: Depth of rainfall during the 20<sup>th</sup> October event



### 3.3 Affected Locations and Hydrological Catchments

On the dates of the 12<sup>th</sup> July, 25<sup>th</sup> July, 7<sup>th</sup> August, and 20<sup>th</sup> October, a total of 59 reports of flooding were received by LB Sutton. These reports were classified into internal, external, highway and unknown flooding as defined below:

- Internal flooding: flooding inside of the building, including basements.
- External flooding: flooding within property boundaries but not to buildings, this includes gardens, garages and driveways.
- Highway flooding: flooding on public roads.
- Unknown flooding: the specific location of flooding is unconfirmed.

A total of 41 internal, 12 external, one highway, and one unknown flooding report were received by LB Sutton. Four social media reports were also found for the 25<sup>th</sup> July event. Most of the flooding experienced was associated with surface water, and surcharging gullies where the drainage network, including the Beverley Brook, was unable to cope with the volume of water entering the system.

The hydrological catchment area was defined to understand the potential causes of flooding within the area. The one used herein is that created for LB Sutton’s (and RB Kingston’s) Surface Water Management Plan. A catchment area is an area of land where rain falls and drains towards the same waterbody, flow path or topographical low point. Topographic and sewer data was used to define the catchment. The affected locations in Worcester Park for all the reported dates are located within the Beverley Brook catchment area (*Figure 3-9*).

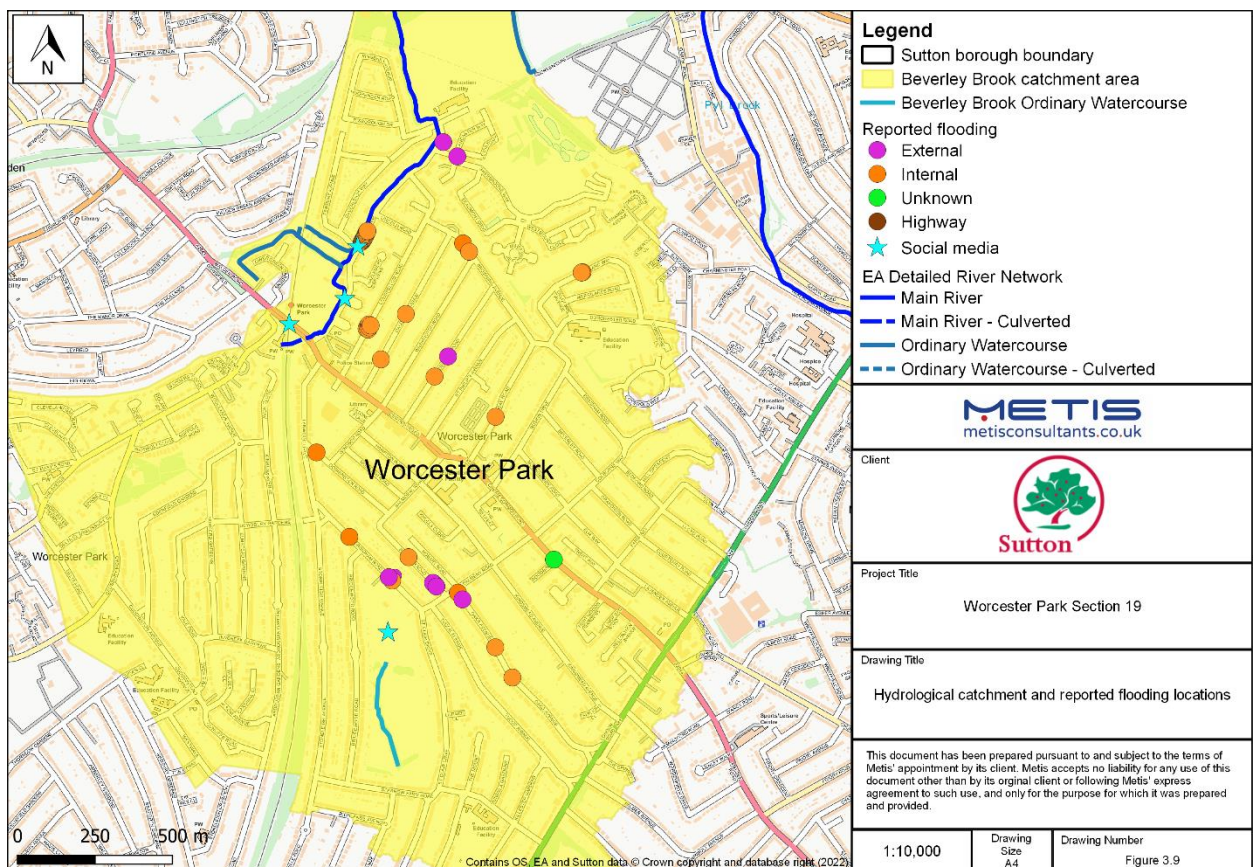


Figure 3-9: Hydrological catchment area and reported flooding locations

## 4 JULY EVENTS

### 4.1 12<sup>th</sup> July 2021

On the 12<sup>th</sup> July heavy rain across London caused widespread flooding and flash floods. The high level return period map produced by TWUL shows that Worcester Park experienced between 1 in 20 and 1 in 100 year return periods (*Figure 3-1*). TWUL estimates for Browning Avenue calculated a 1 in 331 year return period which is more accurate. In Worcester Park only one report of highway flooding was received on Browning Avenue. Browning Avenue is in the northern section of the Worcester Park catchment, southeast of Green Lane. The heavy rain recorded for the 12<sup>th</sup> July did not cause any properties to flood, however it may have raised the water table, influencing the later flood events.

It is possible that the surface water sewer system in Browning Avenue was overwhelmed by rainwater or blocked as TWUL attended the road on the 12<sup>th</sup> July to clear the surface water sewer. TWUL attended Browning Avenue multiple times during 2021 and once during 2022 to clear blockages in a specific stretch of the foul water sewer due to sewer misuse (wet wipes, thick rag and concrete). There is only one gully located at the junction of Washington Road and Browning Avenue, which may not have allowed sufficient drainage into the sewer during this event (*Figure 4-3*). A review of the EA's Risk of Flooding from Surface Water (RoFSW) data shows that the area which experienced flooding on Browning Avenue is at risk from the 1 in 30, 1 in 100, and 1 in 1000 year events (*Figure 4-2*). *Figure 4-1* shows water pooling on the surface of the road. This suggests that the corner where Browning Avenue intersects with Washington Road is likely to be at a topographical low point, where surface water has accumulated as it has nowhere to drain to. They may be due to either a blocked sewer or a lack of drainage assets. This area is therefore at high risk from surface water flooding.



Figure 4-1: Flooding on Browning Avenue on the 12<sup>th</sup> July. Source: LB Sutton



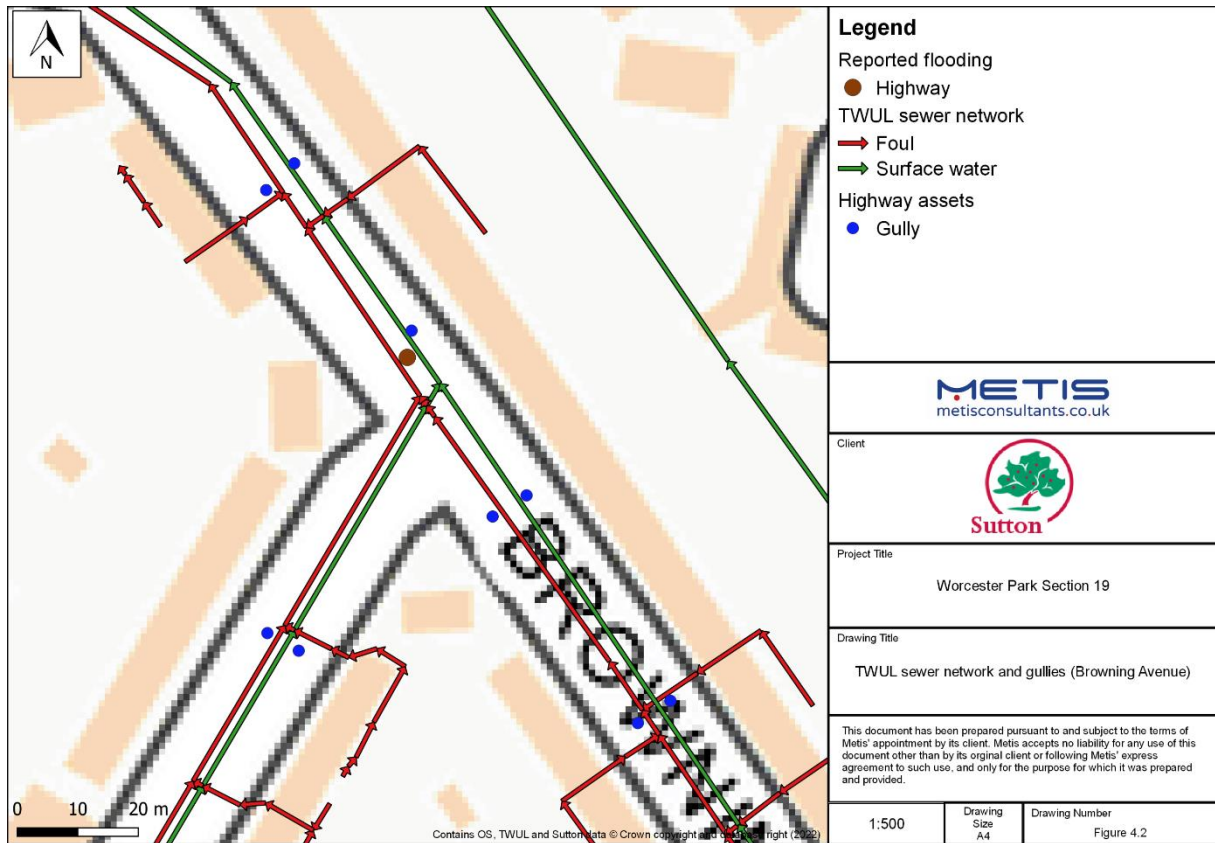


Figure 4-3: TWUL sewer network and gullies (Browning Avenue)

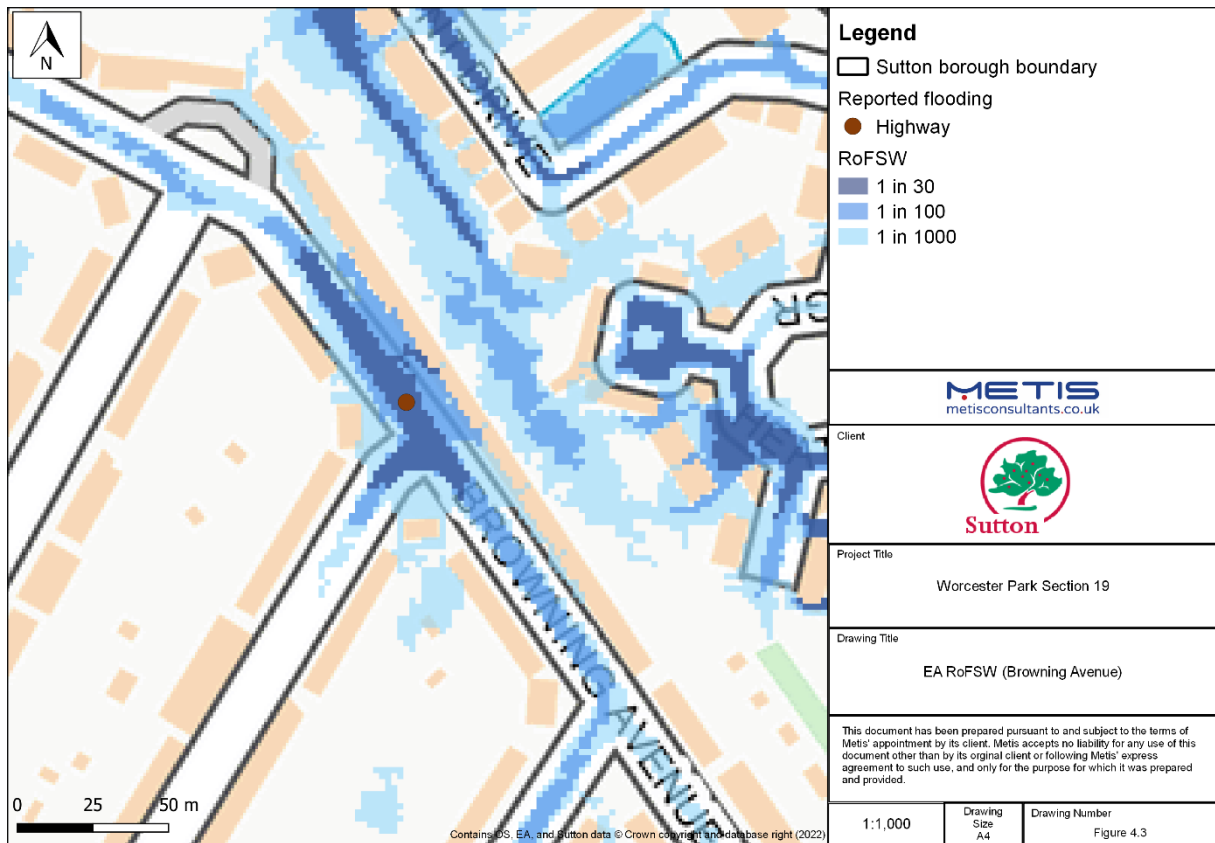


Figure 4-2: EA RoFSW (Browning Avenue)

### 4.1.1 Actions taken by relevant RMAs (and other stakeholders affected)

The actions taken by relevant RMAs before, during, and after the flood event of the 12<sup>th</sup> July are summarised below in *Table 4-1*.

**Table 4-1: RMA actions 12/07/21**

Authority	Authority Contributing Action to Flooding Incident
<i>TWUL</i>	<p style="text-align: center;"><b><u>Before</u></b></p> <p style="text-align: center;">Clearance of foul water sewer on Browning Avenue on the 20<sup>th</sup> April due to sewer misuse and completion of a camera survey following the incident.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p style="text-align: center;">Clearance of surface water sewer on Browning Avenue.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p style="text-align: center;">A customer education visit has been arranged for Browning Avenue, to speak to residents individually about sewer misuse and the importance of reporting sewer related issues. Bin It, Don't Block It (BIDBI) leaflets will also be provided.</p> <p style="text-align: center;">Have ongoing work to encourage customers to refrain from putting wet wipes and sanitary products down the toilet, which includes their BIDBI campaign which can be seen on a range of broadcast channels.</p> <p style="text-align: center;">Working to influence manufacturers to remove the plastic in wet wipes, whilst supporting Fleur Anderson MP's bill to remove plastic from all wet wipes.</p> <p style="text-align: center;">Will complete a survey of the surface water system at the junction of Washington Road and Browning Avenue to ensure that there are no defects which could have contributed to the flooding experienced.</p>

### 4.1.2 Recommendations

- LB Sutton LLFA to liaise with TWUL on sewer clearance on Browning Avenue before any significant rainfall events.
- LB Sutton to investigate whether SuDS or additional highway drainage could be included on Browning Avenue, specifically at the intersection between Washington Road and Browning Avenue.
- TWUL to work with residents to provide information on the incorrect disposal of waste via the sewer system and encourage communication of any blockages.
- TWUL to conduct a detailed investigation of the surface water sewer network at the intersection between Washington Road and Browning Avenue.

## 4.2 25<sup>th</sup> July 2021

On the 25<sup>th</sup> July, a significant flooding incident occurred due to thunderstorms, which resulted in several areas in Worcester Park being flooded. The high level return period map produced by TWUL shows that Worcester Park experienced 1 in 30, 1 in 50, and 1 in 100 year return periods (*Figure 3-2*). TWUL estimates for Browning Avenue and Sandringham Road recorded the return period for the 25<sup>th</sup> July as a 1 in 62 year event, which supports the mapped return periods.



### 4.2.1 Areas affected

There were 50 reports of flooding received by LB Sutton from residents on the 25<sup>th</sup> July and in the days following the event, and four reported on social media (Figure 4-4). These are broken down into the affected roads and classified into internal or external flooding (Table 4-2).

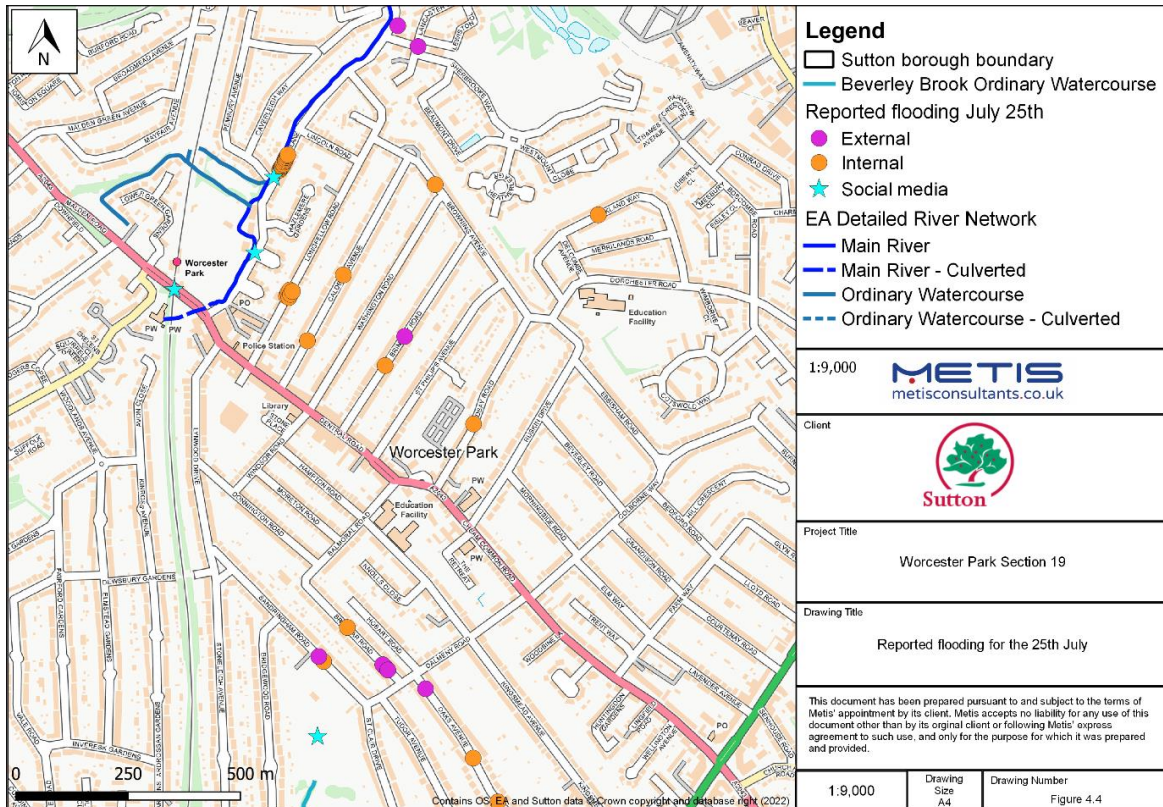


Figure 4-4 Reports of flooding for 25th July 2021

Table 4-2: Locations affected, and type of flooding reported

Locations affected	Type of flooding reported		
	Internal	External	Social media
Braemar Road	1	3*	
Brinkley Road	1	1	
Browning Avenue	1		
Buckland Way	1		
Caldbeck Avenue	2		
Central Road			1
Cuddington Recreation Ground			1
Green Lane	14	1	2
Lindsay Road	1		
Oaks Avenue	2	1	
Sandringham Road	1	1	
Longfellow Road	12**		
The Hamptons		1	
Killester Gardens		2***	

\*Two reports provided by a neighbour

\*\* Estimated by one resident on behalf of others

\*\*\*Not shown on map

### 4.2.2 Local drainage network

Figure 4-5, Figure 4-6 and Figure 4-7 show the TWUL sewer network within the local area. These are predominantly foul and surface water sewers. The sewers generally flow in a north-westerly direction in the southern area of Worcester Park (Figure 4-7), and in a north-easterly direction in the northern areas (Figure 4-5 and Figure 4-6) These all discharge into the Beverley Brook.

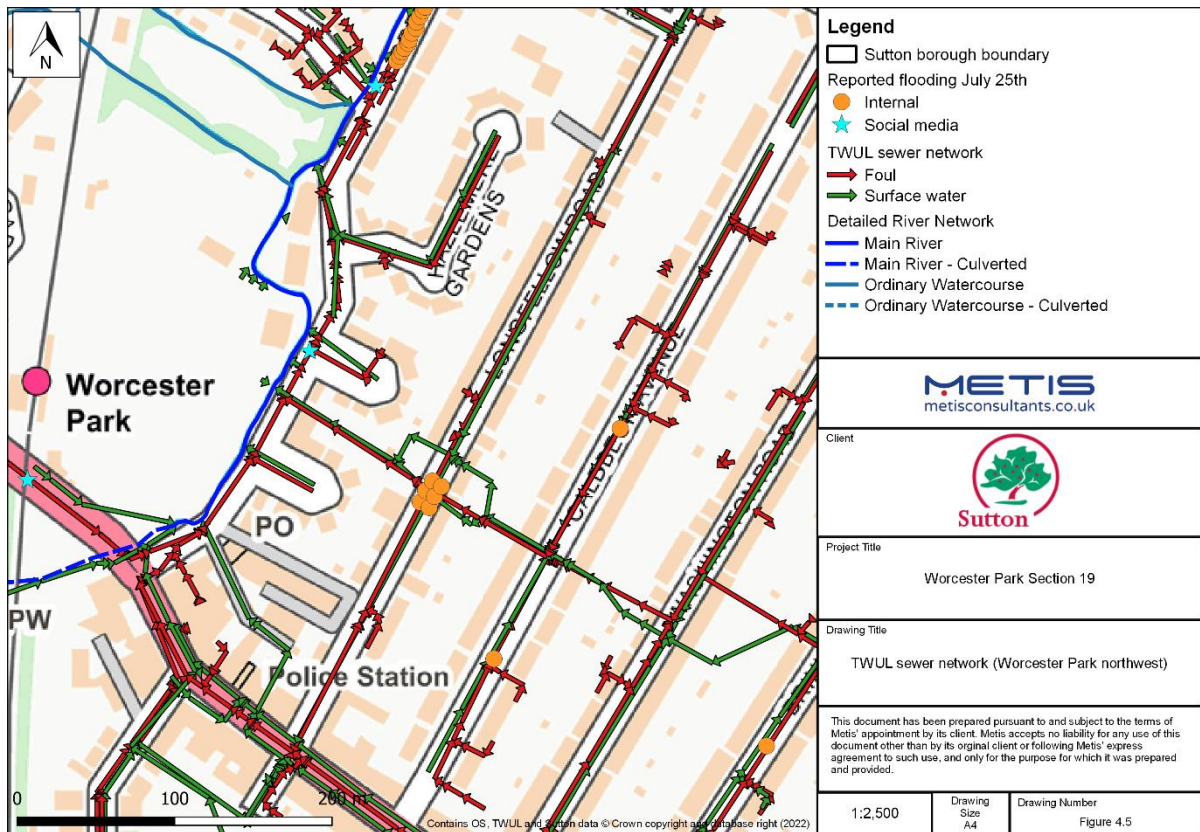


Figure 4-5 TWUL sewer network (Worcester Park northwest)



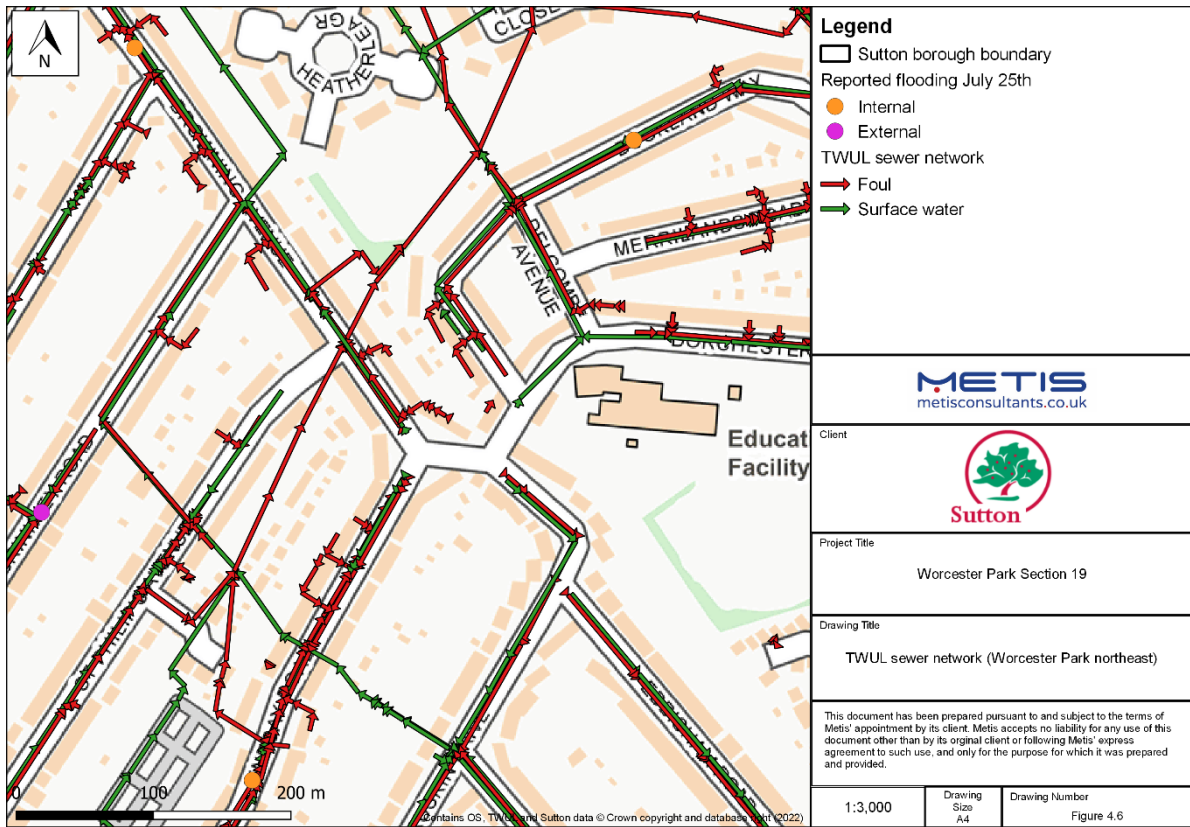


Figure 4-6 TWUL sewer network (Worcester Park northeast)

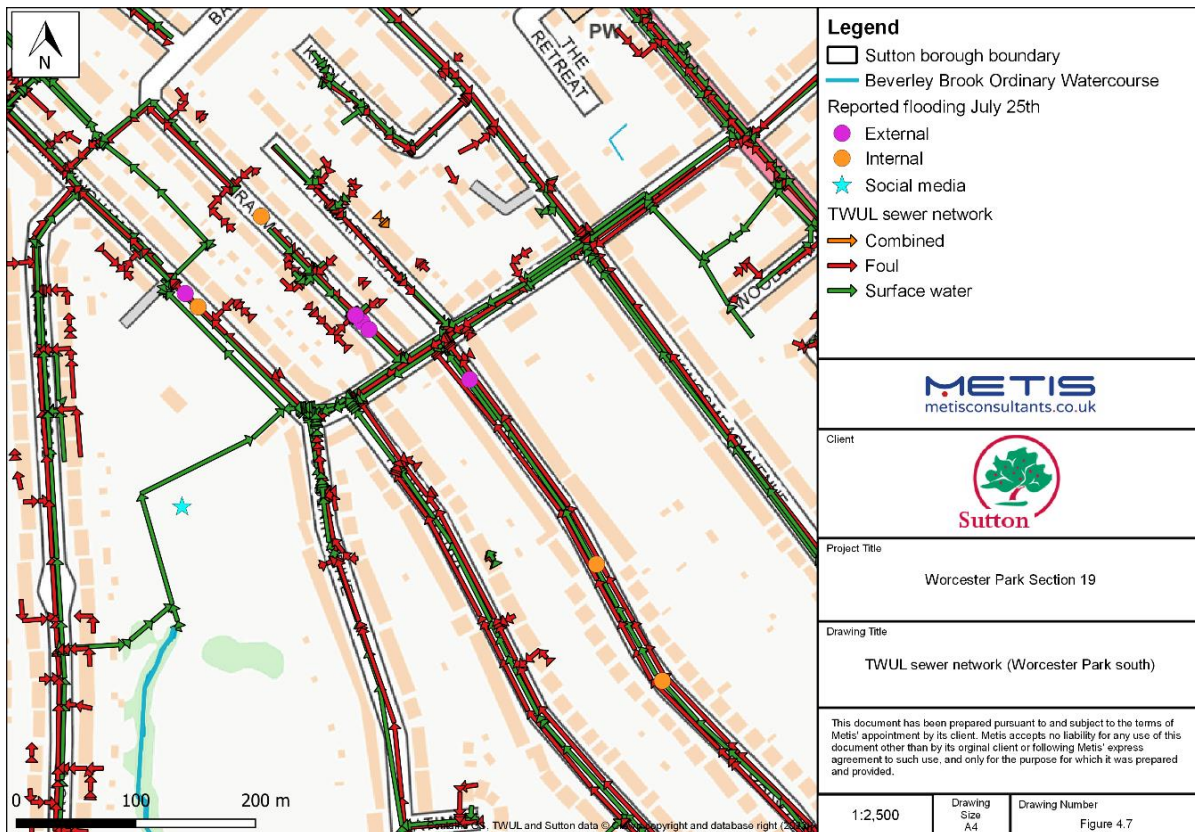


Figure 4-7 TWUL sewer network (Worcester Park south)

### 4.2.3 Local flood mechanisms

In Worcester Park, water predominantly flows in a northerly direction towards the Beverley Brook. The flooded properties on Caldbeck Avenue, Longfellow Road, Brinkley Road, and Lindsay Road, lie on a topographical low point within the catchment area. Surface water is conveyed towards the mid-point of these roads before moving northwest towards Green Lane and the Beverley Brook. Cuddington Recreation Ground is situated on a slope and surface water is conveyed downhill and then along Sandringham Road. Residents on Sandringham Road reported that the flooding had likely taken place due to the Beverley Brook trash screen on Cuddington Recreation Ground being blocked (*Figure 4-6*) as water was flowing out from the park onto the road.

The southern end of Oaks Avenue is at a topographical high point which causes water to flow downhill in a northerly direction towards the junction with Dalmeny Road. A2043 Central Road, at the point where it passes under the railway bridge, is also at a low point within the catchment where water is likely to accumulate. The underpass has flooded during previous flooding events, including in June 2016, April / May 2018, and February 2020. Many of these roads reported gullies surcharging which is likely to have been due to the Beverley Brook being unable to accommodate this volume of water as sewer outfalls were likely submerged. Given that the bedrock geology of the area is London Clay, which has low permeability, this is also likely to add to the risk of flooding in the area due to a lack of infiltration.



**Figure 4-6 The blocked culvert entrance on Cuddington recreation ground. Source: Resident**



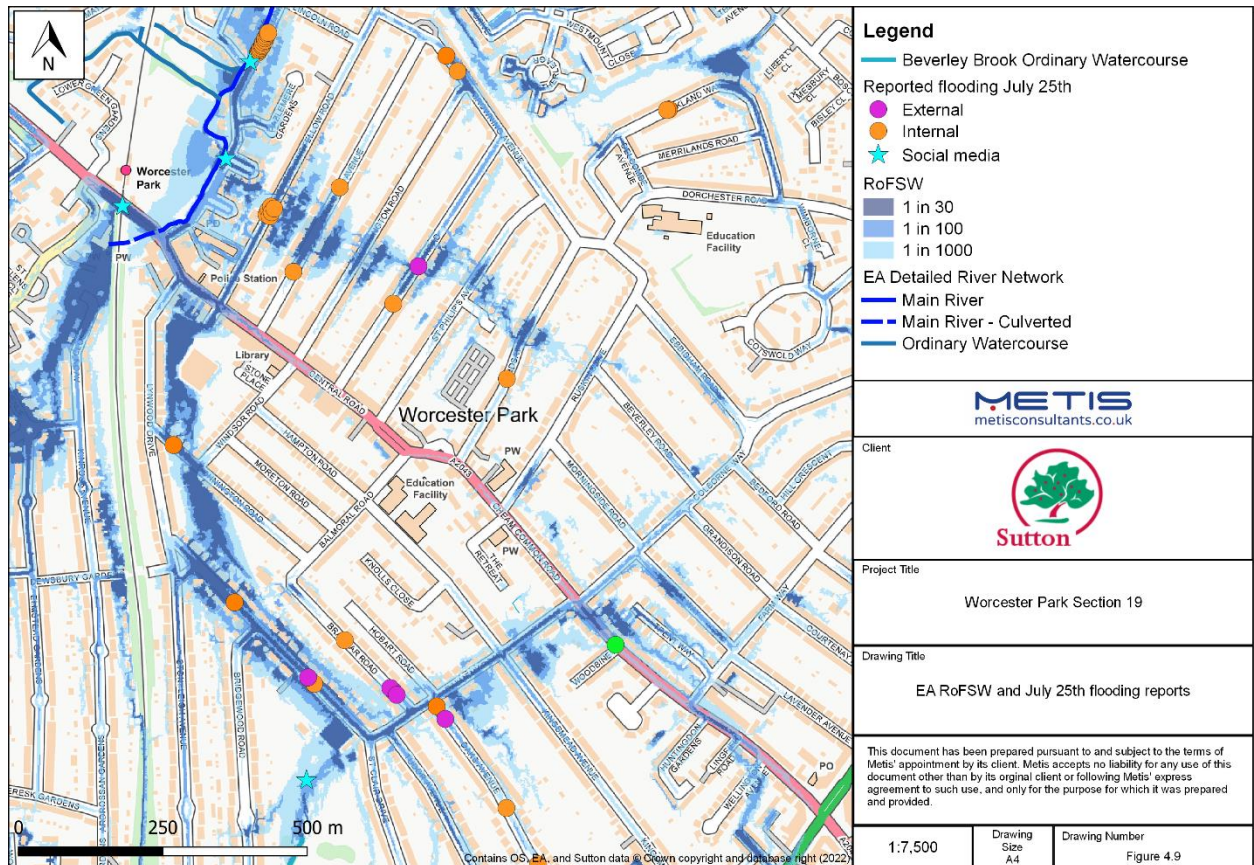
## 4.2.4 Local flood risk

In order to understand the flood mechanisms that caused the flooding events on the 25<sup>th</sup> July, it is important to consider the risk of flooding from surface water, ordinary watercourses, main rivers (fluvial), groundwater, sewers, and any other sources. This will help to determine what the main causes were and therefore help to determine any mitigation strategies.

### 4.2.4.1 Surface water flood risk

Surface water flood risk can increase due to increasing urbanisation and therefore an increase in impermeable surfaces. This means that after a period of heavy rain, rainwater accumulates at ground level and often cannot drain away via drainage systems. This leads to water flowing over the ground surface or pooling on the ground, which may cause flooding. Historically, LB Sutton used to be marsh land and a floodplain for the Beverley Brook which is also an indicator as to why there is a higher risk of surface water flooding through development. Climate change will have also been a key cause of increasing frequency of surface water flooding due to a rising frequency and intensity of rainfall events.

A review of the EA's RoFSW data shows which areas are most at risk from flooding, and from what return period. All of the roads are predicted to be affected by the 1 in 30, 1 in 100, and 1 in 1000 year events, however this may only cover part of the road. This is shown in more detail in (Figure 4-7). The map shows that there are two distinct flow paths for surface water, one flowing northwest from Lindsay Road towards Green Lane, and the other flowing southwest from Cheam Common Road and then northwest from Sandringham Road back towards A2043 Central Road. Almost all the properties which reported flooding are located on these flow paths. The majority of the properties that reported flooding are within the 1 in 1000 year flood risk extent. However, the properties on Browning Avenue, Green Lane, Longfellow Road and Sandringham Road are at risk from 1 in 30 and 1 in 100 year events. Overall, there is high risk of surface water flooding on these roads in Worcester Park.

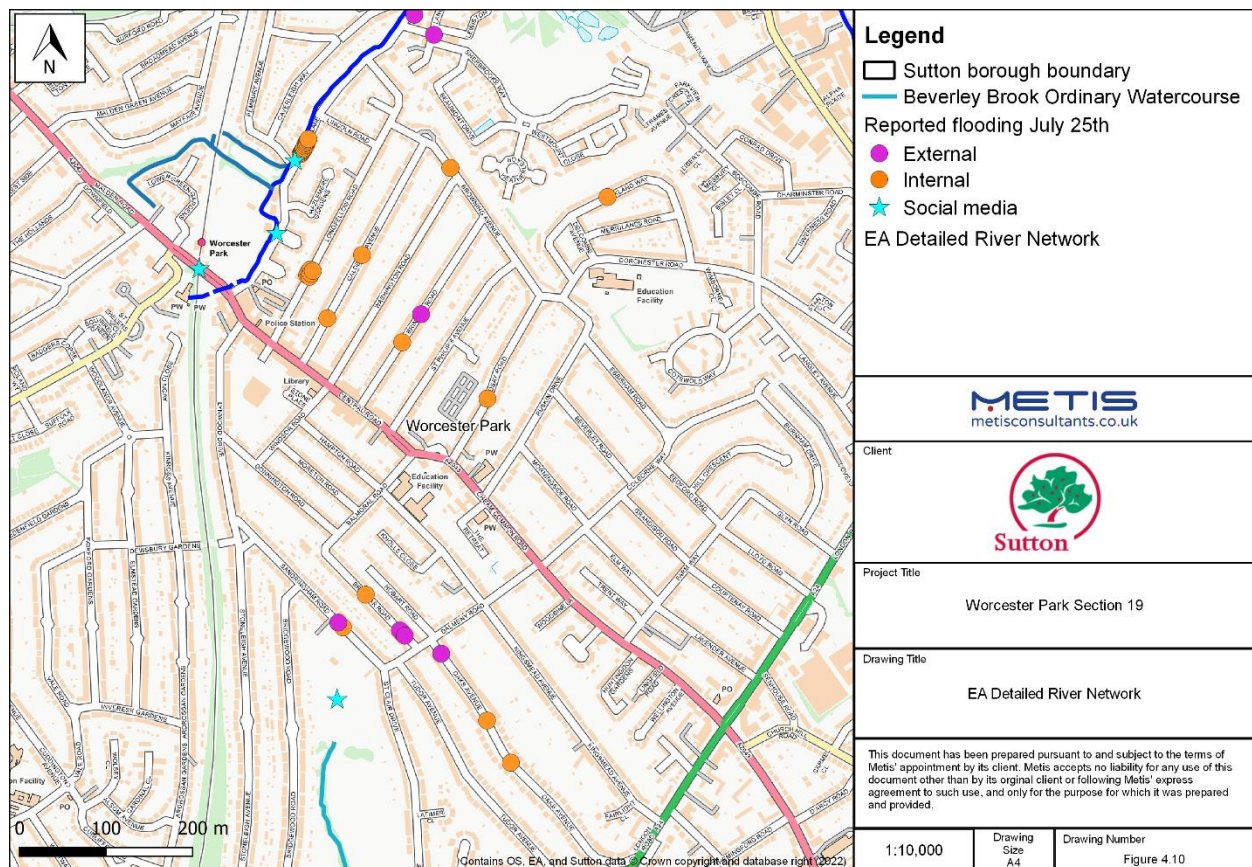


**Figure 4-7 EA RoFSW and reported flooding for 25th July**

**4.2.4.2 Ordinary watercourse flood risk**

Ordinary watercourses are rivers, ditches and streams that are not designated by the EA as a 'main river'. Peak flow of these watercourses may be increased due to significant rainfall events as there is not enough capacity within the channels to cope with the increased volume of water. This can therefore lead to surface water flooding when the watercourses overflow.

Flooding from ordinary watercourses is shown on the EA's RoFSW map. A review of the EA's detailed river network data shows that there are two streams leading off from the Beverley Brook, heading away from Green Lane towards the railway line (Figure 4-8). There is potential for these streams to have indirectly influenced the flooding experienced on Green Lane, given that they may have influenced the water levels in the Beverley Brook thereby contributing to the outfalls being submerged. The stretch of the Beverley Brook in Cuddington Recreation Ground is also an ordinary watercourse which is likely to have contributed to the flooding experienced in the recreation ground as well as on the surrounding roads.

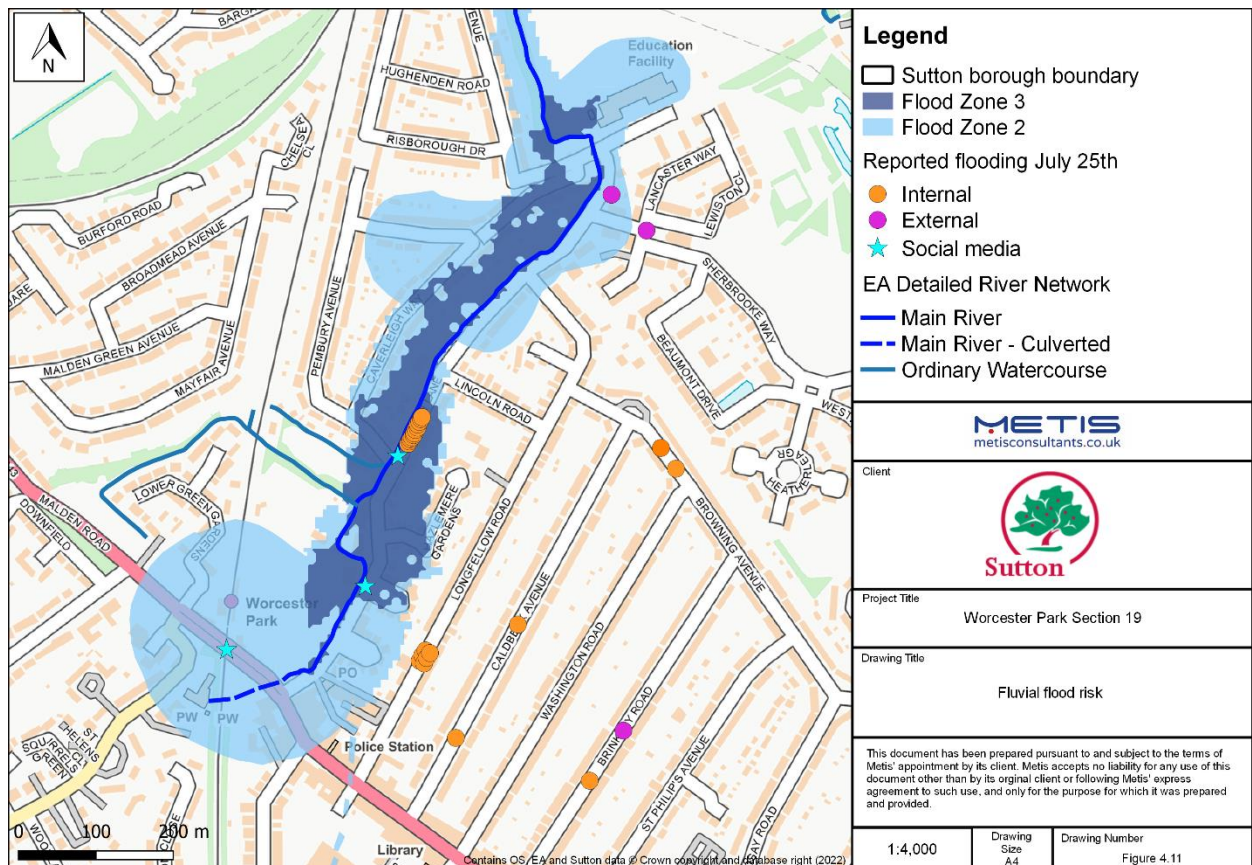


**Figure 4-8 EA Detailed River Network and reported flooding for 25th July**

**4.2.4.3 Fluvial flood risk**

Fluvial flooding occurs when extreme rainfall events cause watercourses designated as a ‘main river’ by the EA to overflow their banks, thereby leading to flooding in the surrounding areas. There is one river in Worcester Park that has been designated as a ‘main river’ by the EA which is the Beverley Brook. The Beverley Brook is culverted underneath the railway bridge and then flows north alongside Green Lane. Part of Green Lane lies within Flood Zone 3 (land assessed as having a 1 in 100 or greater annual probability of main river flooding, or a 1 in 200 or greater annual probability of flooding from the sea). There were 14 internal flooding reports within this Flood Zone (*Figure 4-9*). A2043 Central Road and the majority of Green Lane lie within Flood Zone 2 (land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of main river flooding or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding). One video was posted on social media showing very fast flows on the Beverley Brook on the 25<sup>th</sup> July and a high-water level. There is potential that fluvial flooding may have occurred here given that the property lies within Flood Zone 3.





**Figure 4-9 Fluvial flood risk in Worcester Park**

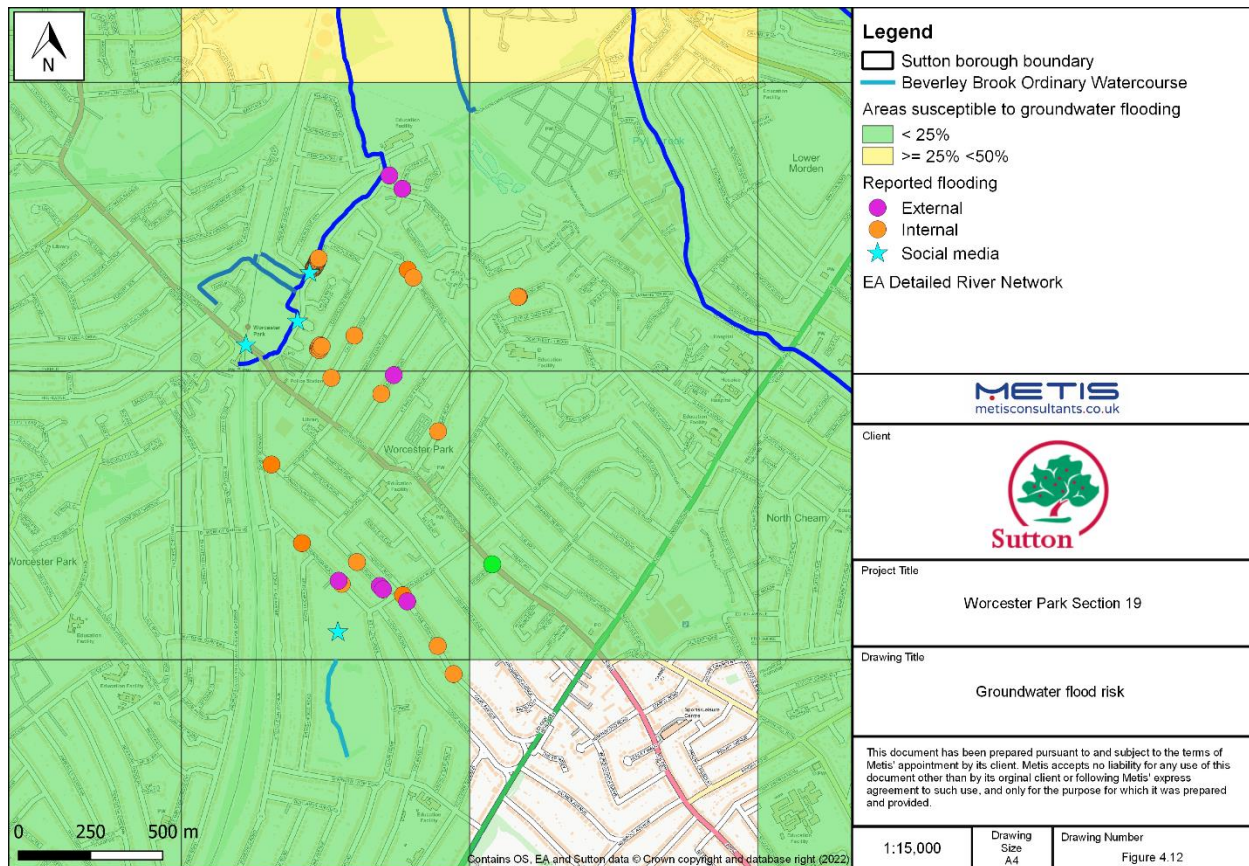
**4.2.4.4 Groundwater flood risk**

Groundwater flooding occurs when periods of high rainfall cause the water table to rise, causing basement and surface flooding as the water is no longer able to infiltrate into the ground. It may take longer for groundwater flooding to occur, and it can last much longer whilst the water table recedes.

The majority of Worcester Park lies within the '<25%' risk class of the EA's Areas Susceptible to Groundwater Flooding data (Figure 4-10). There is only a small area to the north which lies within the '>= 25% to <50%' risk class, however none of the flood reports received were in this area.

A Section 19 Borough Wide report was produced for LB Sutton in 2017 following a flood event on the 2<sup>nd</sup> June 2017, and Oaks Avenue was one of the hotspots investigated. Within the report, residents on Oaks Avenue reported groundwater rising in their garden two weeks after the flood event. The report noted that as the bedrock geology is London Clay and has low permeability, this may have led to a higher groundwater table and potential groundwater flooding after the heavy rainfall event. In this case, the heavy rainfall event on the 12<sup>th</sup> July 2021 may have raised the water table which could have increased the risk of groundwater flooding on the 25<sup>th</sup>. Therefore, groundwater flooding may have contributed to the flooding recorded on Oaks Avenue.





**Figure 4-10 Groundwater flood risk**

#### 4.2.4.5 Sewer flood risk

Sewer flooding occurs when the capacity of the sewer system is exceeded due to heavy rainfall events or blockages downstream. This causes the system to overflow and can lead to flooding.

Several residents reported that the gullies on the roads outside of their houses were surcharging, leading to water pooling on the road. It is likely that the surface water sewers were unable to cope with the high volume of water, or that there were potential blockages in the system. There were two reports of grass cuttings blocking the gullies on Oaks Avenue and Sandringham Road, which may have prevented surface water from draining into the sewer network. Given that the water from the sewer network eventually discharges into the Beverley Brook, it is likely that the levels in the brook were so high that the outfalls were submerged. This likely meant that there was no capacity for water to drain away which caused the sewers to surcharge. This has been confirmed in the Surrey County Council Section 19 for the 25<sup>th</sup> July, where surface water also discharges into the Beverley Brook. The report states that the water level in the Beverley Brook was confirmed to be above the TWUL outlet pipe at that location, which is west of this site, as the Surrey County Council and LB Sutton boundaries bisect Worcester Park east and west of the Beverley Brook.

There was one report of flooding from a resident on Oaks Avenue, where the resident stated that there was a mass of water coming into the garden which could have potentially been sewage waste. Given that the water is draining in a north-westerly direction downhill along Oaks Avenue towards the junction with Dalmeny Road it is possible that surface water accumulated in the foul

sewer due to a potential misconnection in the sewer network and was unable to drain away as the sewers were at full capacity. Resident reports confirmed that the gullies on the corner of these roads were full, with a mass of water coming out of the gullies into the garden. It is likely that the flooding experienced on this date has been partially caused by sewer flooding.

**4.2.4.6 Flood risk from other sources**

The EA’s Risk of Flooding from Reservoirs map shows that Worcester Park sits outside of the predicted reservoir flooding extent. There are also no canals in the vicinity of Worcester Park. Therefore, Worcester Park is at a low risk of flooding from other sources.

**4.2.5 Actions taken by relevant RMAs (and other stakeholders affected)**

The actions taken by relevant RMAs before, during, and after the flood event of the 25<sup>th</sup> July are summarised below in *Table 4-3*.

**Table 4-3: RMA actions 25/07/21**

Authority	Authority Contributing Action to Flooding Incident
<p><i>LB Sutton</i></p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>All gullies on Longfellow Road were serviced and designated as free runners on 22 - 23<sup>rd</sup> April 2021.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Deployment of a rapid-response team.</p> <p>Contractors were contacted to attend the area and support with gully cleansing and traffic management. The A2043 Central Road (Worcester Park Bridge underpass) and Green Lane were closed. A request was made to one of LB Sutton’s contractors to close Browning Avenue, Wordsworth Drive and Langley Avenue to traffic.</p> <p>Issued warnings on social media to warn of flooding in the area.</p> <p>Liaised with the MPS regarding road closures on A2043 Central Road and Green Lane.</p> <p>Liaised with Waitrose to lift enforcements and to allow residents on flooded roads to park their cars in the Waitrose carpark overnight.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Gullies on roads were cleared, silt and debris were removed from the Cuddington Recreation Ground trash screen as an interim measure by Parks contractor whilst engaging with TWUL.</p> <p>Communication with TWUL to carry out their responsibilities of regular clearance of the blocked trash screen on Cuddington Recreation Ground.</p> <p>Community Safety Services deployed their contractor on the 31<sup>st</sup> July and 1<sup>st</sup> August to support the clearance of debris and silt from the culvert on Cuddington Recreation Ground.</p> <p>Officers have been deployed each time heavy rainfall has been forecast.</p> <p>Placing signage on St Clair Drive advising of the risk of flooding.</p> <p>Posted updates on the council website, and updated residents via social media channels.</p>

Authority	Authority Contributing Action to Flooding Incident
<p>TWUL</p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>Cleared blockages in the foul sewer network on Green Lane on the 15<sup>th</sup> April and 15<sup>th</sup> June and then completed a camera survey of the sewer.</p> <p>Completed a camera survey for the manholes on Green Lane on the 7<sup>th</sup> April and noticed a scale build-up.</p> <p>Surveyed and cleaned 160m of sewer length on Green Lane on the 7<sup>th</sup> May.</p> <p>Cleared blockages in the foul sewer and undertook a camera survey on Caldbeck Avenue on the 20<sup>th</sup> and 23<sup>rd</sup> July.</p> <p>Cleared blockages in foul sewer on Sandringham Road on the 14<sup>th</sup> April and the 3<sup>rd</sup> July due to sewer misuse and completed camera surveys afterwards.</p> <p>Site meeting with BT Openreach on the 6<sup>th</sup> May and sewer repairs completed In July on Oaks Avenue following a telephone pole going through the public foul sewer.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Cleared blockage in the surface water sewer on Browning Avenue.</p> <p>Cleared blockages in the foul sewers on Sandringham Road.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Undertaking an independent review following the heavy rainfall across London in July.</p> <p>Surface water sewer on Browning Avenue checked via camera on the 6<sup>th</sup> October.</p> <p>Cleared blockages in the foul water sewer on Browning Avenue on the 5<sup>th</sup> November and 4<sup>th</sup> March (2022) due to sewer misuse.</p> <p>Camera survey of entire surface water network on Braemar Road completed on the 20<sup>th</sup> August.</p> <p>Cleared blockages in the foul sewer and undertook a camera survey on Caldbeck Avenue on the 28<sup>th</sup> July and 1st August.</p> <p>Cleared blockages in foul sewer on Sandringham Road on the 7<sup>th</sup> December and on several occasions during the start of 2022 due to sewer misuse and completed camera surveys afterwards.</p> <p>Jet-cleaned 85m of sewer on Green Lane on the 27<sup>th</sup> November.</p> <p>Cleared a blockage and completed a camera survey on foul sewer on Kingsmead Avenue on the 10<sup>th</sup> January.</p>

Authority	Authority Contributing Action to Flooding Incident
<i>London Fire Brigade</i>	<p><b><u>Before</u></b> No known actions taken.</p> <p><b><u>During</u></b> The London Fire Brigade were required to rescue three adults and two children from a car under the flooded railway bridge on the A2043 Central Road.</p> <p><b><u>After</u></b> No known actions taken.</p>

#### 4.2.6 Source and Cause

The most likely causes of the flooding experienced in Worcester Park on the 25<sup>th</sup> July 2021 has been investigated. The heavy rainfall from this event led to an inundation of water in the area. One of the main sources of flooding was surface water flooding, where water accumulated on the roads and was unable to drain away via the drainage system. The sewers were surcharging into the road at several locations suggesting that they were unable to accommodate this volume of water. At some locations the sewers were blocked by grass cuttings and debris, as reported by residents and TWUL, exacerbating this problem. Furthermore, the water levels in the Beverley Brook were very high, suggesting that the outfalls from the sewers into the Beverley Brook were submerged. This meant that there was no capacity to take on the water from the sewer system. Since water was unable to drain to the river through the sewer system, water pooled against the flood wall along the Beverly Brook on Green Lane. The presence of the flood wall prevented the Beverley Brook from bursting its banks, so it was not likely a cause of flooding. However, it may have prevented water draining away after the flooding event. There is potential for there to have been groundwater flooding on Oaks Avenue, which was also previously suggested in the Section 19 Borough Wide report for LB Sutton (2017). This may have been caused by the 12<sup>th</sup> July 2021 event increasing the groundwater table. Lastly, the trash screen in Cuddington Recreation Ground was blocked during this event which led to water flowing out across the park and onto Sandringham Road, increasing the volume of flooding experienced there.

#### 4.2.7 Recommendations

- LB Sutton LLFA to undertake further research into Oaks Avenue and the surrounding area to the south to confirm if the site is vulnerable to groundwater flooding, using strategically placed boreholes.
- LB Sutton Emergency team to update Multi-agency flood plan to outline the council’s response for future flood events.
- LB Sutton LLFA to consult with residents to explore property level protection through organising the National Flood Forum workshop with residents.
- LB Sutton to investigate whether SuDS or additional highway drainage could be included on the affected roads.
- LB Sutton LLFA to install permanent signage on the underpass on the A2043 Central Road to highlight the deep-water flood risk at this location.
- TWUL to ensure that they continue to fortnightly check/clear and maintain the culvert and trash screen on Cuddington Recreation Ground, prior to the construction of the Worcester Park FAS.

- TWUL to survey and identify a potential misconnection in the sewer network on the corner of Oaks Avenue and Dalmeny Road.
- LB Sutton LLFA, EA, and TWUL to investigate potential issues caused by multiple catchment areas discharging into the Beverley Brook.



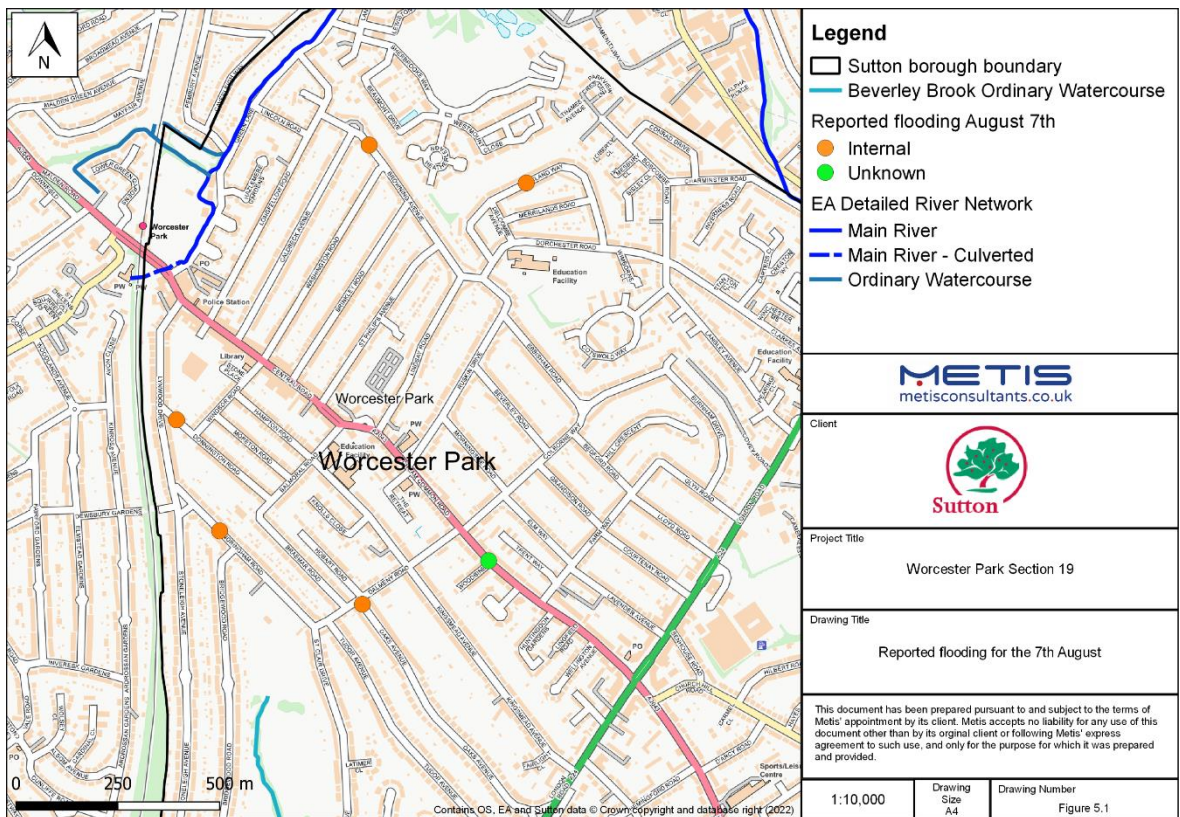
# 5 AUGUST EVENT

## 5.1 7<sup>th</sup> August 2021

Further heavy rainfall occurred on the 7<sup>th</sup> August, causing flooding within Worcester Park. The TWUL high level return period map for this date (*Figure 3-3*) estimates that this was a 1 in 10-year event.

### 5.1.1 Areas affected

There were six reports of flooding received from residents around the flooding event of the 7<sup>th</sup> August (*Figure 5-1*). These are broken down into the affected roads and classified into internal or unknown sources of flooding (*Table 5-1*).



**Figure 5-1: Reported flooding for the 7th August**

**Table 5-1: Locations affected, and type of flooding reported**

Locations affected	Type of flooding reported	
	Internal	Unknown
Browning Avenue	1	
Buckland Way	1	
Cheam Common Road		1
Donnington Road	1	
Oaks Avenue	1	
Sandringham Road	1	

### 5.1.2 Local drainage network

Figure 5-2 and Figure 5-3 show the TWUL sewer network within the area, and the reported flooding locations on 7<sup>th</sup> August. They are mostly foul and surface water sewers. The sewers in the northern section of Worcester Park generally flow in a north-westerly direction, and in the southern section they flow in a northwest or north-easterly direction. The sewers eventually discharge into the Beverley Brook to the north.

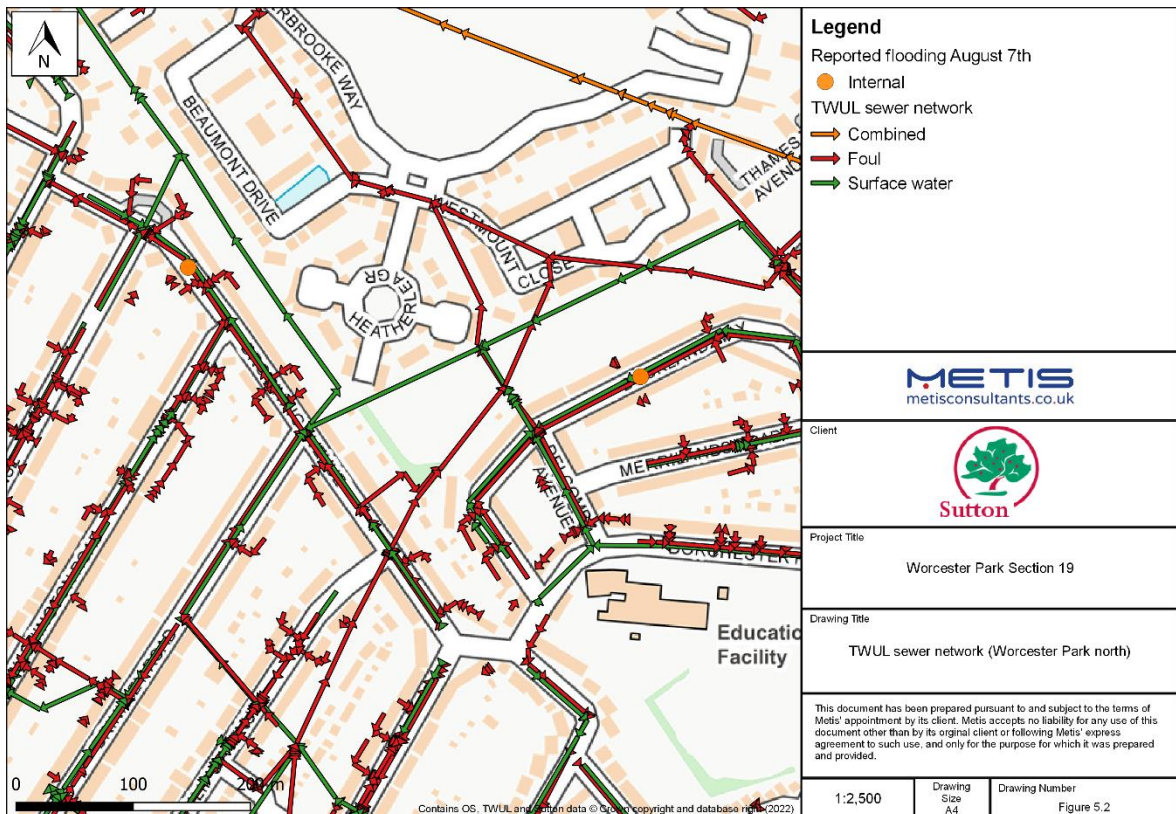
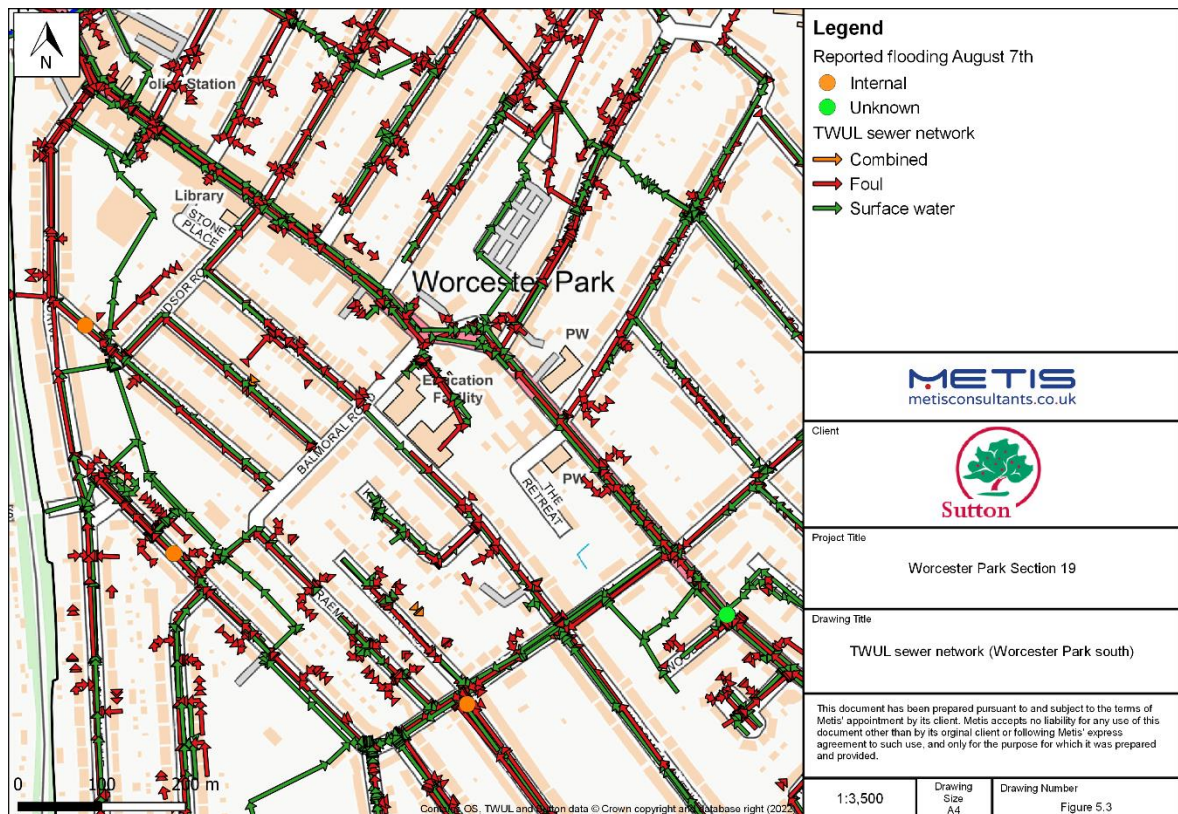


Figure 5-2: TWUL sewer network (Worcester Park north)





**Figure 5-3: TWUL sewer network (Worcester Park south)**

### 5.1.3 Local flood mechanism

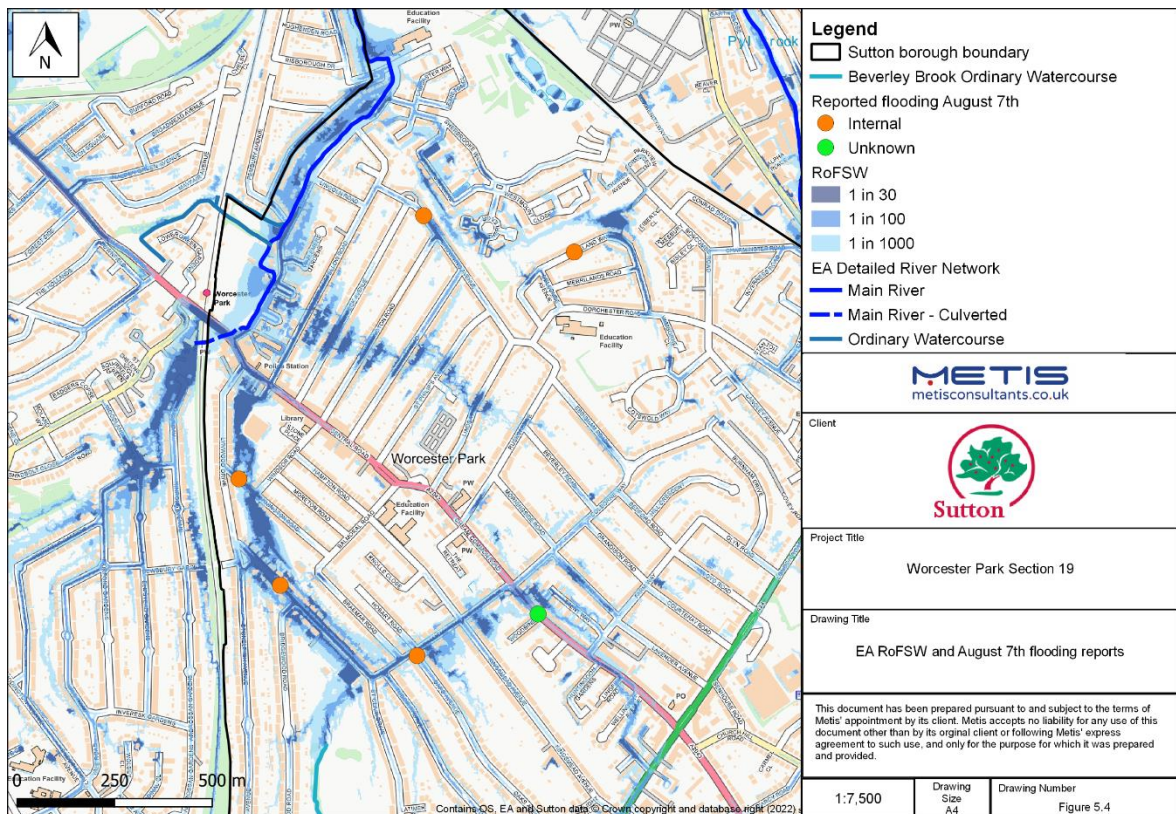
The surface water within this catchment predominantly flows in a northerly direction towards the Beverley Brook. Surface water flows downhill on Oaks Avenue towards the junction with Dalmeny Road. From Cuddington Recreation Ground, surface water flows in the direction of Sandringham Road and then towards the A2043 Central Road and the Beverley Brook. Due to the trash screen frequently being blocked on Cuddington Recreation Ground (*Figure 4-6*), it is likely that the high volume of water flowing through the recreation ground caused flooding on Sandringham Road. Residents on Sandringham Road reported that properties came close to internally flooding on this date. Buckland Way is situated at a topographical high point within the catchment area; however, it is likely to have still been influenced by surface water flooding due to the location of the gullies on this road and the likelihood that there may have been a surcharging sewer given the level of rainfall on this date. On Browning Avenue water is likely to pool on the corner by Washington Road before flowing north towards the Beverley Brook. This may have been caused by insufficient drainage and extensive impermeable surfaces.

### 5.1.4 Local flood risk

#### 5.1.4.1 Surface water flood risk

A review of the EA's RoFSW data shows which areas are most at risk from flooding, and from which return period. All of the roads which reported flooding on the 7<sup>th</sup> August are predicted to be affected by the 1 in 30, 1 in 100, and 1 in 1000 year events (*Figure 5-4*). The map shows where the properties that reported internal or unknown flooding are in relation to RoFSW data. The majority of the properties that reported flooding are within or around the 1 in 30, 1 in 100, and 1 in 1000-year flood risk areas, other than the property on Buckland Way.





**Figure 5-4: EA RoFSW and reported flooding for August 7th**

**5.1.4.2 Ordinary watercourse flood risk**

Flooding from ordinary watercourses is shown on the EA’s RoFSW map. There are two ordinary watercourses draining into the Beverley Brook close to Green Lane. These are located to the northwest of the catchment away from reported flooding on the 7<sup>th</sup> August. It is therefore unlikely that these watercourses were the cause of flooding on this date. However, the stretch of ordinary watercourse of the Beverley Brook on Cuddington Recreation Ground is likely to have contributed to the flooding experienced on Sandringham Road.

**5.1.4.3 Fluvial flood risk**

According to the EA’s online Flood Map for Planning, the only areas within a flood zone in Worcester Park are Central Road and Green Lane (see *Figure 4-9*). The only river in the area that has been designated as a ‘main river’ by the EA is the Beverley Brook. As the roads reporting flooding for August 7<sup>th</sup> were not within the flood zone or close to the Beverley Brook, it is unlikely that they are at risk from fluvial flooding.

**5.1.4.4 Groundwater flood risk**

The main area of Worcester Park including where the flooding events were reported lies within the ‘<25%’ risk class of the EA’s Areas Susceptible to Groundwater Flooding data (see *Figure 4-10*). It has however been suggested in the Section 19 Borough Wide report for LB Sutton (2017) that heavy rainfall events may have contributed to a higher groundwater table and potential groundwater flooding on Oaks Avenue. Given that this event on the 7<sup>th</sup> August followed two rainfall events on both the 12<sup>th</sup> and 25<sup>th</sup> July, it is likely that the groundwater level was still high at this time. Therefore, there is potential for groundwater flooding on Oaks Avenue to have occurred on this date.

**5.1.4.5 Sewer flood risk**

TWUL went on site to Oaks Avenue on the 7<sup>th</sup> August to check the foul and surface water sewers following reports of flooding. Inspections on the day suggested that the flooding was caused by the sewers being inundated by the amount of rainfall, not due to any blockages in the system. The high amount of rainfall recorded on this day therefore suggests that the sewers were overwhelmed, causing a risk of sewer flooding in this area. TWUL also removed tree roots from the foul sewer on Sandringham Road following flooding on this date. Debris was also cleared from a surface water sewer on Browning Avenue on this date and again a few weeks later. It is therefore likely that these roads were affected by sewer flooding on this date, due to a combination of lack of capacity within the sewers to accommodate for the level of rainfall, and blockages within the system not allowing for sufficient drainage.

*5.1.4.6 Flood risk from other sources*

The EA’s Risk of Flooding from Reservoirs map shows that Worcester Park sits outside of the predicted reservoir flooding extent. There are no canals in the vicinity of Worcester Park. There is therefore low risk of flooding from any other sources.

**5.1.5 Actions taken by relevant RMAs (and other stakeholders affected)**

The actions taken by relevant RMAs before, during, and after the flood event of the 7<sup>th</sup> August are summarised below in *Table 5-2*.

**Table 5-2: RMA actions 07/08/21**

Authority	Authority Contributing Action to Flooding Incident
<i>LB Sutton</i>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>Warning issued to residents about potential heavy rain, prepared support and rescue teams, provided contact details to report flood incidents.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Deployment of officers following the forecast of heavy rainfall.</p> <p>Arranged for gully sucking, checked vulnerable residents with the duty social worker, requested TWUL attendance, issued communications to residents.</p> <p>Sandbags provided for high risk locations, including Sandringham Road.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Contractor employed to clear debris from the brook on Cuddington Recreation Ground.</p> <p>The Parks team has completed improvements to the 1930s field drainage system in the park which should help contain surface water by carrying it into the surface water sewers instead of pooling in the park or flowing onto Sandringham Road. Road gullies and inspection chambers on the driveway between the bowling green and tennis courts were checked and cleaned out to get them working again. The small gullies around the tennis courts were cleaned out and had new covers fitted. An Aco drain was installed at the driveway entrance to the park and connected to the surface water sewer. The main channel of the brook has been cleaned out, the banks regraded and the drain under the bridge brought back into operation.</p> <p>Reported blockage in the surface water sewer at the junction of Balmoral Road and Braemar Road to TWUL.</p>

Authority	Authority Contributing Action to Flooding Incident
<p><i>TWUL</i></p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p style="text-align: center;">No known actions taken.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Attended site to check foul and surface water sewers on Oaks Avenue following reports of flooding.</p> <p style="text-align: center;">Cleared debris from a surface water sewer on Browning Avenue.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Removed tree roots from part of the foul sewer network on Sandringham Road on the 24<sup>th</sup> November and repaired the fractured sections of pipe.</p> <p>Re-attended Oaks Avenue site on the 14<sup>th</sup> August to check for residual blockages, one sewer was cleared with a high-pressure jet.</p>
<p><i>Highways</i></p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>Provided approximately 200 sandbags to residents directly adjacent to the Cuddington Recreation Ground culvert, including Sandringham Road, and other high-risk locations.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p style="text-align: center;">No known actions taken.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p style="text-align: center;">No known actions taken.</p>

### 5.1.6 Source and Cause

The main sources and causes of flooding for the event on the 7<sup>th</sup> August in Worcester Park are as follows. The high level of rainfall on this day caused six different flood incidents to be reported. The most likely causes for this are surface water flooding combined with sewer flooding. The sewers were inundated with water, and the water was therefore unable to drain away, causing the gullies to surcharge and water to accumulate on the surface. There is potential for groundwater flooding to have caused flooding on Oaks Avenue. There was a reported issue with the trash screen on Cuddington Recreation Ground; water was reported as flowing through the park onto Sandringham Road, causing flooding there.

### 5.1.7 Recommendations

- LB Sutton to investigate whether SuDS or additional highway drainage could be included on the affected roads.
- LB Sutton LLFA to consult with residents to explore property level protection through organising the National Flood Forum workshop with residents.
- TWUL to consider increasing the capacity of the sewer network on Oaks Avenue and Dalmeny Road as part of the plans in their updated DWMP.
- TWUL to ensure that they continue to fortnightly check/clear and maintain the culvert and trash screen on Cuddington Recreation Ground, prior to the commencement of the Worcester Park FAS.



# 6 OCTOBER EVENT

## 6.1 20<sup>th</sup> October 2021

A period of heavy rainfall occurred on the 20<sup>th</sup> October causing flooding in Worcester Park.

### 6.1.1 Areas affected

There were two reports of external flooding on the 20<sup>th</sup> October which occurred on Browning Avenue and Sandringham Road (Figure 6-1). There were no reports of internal flooding received.

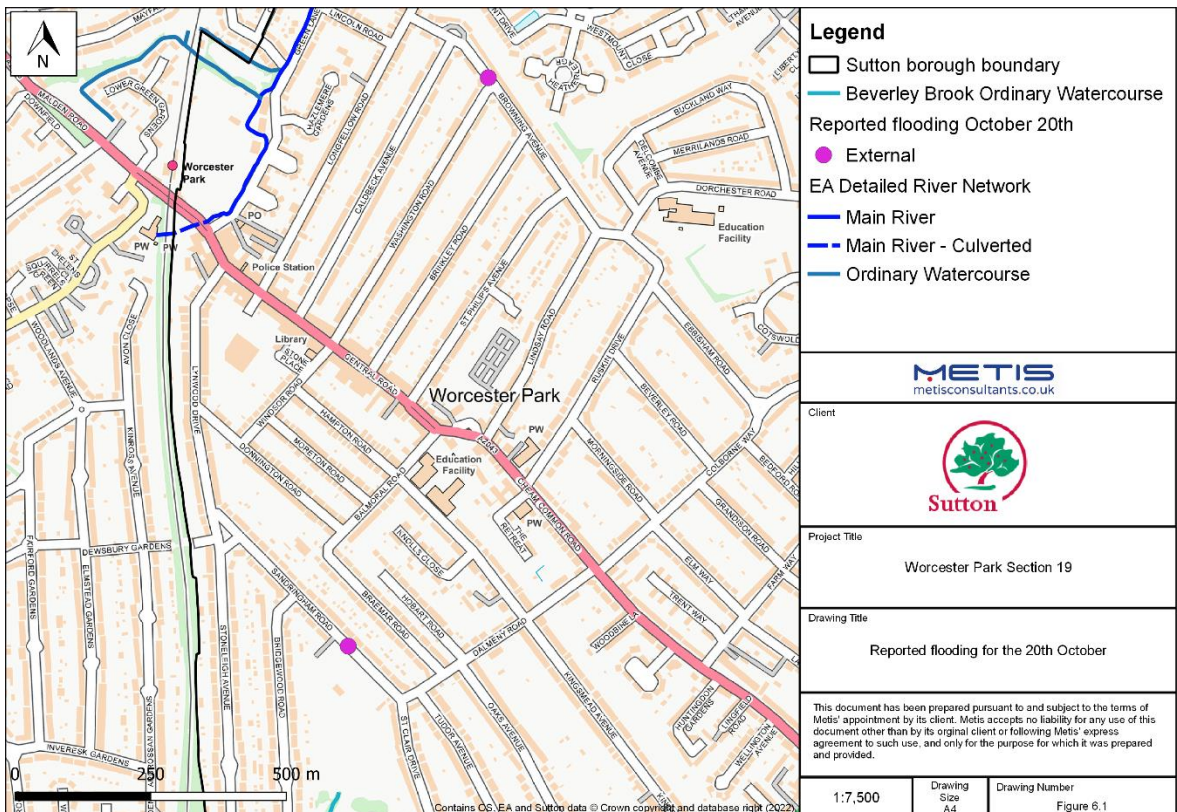


Figure 6-1: Reported flooding for the 20<sup>th</sup> October

### 6.1.2 Local drainage network

Figure 6-2 and Figure 6-3 show the TWUL sewer network on Sandringham Road and Browning Avenue. There are two main surface water sewers running alongside Sandringham Road, and one main foul sewer. Water from Cuddington Recreation Ground also enters the surface water sewers via the culvert in the park. On Browning Avenue, as noted in Section 4.1, there is only one gully on this corner of road. The sewers then flow northwest where they discharge into the Beverley Brook.



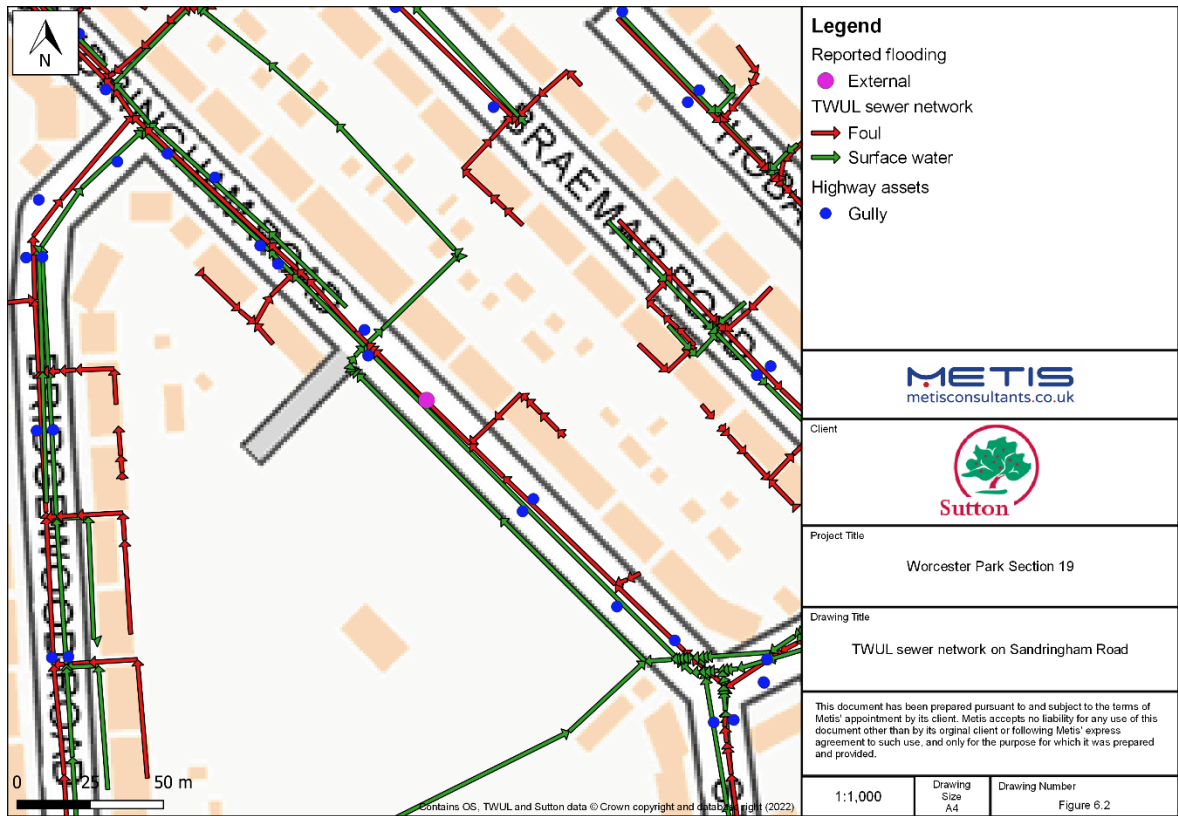


Figure 6-2: TWUL sewer network on Sandringham Road

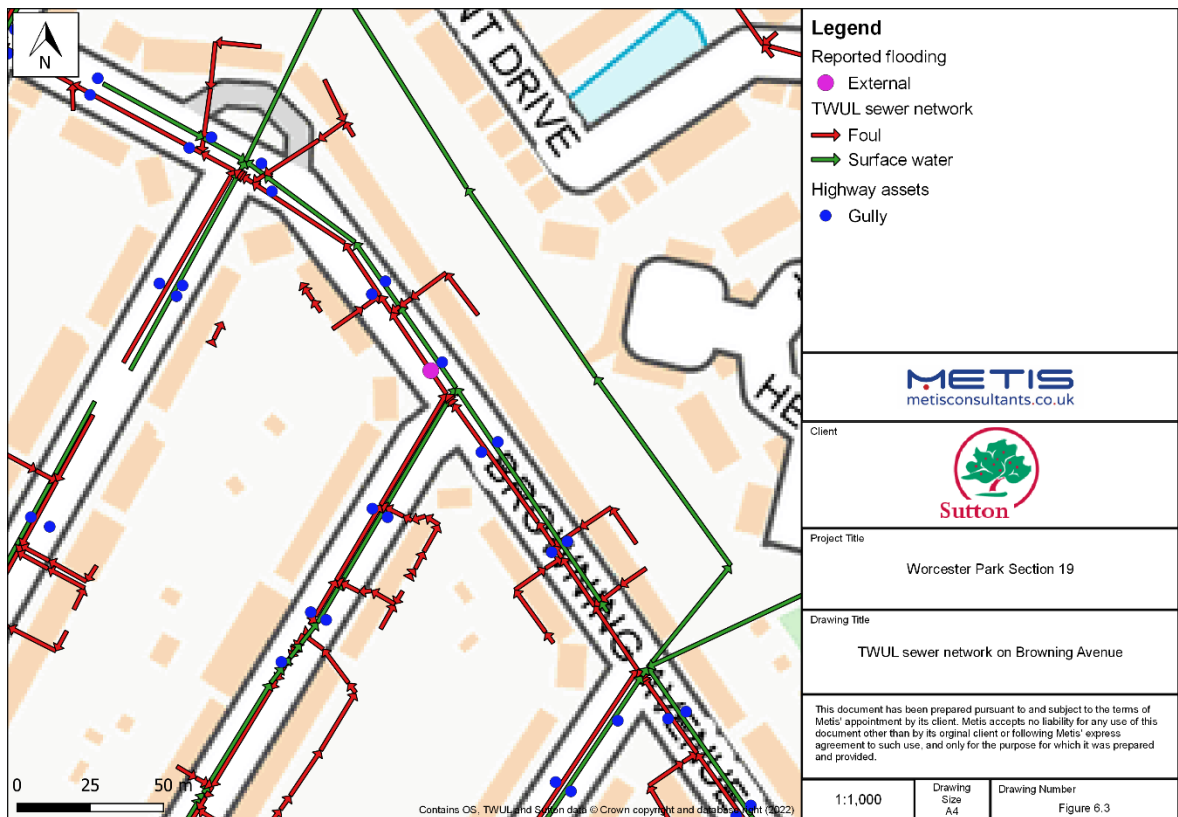


Figure 6-3: TWUL sewer network on Browning Avenue

### 6.1.3 Local flood mechanism

On Browning Avenue, water is predicted to flow in a north-westerly direction before it eventually discharges into the Beverley Brook. The reported flooding seems to have predominantly covered the road and driveway however it is not confirmed that it reached the property boundary. Upstream of Sandringham Road, water flows down through Cuddington Recreation Ground which then accumulates in the road and flows in a northerly direction through the catchment towards the Beverley Brook. During the previous events, the gullies have been inundated with water at this location, causing water to accumulate and therefore cause flooding to properties in the area. The resident reported their back garden to be flooded and said that their house came close to internally flooding. They stated that water was pouring out of Cuddington Recreation Ground as the trash screen was once again blocked. TWUL were reported to have cleared the sewers on Sandringham Road a few weeks prior to the event however the sewers on this date were not coping with the volume of water.

### 6.1.4 Local flood risk

The primary source of flood risk suspected to have caused the external flooding reported was surface water flooding (*Figure 6-4*). Both Browning Avenue and Sandringham Road are predicted to be at risk from 1 in 30, 1 in 100, and 1 in 1000 year events. Sandringham Road also lies within a surface water flow path. Water was reported to have been flowing across the recreation ground and accumulating on Sandringham Road. It is therefore likely that both roads are at risk from surface water flooding.

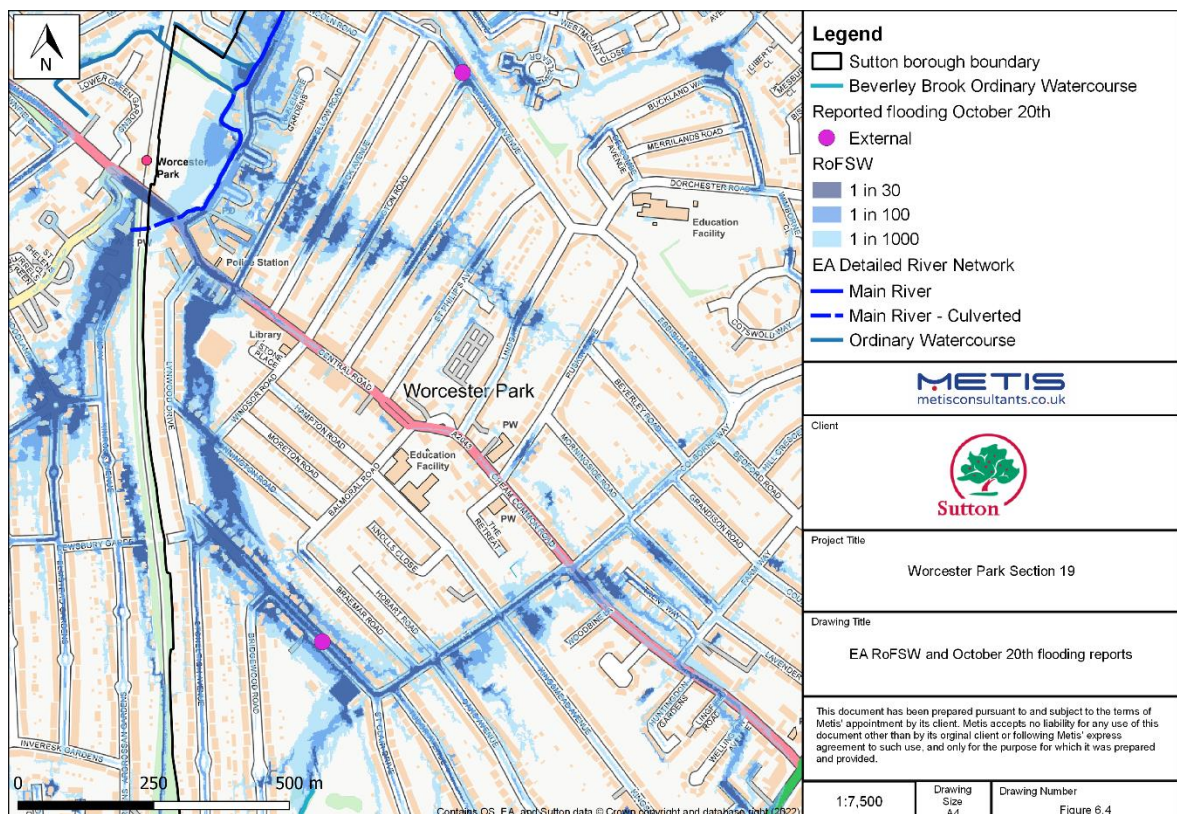


Figure 6-4: EA RoFSW and reported flooding for October 20th

### 6.1.5 Actions taken by relevant RMAs (and other stakeholders affected)

The actions taken by relevant RMAs before, during, and after the flood event of the 20<sup>th</sup> October are summarised below in Table 6-1.

**Table 6-1 RMAs action 20/10/21**

Authority	Authority Contributing Action to Flooding Incident
<p>LB Sutton</p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>Alerted Highways, Street Cleansing and Neighbourhood Services to take action and inspect their land and assets to ensure this was prepared to deal with heavy rainfall.</p> <p>A Local Authority Liaison Officer (LALO) was pre-emptively deployed to Cuddington Recreation Ground to inspect the ordinary watercourse channel and trash screen and assess the level of accumulated debris.</p> <p>Adult Social Care were contacted to identify vulnerable residents on the roads surrounding Cuddington Recreation Ground.</p> <p>A yellow weather warning for rain issued by the Met Office was circulated on media channels and directed people to the Council’s website for flooding advice to warn/inform residents.</p> <p>The Head of Neighbourhood Services met with the Council’s grounds maintenance contractor on site to walk the brook on Cuddington Recreation Ground and look for any loose material that could wash down the culvert.</p> <p>The Council’s contractor was on site on the 1<sup>st</sup> October and cleared debris from the brook on Cuddington Recreation Ground.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Circulated the Met Office’s revised Amber warning.</p> <p>Deployed a LALO to inspect locations across the borough as they were reported to confirm level of response required.</p> <p>Contacted TWUL to attend initial location reports (Browning Avenue and Cuddington Recreation Ground).</p> <p>Organised road closures for Green Lane, Browning Avenue and Sandringham Road.</p> <p>Organised a contractor to attend with a gully sucking crew to support flooded areas.</p> <p>Notified the duty social worker in preparation for internal flooding to properties surrounding Cuddington Recreation Ground.</p> <p>Emergency planning team call to report TWUL lack of attendance at the Cuddington Recreation Ground trash screen.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Cleaning of culvert entrance trash screen and the screen by the pedestrian crossing further upstream.</p> <p>Installation of additional gully pots on the Cuddington Recreation Ground car park driveway.</p>

Authority	Authority Contributing Action to Flooding Incident
<p>TWUL</p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>Clearance of blockages in foul sewer on Caldbeck Avenue on the 20<sup>th</sup>, 23<sup>rd</sup>, and 28<sup>th</sup> July, and the 1<sup>st</sup> August followed by camera surveys.</p> <p>Camera survey and clean of 82m of foul sewer on Caldbeck Avenue on the 1<sup>st</sup> February.</p> <p>Clearance of blockages in foul sewer on Cheam Common Road on the 4<sup>th</sup> May, 1<sup>st</sup> July and 3<sup>rd</sup> July due to sewer misuse.</p> <p>Cleared the culvert entrance on Cuddington Recreation Ground on the 1<sup>st</sup> October.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Clearance of blockage in surface water sewer on Browning Avenue.</p> <p>Clearance of blockage in foul water sewer on Sandringham Road.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Cleaning of the culvert entrance trash screen and further screen upstream on Cuddington Recreation Ground, cleaning order for fortnightly visits reinstated.</p> <p>Conducted a survey and re-lining work on their surface water sewers on Sandringham Road on the 24<sup>th</sup> November.</p> <p>Further work planned: remove and replace existing trash screen, partially remove the brickwork to the pipe, install a temporary trash screen, replace the fencing surrounding the trash screen including the removal of the dead trees.</p> <p>Clearance of blockages in foul sewer on Caldbeck Avenue followed by camera surveys on several dates during November and December, and January 2022.</p> <p>Clearance of blockages in foul sewer on Cheam Common Road on the 14<sup>th</sup> November and 6<sup>th</sup> January (2022) due to sewer misuse.</p> <p>Cleared a partial collapse between two manholes on Cheam Common Road and completed a camera survey on the 4<sup>th</sup> February 2022, aiming to reattend and replace a manhole cover and continue investigations.</p>
<p>Highways</p>	<p style="text-align: center;"><b><u>Before</u></b></p> <p>No known actions taken.</p> <p style="text-align: center;"><b><u>During</u></b></p> <p>Reported the Beverley Brook trash screen and culvert to be cleared to TWUL.</p> <p style="text-align: center;"><b><u>After</u></b></p> <p>Installation of six new gullies on Sandringham Road.</p> <p>Planning for the removal of speed humps and replacing them with speed cushions.</p> <p>Department highway inspectors monitoring the situation on Sandringham Road with a view to call for additional road sweeping and to action remodelling of the road hump.</p>



### 6.1.6 Source and Cause

The heavy rainfall event of the 20<sup>th</sup> October caused two external flooding incidents, the causes of which have been examined. The main causes of flooding for Browning Avenue have been summarised as surface water and sewer flooding. For Sandringham Road, the main causes of flooding are suspected to be surface water flooding, sewer flooding, and the blockage of the trash screen on the recreation ground creating additional surface water flooding.

### 6.1.7 Recommendations

- LB Sutton Highways team to ensure that the road hump that was installed on Sandringham Road following the flooding event is reprofiled, to prevent highway profile issues and surface water pooling.
- LB Sutton LLFA to investigate whether SuDS could be incorporated on Browning Avenue and Sandringham Road to reduce the risk of flooding, and whether additional highway drainage could be included on Browning Avenue.
- TWUL to ensure that they continue to fortnightly check/clear and maintain the culvert and trash screen on Cuddington Recreation Ground, prior to the commencement of the Worcester Park FAS.

# 7 CONCLUSIONS AND RECOMMENDATIONS

## 7.1 Conclusions

This Section 19 investigation for Worcester Park was triggered following four significant flood events that took place on the 12<sup>th</sup> July, 25<sup>th</sup> July, 7<sup>th</sup> August, and 20<sup>th</sup> October 2021. On each date heavy rainfall led to flooding incidents being reported in the area. There was a total of 25 flooding reports received by LB Sutton across the four dates that were investigated. A summary of the actions taken by the relevant RMAs before, during and after the flooding events has been provided in *Sections 4.1.1, 4.2.5, 5.1.5, and 6.1.5*.

There is expected to be an increase in heavy rainfall events in the future due to climate change. This is likely to affect the number of events and severity of flooding in many areas, and future mitigation measures need to consider this. This area of Worcester Park sits within one hydrological catchment area, which is the upstream end of the Beverley Brook. Water within this catchment predominantly flows north before discharging into the Beverley Brook.

This investigation established that Worcester Park is predominantly at risk from surface water and sewer flooding. However, there is potential for Oaks Avenue to have been affected by groundwater flooding, and Green Lane may be at risk from fluvial flooding given its proximity to the Beverley Brook and its position within Flood Zones 2 and 3. One of the main sources of flooding also arises from the culvert and trash screen in Cuddington Recreation Ground where there has been a lack of maintenance since it was taken over by TWUL several years ago. Persistent blockage of the trash screen has led to an increase in surface water flowing across the park and towards Sandringham Road.

A Worcester Park FAS has been developed for Cuddington Recreation Ground with construction planned for 2022. The current TWUL culvert and trash screen issue may be bypassed by redirecting overflow directly into wetlands and basins. Therefore, this FAS should address some of the flooding issues in Worcester Park, specifically on Sandringham Road and the areas surrounding Cuddington Recreation Ground.

## 7.2 Recommendations

Recommendations have been provided in each chapter to provide suggestions for reducing the risk of flooding for any future events. These are summarised below:

- LB Sutton to investigate whether SuDS or additional highway drainage could be included on the affected roads, specifically at the intersection between Washington Road and Browning Avenue.
- TWUL to work with residents to provide information on the incorrect disposal of waste via the sewer system and encourage communication of any blockages.
- TWUL to conduct a detailed investigation of the surface water sewer network at the intersection between Washington Road and Browning Avenue.
- LB Sutton LLFA to undertake further research into Oaks Avenue and the surrounding area to the south to confirm if the site is vulnerable to groundwater flooding, using strategically placed boreholes.
- LB Sutton Emergency Planning to update multi-agency flood plan to outline Sutton's response for future flooding events.
- LB Sutton LLFA to consult with residents to explore property level protection through organising the National Flood Forum workshop with residents.

- LB Sutton LLFA to install permanent signage on the underpass on the A2043 Central Road to highlight the deep-water flood risk at this location.
- LB Sutton LLFA, EA, and TWUL to investigate potential issues caused by multiple catchment areas discharging into the Beverley Brook, and to identify new solutions and funding opportunities.
- TWUL to consider increasing the capacity of the sewer network on Oaks Avenue and Dalmeny Road as part of the plans in their updated DWMP.
- TWUL to survey and identify a potential misconnection in the sewer network on the corner of Oaks Avenue and Dalmeny Road.
- The LB Sutton Highways team to ensure that the road hump that was installed on Sandringham Road following the flooding events is reprofiled, to prevent highway profile issues and surface water pooling.
- TWUL to ensure that they continue to fortnightly check/clear and maintain the culvert and trash screen on Cuddington Recreation Ground, prior to the commencement of the Worcester Park FAS.

# APPENDICES

## Appendix 1 – EA Rain Gauge Data

Table 0-1: Rain gauge data for the 12th July, 25th July, 7th August, and 20th October

Time (BST)	Depth of rainfall (mm)							
	12 <sup>th</sup> July 2021		25 <sup>th</sup> July 2021		7 <sup>th</sup> August 2021		20 <sup>th</sup> October 2021	
	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW
00:00	0	0	0	0	0	0	1.4	1.8
00:15	0	0	0	0	0	0	1.7	1.4
00:30	0	0	0	0	0	0	0.8	1
00:45	0	0	0	0	0	0	0.9	1
01:00	0	0	0	0	0	0	0.7	0.7
01:15	0.1	0	0	0	0	0	0.5	0.5
01:30	0	0	0	0	0	0	0.3	0.3
01:45	0	0	0	0	0	0	0.5	0.3
02:00	0.1	0.1	0	0	0	0	0.4	0.4
02:15	0	0	0	0	0	0	0.7	0.6
02:30	0.4	0	0	0	0	0	0.5	1.2
02:45	0.1	0.1	0	0	0	0	0.7	1
03:00	0	0	0	0	0	0	0.6	0.3
03:15	0	0.2	0	0	0	0.3	0.3	0.3
03:30	0	0.1	0	0	0.5	0.6	0	0
03:45	0	0	0	0	0.4	0.6	0.1	0.1
04:00	0.1	0	0	0	0.1	0.1	0.2	0



Depth of rainfall (mm)								
Time (BST)	12 <sup>th</sup> July 2021		25 <sup>th</sup> July 2021		7 <sup>th</sup> August 2021		20 <sup>th</sup> October 2021	
	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW
04:15	0	0	0	0	0	0.3	0.6	0.4
04:30	0	0	0	0	0.3	0.1	0.6	0.1
04:45	0	0	0	0	1.3	0.2	0.1	0
05:00	0	0	0	0	0.9	0.3	0.5	0.8
05:15	0	0	0	0	2.1	0.1	0.1	0.2
05:30	0	0	0	0	0.5	0.1	0.2	0
05:45	0	0	0.1	0	1.3	0	0.2	0
06:00	0	0	0	0	1.4	0.5	0	0
06:15	0	0	0	0	0.8	0.7	0	0
06:30	0	0	0	0	0.6	1	0	0
06:45	0	0	0	0	0.1	1.9	0	0
07:00	0	0	0	0	0.7	6.3	0	0
07:15	0.1	0	0	0	5.8	1.5	0	0
07:30	0.1	0.1	0	0	0.2	3.7	0	0
07:45	0	0.1	0	0	0	0.1	0	0
08:00	0	0	0	0	0	0	0	0
08:15	0	0	0	0	0.1	0	0	0
08:30	0	0	0	0	1.2	0.9	0	0
08:45	0	0	0	0	2.1	2.6	0	0
09:00	0	0	0	0	2.1	0.3	0	0
09:15	0	0	0	0	0.1	0.1	0.1	0
09:30	0	0	0.1	0	0.2	5.5	0.1	0
09:45	0	0	0	0	0	2.4	0	0

Depth of rainfall (mm)								
Time (BST)	12 <sup>th</sup> July 2021		25 <sup>th</sup> July 2021		7 <sup>th</sup> August 2021		20 <sup>th</sup> October 2021	
	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW
10:00	0	0	0	0	3.8	0	0	0
10:15	0	0	0	0	1.1	1.7	0	0
10:30	0	0	0	0	0.2	0.2	0	0
10:45	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	0
11:15	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	6.4
12:00	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0.2	0	0
12:30	0	0	0	0.1	0.1	0	0	0
12:45	0	0	0	0	0	0	0.1	0
13:00	0	0	0	0	0	0	0.1	0
13:15	0	0	5.8	0.5	0	0	0	0
13:30	0	0	0.1	1.3	0	0	0	0
13:45	0	0	1.1	4.7	0	0	0	1.6
14:00	0	0	0.9	0.5	0	0	0	0.5
14:15	0	0	0.2	0.5	0	0	0	0
14:30	0	0	0.1	0.1	0	0	0	0
14:45	0	0	0	0.2	0	0	0	0.2
15:00	0	0	0	0.4	0	0	0	0
15:15	3.9	0	0	0.5	0	0	0	0
15:30	7.2	1.1	0.1	0.3	0	0	0	0

Depth of rainfall (mm)								
Time (BST)	12 <sup>th</sup> July 2021		25 <sup>th</sup> July 2021		7 <sup>th</sup> August 2021		20 <sup>th</sup> October 2021	
	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW
15:45	3.1	5	0.1	0.2	0	0	0	0
16:00	1.7	2.6	0.2	0.7	0	0	0	0
16:15	0.6	2.3	0.7	1.6	0	0	0	0
16:30	2.1	1.1	0.3	0.9	0	0	0	0
16:45	1.9	1.3	0.6	0.7	0	0	0	0
17:00	0.5	1.6	0.4	0.7	0	0	0	0
17:15	0.2	1.2	0.4	0.6	0	0	0	0
17:30	0.1	1	0	0	0	0	0	0
17:45	0	1.4	0.1	0	0	0.1	0	0
18:00	0	0.3	0.1	0	0.3	0.2	0	0
18:15	0	0.1	0.3	0.6	0	0	0	0
18:30	0	0.4	0.3	0.4	0	0.1	0	0
18:45	0	0.3	0.3	0.4	0	0	0	0
19:00	0	0.5	0.2	0.5	0	0	0	0
19:15	0	0.2	0.1	0	0	0	0	0
19:30	0	0.3	0.1	0.1	0	0	0.8	0.5
19:45	0	0.3	0	0	0	0	1.5	1.5
20:00	0	0.2	0	0	0	0	2.2	2.1
20:15	0	0	0.1	0.1	0	0	2.8	2.4
20:30	0	0.1	0	0.1	0	0	0.7	0.8
20:45	0	0	0	0	0	0	0.7	0.5
21:00	0	0	0	0	0	0	2	2.5
21:15	0	0	0	0	0	0	1.9	1.8

Depth of rainfall (mm)								
Time (BST)	12 <sup>th</sup> July 2021		25 <sup>th</sup> July 2021		7 <sup>th</sup> August 2021		20 <sup>th</sup> October 2021	
	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW	Cheam PS	Hogsmill STW
21:30	0	0	0.1	0	0	0	3.5	1.3
21:45	0	0	0	0	0	0	2.4	3
22:00	0	0	0	0	0	0	4.8	2.1
22:15	0.1	0	0	0	0	0	2.3	1.5
22:30	0	0	0	0	0	0	1.4	2.9
22:45	0	0	0	0	0	0	1.9	1.8
23:00	0	0	0	0	0	0	0.7	0.7
23:15	0	0	0	0	0	0	0.1	0.1
23:30	0	0	0	0	0	0	0	0.4
23:45	0	0	0	0	0	0	0.5	0.3