SECTION 19

FLOOD RISK INVESTIGATION REPORT

PREPARED FOR THE LONDON BOROUGH OF MERTON

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Date June 2019
Version 1.3

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Revision History

Version	Date	Description	Prepared	Approved
1.0	25/01/2019	Pre-consultation version for client review	DC/GT/MM	MA
1.1	18/04/2019	RMA consultation version	MM	MA
1.2	03/06/2019	Post-consultation version for client review	MM	DP
1.3	26/06/2019	Final report following client review	MM	MA

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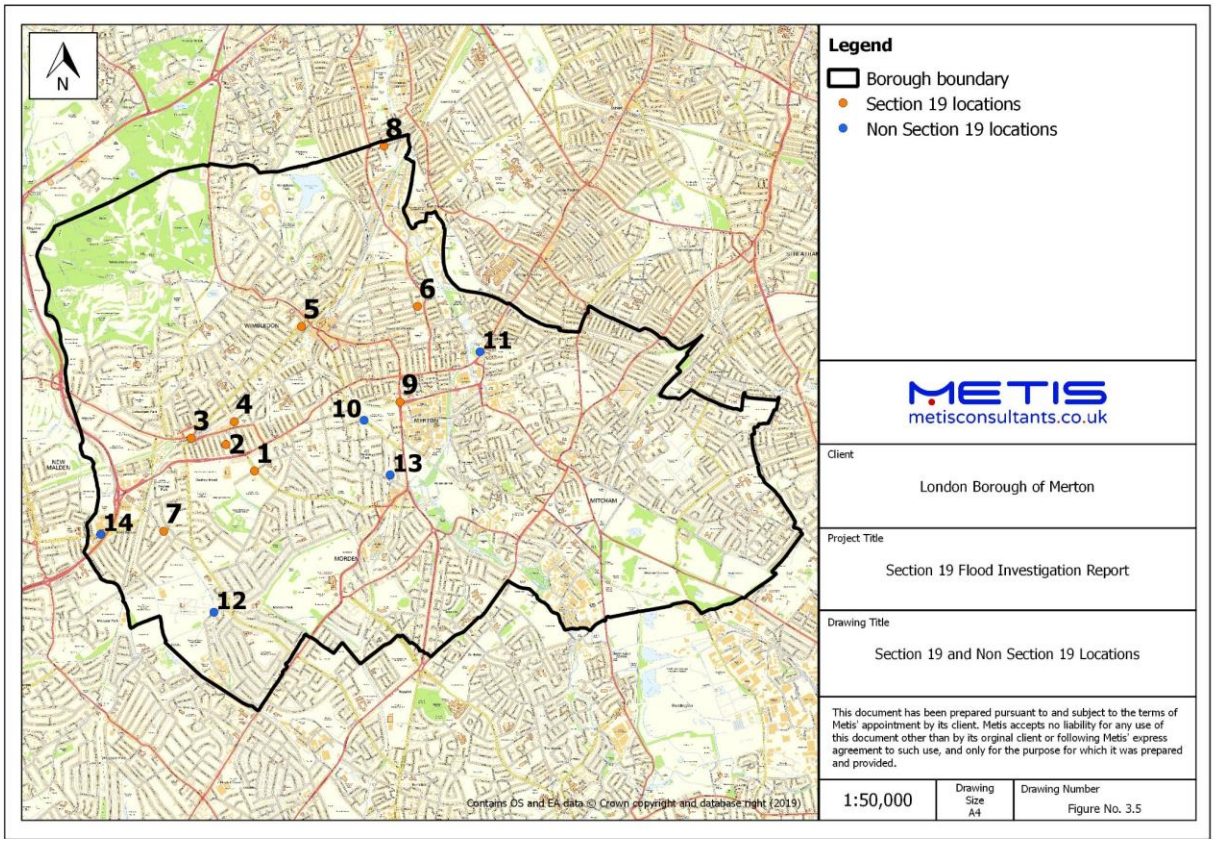
EXECUTIVE SUMMARY

This report was written as part of the London Borough of Merton's (Merton) duty as a Lead Local Flood Authority (LLFA), under Section 19 of the Flood and Water Management Act (2010). Section 19 requires LLFAs to investigate flood incidents where necessary, based on each LLFA's published flood investigation criteria set out within their Local Flood Risk Management Strategy, in order to establish responsible parties as well as their actions as a result of the flooding event. After the completion of each investigation, the report must be made publicly available and the relevant flood Risk Management Authorities (RMAs) should be notified of the investigation's conclusions and recommendations.

There were three significant rainfall events that led to the investigation of nine locations:

- 23rd June 2016, during which nine locations were heavily affected and reached the Section 19 investigation threshold level
- 29th/30th July 2017, during which five locations were heavily affected and reached the Section 19 investigation threshold level
- 9th August 2017, during which three locations were affected and reached the Section 19 investigation threshold



Map showing the fourteen flooding locations being investigated

There were also five additional locations which flooded during at least one of the three events. However, to the knowledge of the LLFA at no time did any of the five achieve any of the threshold criteria. Given the severity of the flooding across the borough during each of the three rainfall events, the latter five locations are still regarded as part of major flooding incidents across the borough. These locations have been analysed within the report but in less detail. The figure above shows the geographic spread of the nine Section 19 threshold-reaching locations and the five locations where the threshold for a Section 19 investigation was not reached.

The flooding mechanism for each location varied, however, they also displayed similarities of complex interactions between flooding sources, predominantly surface water runoff and sewers. Across all 14 locations, the main causes of the flooding were the lack of appropriate maintenance of the assets, misconnections within the foul or surface water network or the local topography of the areas resulting in drainage systems being overwhelmed sooner than expected. Although exacerbated by other factors, such as network configuration, misconnections and blockages, the flooding experienced was beyond design capacities for typical surface water sewer systems. The impact of sewers being at hydraulic capacity is a key issue throughout each of the three flooding events. The main recommendations for the nine Section 19 threshold-reaching locations (mapped locations 1 to 9) are as follows:

- **Whatley Avenue and Martin Way:** CCTV survey by Thames Water of the foul sewer at the junction and the combined sewer network adjacent to Bushey Road, to identify any misconnections from the surface water network or private drainage which is causing hydraulic overflow/capacity issues in the foul sewer network.
- **Apostles area (incl. Dupont Road):** Investigation / CCTV survey by Thames Water of the 2000 by 1524 mm main surface water sewer in Bushey Road and the few connections from the Apostles side roads surface water sewers. Options to address the hydraulic throttle affect, which appears to be the common issue in the flooding incidents in both Whatley Avenue / Martin Way and the Apostles area, should be investigated alongside the above recommendation. Alternatives to remove the 90 degree turns in the sewers should also be identified to reduce the potential for blockage in the bends
- **Coombe Lane (by Raynes Park railway bridge):** Thames Water and Merton should investigate condition and operation of the pumps underneath Raynes Park railway bridge and incorporate into surface water and sewer flood modelling.
- **Abbott Avenue (incl. Dundonald Church):** Full review and prioritised surveys and investigations by Merton and Thames Water of foul and surface water sewer network(s) across the Cottenham Park area. Any additional information, mapping or previously unknown hydraulic controls should be incorporated into the London Borough of Merton's Cottenham Park critical drainage area flood risk modelling and Thames Water asset records. Additional information already identified through survey work by Thames Water should also be incorporated.
- **Worple Road and Wimbledon Hill Road:** CCTV investigation by Thames Water of the surface water sewer network in Worple Road, Worple Road Mews, St. George's Road and Wimbledon Hill Road to establish the condition of the sewers.
- **Effra Road:** Topographical survey of the area by Merton in order to determine the levels and possible low point on Edith Road. If it is determined that surface water is coming from Edith Road, the raising of kerb levels at this point would help keep surface water on the carriageway.

- **West Barnes Lane:** Thames Water should investigate the local surface water sewer network around the affected roads to determine the preferential network flow routes, especially from West Barnes Lane by the affected properties and along Adela Avenue towards Douglas Avenue. Any blockages found should be cleared and remedial work programmed if necessary.
- **Mount Road, Acuba Road and Brooklands Avenue:** Merton should continue dialogue with Thames Water with regards to re-benching of the sewer on Acuba Road / Mount Road.
- **Merantun Way and Morden Road:** Coordination between Transport for London and Thames Water to evaluate the combined drainage system in Merantun Way and completion of any additional required works.

Before, during and after all the flooding incidents, closer cooperation between all the Risk Management Authorities was identified as a key action in order to manage those incidents effectively and to reduce the risk of future occurrence. The sharing of investigations, asset information and planned maintenance work programmes between RMAs should be increased to reduce the effect of future flooding events anywhere in the borough. All RMAs should work collaboratively to enable sustainable drainage system features to be retrofitted wherever possible to increase available capacity within the sewer network.

CONTENTS

FIGURES AND TABLES

ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
BST	British Summer Time
EA	Environment Agency
FWMA	Flood and Water Management Act (2010)
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
Merton	London Borough of Merton
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SuDS	Sustainable Drainage Systems
TfL	Transport for London
TWUL	Thames Water Utilities Limited

1 INTRODUCTION

This flood investigation has been carried out by Metis Consultants on behalf of the London Borough of Merton ('Merton'), as part of the Merton's duty as a Lead Local Flood Authority (LLFA) under Section 19 of the Flood and Water Management Act (FWMA) (2010). Section 19 requires LLFAs to investigate flood incidents where necessary, based on each LLFA's published flood investigation criteria in order to establish responsible parties as well as their actions as a result of the flooding event.

After the completion of each investigation, the report must be made publicly available and the relevant flood risk management authorities (RMAs) should be notified of the investigation's conclusions and recommendations. Merton's flood investigation criteria, defined in their Local Flood Risk Management Strategy (2014), are shown in *Table 1.1*.

Table 1.1: London Borough of Merton's flood investigation criteria

Risk of loss of life • There is a considered risk of loss of life, injury or health implications
Risk to residential property • Two or more residential properties flood internally
Risk to commercial property • One commercial property over 250 m^2 floods internally • Two or more commercial properties (of any size) flood internally
Risk to critical infrastructure[1] property ✓ One or more critical infrastructure property: o Were flooded internally and/or o Were rendered inoperable due to impassable access and/or o Resulted in loss or potential loss of service or causing or potentially causing flooding to other property
Risk to transport • A section of:

[1] Critical infrastructure is defined as hospitals, schools, emergency services, electricity installations, water supply, sewage treatment etc.

○ Major Highway[2], Major Rail Link[3] or Tramlink becomes impassable, and / or ○ Minor Highway[4] becomes impassable to emergency vehicles or Minor Rail Link[5] becomes impassable
Risk to environment and cultural sites[6] • Council officer deems an investigation to be necessary due to environmental or cultural risk

[2] Major Highway is defined as TfL operated roads (Transport for London Road Network), Strategic Road Network, Principal Road Network and Distributor Roads
[3] Major Rail Link is defined as any part of the South Western network into London Waterloo
[4] Minor Highway is defined as Unclassified Road Network including Local Access Roads and Private Streets
[5] Minor Rail Link is defined as any rail route not on the South Western route into London Waterloo
[6] Environment and cultural sites include parks, ponds, Sites of Special Scientific Interest, Special Area of Conservation etc.

2 RISK MANAGEMENT AUTHORITIES

As defined in Section 6(13) of the FWMA (2010), there are several parties responsible for the management of the risks of flooding. *Table 2.1* introduces these RMAs at a borough-level. More information about each RMA within the borough can be found in *Sections 2.1-2.4*.

Table 2.1: Relevant Flood Risk Management Authorities

RMAs	Relevant authorities
Lead Local Flood Authority	London Borough of Merton
Environment Agency	Environment Agency
Water and Sewerage Company	Thames Water Utilities Limited
Highway Authority	London Borough of Merton and Transport for London

2.1 Environment Agency

Under Section 165 of the Water Resources Act (1991), the Environment Agency (EA) has permissive powers related to main rivers, including the maintenance and improvement of existing works as well as the construction of new works. Under the FWMA (2010), it is also responsible for the management of the risks of fluvial (river) flooding. The risk of fluvial can be viewed on the EA's Fluvial Flood Map for Planning. The Flood Zones are defined as having the following risk boundaries:

- Flood Zone 3: Areas with a greater than 1 in 100 years (> 1%) annual probability of river flooding
- Flood Zone 2: Areas with an annual probability of river flooding between 1 in 100 years and 1 in 1,000 years (1% to 0.1%)
- Flood Zone 1: Areas with less than a 1 in 1000 years (< 0.1%) annual probability of river flooding

The main rivers within the borough of Merton are:

- River Wandle, including tributaries such as the Graveney River, Pickle Ditch and Bunce's Ditch
- Beverley Brook, including tributaries such as the Pyl Brook

The EA's regular maintenance activities, as part of their permissive powers, include the inspection of any flood risk assets (EA or third party owned) for defects or debris build up. Inspections of trash screens are performed at least once a week and any debris is removed where it is deemed a potential flood risk. The frequency of the inspections is increased when the weather is wet or the flow within the watercourses is increased. Additionally, there is a programme of culvert inspections performed annually to assess the condition of those structures and to notify third party owners of any defects. Site visits on parts of the river also occur twice a year, in order to identify any works that may need to be undertaken. The EA is also regarded as a Category One responder under the Civil Contingencies Act (2004).

2.2 Thames Water Utilities Limited

Thames Water Utilities Limited (TWUL) are the regional water and sewerage company, who are responsible for managing the risk of flooding from sewers including surface water, foul and combined sewer systems. Section 94 of the Water Resources Act (1991) places a duty on sewerage companies to maintain their sewers to ensure that their area is effectually drained. Their key responsibilities include undertaking inspections, maintenance, repair and any required works on their drainage assets. TWUL should work closely with the LLFA to advise about any works being undertaken, and provide a platform for which sewer flooding incidents can be reported by residents. TWUL sewer data has been used within this report to analyse local drainage networks. More information about sewer flooding is available via TWUL's online advice leaflet.

TWUL are also a clean water supply provider in Merton. They are responsible for mitigating water main leaks including reinstatement of the public highway if any damage was caused.

2.3 London Borough of Merton

The London Borough of Merton have a number of RMA roles and associated functions within the borough.

As a **Highways Authority**, Merton are responsible for routine works on any highway assets on adopted roads not on the Strategic Road Network to ensure they stay operable to their full efficiency. In Merton, this role sits within the Highways team and they are responsible for managing the highway drainage of these roads and footpaths. Merton's Waste team manage the highway cleansing contract which includes the cleansing of gullies. This contract includes both routine cleansing (each gully is cleaned at least once every two years) and reactive cleansing in the event of a flooding incident or customer reports (typically within five working days). Merton's LLFA also fund and programme a priority programme of high risk gully cleansing, which changes annually. Merton's highway drainage responsibilities include highway gullies and pipework up to the point it connects to the public sewer network (where it becomes TWUL's responsibility). Where blockage or collapse issues are within the sewer network, gully cleansing will typically have limited impact upon the risk of local flooding incidents, therefore cooperation with TWUL is key.

The **LLFA** have local flood risk management functions which include:

- development of a Local Flood Risk Management Strategy
- maintenance of a register of structures that have a significant effect on flood risk
- ordinary watercourse regulation (consenting and enforcement)
- undertaking Section 19 flood risk investigations
- statutory consultee reviews of surface water management proposals for major development

Local flood risk includes the management of flooding from surface water, groundwater and ordinary watercourse sources. All other RMAs must cooperate with the LLFA where necessary to undertake the above responsibilities above under the FWMA (2010). Merton continues to undertake surface water flood risk modelling in more at risk areas, the outputs of which are included in the EA's Risk of Flooding from Surface Water (RoFSW) maps. The mapped risk extents are defined as follows:

- High flood risk: Areas with an annual probability of surface water flooding greater than 1 in 30 years (> 3.3%).
- Medium flood risk: Areas with an annual probability of surface water flooding between 1 in 30 and 1 in 100 years (3.3% and 1%).
- Low flood risk: Areas with an annual probability of surface water flooding between 1 in 100 and 1 in 1000 years (1% and 0.1%).
- Very low flood risk: Areas with an annual probability of surface water flooding less than 1 in 1000 years (< 0.1%).

Merton's **Emergency Planning** team are a Category One responder under the Civil Contingencies Act (2004). This means they are responsible for responding to incidents and emergencies that occur within the borough, of which flooding is one such potential emergency.

2.4 Transport for London

Transport for London (TfL) are responsible for managing the operation of the public transport network across London and the Strategic Road Network. TfL's Strategic Road Network includes red routes and they are responsible for the management of drainage from these roads. TfL's responsibility within the borough are for the following roads:

- A24 - Epsom Road / London Road / Morden Road / Merantun Way / Christchurch Road / High Street Colliers Wood
- A297 - St Hellier Avenue / Morden Hall Road
- A3 - Beverley Way

2.5 Other relevant Authorities

2.5.1 Other Category One responders

All blue light emergency services are also Category One responders under the Civil Contingencies Act (2004). Most relevant to flooding incidents are the London Fire Brigade, the statutory fire and rescue service for London, and the Metropolitan Police Service, responsible for law enforcement across London.

2.5.2 Sutton and East Surrey Water

Sutton and East Surrey Water are a water company who provide the supply of clean water from a combination of underground sources (aquifers), rivers and storage reservoirs. They treat and recycle wastewater at a number treatment works, and then pump it via their piped network across East Surrey and parts of West Sussex and South London. They are responsible for carrying out repairs and responding to emergency incidents, including leaks and flooding issues, on their network, including reinstatement of the public highway if any damage was caused.

3 RAINFALL EVENTS

All three rainfall events that led to the Section 19 investigation are regarded as significant, causing disruption in different areas across the UK. Of the three, the most significant was in June 2016 as it coincided with the European Union Referendum Day.

3.1 23rd June 2016

On the 23rd June 2016 heavy showers, which started during the night of the 22nd, caused widespread flooding in the south-east of the UK. Those events caused significant disruption across roads and railway lines across south London. Category One responders attended different incidents, including properties hit by lightning and flooding. Polling stations in the neighbouring Royal Borough of Kingston upon Thames were affected and some London Underground stations across London were closed. Within Merton nine locations were heavily affected and reached the Section 19 investigation threshold level. Prior to this date, the previous noteworthy rainfall event within the borough was from the night of the 19th until the morning of 20th June, with approximately 12 mm of rainfall recorded. EA rain gauge records stated that the return period for this event was estimated to be a 1 in 60 year event across South London. TWUL network gauges stated that the return period for this event within their closest Merton sewer catchment was estimated as being between a 1 in 32 and 1 in 38 year events.

3.2 29th/30th July 2017

On the 29th and 30th July 2017, heavy showers caused delays on major highways, led to delayed flights at Gatwick Airport and the closure of Balham Station in the neighbouring London Borough of Wandsworth. Within Merton five locations were heavily affected and reached the Section 19 investigation threshold level. Prior to this date, the previous noteworthy rainfall event within the borough was from the afternoon of the 11th until early morning of the 12th June, with approximately 33 mm of rainfall recorded. TWUL network gauges stated that the return period for this event within their closest Merton sewer catchment was estimated as being between a 1 in 2 and 1 in 3 year events.

3.3 9th August 2017

On the 9th August 2017 different parts of the UK, especially in the central and south-east, were affected by heavy thunderstorms. Those events caused significant problems on major highways including the M20 and M25 motorways, while many other roads and railway lines were disrupted. Within Merton, three locations were heavily affected and reached the Section 19 investigation threshold level. Prior to this date, the previous noteworthy rainfall event within the borough was during the 2nd August, lasting for approximately four hours with approximately 7 mm amount of rainfall recorded. TWUL network gauges stated that the return period for this event within their closest Merton sewer catchment was estimated as being between a 1 in 2 and 1 in 7 year events.

3.4 Rain gauge data

Rainfall data from five rain gauge stations across south-west London has been used to assess the three flooding events. Only one of them lies within the borough boundary ('Mitcham Station gauge'), the rest being located outside, but within 1-2.5 km of the boundary. The locations of the five stations are depicted in *Figure 3.1*.

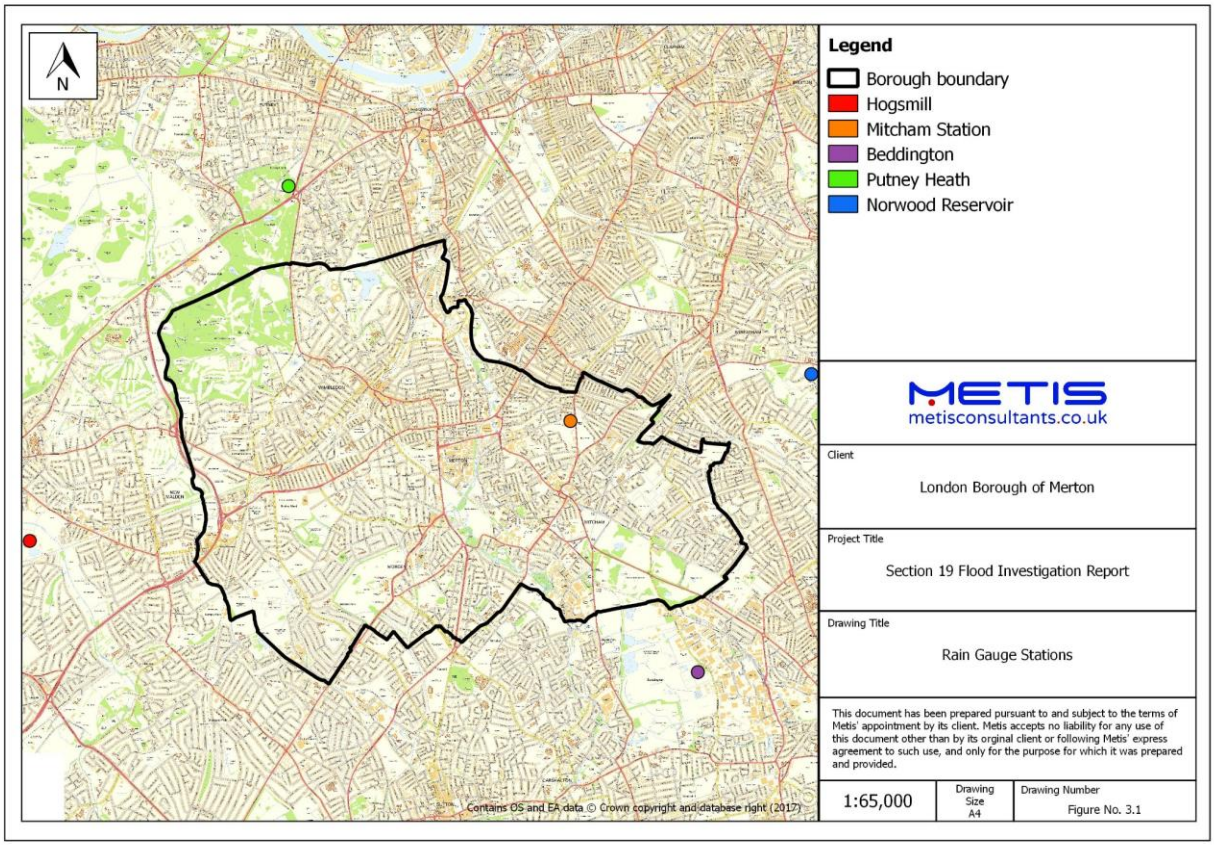


Figure 3.1: Local rain gauge stations to the London Borough of Merton

Figures 3.2 to 3.4 present the local variations of the rainfall recorded at the five gauge stations for each of the three event dates. For the **June 2016 event**, in all the stations the peak amount of rainfall recorded occurred during the night of the 22nd and the early morning hours of 23rd. Later on the 23rd, from 14:00 to 16:00 BST, only the gauge stations to the north and west of the borough boundary received significant amounts of precipitation. For the **July 2017 event**, all the locations recorded the peak amount of rainfall in the early morning hours of the 30th, from 00:00 to 03:00 BST, again with most significant levels recorded at the gauge stations to the north and west of the borough boundary. Unlike the other two events, there was only one measured peak of rainfall, suggesting a shorter but more intense storm. Finally, during the **August 2017 event**, all the gauge stations recording rainfall between 08:00 and 22:00 BST. The peak amount of rainfall recorded was at 11:00 BST but this was considerably lower compared to the other two events. Tables showing the amount of rainfall per hour for each location and event can be found in *Appendix A*.

Additional data about the June 2016 event has also been made available through Merton's use of HydroMaster. This uses a combination of Environment Agency, Met Office and third party rain gauge and radar data enabling the assessment of historic rainfall events at a localised scale. *Appendix B* summarises the rainfall depths and intensities recorded for each of the locations where flooding was experienced, in tabular, map and graphical formats. *Tables B.1.1 and B.1.2* record the rainfall data for a 29 hour time period between 22nd June and 24th June and also focuses in more detail upon the 10 hour period where the majority of the rainfall was experienced. *Table B.1.3* shows the maximum rainfall intensity recorded across a five minute duration in the early morning of 23rd June 2016.

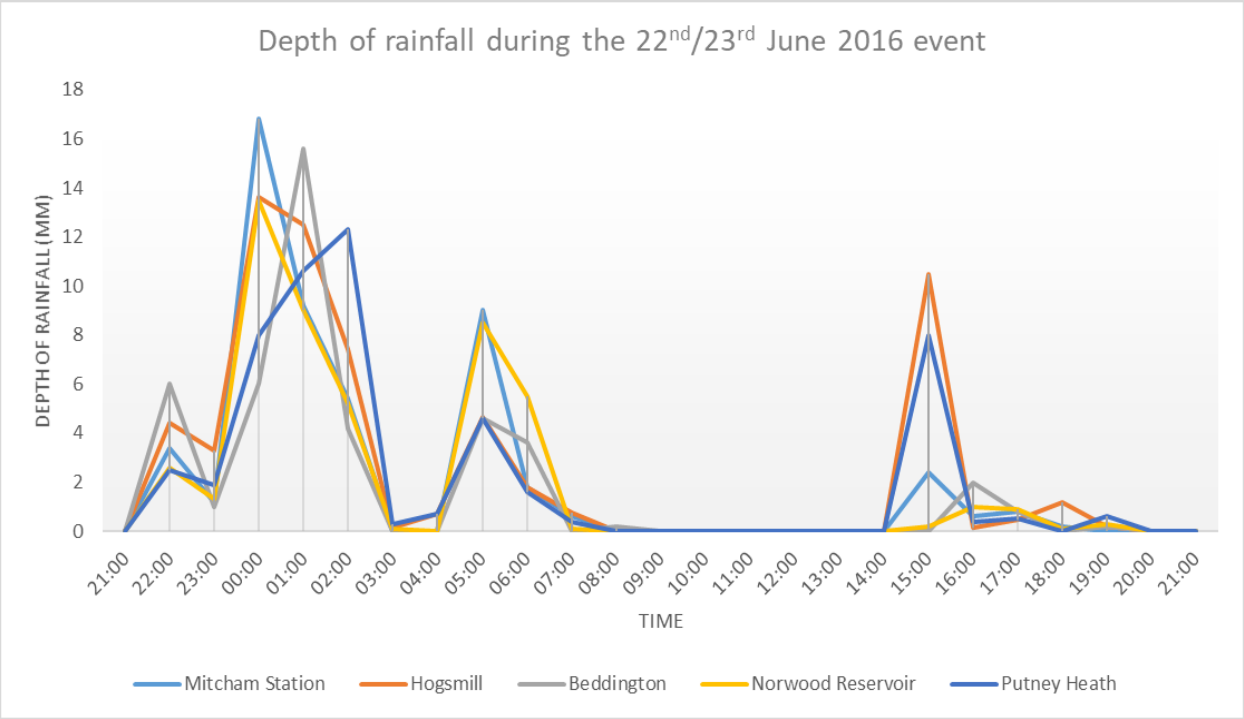


Figure 3.2: Depth of rainfall per hour for the June 2016 event

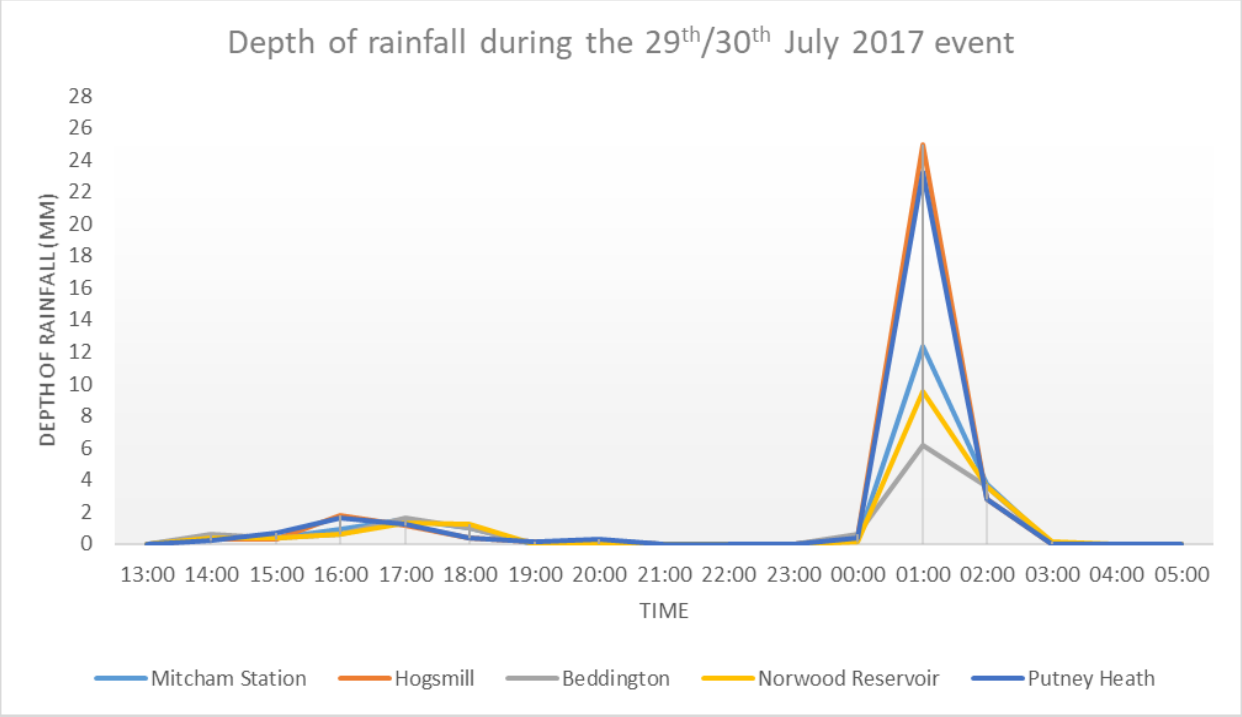


Figure 3.4: Depth of rainfall per hour for the July 2017 event

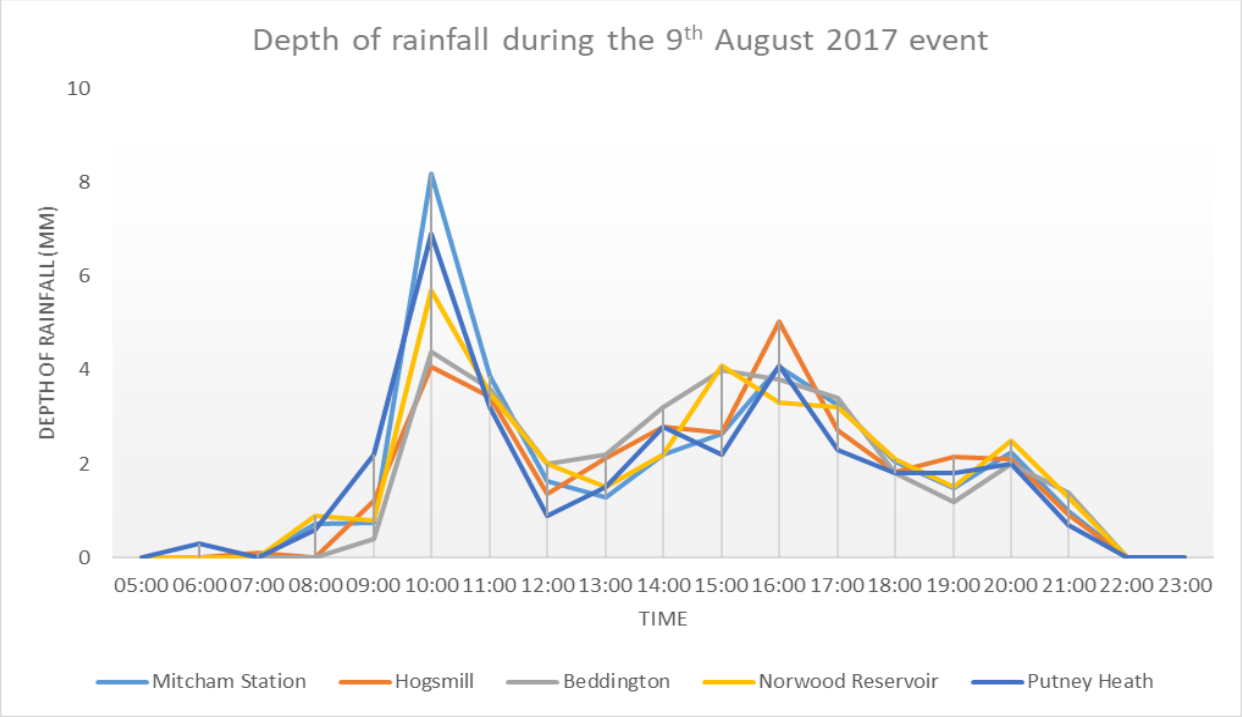


Figure 3.3: Depth of rainfall per hour for the August 2017 event

3.5 Affected locations

During the three rainfall events there were nine locations where flooding reached Merton's flood investigation threshold at least on one occasion. Some of these nine flooded and did reach the threshold, some flooded and did not reach the threshold, and some did not flood on one or both of the July and August 2017 events. Some of the information in this report is based upon anecdotal evidence provided to Merton by residents, and additional locations may have been flooded but were not reported. The flood mechanism for each location varies and each has been analysed in greater detail in *Chapters 4 to 12* of the report. Each chapter includes a table of any actions undertaken by relevant RMAs before, during or after the initial June 2016 flood event. Where flooding occurred at locations affected in either / both the July and August 2017 events, all actions taken during or after the event(s) are included in the 'after' category to prevent confusion with those from the June 2016 event. An assessment of the flooding incident(s) has been made and recommendations suggested, predominantly collaborative ensuring joined up working between RMAs.

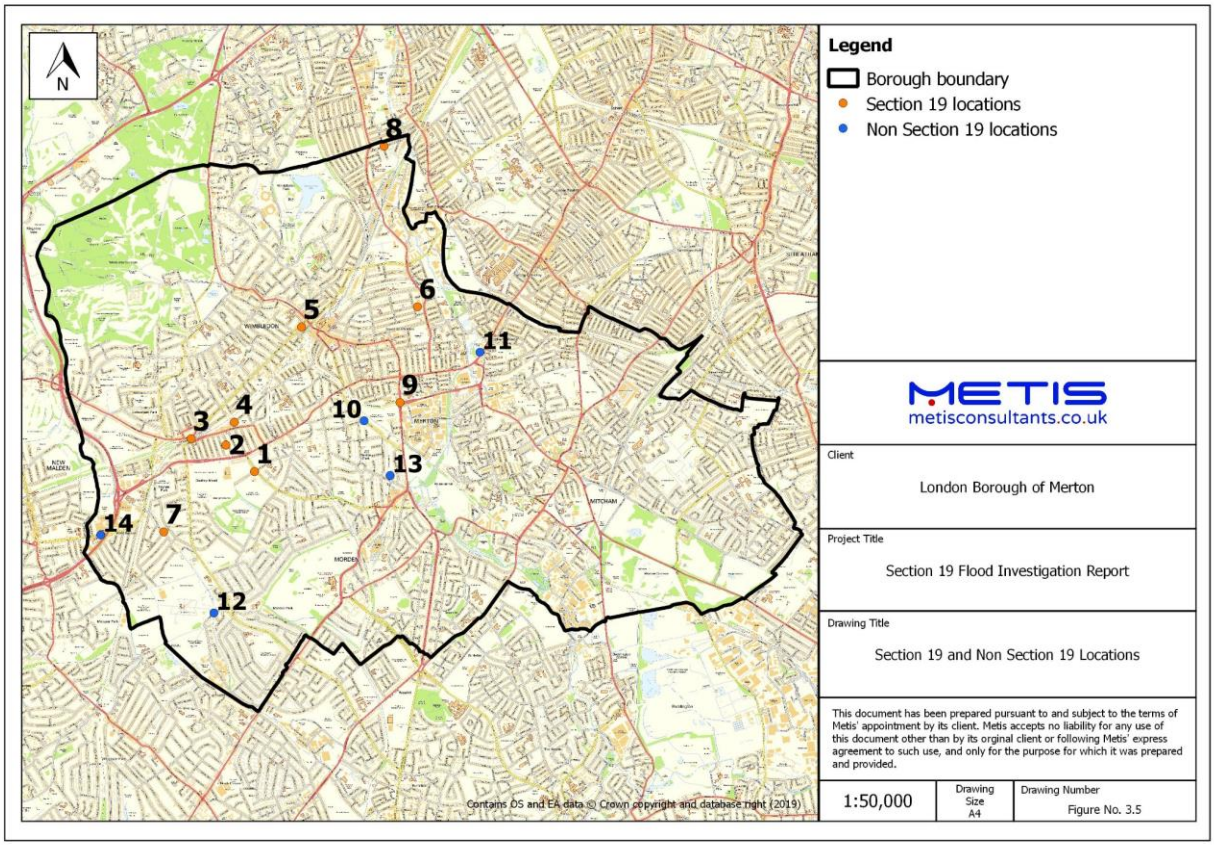


Figure 3.5: Map showing the fourteen flooding locations being investigated

There were five additional locations which also flooded during at least one of the three events. However, to the knowledge of the LLFA at no time did any of the five achieve any of the threshold criteria. Given the severity of the flooding across the borough during each of the three rainfall events, the latter five locations are still regarded as part of major flooding incidents across the borough. These locations have been analysed in *Chapter 13*.

Figure 3.5 shows the geographic spread of the nine Section 19 threshold-reaching locations and the five locations where the threshold for a Section 19 investigation was not reached. *Table 3.1* lists each

of the locations by ward and date(s) when flooding occurred. Where flooding was experienced, regardless of whether Merton's investigation was reached, the estimated maximum storm return period is stated. This data has been taken from four location-specific TWUL sewer gauges, the nearest gauge geographically being used for each of the fourteen flooding locations. The relevant chapter and page numbers for each location are also listed within *Table 3.1*.

Table 3.1: Reference table of the fourteen flooded locations

Flooding Location Number	Location	Ward	Flooding Event Date and Recorded Sewer Return Period			Reference in the report
			June 2016	July 2017	August 2017	
1	Whatley Avenue and Martin Way	Cannon Hill	✓ 1 in 24 yr	X 1 in 3 yr	X 1 in 6 yr	Chapter 4 p. 13
2	Apostles area (incl. Dupont Road)	Dundonald	✓ 1 in 24 yr	* 1 in 3 yr	* 1 in 6 yr	Chapter 5 p.19
3	Coombe Lane (by Raynes Park railway bridge)	Raynes Park	✓ 1 in 24 yr	✓ 1 in 3 yr	✓ 1 in 6 yr	Chapter 6 p.25
4	Abbott Avenue (incl. Dundonald Church)	Dundonald	✓ 1 in 24 yr	✓ 1 in 3 yr	X 1 in 6 yr	Chapter 7 p.32
5	Worple Road and Wimbledon Hill Road	Hillside	✓ 1 in 21 yr	✓ 1 in 2 yr	✓ 1 in 5 yr	Chapter 8 p.39
6	Effra Road	Trinity	✓ 1 in 21 yr	X 1 in 2 yr	X 1 in 5 yr	Chapter 9 p.45
7	West Barnes Lane	West Barnes	✓ 1 in 30 yr	✓ 1 in 2 yr	* 1 in 4 yr	Chapter 10 p.49
8	Mount Road, Acuba Road and Brooklands Avenue	Wimbledon Park	✓ 1 in 23 yr	X 1 in 3 yr	X 1 in 2 yr	Chapter 11 p.55
9	Merantun Way and Morden Road	Abbey	✓ 1 in 21 yr	✓ 1 in 2 yr	✓ 1 in 5 yr	Chapter 12 p.60
10	Dorset Road	Merton Park	* 1 in 21 yr	* 1 in 2 yr	* 1 in 5 yr	Chapter 13 p.65
11	Baltic Close and Colliers Wood Station	Colliers Wood	* 1 in 21 yr	X 1 in 2 yr	X 1 in 5 yr	Chapter 13 p.65
12	Lower Malden Lane	Lower Morden	* 1 in 30 yr	* 1 in 2 yr	* 1 in 4 yr	Chapter 13 p.68
13	Kenley Road car park	Merton Park	* 1 in 21 yr	* 1 in 2 yr	* 1 in 5 yr	Chapter 13 p.68

Flooding Location Number	Location	Ward	Flooding Event Date and Recorded Sewer Return Period			Reference in the report
			June 2016	July 2017	August 2017	
14	Burlington Road and Shannon Corner junction	West Barnes	* 1 in 30 yr	* 1 in 2 yr	* 1 in 4 yr	Chapter 13 p.69

Key

✓ = Flooding occurred and Section 19 threshold was reached

* = Flooding occurred, but Section 19 threshold was not reached

X = No flooding occurred

4 WHATLEY AVENUE AND MARTIN WAY

Whatley Avenue and Martin Way lie in the Cannon Hill ward, at the south west part of the borough. This area was heavily affected once, reaching the threshold criteria only during the June 2016 event.

4.1 Location-wide flood incident(s)

Flooding started at approximately 09:00 BST on the morning of 23rd June 2016 and lasted about 12 hours. The result was the internal flooding of approximately ten properties and the peak depth of the flooding is understood to be between 300 and 450 mm. The measurements from the nearest rain gauge station (Mitcham Station), during the June 2016 rainfall event, can be found in *Appendix A*. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the second lowest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the fifth highest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 24 year return period.

4.2 Local drainage network

Figure 4.1 shows the TWUL sewer network within the affected area. There are surface water sewers on both sides of the road serving Martin Way towards Bushey Road. The first one is a 750 mm diameter pipe, flowing north-westwards from the south of Martin Way (after the junction with Cannon Hill Lane) which discharges into a 2000 by 1524 mm rectangular trunk main sewer at the junction with Bushey Road. There are two 225 mm surface water pipes which are connected to the 750 mm pipe, one on the junction with Whatley Avenue and one in the unnamed road below Bushey Road. The second surface water sewer flows from the south of Martin Way and Whatley Avenue with interchanging diameters of 300 mm and 375 mm and is diverted in Bushey Road.

There is also a separate foul sewer network, flowing from west to east. The diameter of the pipe in the cross of Whatley Avenue and Martin Way is 225 mm. A 991 by 660 mm rectangular combined sewer also runs beneath the slip roads behind properties on Bushey Road.

Data provided by Merton confirms that the highway gullies on those roads (excluding the eastern part of Whatley Avenue) were part of their high priority cleansing programme during 2015/16, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the flooding incident, the gullies had last been cleaned as part of this work programme in January and February 2016.

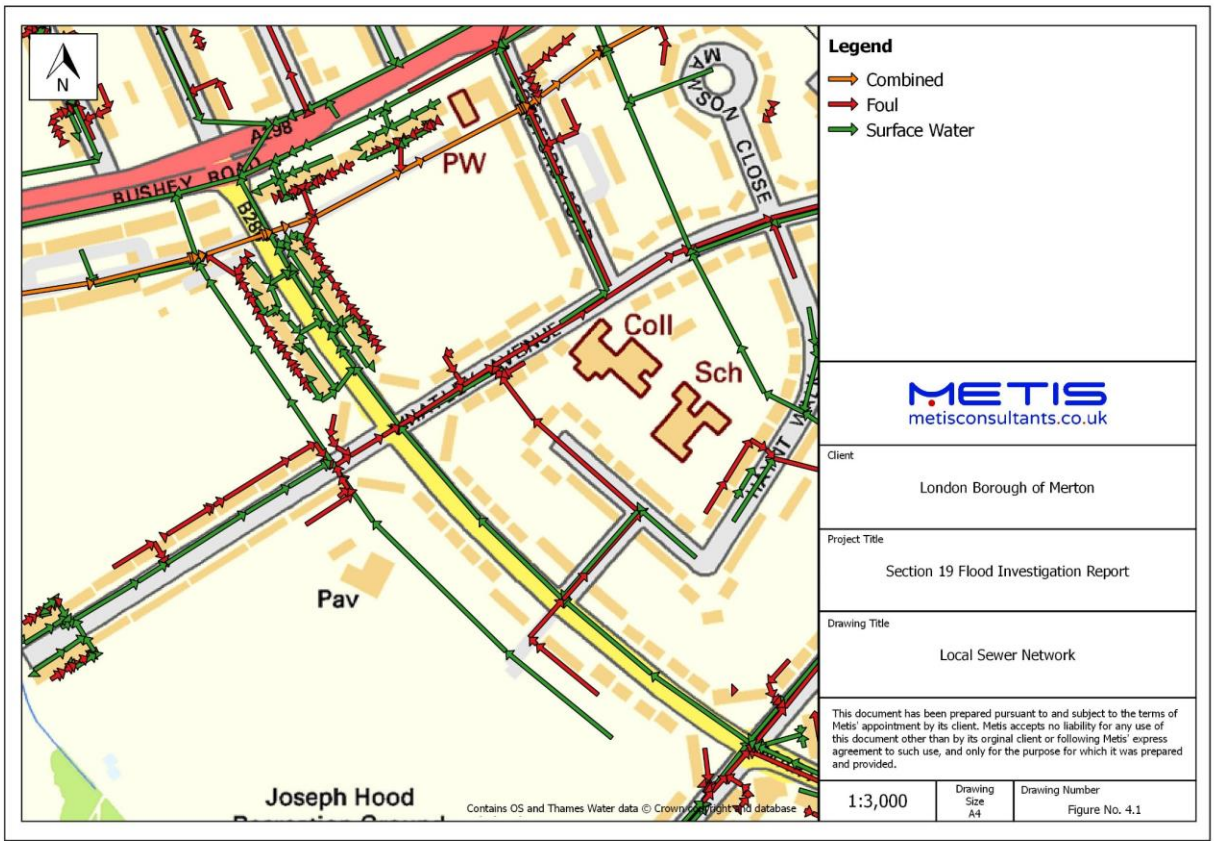


Figure 4.1: Local sewer network in this location

4.3 Local flood mechanism

In terms of topography, LiDAR data shows that there is a local low point near the junction, which is where the flooding occurred. Whatley Avenue slopes down towards the junction with Martin Way from both sides. This, and a nearby footpath, channel flows down towards this low point. The nearby Cannon Hill Common Recreation Ground and Joseph Hood Recreation Ground, south-east and south respectively of this low point, are at a significantly higher level.

The location falls within drainage catchment DC27 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 4.2* shows that there are locations at high risk of surface water flooding in the area, including the west side of the junction of Whatley Avenue and Martin Way as well as the properties close to the junction that were affected from the flooding incident. The properties here are set lower than the level of the highway. The biggest part of Martin Way is at medium risk of surface water flooding.

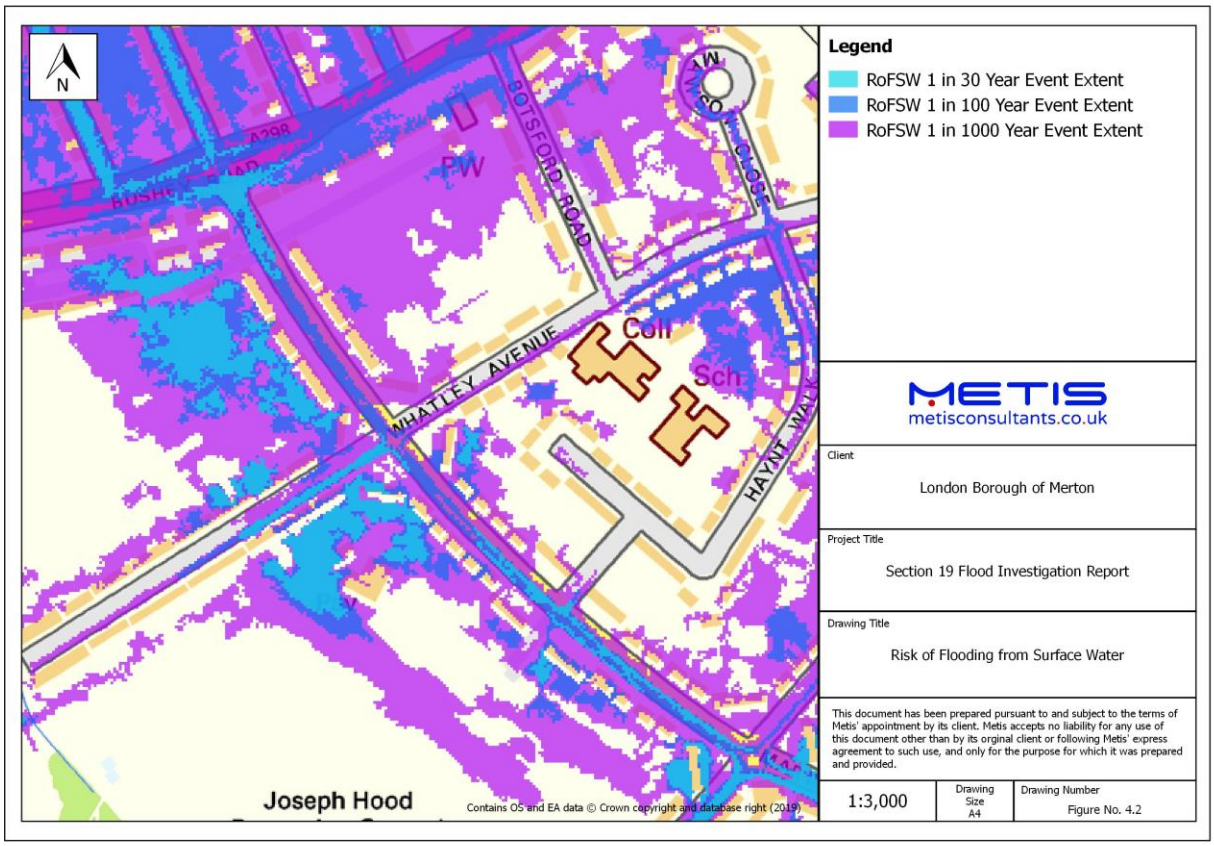


Figure 4.2: Risk of flooding from surface water in this location

Merton's Flood Incident database shows that flooding has previously occurred in different locations across Martin Way and Whatley Avenue. There have been various fluvial flooding events to the gardens of the properties on Martin Way, south of Whatley Avenue from overland flows arising from Joseph Hood Recreation Ground.

4.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 4.1 shows the actions that have been taken by the involved RMAs.

Table 4.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** ✓ Gully cleansing in January and February 2016 ***During*** ✓ LLFA attended on site on 23rd June 2016, liaising with the London Fire Brigade and TWUL onsite ✓ Gully cleansing crew attended on site on the same date to jet the gullies. Flows could not get away due to the surface water sewer running at capacity. ***After*** ✓ Installation of two SuDS tree pits and carriageway level changes near the junction of Whatley Avenue and Martin Way (*Figure 4.3*)
Thames Water	***Before*** No actions taken ***During*** ✓ Contractors (Lanes Utilities, TWUL's wastewater network services maintenance partner) attended on site on site on 23rd June 2016 confirming the internal flooding of properties ✓ Checked all the manholes in the area, which were running but falling slowly ✓ Checked the main trunk sewer which was running at full capacity ***After*** ✓ Attended on 21st July 2016 and carried out a survey on the foul sewer ✓ Attended on 28th July 2016 and cleaned 127 m of foul sewer on Whatley Avenue (either side of the junction with Martin Way)
London Fire Brigade	No information was received from the London Fire Brigade, but Merton's LLFA confirmed that they attended on site on 23rd June 2016 supporting evacuated or affected residents

Figure 4.3: New tree pits close to the junction

4.5 Assessment of flooding incident(s)

Flooding was mainly caused by the 750 mm surface water sewer which was running full before the junction of Martin Way with Whatley Avenue. The local foul sewer network was also running full. Additional flow backed up, causing flooding in the adjacent gullies and consequently at the properties at low level locations near the junction of Martin Way and Whatley Avenue. Had there been some non-return valves in the local sewers, this could have decreased the flooding experienced. The topography of the location confirms that runoff from Cannon Hill Common and Joseph Hood Recreation Ground slopes down to Whatley Avenue affecting the local drainage network. This pipe discharges into the 2000 by 1524 mm trunk main which also receives multiple flows from the north and south. Other reasons include possible foul sewer misconnections adjacent to the junction, with gullies discharging into the foul sewer. Misconnections can also result from landowner lateral drains from private land discharging into the public sewer network. Weeds are also growing at the edges of

the carriageway further up Whatley Avenue, thereby causing a potential blockage to runoff entering the sewer network, in turn also leading to more silt potentially getting into the gullies and sewers.

4.6 Recommendations

- CCTV survey by TWUL of the foul sewer at the junction and the combined sewer network adjacent to Bushey Road, to identify any misconnections from the surface water network or private drainage which is causing hydraulic overflow/capacity issues in the foul sewer network.
- Asset inspection by TWUL to confirm the location, or future need, of any non-return valves within the local sewer network (combined, foul or surface water).
- Merton to look into the potential of constructing a detention basin at the northern edges of the Joseph Hood Recreation Ground (behind Whatley Avenue and Martin Way properties). This could increase the capacity within the local sewer network and provide environmental benefits.
- Installation of new gullies or swales in the eastern boundary of the Joseph Hood Recreation Ground by Merton.
- Increase of the frequency of street cleansing activities in Whatley Avenue and Martin Way by Merton.
- Installation of sustainable drainage system (SuDS) features in the two roads through a Merton and TWUL collaborative scheme. For example, raingardens in the existing green spaces in the junction would reduce flow rates and volumes into the surface water network. Tree pits or raingardens could be installed in the south-west part of Whatley Avenue in the locations that are currently used as parking spaces.

5 APOSTLES AREA (INCLUDING DUPONT ROAD)

This area lies in Raynes Park ward and is composed of twelve roads between Kingston Road, Grand Drive and Bushey Road. Levels on these north-south roads slope towards Bushey Road, but are no longer accessible for vehicular traffic. The flooding in the area was significant during the 2016 event, while during the 2017 events there was flooding but did not reach any of Merton's Section 19 threshold criteria.

5.1 Location-wide flood incident(s)

Flooding started on the 22nd June 2016, however the area was worst affected on the 23rd, starting at approximately 09:00 BST. The total duration of the incident lasted about 36 hours and resulted in the internal flooding of approximately ten properties. The maximum depth of the flooding is understood to have been between 300 and 450 mm. The measurements from the nearest rain gauge station (Mitcham Station), during the June 2016 rainfall event, can be found in *Appendix A*. *Figure 5.1* shows the extent of the flooding in Dupont Road. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the joint third highest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the joint second lowest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 24 year return period.

Figure 5.1: Extent of the flooding in Dupont Road

5.2 Local drainage network

Figure 5.2 shows the TWUL sewer network within the affected area. Eleven of the roads are served by surface water sewers flowing from north to south into the 2000 by 1524 mm rectangular trunk main sewer in Bushey Road. In Dupont Road, which was the worst affected road, there is one 225 mm diameter surface water sewer which turns 90 degrees before Bushey Road and connects to the surface water sewer from Dorien Road. This sewer then discharges to the 2000 by 1524 mm trunk main on the southern side of Bushey Road. The rest of the Apostles area roads have a similar drainage network apart from Chestnut Road. Chestnut Road has no surface water sewer, but the existence of a combined sewer pipe would imply that surface water runoff flows into the mapped foul sewer before discharging into the combined drainage network to the north on Kingston Road.

Data provided by Merton confirms that the highway gullies on Dupont Road were part of the high priority cleansing programme during 2015/2016, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the initial flooding on 22nd June 2016, the gullies had last been cleaned, as part of the programme, in February 2016. Other roads included in the programme for 2015/16 prior the flooding event were Bronson Road, Sydney Road, Carlton Park Avenue, Clifton Park Avenue and Gore Road. Subsequently, the 2016/17 programme removed Sydney Road and Clifton Park Avenue but added Dorien Road and Edna Road, and the 2017/18 programme removed Bronson Road and Carlton Park Avenue but added Vernon Avenue.

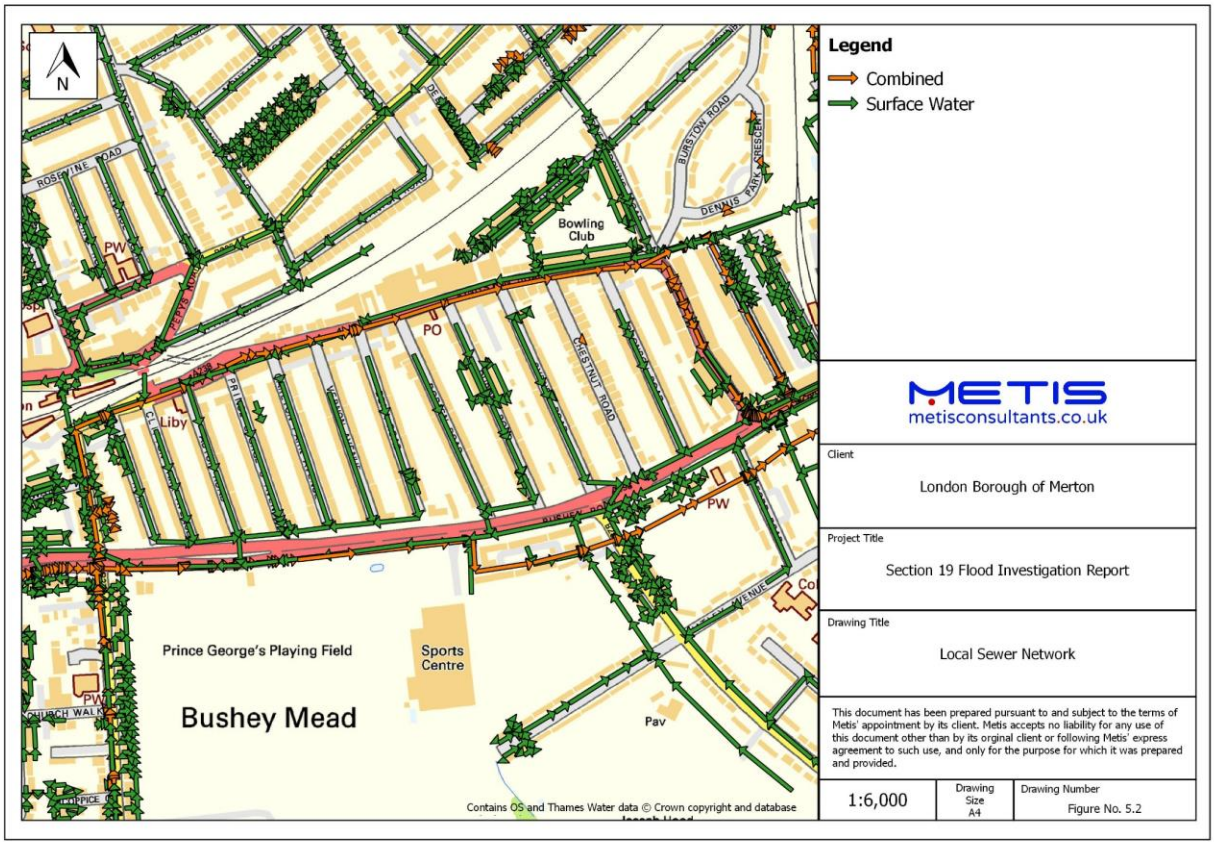


Figure 5.2: Local sewer network in this location

5.3 Local Flood Mechanism

In terms of topography, LiDAR data shows that the twelve roads generally slope from north to south. Most of the Apostles area roads have a localised low point approximately two thirds of the way along the roads from Kingston Road or Approach Road.

The location falls within drainage catchments DC27 and DC29 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 5.3* shows that that the entirety of Clifton Park Avenue, Gore Road and parts of Dupont Road and Sydney Road (including their junctions with Bushey Road) highways are at high risk of surface water flooding. Additionally, the properties on either side of Dupont Road and Aston Road are at medium risk of surface water flooding.

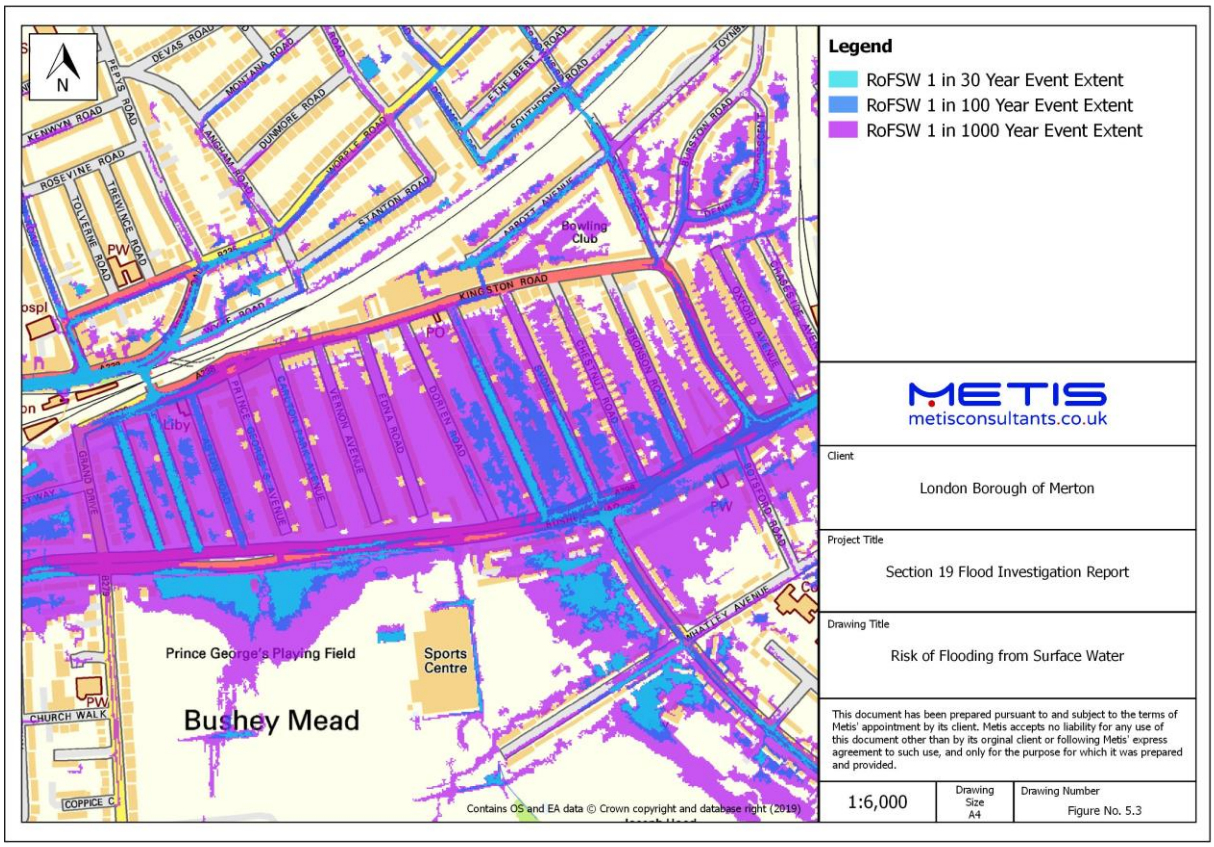


Figure 5.3: Risk of flooding from surface water in this location

Merton's Flood Incident database shows that highway flooding has previously occurred in Dupont Road, Edna Road, Clifton Park Avenue and Gore Road during the extensive flooding incident of 2007, without causing internal property flooding.

5.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 5.1 shows the actions that have been taken by the involved RMAs.

Table 5.1: Risk Management Authorities - Actions

Authority	Authority Contributing Action to Flooding Incident
London Borough of Merton	***Before*** ✓ Scheduled cleansing in all of the gullies in Dupont Road (and other roads) on February 2016 ✓ Undertook non-scheduled gully cleansing on 22nd June 2016 following residents' reports. During those works, an issue with the surface water sewer main line was identified. ✓ Reported the issue to TWUL on 22nd June 2016 ***During*** ✓ Attended on site on 23rd June 2016 and dispatched a Merton jetting tanker in order to solve the blockage issue that was identified further down the surface water sewer line. This resolved the flooding. ***After*** ✓ Installation of SuDS tree pits, at the downstream end of the side roads, providing stormwater storage volume of approximately 2 m^3 plus infiltration potential. These were installed following a successful funding bid to the Greater London Authority. The tree pits have a high level overflow connection into the highway drainage network. ✓ Attended the Raynes Park Community Forum to raise awareness
Thames Water	***Before*** ✓ Attended on site on 22nd June 2016 but found no issues with the surface water sewer line. Leaflets confirming their attendance were posted through local resident's doors. ***During*** ✓ Attended on site in Sydney Road on 23rd June 2016, checked the surface water sewer which was found to be running clear ***After*** ✓ Attended on site in Dupont Road on 28th June 2016 and checked the surface water sewer. It was found to be running clear, however there were

Authority	Authority Contributing Action to Flooding Incident
	manholes that could not be accessed due to parked cars. Re-attended on site on 30th June 2016. ✓ Attended on site in Bushey Road on 26th June 2016 and checked the 2000 by 1524 mm main sewer which found to be running clear ✓ Attended on site in Dupont Road on 25th August 2016 and carried out a CCTV survey (58 m length) on the surface water sewer, but it was abandoned due to 20% siltation of the pipe. An unmapped manhole was located, but when lifted it was found to be 50% silted. ✓ Re-attended on site on 6th September 2016 and cleaned 280 m length of surface water sewer, removing a large quantity of concrete ✓ Attended the Raynes Park Community Forum to raise awareness

5.5 Assessment of flooding incident

Flooding was caused by the blockage of the surface water sewer in the junction of Dupont Road and Dorien Road, which then flows across Bushey Road. The main reasons of the flooding are the blocked 225 mm sewer which runs through Dupont Road and its connection via three 90 degree turns into the 2000 by 1524 mm main trunk sewer on Bushey Road. The trunk sewer also acts as a hydraulic throttle to any flow attempting to enter from the Apostles area roads. Due to the blockage, the water was backing up and flooding at the low point of Dupont Road. This blockage was not identified by TWUL during their site visit on the 22nd June due to a focus on the initial Dupont Road survey work. The blockage was subsequently cleared resolved by Merton on the 23rd June through the use of a jetting tanker. Additionally, there was highway ponding in Bushey Road at the junction of Grand Drive, suggesting a potential network capacity issue or hydraulic overload. The topography of Dupont Road led to the internal flooding of the properties which were at a lower level.

5.6 Recommendations

- Investigation / CCTV survey by TWUL of the 2000 by 1524 mm main surface water sewer in Bushey Road and the few connections from the Apostles side roads surface water sewers. Options to address the hydraulic throttle affect, which appears to be the common issue in the flooding incidents in both Whatley Avenue / Martin Way and the Apostles area, should be investigated. Alternatives to remove the 90 degree turns in the sewers should also be identified to reduce the potential for blockage in the bends.
- Merton and TWUL collaborative drainage modelling of the area and identification of SuDS feature opportunities along and at the junctions of the 12 Apostles roads with Bushey Road. These would help to reduce the incoming runoff into the main 2000 by 1524 mm sewer, increasing that sewer's capacity potential, and would also provide an 'overflow' safety to the system. A storm relief option via a bypass connection across Bushey Road should also be assessed for viability

- CCTV investigation of the sewer network in Chestnut Road by Merton and TWUL to identify whether surface water runoff is drained into the mapped foul sewer. If so, opportunities to disconnect the runoff from the combined network should be identified.
- Further engagement by Merton with the street champion volunteers of the area (residents who get involved in different local community activities) in order to provide awareness about flooding issues to the other residents. This should build upon work done by Merton and TWUL through their attendance at the Raynes Park Community Forum.

6 COOMBE LANE (BY RAYNES PARK RAILWAY BRIDGE)

Coombe Lane and Raynes Park Station are located in the west part of the borough, in Raynes Park ward. Raynes Park Station is one of the primary train stations within the borough. The location reached Merton's Section 19 threshold criteria in all three events. This location is a flooding hotspot due to the local topography and size of the contributing sewer catchment running down to Coombe Lane and the low levels below Raynes Park railway bridge.

6.1 Location-wide flood incident(s)

6.1.1 23rd June 2016

Flooding started at approximately 09:00 BST on the morning of 23rd June 2016 and lasted for approximately 12 hours. The result was the internal flooding of approximately four commercial properties and the Metropolitan Police highway closure of Raynes Park railway bridge underpass. The depth of the flooding is understood to have been between 600 mm and 1000 mm. The measurements from the nearest rain gauge station (Hogsmill Station), during the June 2016 rainfall event, can be found in *Appendix A*. *Figure 6.1* shows the extent of the flooding beneath Raynes Park railway bridge. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the highest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the lowest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 24 year return period.

Figure 6.1: Extent of the flooding below Raynes Park railway bridge

6.1.2 29th/30th July 2017

Flooding started at approximately 08:00 BST on the morning of 30th July 2017 and lasted about six hours. There are no specific details regarding this incident, however it is understood that the incident impacted local transport and flooded some commercial properties. The measurements from the nearest rain gauge station (Hogsmill Station) during the July 2017 rainfall event can be found in *Appendix A*. TWUL sewer rainfall records estimated the incident as being a 1 in 3 year return period.

6.1.3 9th August 2017

Flooding started at approximately 08:00 on the morning of 9th August 2017and lasted about six hours. There are no specific details regarding this incident, however it is understood that the incident caused risk to transport and flooding of commercial properties. The measurements

from the nearest rain gauge station (Hogsmill Station), during the August 2017 rainfall event, can be found in *Appendix A*. TWUL sewer rainfall records estimated the incident as being a 1 in 6 year return period.

6.2 Local drainage network

Figure 6.2 shows the TWUL sewer network within the affected area. There are a numerous sewers flowing north to south and east to west through Pepys Road and Wyke Road respectively to Coombe Lane. In the junction of Pepys Road and Worple Road a 525 mm and a 600 mm pipe converge into a 600 mm diameter pipe. In the junction with Wyke Road this 600 mm sewer and a 450 mm pipe from Wyke Road are discharging into a 1050 mm sewer near Raynes Park railway bridge that flows towards Coombe Lane. The diameter of this pipe further downstream alternates between 1050 and 950 mm. Adjacent to Raynes Park Station there are two more surface water sewers connected to the main sewer. One flows from south to north with a 950 mm diameter, and one flows from north to south, in Lambton Road with diameter 450 mm. According to the information provided by Merton and TWUL there are pumps to the south of the railway bridge underpass on Approach Road, installed in 2008 following the 2007 flooding incident, connected to a 225 mm sewer pipe. The highway gullies discharge into the surface water sewer to the south of the railway bridge.

Data provided by Merton confirms that the highway gullies in Coombe Lane and in the south part of Pepys Road were part of their high priority cleansing programme during 2015/2016, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the flooding incidents, the gullies had last been cleaned in December 2015 and through frequent reactive call outs before and after the incidents. The four gullies directly underneath Raynes Park railway bridge were not cleaned due to lack of access to those locations. After the 2016 flooding incident the gullies along Pepys Road, Worple Road, Langham Road and Wyke Road were added to this programme. Prior to the 2017 incidents they were cleaned in January 2017 (and in April 2017 for part of Worple Road). The four gullies under the railway bridge were able to be cleaned in April 2017 as well.

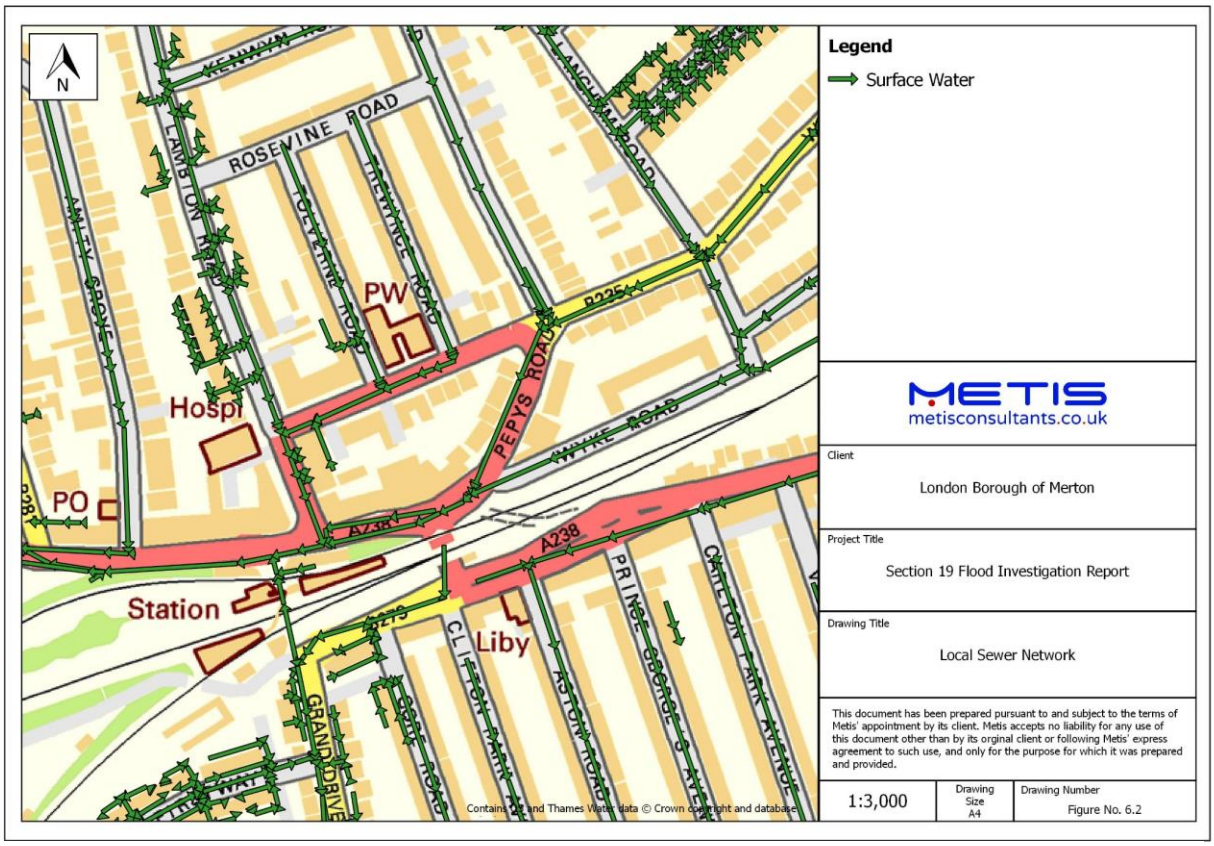


Figure 6.2: Local sewer network in this location

6.3 Local flood mechanism

In terms of topography, LiDAR data shows that the roads in the north slope towards Coombe Lane, which is a local low point. This general slope extends from Wimbledon Common, incorporating all of the roads from Copse Hill down to Coombe Lane. This wider area is covered within the Cottenham Park critical drainage area, as defined in Merton's Surface Water Management Plan. There is a notable steep slope from Rosevine Road to Coombe Lane (a 250-300 m distance), the overall fall being approximately 5 m.

The location falls within drainage catchment DC28 and the Raynes Park railway bridge is the boundary with catchment DC29 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 6.3* shows that Coombe Lane and the area south of Raynes Park railway bridge are at high risk of surface water flooding. At medium risk of flooding are the adjacent roads plus parts of Pepys Road and Lambton Road.

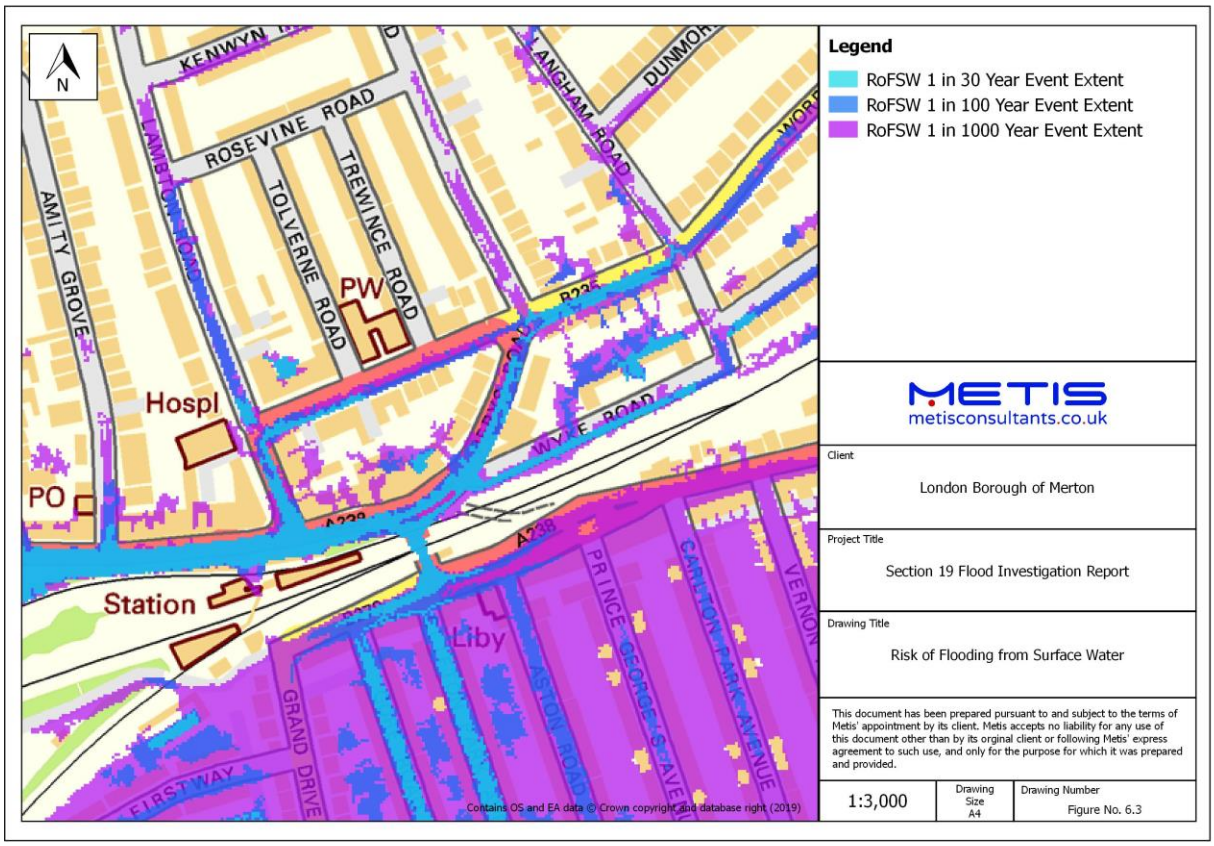


Figure 6.3: Risk of flooding from surface water in this location

Merton's Flood Incident database shows there are two other historic flooding incidents in the area. The first was on 27th September 1999, possibly due to a blocked surface water sewer, and the second was during the extensive flooding incident of 2007. Whilst writing this report, Merton confirmed that the location flooded again in November 2018 but did not reach the S19 threshold.

6.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 6.1 shows the actions that have been taken by the involved RMAs.

Table 6.1: Risk Management Authorities - Actions

Authority	Authority Contributing Action to Flooding Incident
London Borough of Merton	***Before*** ✓ The location was assessed as part of Merton's Cottenham Park flood alleviation study of the surrounding critical drainage area ✓ Installation of new pumps and additional gullies following the 2007 flooding incident ✓ Gully cleansing in the surrounding roads as part of Merton's high priority programme ***During*** No actions taken ***After*** ✓ Liaison with TWUL in order to investigate the drainage network in the surrounding area ✓ Attended the Raynes Park Community Forum to raise awareness
Thames Water	***Before*** No actions taken ***During*** No reports received of flooding on 23rd June 2016 ***After*** ✓ Attended on site on 30th July 2017 ✓ Carried out cleaning and a CCTV survey along 84 m of their surface water sewer on 8th November 2017. Silt and debris were removed, but no defects found. ✓ Investigated the foul sewer network close to the bridge underpass on September 2018. Debris found and cleaned. ✓ Surface and foul water sewers close to the underpass checked in late 2018 and found to be in good order. The foul sewer was found to have minimal connections, in contrast to surface water one which has multiple, indicating that the highway gullies are connected to the surface water sewer system. ✓ Attended the Raynes Park Community Forum to raise awareness

Authority	Authority Contributing Action to Flooding Incident
Metropolitan Police Service	***Before*** No actions taken ***During*** Contacted Merton's highway team to advise that the significant flooding had led to a closure of the railway bridge underpass at the point it became impassable to pedestrians and vehicles ***After*** No actions taken

6.5 Assessment of flooding incident

The flooding in all three incidents are believed to result from similar issues, predominantly the number of sewers flowing southwards down to Coombe Lane and the local area's topography. The road slopes down underneath Raynes Park railway bridge, creating a man-made low spot, and takes the flows from Coombe Lane, Pepys Road and Langham Road. A large proportion of surface water runoff is also received from the higher ground, in and around Cottenham Park and Copse Hill. It should also be noted that, during the three incidents, the local sewer network received significant amounts of rainfall which probably exceeded its designed capacity.

6.6 Recommendations

- TWUL and Merton should investigate condition and operation of the pumps underneath Raynes Park railway bridge, and incorporate into surface water and sewer flood modelling.
- General improvements of the foul and surface water sewer networks in the local catchment by TWUL. This could be achieved in parallel to the Crossrail 2 project through close cooperation of Merton and TWUL with Crossrail 2 (TfL and National Rail). Potential improvements should assess whether the sizes of the surface water sewers are sufficient given the size of the contributing catchment, especially whether the sewer between the highway gullies and the pump capacity needs to be increased.
- Creation of upstream storage in Wimbledon Hill Park, Cottenham Park and / or Holland Garden should decrease the amount and rate of runoff flowing towards Coombe Lane through a Merton and TWUL collaborative scheme.
- Identification of SuDS feature opportunities by Merton along Pepys Road and Lambton Road which are upstream of Coombe Lane and are at high or medium risk of surface water flooding.

7 ABBOTT AVENUE (INCLUDING DUNDONALD CHURCH)

Abbott Avenue lies in Dundonald ward, in the western part of the borough. This area has a complicated drainage system and includes a significant pumping station. It reached Merton's Section 19 threshold criteria twice, once in 2016 and once in 2017. During these two rainfall events, the foul sewer surcharged at the lowest point of the catchment, at Abbott Avenue. During the 2017 incident, the existing pump failed for 12 hours. Flooding subsequently occurred in May 2018 and did reach the Section 19 threshold but is outside the scope of this report.

7.1 Location-wide flood incident(s)

7.1.1 23rd June 2016

There is limited available information regarding when the flooding incident started, how long it lasted, or its depth or its extent. It is understood that a manhole surcharged, causing internal flooding in some properties, mainly affecting those at the western end of Abbott Avenue adjacent to the pumping station, including the internal flooding of Dundonald Church. The measurements from the nearest rain gauge station (Mitcham Station), during the June 2016 rainfall event, can be found in *Appendix A*. *Figure 7.1* shows the post-flooding situation in Abbott Avenue, taken approximately one week later. The effects of foul flooding, including part of its extent, can be seen in this image. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the joint third highest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the joint second lowest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 24 year return period.

Figure 7.1: Extent of the flooding in Abbott Avenue post-June 2016 incident

7.1.2 29th/30th July 2017

TWUL records confirmed that flooding started at approximately 02:30 BST on the morning of 30th July and lasted about six hours. Similar to the 2016 incident, it is understood that the flooding caused internal damage to properties. The measurements from the nearest rain gauge station (Mitcham Station) during the July 2017 rainfall event can be found in *Appendix A*. TWUL sewer rainfall records estimated the incident as being a 1 in 3 year return period.

7.2 Local drainage network

A surface water sewer, of 225 mm diameter, and a storage tank with dimensions 500 mm x 1250 mm flow north-east along Abbott Avenue before being diverted to the south into Kingston Road through an existing footpath in Abbott Avenue. Another surface water pipe, from the eastern end of Abbott

Avenue, is diverted through the same pipe, however there is no available information regarding the size of the asset. This pipe receives the flow from Toynbee Road.

There are two foul sewers which join at Abbott Avenue. One receives the flow from the Abbott Avenue foul pumping station and its diameter is 450 mm. The second one flows from Stanton Road under the railway and is of 450 mm diameter. Both foul sewers are then connected into a rectangular sewer, with dimensions 660 mm x 1015 mm, and flows north east along Abbott Avenue. There is an approximately 30 m section of foul sewer that starts from the manhole adjacent to the backyard of Dundonald Church, with dimensions 991 mm x 661 mm, which then increases again to 1015 mm x 660 mm.

It should be noted that there are several upstream foul and surface water sewers draining from north to south and could potentially affect the functionality of the sewers in Abbott Avenue. These are not described in this chapter, however there are references to them within actions or events regarded as related flooding incidents elsewhere in this report.

Data provided by Merton stated that prior the 2016 event, the gullies in Abbott Avenue were not included within the high priority cleansing programme of 2015/2016. This means they were cleaned at least once every two years as per the standard contract for other areas of the borough and as part of a reactive service on the basis of reports of blocked gullies. Following the 2016 incident the gullies in Abbott Avenue were added in the programme for 2016/17 and 2017/18. This resulted in these gullies being cleaned at least once per year. Prior to the 2017 flooding incident, the gullies had last been cleaned in February 2017.

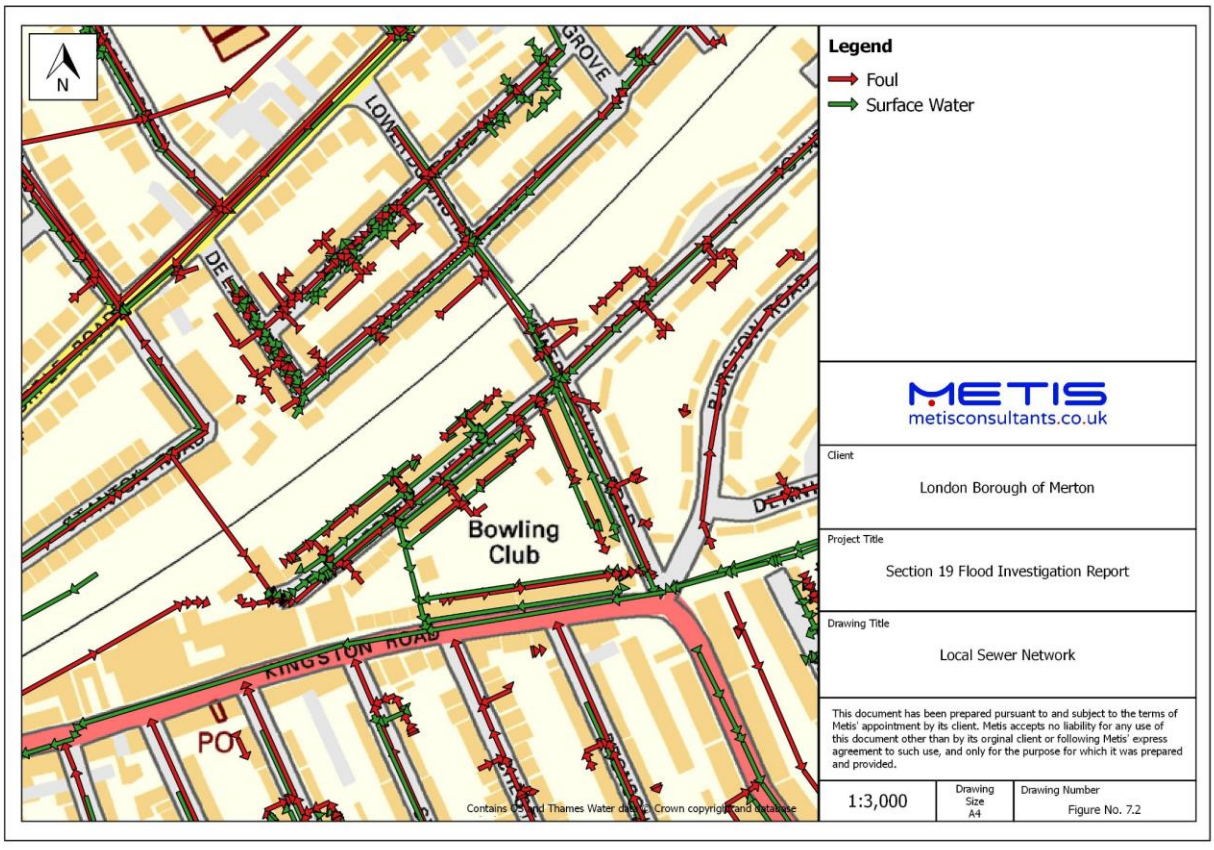


Figure 7.2: Local sewer network in this location

7.3 Local flood mechanism

In terms of topography, LiDAR data confirms that the area's general topography falls from north to south, sloping down towards Abbott Avenue. There is a local high point to the north of Abbott Avenue due to the railway being on a raised embankment along the rear of the properties.

The location falls within drainage catchment DC27 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 7.3* shows that parts to western end of the south side of Abbott Avenue and Lower Downs Road are at high risk of surface water flooding, while the rest of the southern side of Abbott Avenue and most of Lower Downs Road are at medium risk.

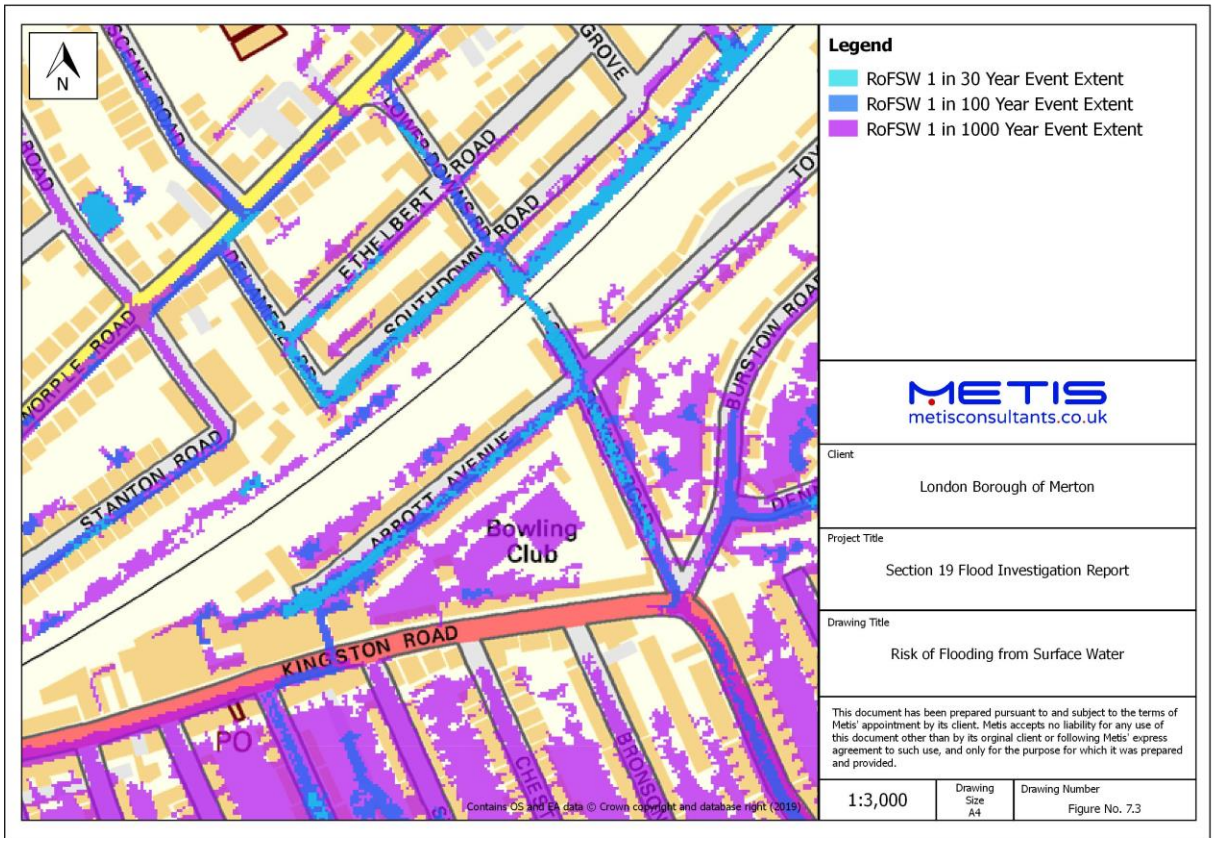


Figure 7.3: Risk of flooding from surface water in this location

Merton's historic flood incident records do not include any flooding incidents in Abbott Avenue, however discussions with the LLFA confirmed that flooding incidents have been experienced in the area in three consecutive years between 2016 and 2018, with the most significant one in 2016.

7.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 7.1 shows the actions that have been taken by the involved RMAs.

Table 7.1: Risk Management Authorities - Actions

Authority	Authority Contributing Action to Flooding Incident
London Borough of Merton	***Before*** No actions taken ***During*** No actions taken ***After*** ✓ Abbott Avenue added to the high priority gully cleansing programme after the 2016 incident ✓ Cleaned the gullies on Abbott Avenue and Lower Downs Road on January/February 2017 ✓ Close cooperation with TWUL in order to identify the source of the flooding ✓ Attended the Raynes Park Community Forum to raise awareness
Thames Water	***Before*** ✓ Undertook a flood investigation at Kingston Road, in 2006, following flood incidents reported as surface water flooding on Abbott Avenue and nearby properties. The investigation determined that the flooding was caused by insufficient capacity of the surface water sewer network in the area. ✓ In 2008 TWUL installed a 60 m^3 surface water storage tank in Abbott Avenue to provide additional capacity to the surface water sewer network ***During*** No actions taken ***After*** ✓ Contractor attended on 28th June 2016 and carried out clean up works. The pumping station was confirmed as operational. ✓ Network investigations post-July 2017 incident, including a CCTV survey and manhole 'lift and look', review and confirmation of pump station arrangement and sewer cleaning in Abbott Avenue ✓ Desktop study, including analysis of pumping station data, rainfall data and historic network information for June 2016 and July 2017 flood events ✓ Network modelling in order to verify the performance of the network and pump station during the July 2017 flood event

Authority	Authority Contributing Action to Flooding Incident
	✓ Surveys and cleaning works of the sewer system upstream, including Arterberry Road and Crescent Road in October 2018 ✓ Abbott Avenue Sewage Pumping Station underwent an electrical upgrade in August 2017 ✓ Following the July 2017 incident, an emergency response plan for Abbott Avenue was created for the protection of the nearby properties ✓ Investigation of the storage tank in October 2018 in Abbott Avenue, which was found to be operating and with minimum silt deposits ✓ Investigation of the surface water sewer network in Abbott Avenue. The flow from surface water sewers at the western end of Abbott Avenue appear to be limited by the unknown diameter surface water sewers which flow from the eastern end (Toynbee Road). ✓ Attended the Raynes Park Community Forum to raise awareness

7.5 Assessment of flooding incident

The main causes of the flooding are understood to be the amount of foul water draining downstream of the railway line and also the potential for surface water entering into the foul system. The foul sewer backed up due to the rainwater entering the system and surcharged downstream of the railway line at the lowest point of the catchment, at Abbott Avenue. This surcharging occurred out of the foul manhole where the flows from under the railway converge with those from the pump station. Another contributing factor to the flooding was the pumping station failure at 03:00 BST for twelve hours during the 2017 incident, caused by an electrical fault, although this would not have increased the volume of flooding upon its failure. An additional reason is that debris, including ladders and bricks, were found in the foul sewer network, between the pumping station and Abbott Avenue, causing blockages in the sewer system. No structural defects were found following CCTV survey of the surface water sewer in Abbott Avenue.

The surface water enters the foul sewer either due to misconnections within the drainage network, as believed by the LLFA. An ordinary watercourse in Cottenham Park allotments had been thought to drain into the foul network upstream of Abbott Avenue, but TWUL's subsequently investigation confirms there is no connection into any manhole on Cambridge Road or Coombe Lane. Generally, considering the steeply sloping topography of the area, a lot of water rapidly flows down towards Abbott Avenue increasing the possibility of runoff entering the foul water network, where a misconnection may exist.

7.6 Recommendations

- Full review and prioritised surveys and investigations by Merton and TWUL of foul and surface water sewer network(s) across the Cottenham Park area (whole area drains towards Abbott Avenue and Coombe Lane). Any additional information, mapping or previously unknown hydraulic controls should be incorporated into Merton's Cottenham Park critical drainage area

flood risk modelling and TWUL asset records. Additional information already identified through survey work by TWUL should also be incorporated.

- A joint Merton and TWUL investigation of the connections to the network of recent private developments upstream of the pumping station, to identify any misconnections which contribute surface water into the foul sewer system which drains towards Abbott Avenue.

8 WORPLE ROAD AND WIMBLEDON HILL ROAD

Worple Road and Wimbledon Hill Road lie in the Hillside ward, in the north central part of the borough. This area, including the adjacent St. George's Road and Worple Road Mews, within Wimbledon town centre was affected in all three flood events, reaching the Merton's Section 19 threshold on each occasion.

8.1 Location-wide flood incident(s)

8.1.1 23rd June 2016

Flooding started at approximately 09:00 BST on the morning of 23rd June 2016 and lasted about 12 hours. The result was flooding of the highway and some basements on Worple Road. Runoff entered into the basements of some of The Pavement retail units through basement skylights on the footway. *Figure 8.1* shows the flooding extended onto Worple Road Mews. Two residential properties were affected internally. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the fourth lowest amount of rainfall during the night of the 22nd and 23rd June 2016, but had the third highest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 21 year return period.

Figure 8.1: Flooding of Worple Hill Mews on 23rd June 2016

8.1.2 29th/30th July 2017

The flooding incident started around 08:00 BST on the 30th July 2017 and lasted about six hours. Merton records state that the flood depth was estimated to be between 300 and 600 mm, with commercial units affected internally. TWUL sewer rainfall records estimated the incident as being a 1 in 2 year return period.

8.1.3 9th August 2017

The flooding incident is recorded by Merton as being similar to that experienced on the 29th/30th July 2017 but the flood depth is not known. TWUL sewer rainfall records estimated the incident as being a 1 in 5 year return period.

8.2 Local drainage network

Worple Road takes a lot of water from surrounding roads as it is the low point from Wimbledon Hill. *Figure 8.2* shows the TWUL sewer network in the affected area. There is a 375 mm diameter surface water sewer in Worple Road running in a north-easterly direction to Wimbledon Hill Road, where it connects into another 375 mm diameter surface water sewer. The 375 mm Wimbledon Hill Road sewer which takes surface water from Worple Road only starts approximately 0.15 km upstream of Worple Road (at the junction with Mansel Road and Woodside). This is despite Wimbledon Hill Road extending almost 1 km north-west of Wimbledon Station; the majority of the upper catchment's runoff should flow north-eastwards along Woodside before ultimately discharging into the River Wandle. The 375 mm surface water sewer connects into a 675 mm diameter surface water sewer in Alexandra Road.

Additional surface water sewers contributing to the 375 mm Worple Road sewer include those on Mansel Road and Raymond Road with diameters between 225 and 375 mm. On St. George's Road a 300 mm diameter runs from its north-eastern end and into the Wimbledon Hill Road sewer at the junction with Alexandra Road. A second surface water sewer on St. George's Road, at the south-western end with 300 mm diameter, runs towards the railway line and then along the railway line in a south-westerly direction and away from the rest of this catchment. A second surface water sewer of 300 mm diameter runs from the northern part of the road into Wimbledon Hill Road and into Alexandra Road. Further eastwards along Alexandra Road is a series of complex connections of surface water sewers taking runoff from nearby residential roads, including the Woodside sewer's runoff from higher up the Wimbledon Hill catchment. Any issues in this downstream part of the surface water sewer network could impact upon any of the low points downstream of Wimbledon Hill.

Following historic flooding in 2007, Merton installed 'beany block' kerbs along Worple Road to improve the flow of runoff from off the highway in front of commercial units. After the flooding incident, Worple Road was added to the high priority cleansing programme. Data provided by Merton confirms that the highway gullies within this location are cleaned at least once annually and as part of a reactive service on the basis of reports of blocked gullies.

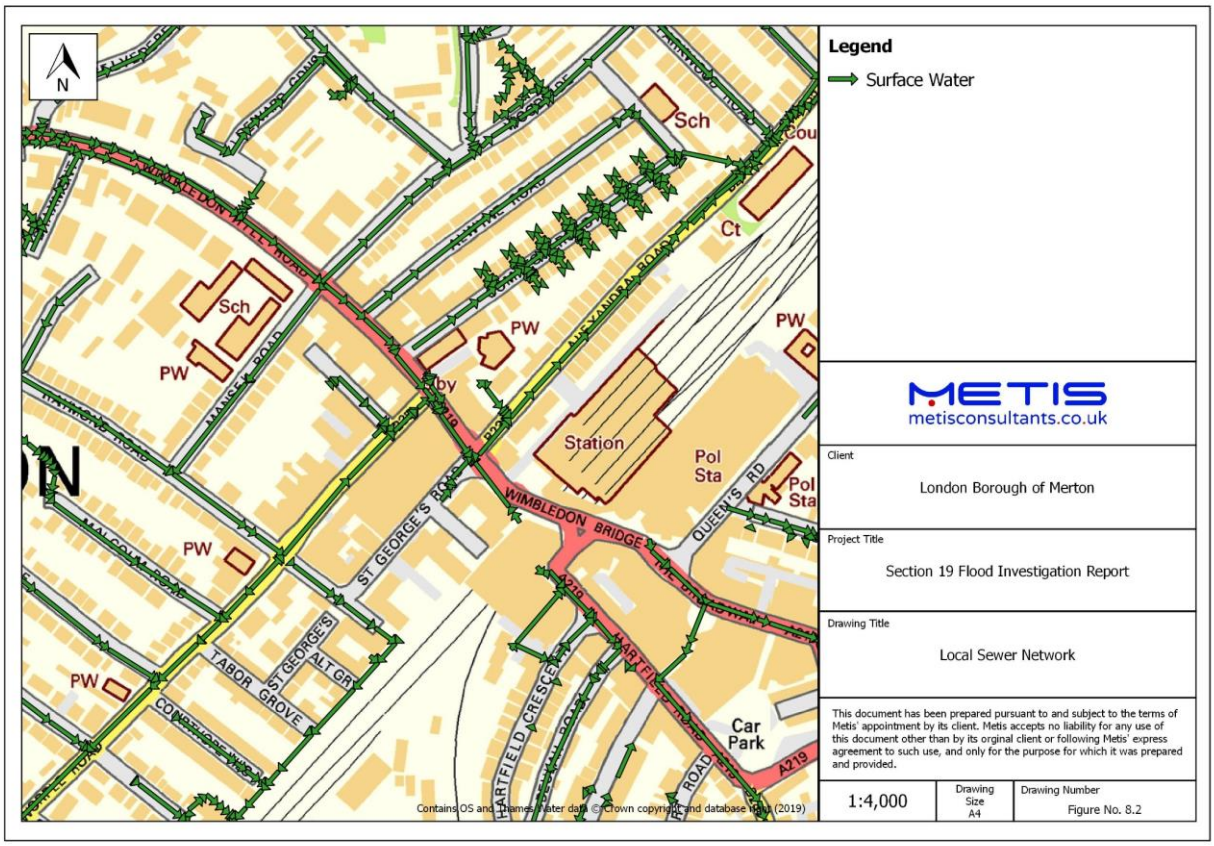


Figure 8.2 Local sewer network in this location

8.3 Local flood mechanism

In terms of topography, LiDAR data shows that the area's general topography is a defined north-west to south-east slope down into Wimbledon town centre. The steeply sloping Wimbledon Hill Road channels surface water runoff towards the local low point at the junction of Alexandra Road and St. George's Road, directly north-west of Wimbledon Station and the railway line. Raymond Road, which is parallel to Wimbledon Hill Road, acts similarly and lies at the south-western end of St. George's Road and bisects Worple Road. Worple Road and St. George's Road are perpendicular to the local sloping nature of the area, causing water to be channelled and pond on these roads, as experienced in the flooding incidents. St. George's Road is relatively flat, Worple Road slopes north-eastwards to Wimbledon Hill Road.

The location falls within drainage catchment DC18 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 8.3* shows that the area is predominantly at risk of flooding from surface water runoff. The high risk areas in the local vicinity are the south-eastern parts of St. George's Road, and at the junction of Wimbledon Hill Road with St. George's Road and Alexandra Road. There are areas also at medium risk of surface water flooding, including along Worple Road in front of commercial units. Increased surface water flooding extents are also predicted on Wimbledon Hill Road and St. George's Road. The EA's Flood Map for Planning shows that the area is within flood zone one and consequently at low risk of fluvial flooding, confirming that surface water is the predominant local flood risk source.

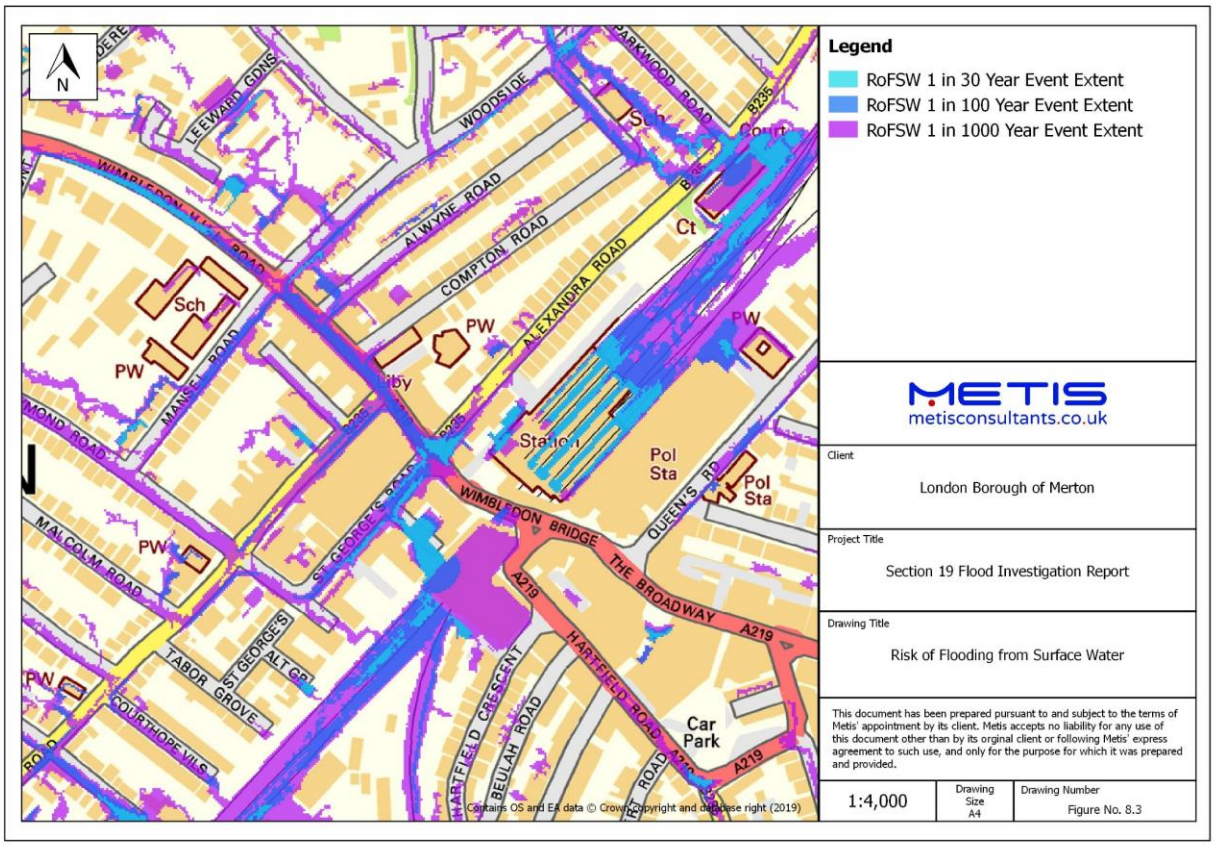


Figure 8.3 Risk of flooding from surface water in this location

Merton's historic flood incident records includes several flooding incidents in the vicinity of Worple Road, including at:

- Wimbledon Hill Road (2007 and 2011)
- Worple Road (2007 and 2011)
- St. George's Road (2007)
- Mansel Road (1981)

These incidents are believed to have been a combination of surface water and sewer flooding, but never reached Merton's Section 19 threshold. Records suggest that similar consequences occurred in these events as those witnessed in 2016 and 2017.

8.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 8.1 shows the actions that have been taken by the involved RMAs.

Table 8.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** No actions taken ***During*** No actions taken ***After*** ✓ Gullies on Worple Road, Wimbledon Hill Road, St. George's Road and Worple Road Mews were cleansed between November 2016 and April 2017 ✓ Merton's Highways team undertook highway surface water drainage improvement works in November 2018. Additional outlet connections were made to the channel drain in front of commercial units and two additional highway gullies added in front of the beany block kerbs. ✓ CCTV survey work performed on the gully outside commercial units, identifying some defects in the connection pipe
Flooded commercial units	***Before*** No actions taken ***During*** No actions taken ***After*** ✓ Cleansing of the drainage channels and grates within their car park to reduce the runoff down the ramp towards the highway
Thames Water	***Before*** No actions taken ***During*** No actions taken

Authority	Authority Response to Flooding
	After ✓ Attended Wimbledon Hill Road on 26th June 2016 and checked the lateral sewer which was found to be clear. Attended 28th and 29th June 2016 and pumped out a basement of a property on Wimbledon Hill Road. A CCTV survey was later carried out on 12th July 2016. ✓ Attended St. George's Road on 18th September 2016 and jetted a 20 m length of surface water sewer and dye tested gullies. 30% silt build up identified within the sewer. Attended again on 2nd October 2016 and cleaned a 21 m length of surface water sewer. ✓ Lifted a private manhole on 30th July 2017 and the system was found to be clear

8.5 Assessment of flooding incident(s)

In August 2017 the cause is believed to have been prolonged rainfall. In addition, due to Worple Road being relatively flat and perpendicular to the steeply sloping local topography, a lot of surface water rapidly flows down into the town centre. This causes water to build up and pond upon Worple Road and St. George's Road. The smaller-sized surface water sewers on these roads are overwhelmed, partly due to being unable to discharge into the larger sewer network under Wimbledon Hill Road.

St. George's Road floods first before flooding internally into commercial units. Water from the multi-story car park runs down onto the pavement in front of commercial units and into the shops. Surface water runoff from Wimbledon Hill Road and Worple Road Mews runs towards The Pavement shopping parade on Worple Road causing flooding to some of the shopping parade's units. Surcharging of surface water sewers occurs at Worple Road Mews. Surface water runoff flows downhill from adjacent roads into Worple Road. The CCTV survey in a gully outside commercial units, which found debris present, will have negatively impacted upon the speed of flow from this gully into the sewer.

8.6 Recommendations

- CCTV investigation by TWUL of the surface water sewer network in Worple Road, Worple Road Mews, St. George's Road and Wimbledon Hill Road to establish the condition of the sewers.
- Merton could raise kerb level outside commercial units to prevent runoff from the multi-story car park reaching the pavement and shops.
- Merton could raise kerb level at The Pavement shopping parade to prevent surface water reaching the basement skylights. When the highway is next resurfaced, levels should also be adjusted to ensure surface water runoff can reach highway gullies more effectively.
- Merton and TWUL should work collaboratively with the Wimbledon Business Improvement District, including flooded commercial units, to increase resilience to flood risk and, if necessary, seek potential funding contributions to assist with future flood mitigation schemes for the wider town centre.

9 EFFRA ROAD

Effra Road is located in the north of the borough in the ward of Trinity. The flooding at this location reached Merton's threshold for Section 19 investigation in the June 2016 incident.

9.1 Location-wide flood incident(s)

Flooding at this location started at approximately 09:00 BST on the morning of 23rd June 2016 and lasted about 12 hours. Two residential properties at this location were affected by internal flooding with one resident reporting damage to the kitchen and flooring of their property. Residents have reported that flooding came from the rear of the property rather than from the road. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the third lowest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the second highest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 21 year return period.

9.2 Local drainage network

A surface water sewer runs from west to east along Effra Road. This sewer varies in diameter between 225 mm and 300 mm until the junction with Ashley Road. From this point eastwards the sewer diameter is predominantly 375 mm, apart from one section between Ashley Road and Edith Road which is 225 mm diameter. Several surface water sewers from adjacent roads including Edith Road and Evelyn Road connect into this. The sewer on Effra Road connects into a 600 mm diameter sewer in Haydon's Road which runs to the east before discharging into the River Wandle.

Data provided by Merton confirms that the highway gullies on Haydon's Road were part of their high priority cleansing programme during 2015/16, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the flooding incident, the gullies had last been cleaned in March 2016. After the flooding incident, Effra Road was added to the high priority cleansing programme for 2016/17 and 2017/18.

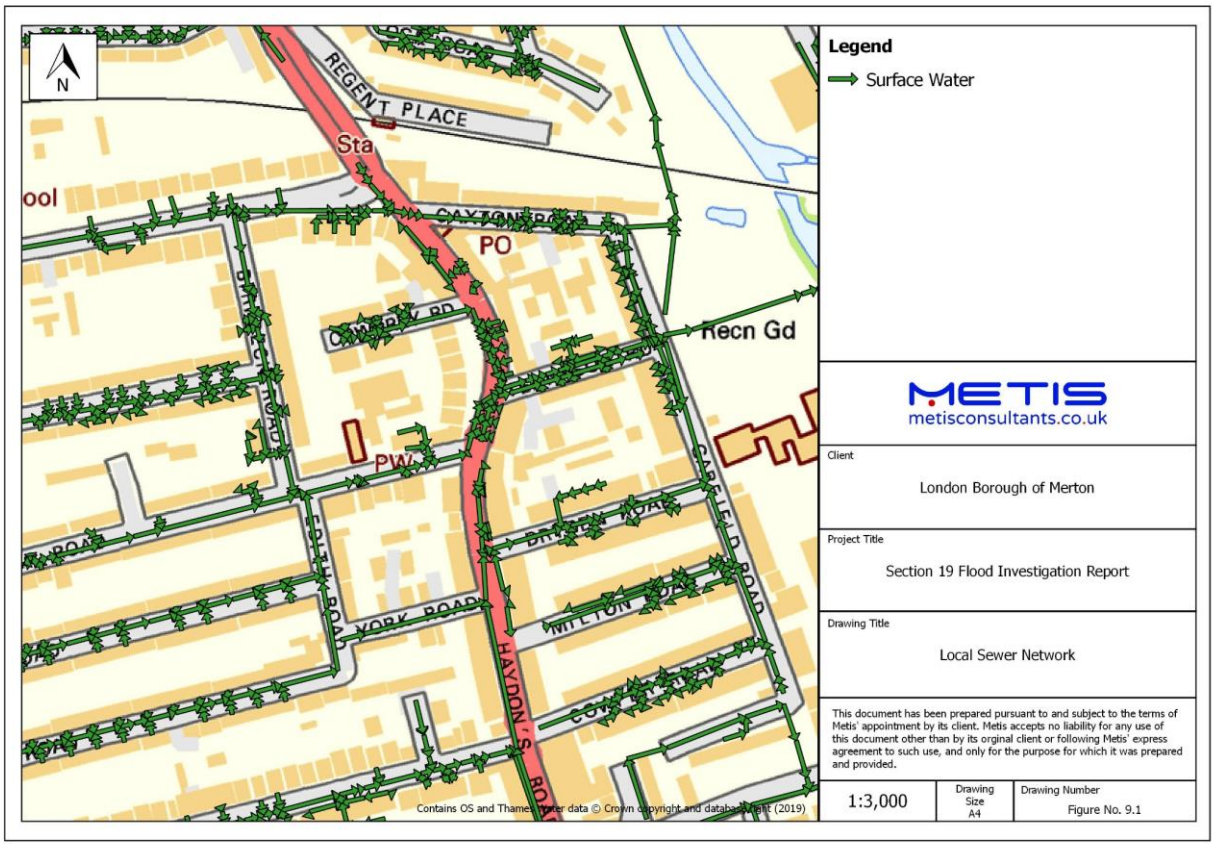


Figure 9.1 Local sewer network in this location

9.3 Local flood mechanism

LiDAR data shows that the topography in the area generally slopes from west to east and from north to south meaning that the eastern end of Effra Road at the junction with Haydon's Road is the low point. Surface water that does not enter the sewer network, such as through the highway gullies, will runoff towards these locations.

The location falls within drainage catchment DC26 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 9.2* shows that Effra Road at the junction with Haydon's Road is predicted to be at high risk of flooding from surface water. This junction is also at medium risk of surface water flooding as well as Effra Road as far as the junction with Ashley Road, Edith Road and York Road. Some properties on Haydon's Road, Effra Road and Edith Road are also predicted to be at medium risk of surface water flooding. Many of the roads and properties are also predicted to be at low risk of surface water flooding.

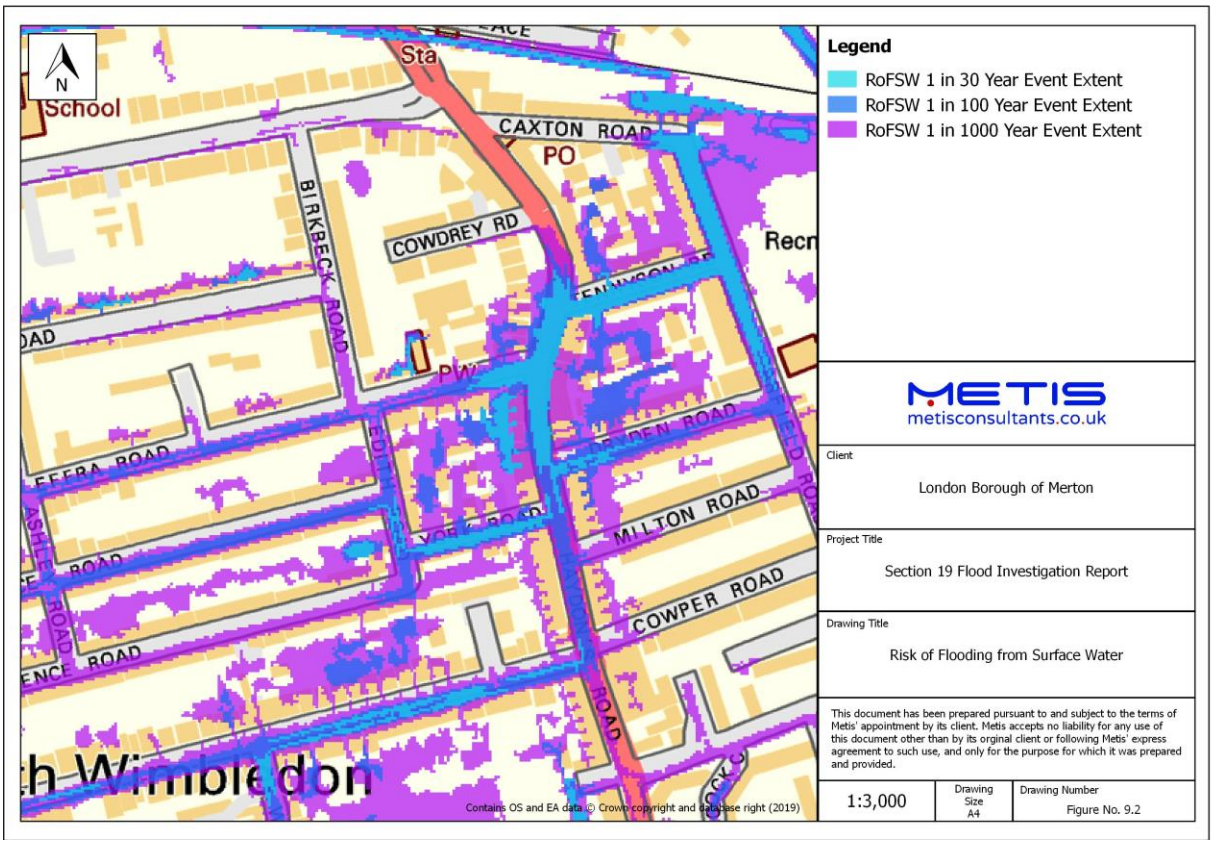


Figure 9.2 Risk of flooding from surface water in this location

Merton's historic flood incidents records includes the following incidents:

- Haydon's Road near the junction with Dryden Road (June 2007)
- Florence Road (summer 2003)

Both of these incidents are believed to have been caused by surface water flooding but neither reached Merton's Section 19 threshold.

9.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 9.1 shows the actions that have been taken by the involved RMAs.

Table 9.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** ✓ Gullies were cleansed on Haydon's Road in March 2016 ***During*** No actions taken ***After*** ✓ Gullies on Effra Road were cleaned in November 2016 and April 2017
Thames Water	***Before*** No actions taken ***During*** No actions taken ***After*** ✓ Attended the site on 28th June 2016 and jetted the foul sewer, clearing an identified blockage ✓ Attended on 6th July 2016, 7th July 2016 and 9th July 2016 to jet and clean 60 m of foul sewer in Effra Road and lateral connections

9.5 Assessment of flooding incident(s)

The expected cause of the flooding is unclear, and both surface water and sewer sources have been recorded, but with no one significant factor. Flooding did not occur from surface water from the highway entering the properties but rather from water from the rear gardens. Likewise, there is no evidence to suggest that the blockage identified and cleared by TWUL in their foul sewer network following the flooding incident was a related factor in the flooding. The potential cause of the flooding may be a low point on Edith Road.

9.6 Recommendations

- Topographical survey of the area by Merton in order to determine the levels and possible low point on Edith Road. If it is determined that surface water is coming from Edith Road, the raising of kerb levels at this point would help keep surface water on the carriageway.
- Merton should liaise with the affected residents to ensure consistency with this Section 19 report.

10 West Barnes Lane

West Barnes Lane is located in the south west of the borough in the West Barnes ward. The flooding at this location reached Merton's threshold for Section 19 investigation in the June 2016 and July 2017 incidents. The flooding experienced focused around the north-eastern end of Adela Avenue and across the highway junction with West Barnes Lane.

10.1 Location-wide flood incidents

10.1.1 23rd June 2016

Surface water runoff flowed north-eastwards along Adela Avenue and ponded on either side of the highway before rising and flowing over the raised table on West Barnes Lane. Once the water had risen above the raised table, it flowed towards properties on the eastern side of West Barnes Lane and the adjacent access gate to the private land behind those properties. There is currently no information available about how much damage this caused to the properties. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the fifth highest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the joint second lowest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 30 year return period.

10.1.2 29th / 30th July 2017

Surface water flooding is understood to have occurred on this date with a very similar scenario as that experienced in June 2016. TWUL sewer rainfall records estimated the incident as being a 1 in 2 year return period.

10.1.3 9th August 2017

Surface water flooding is understood to have occurred on this date with a very similar scenario as that experienced in June 2016. TWUL sewer rainfall records estimated the incident as being a 1 in 4 year return period.

10.2 Local drainage network

A 300 mm diameter surface water sewer runs north-westerly along West Barnes Lane to a manhole at the junction with Adela Avenue. This sewer takes runoff from part of the perpendicular Phyllis Avenue and West Barnes Lane highways. The 300 mm sewer then travels north-easterly between properties 170 and 172 West Barnes Lane (through a 375 mm diameter pipe) and into the 650 m length culverted Pyl Brook watercourse (of unknown diameter) which runs behind properties on West Barnes Lane and the Westway. The culvert flows underneath the private land mentioned in *Section 10.1* which is an overgrown footpath / access route. The Pyl Brook flows in a north-westerly direction towards the A3, before flowing into the Beverley Brook at the borough boundary with the Royal Borough of Kingston upon Thames. This location on West Barnes Lane is halfway along the only culverted stretch of the Pyl Brook within the borough.

At the above mentioned manhole, there is a 225 mm diameter surface water sewer on Adela Avenue flowing in a south westerly direction. This flows to a manhole approximately 100 m along Adela Avenue. TWUL asset records suggest that, at the other end of Adela Avenue, a 225 mm diameter surface water sewer flows from the junction with Seaforth Avenue. This flows north-easterly towards the flooding location, collecting surface water from the adjacent Douglas Avenue, and falling to the same manhole 100 m south west of the Adela Avenue and West Barnes Lane junction. An additional 225 mm diameter sewer flows under Estella Avenue from the junction with Douglas Avenue. This connects with two short 225 mm diameter surface water sewers from West Barnes Lane prior to discharging into the Pyl Brook culvert (via a 300 mm diameter sewer) immediately north-westwards of the affected properties in the 2016 and 2017 flooding incidents.

Data provided by Merton confirms that the highway gullies on Adela Avenue and West Barnes Lane were part of their high priority cleansing programme during 2015/16, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the flooding incident, the gullies had last been cleaned in December 2015 and January 2016.

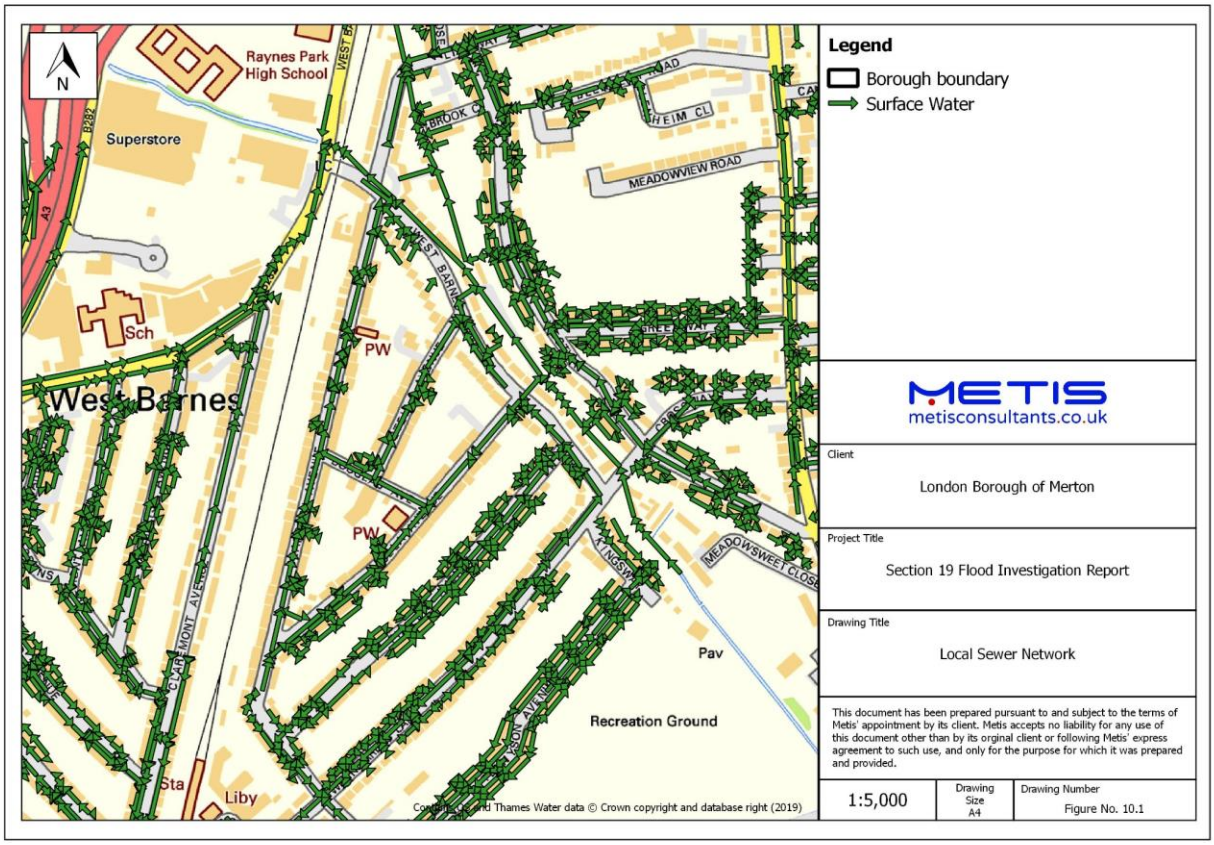


Figure 10.1 Local sewer network in this location

10.3 Local flood mechanism

LiDAR data shows that the topography in the area generally slopes in a north-westerly direction. The south-east to north-west section of West Barnes Lane falls as expected along this trend (as does Douglas Avenue), but the perpendicular side roads (Adela Avenue, Estella Avenue and Seaforth Avenue) fall north-eastwards towards West Barnes Lane and the culverted Pyl Brook. The culverted Pyl Brook is the local low point, suggesting that surface water runoff that cannot enter the sewer network would naturally drain towards properties on the eastern side of West Barnes Lane. These properties, which have driveways which back-slope away from the highway, are also within Flood Zone 3 of the EA's Flood Map for Planning. This covers most of West Barnes Lane and some of the properties on the south side of the Adela Avenue junction. Flood Zone 2 extends approximately 50m south-westwards up Adela Avenue.

The location falls within drainage catchment DC30 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 10.2* shows that the nearest predicted high risk area is 150 m north-west of the flooding location area along West Barnes Lane. None of the area which flooded in 2016 or 2017 is predicted to be at high risk of surface water flooding. The entirety of West Barnes Lane is predicted to be at medium risk of surface water flooding, and this is predicted to extend approximately 50 m up Adela Avenue on the southern side of the road. Properties 144-170 (even numbers only) on the eastern side of West Barnes Lane are predicted to be at risk in the medium risk extent. Most properties, on either side of West Barnes Lane and those at the lower ends of Adela Avenue, Estella Avenue and Seaforth Avenue, are predicted to be at low risk of surface water flooding.

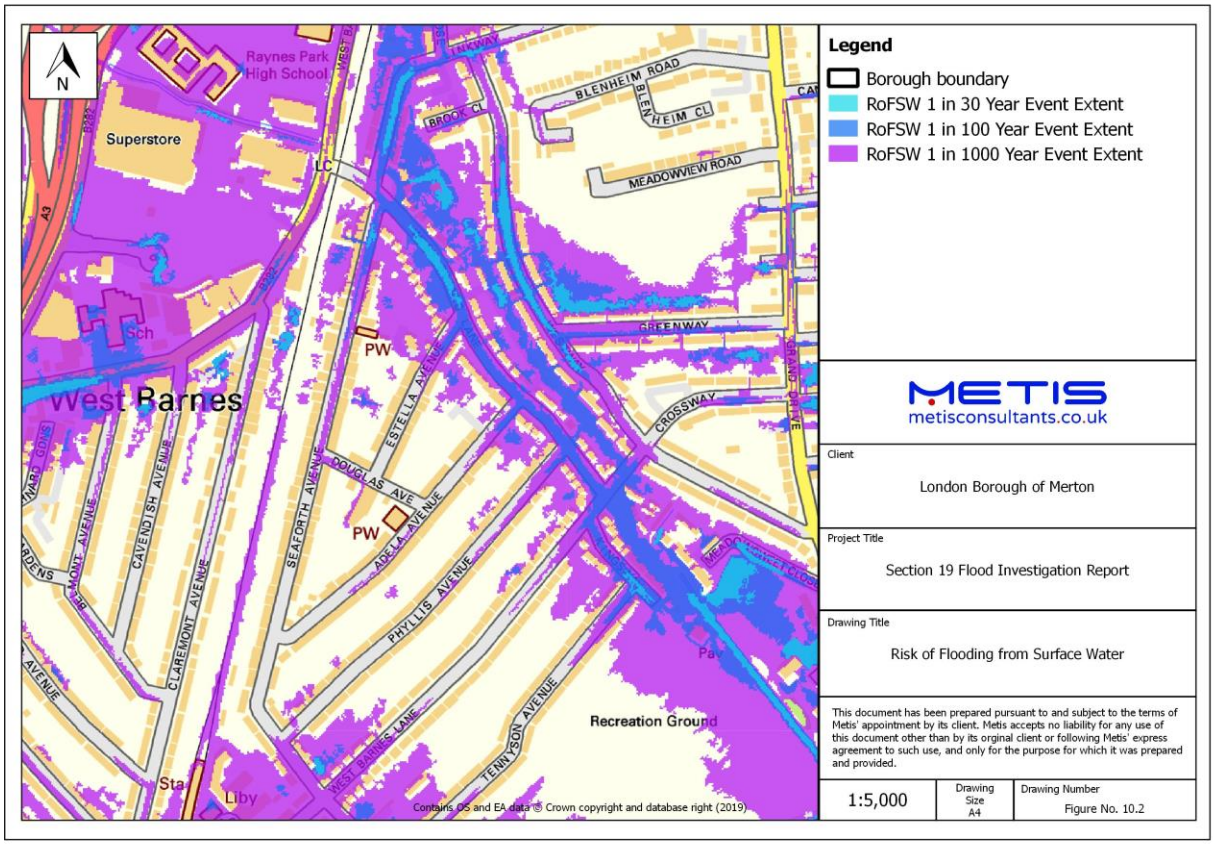


Figure 10.2 Risk of flooding from surface water in this location

The low risk extent also covers properties on the other side of the culverted Pyl Brook (including the Westway).

Merton's historic flood incidents records includes the following incidents at or nearby to this location:

- Seaforth Avenue (northern end) and West Barnes Lane between junctions with Estella Avenue and Seaforth Avenue (20th July 2007)

The above records are believed to be flooding caused by a combination of surface water and fluvial interactions from runoff and the Pyl Brook. No further information exists but Merton's Section 19 threshold was not reached.

10.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 10.1 shows the actions that have been taken by the involved RMAs.

Table 10.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** ✓ The raised table at the Adela Avenue and West Barnes Lane junction was installed as a traffic calming measure ✓ Gullies are cleansed – Merton records confirm that the highway gullies at the affected junction were cleaned in December 2015 (West Barnes Lane) and January 2016 (Adela Avenue). NB: The gully outside 211 West Barnes Lane could not be cleaned due to parked cars on multiple visits between December 2015 and February 2016. ***During*** ✓ Attended on site on 23rd June 2016 and gully cleansing tanker removed as much surface water as possible, but found the surface water sewer was not flowing ***After*** ✓ Levels of the footway and the raised table were adjusted and an additional highway gully was installed on the raised table outside property number 168 in 2018. Kerb improvements were made at the same time to reduce the potential for highway runoff to flow towards the properties' back-sloping driveways. Two additional gullies were installed on Adela Avenue and the main sewers and connections were jetted when this work occurred.

Authority	Authority Response to Flooding
	✓ Gullies are cleansed – Merton records confirm that the highway gullies at the affected junction were cleaned on Adela Avenue and West Barnes Lane between December 2016 and March 2017, and again in February and March 2018. NB: The gully outside 211 West Barnes Lane was cleaned at the seventh attempt in March 2017 and was 50% full of silt pre-clean.
Thames Water	***Before*** No actions taken ***During*** No actions taken – no flooding was reported to TWUL in any of the three incidents ***After*** No actions taken

10.5 Assessment of flooding incident(s)

Flooding at this location occurred following surface water runoff being unable to get into the sewer network via highway gullies. The properties affected by the flooding on West Barnes Lane are slightly lower than the raised table at the Adela Avenue junction. This, the back-sloping driveways, and the fall of the local topography means that any runoff that cannot enter the local sewer network will be naturally channelled towards these properties. Downpipes from the properties need to be adjusted and are understood to not be formally connected to the surface water sewer network, further adding to the local flooding issues.

Insufficient capacity in the drainage system is likely if, as TWUL asset information suggests, the 225 mm surface water sewer does slope down from the West Barnes Lane junction manhole towards the first manhole on Adela Avenue. Due to the limited gradient, as witnessed by standing water in the sewer, any runoff that gets into this Adela Avenue sewer is likely to preferentially flow back towards the raised table and back-up out of gullies on either side of Adela Avenue at the edge of the raised table. This mirrors the predicted surface water flood risk maps.

No information exists about the invert level of the culverted Pyl Brook behind the properties, therefore it is unknown as to whether runoff from the larger 300 mm surface water sewer preferentially flows north-eastwards to the culverted Pyl Brook or south-westwards along Adela Avenue. The flooding incidents experienced in 2016 and 2017 are believed to be caused by the Adela Avenue 225 mm sewer, but if the preferential flow of the 300 mm sewer is towards the Pyl Brook there may also be interconnected issues if the Pyl Brook culvert is also at capacity. Given the proximity

of the gullies around this junction, this may be the lowest point and runoff preferentially surcharges from the highway gullies.

Following the kerb and highway drainage improvement work done by Merton, this has improved the local flood risk. The additional gully installed is connected to an existing gully which discharges into one of the two 225 mm diameter surface water sewers north-west of the flooded junction, not the surface water sewer under West Barnes Lane which turns north-eastwards towards the culverted Pyl Brook. This is unlike the Adela Avenue gullies which drain into the surface water sewer falling south-westwards. If runoff gets away via these West Barnes Lane 225 mm diameter sewers it would suggest that the next downstream inlet into the culverted Pyl Brook has greater flow capacity.

During the September 2018 site visit, there was visual evidence that runoff was not well-draining from the gullies at either side of Adela Avenue adjacent to the edge of the junction's raised table. Although water was not visible, debris left on the carriageway and at dropped kerbs suggests a blockage still may remain within the surface water sewer line.

10.6 Recommendations

- TWUL should investigate the local surface water sewer network around the affected roads to determine the preferential network flow routes, especially from West Barnes Lane by the affected properties and along Adela Avenue towards Douglas Avenue. Any blockages found should be cleared and remedial work programmed if necessary.
- EA should investigate the culverted Pyl Brook behind the properties of West Barnes Lane and the Westway. If the EA do not already have asset information for the culvert (including dimensions and invert levels), a survey should be undertaken and TWUL's sewer asset records updated.
- A small highway SuDS retrofit scheme could be introduced by Merton on Adela Avenue before the raised table to provide some additional storage capacity for runoff in the event of prolonged rainfall. It is acknowledged that this may not currently be viable following the 2018 resurfacing work of the carriageway where two additional gullies were also added.

11 Mount Road, Acuba Road and Brooklands Avenue

Mount Road, Acuba Road and Brooklands Avenue are located in the north of the borough in the Wimbledon Park ward. Acuba Road crosses the borough boundary into the London Borough of Wandsworth. The flooding at this location reached Merton's threshold for Section 19 investigation in the June 2016 event.

11.1 Location-wide flood incident(s)

Flooding at this location started at approximately 09:00 BST on the 23rd June 2016 and lasted about 12 hours. More than two properties were affected by internal flooding, including the flooding of some residential basements on Brooklands Avenue. There were also reports of foul sewage on the road at the junction of Acuba Road and Ravensbury Road. Flooding also occurred across the borough boundary in the neighbouring London Borough of Wandsworth. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the second highest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the fourth highest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 23 year return period.

11.2 Local drainage network

The River Wandle is situated to the east of this location. A culvert runs from Wimbledon Park Lake to the south-west of the location in a north-easterly direction and discharges into the River Wandle. An ordinary watercourse runs through the allotments to the east of Brooklands Avenue, discharging into a 525 mm diameter surface water sewer. This then runs under the railway line and discharges into the River Wandle to the south-east of the location.

A 225 mm diameter surface water sewer runs south to north on Brooklands Avenue. Several smaller surface water sewers along Brooklands Avenue connect into this. On Mount Road an alternating 225 mm / 300 mm diameter surface water sewer runs from west to east with several adjacent sewers connecting into this. The sewers from both Brooklands Avenue and Mount Road connect into a 300 mm diameter surface water sewer on Acuba Road. This connects into the larger Lake-fed surface water culvert which runs to the east and varies in size from 1050 mm to 1500 mm diameter before discharging into the River Wandle. Surface water sewer information for Acuba Road is incomplete north of Ravensbury Road, and asset records do not suggest a direct connection into a combined or foul sewer.

A 225 mm diameter foul sewer runs north on Acuba Road in the London Borough of Wandsworth. This connects into a 450 mm diameter sewer at the junction with Penwith Road which runs eastwards from here. A 225 mm diameter foul sewer runs from west to east on Ravensbury Road. East of the junction with Acuba Road this increases in diameter to 300 mm. There are some smaller combined sewers on Ravensbury Road and Penwith Road where both foul and surface water sewers connect into the foul sewers.

Data provided by Merton confirms that the highway gullies on Mount Road were part of their high priority cleansing programme during 2015/16, 2016/17 and 2017/18. This means they are cleaned at least once per year and as part of a reactive service on the basis of reports of blocked gullies. Prior to the flooding incident, the gullies had last been cleaned in March 2016. After the flooding incident, gullies at the junction of Mount Road and Acuba Road were added to the high priority cleansing programme for 2016/17 and 2017/18.

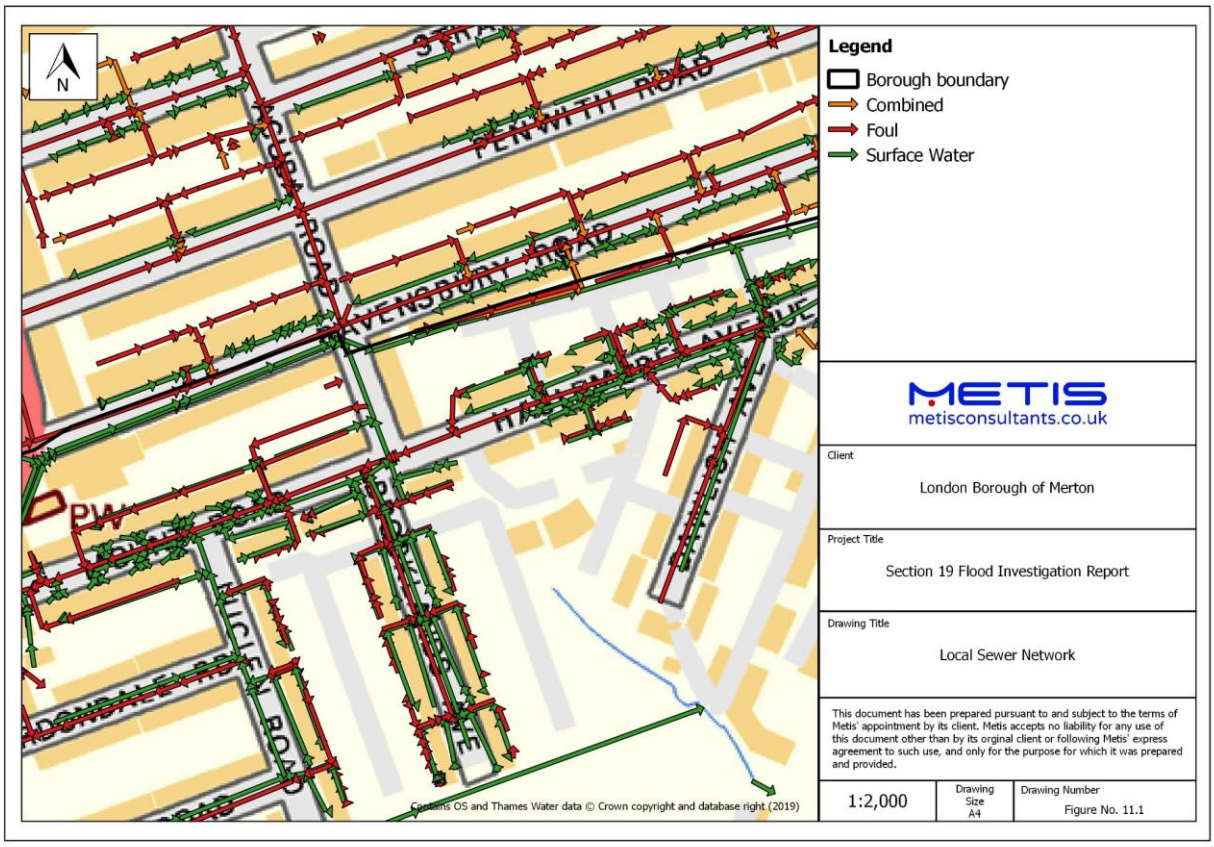


Figure 11.1 Local sewer network in this location

11.3 Local flood mechanism

Because of the local topography there is a low point at the junction of Acuba Road, Mount Road and Brooklands Avenue. LiDAR data shows that the land slopes from west to east and also from south to north with a low point at the junction of the roads mentioned. The surface water sewer network downstream of this location is fed by the overflow from Wimbledon Park Lake from which a large volume of flow comes from. This is evidenced by the size of the surface water culvert, necessary due to the large catchment feeding the Lake from part of Wimbledon Common.

The location falls within drainage catchment DC16 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 11.2* shows that Acuba Road, Ravensbury Road and the junction of Acuba Road, Mount Road and Brooklands Avenue are at high risk of surface water flooding. The allotments to the east of Brooklands Avenue adjacent to the ordinary watercourse is also predicted to be at high risk. The same areas are also identified to be at medium risk of surface water flooding

along with Ravensbury Road and Penwith Road. Almost all of the roads in the local area are identified to be at low risk of surface water flooding.

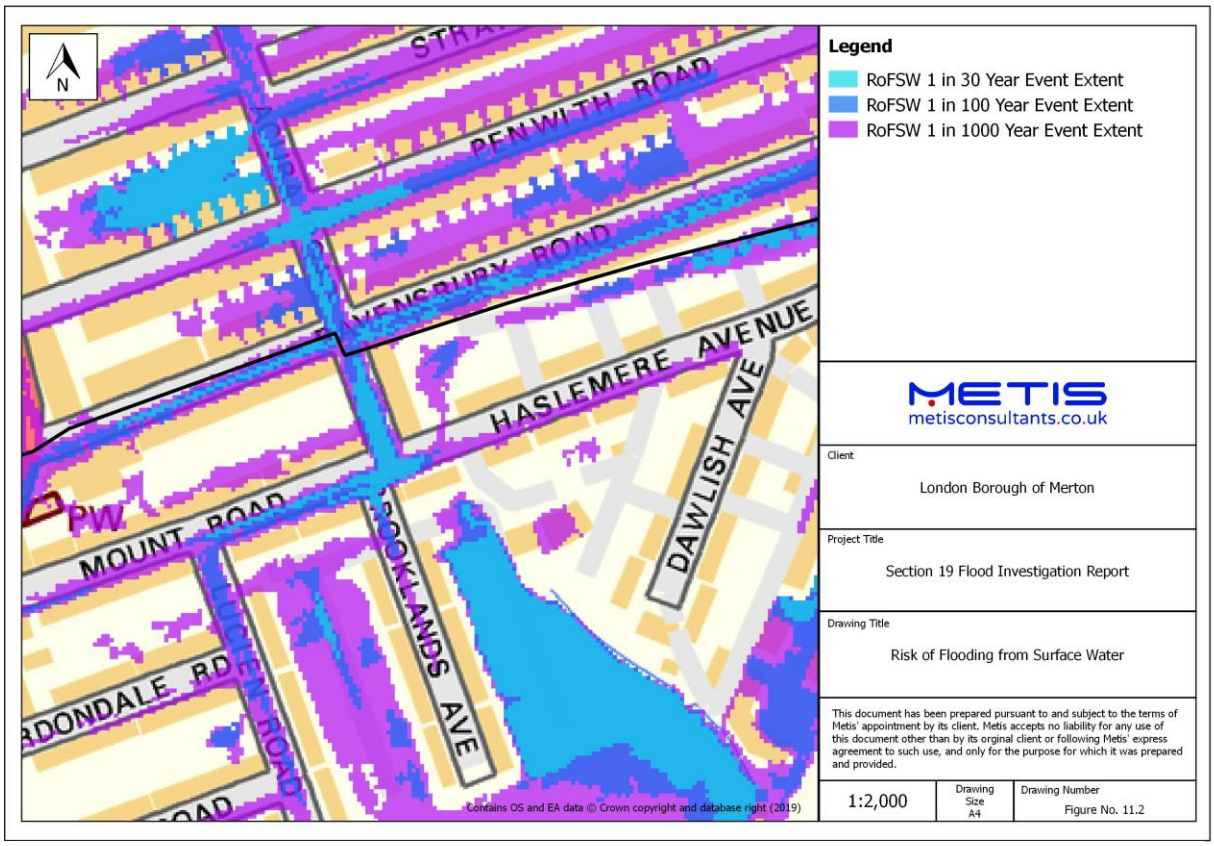


Figure 11.2 Risk of flooding from surface water in this location

Merton's historic flood incident records include an incident at Brooklands Avenue dated 16th May 2008. Gardens were waterlogged and the source is believed to be groundwater.

11.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 11.1 shows the actions that have been taken by the involved RMAs.

Table 11.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** ✓ Gullies on Mount Road were cleansed in March 2016 ✓ This issue had been raised to TWUL previously ***During*** No actions taken ***After*** ✓ The ordinary watercourse to the east of Brooklands Avenue was cleaned and desilted in winter 2016/2017 as part of Merton's annual ditch cleansing programme (where each ditch is typically cleaned in alternate years) ✓ Gullies at the junction of Mount Road and Acuba Road were cleansed in March 2017 ✓ The existing inflows and probable maximum flood into Wimbledon Park Lake has been modelled, predominantly to comply with reservoir safety standards. Modelling is ongoing and feasibility being assessed for potential improvement works.
Thames Water	***Before*** No actions taken ***During*** No actions taken ***After*** ✓ Attended location on 25th June 2016 and checked foul sewer manholes on Acuba Road. No blockages were found and the sewer was running clear. ✓ Attended Acuba Road on 10th July 2016 to clean up and disinfect the road ✓ TWUL have mentioned the possibility of rebenching the 300 mm diameter sewer on Acuba Road (from Mount Road), which would allow for water to discharge into the larger sewer more easily

Authority	Authority Response to Flooding
London Borough of Wandsworth	***Before*** ✓ Gullies on Acuba Road are maintained annually ***During*** No actions taken ***After*** No actions taken

11.5 Assessment of flooding incident(s)

The cause of the flooding is suspected to be both foul and surface water sewer surcharging. The foul sewer surcharging occurred on Acuba Road at the junction with Ravensbury Road. Flooding also occurred to the basement of properties at Brooklands Avenue where there is a natural low point due to local topography. This is likely to have been caused by surface water sewer surcharging with water finding its way to a natural low point in the area.

11.6 Recommendations

- Merton should continue dialogue with TWUL with regards to re-benching of the sewer on Acuba Road / Mount Road.
- Merton could recommend property level resilience to those properties with basements on Brooklands Avenue. This may not be suitable if part of the local flooding mechanism is groundwater-related and such investigations should take this into account.
- If attenuation option as part of the Wimbledon Park Lake scheme is not feasible, Merton should explore further options which may help reduce the risk, include highway SuDS features. A collaborative scheme with the London Borough of Wandsworth may be possible.

12 MERANTUN WAY AND MORDEN ROAD

The junction between Merantun Way and Morden Road is located in the central part of Merton, in Abbey ward. It is regarded as a critical highway through the borough and is maintained as part of TfL's Strategic Road Network (not Merton). The location has reached Merton's Section 19 threshold criteria all the three times, once in 2016 and twice in 2017. The main reason of the flooding in all events is the topography in Morden Road (low point), which receives runoff from the southern and northern areas of the borough.

12.1 Location-wide flood incident(s)

12.1.1 23rd June 2016

Flooding started at approximately 07:00 BST on the morning of 23rd June 2016 and lasted about 12 hours. The depth of the flooding is understood to range from 300 to 600 mm across the highway, leading to the closure of the road during the morning. The event did not cause internal flooding. The measurements from the nearest rain gauge station (Mitcham Station), can be found in *Appendix A*. When compared with the other eight locations where flooding reached Merton's Section 19 threshold, the location received the lowest amount of rainfall during the night of the 22nd and 23rd June 2016 but had the highest rainfall intensity over a five minute duration (see *Appendix B*). TWUL sewer rainfall records estimated the incident as being a 1 in 21 year return period.

12.1.2 29/30th July 2017

Flooding started at approximately 08:00 BST on the morning of 30th July 2017 and lasted about six hours. The depth of the flooding is understood to range from 600 to 1000 mm across the highway, leading to the closure of the road. The event did not cause internal flooding. The measurements from the nearest rain gauge station (Mitcham Station), can be found in *Appendix A*. TWUL sewer rainfall records estimated the incident as being a 1 in 2 year return period.

12.1.3 9th August 2017

Flooding started at approximately 08:00 BST on the morning of 9th August 2017 and lasted about six hours. The depth of the flooding is understood to range from 600 to 1000 mm across the highway, leading to the closure of the road. The event did not cause internal flooding. The measurements from the nearest rain gauge station (Mitcham Station), can be found on *Appendix A*. TWUL sewer rainfall records estimated the incident as being a 1 in 5 year return period.

12.2 Local drainage network

Figure 12.1 shows that the sewer network in Merantun Way is combined, flowing from east to west, crossing Morden Road, and the size of the pipe is 1050 mm. In Morden Road there are two surface water pipes, one on the west side of the road serving the south to the north with diameter 450 mm and one on the east side draining in parallel, with diameter 300 mm.

Since both Merantun Way and Morden Road are TfL managed roads, there are no gullies in Merton's high priority cleansing programme for these roads.

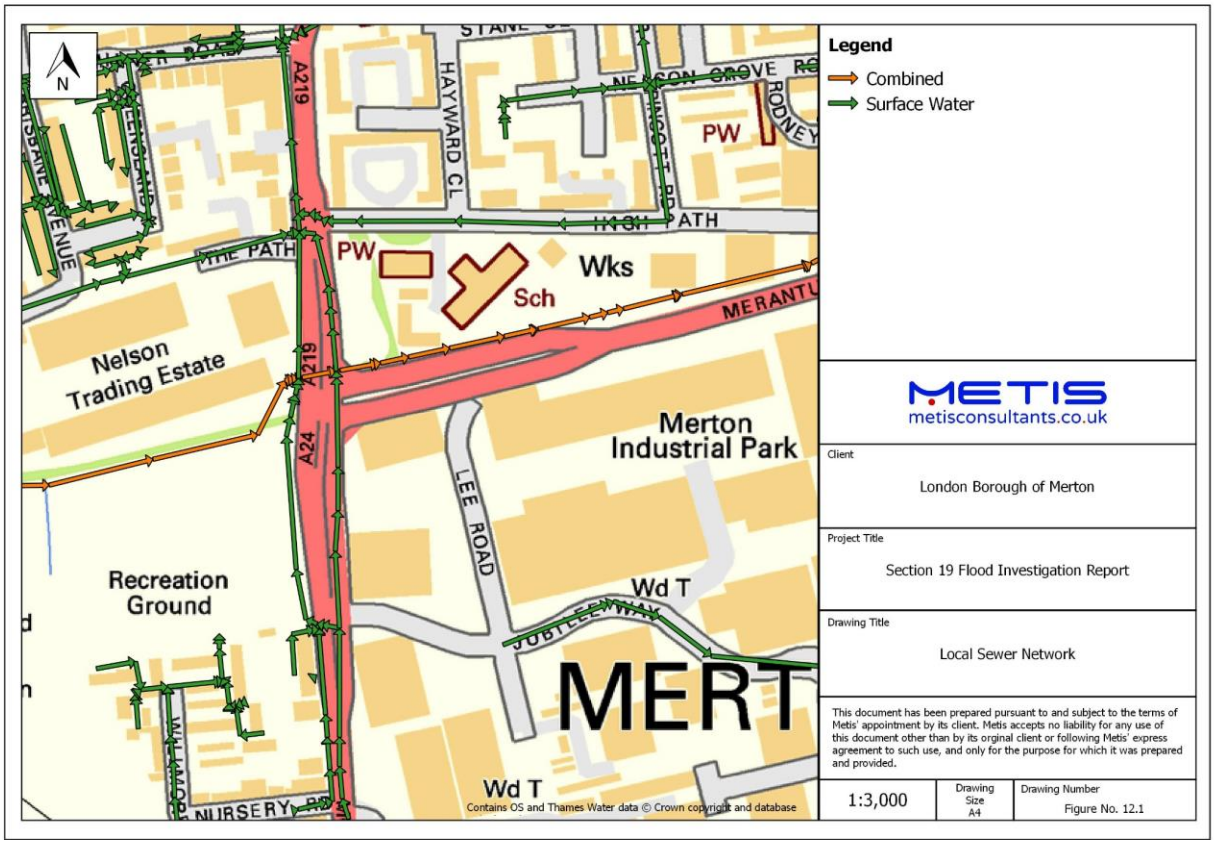


Figure 12.1: Local sewer network in this location

12.3 Local flood mechanism

LiDAR data confirms that close to the junction of the Merantun Way with Morden Road there is a local low point and the surrounding area slopes towards there. Surface water that does not enter the sewer network will runoff to these locations.

The location falls within drainage catchment DC26 (as defined in Merton's 2015 Level 1 Strategic Flood Risk Assessment). *Figure 12.2* shows that a small part of the junction of Merantun Way and Morden Road is at high or medium risk of surface water flooding, while the majority of both Merantun Way and Morden Road are at low risk. The EA's Flood Map for Planning shows that the junction of the two roads, the Abbey Recreation Ground, properties on the west side of Morden Road and properties in the north of Merantun Way are located within Flood Risk Zone 2.

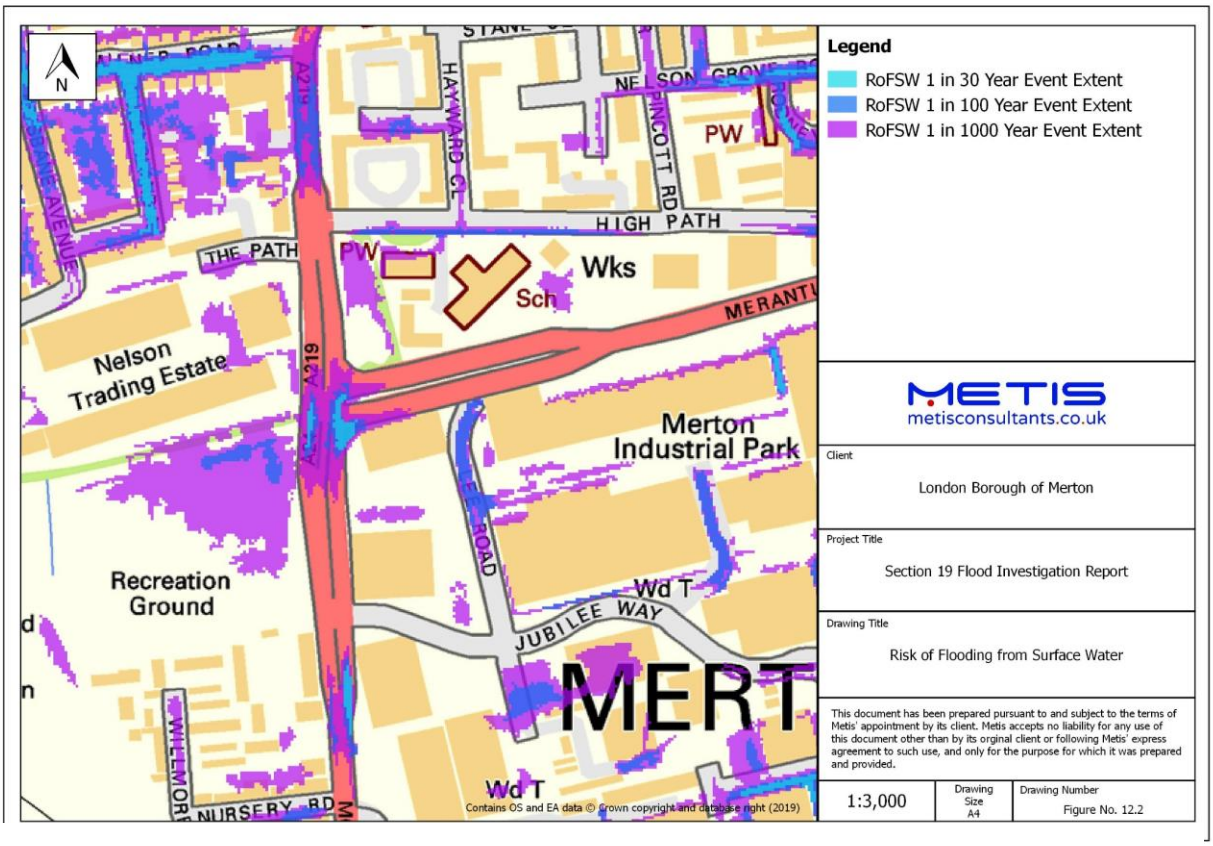


Figure 12.2: Risk of flooding from surface water in this location

Merton's historic flood incident records includes an incident at the same junction on the 26th August 2011. The source of the flooding was recorded as surface water-related and caused minimum internal damage in properties.

12.4 Actions taken by relevant RMAs (and other stakeholders affected)

Table 12.1 shows the actions that have been taken by the involved RMAs.

Table 12.1: Risk Management Authorities - Actions

Authority	Authority Response to Flooding
London Borough of Merton	***Before*** No actions taken ***During*** ✓ Reported the flooding to TfL and TWUL ***After*** ✓ Working with TfL in 2019 to identify potential SuDS retrofit scheme to the south of the Morden Road junction with Merantun Way to alleviate the impact of surface water flooding from overcapacity highway gullies (Morden Road junction with Jubilee Way)
Transport for London	No specific information was received from TfL about any of the incidents, but they confirmed that, when it does flood, the use of a tanker is the only option to clear the volume of water. TfL has also lifted the TWUL manhole covers in the past and completed clearing works of the silt identified. Also working with Merton with a potential SuDS retrofit scheme at the nearby Morden Road junction with Jubilee Way.
Thames Water	***Before*** No actions taken ***During*** No actions taken – no flooding was reported to TWUL in any of the three incidents ***After*** No actions taken
Metropolitan Police	No information was received from the Metropolitan Police, but Merton's LLFA confirmed that the significant flooding led to a closure of Morden Road (from South Wimbledon station).

12.5 Assessment of the flooding incident

The main cause of the flooding is believed to be the levels of the road in the junction of Morden Road with Merantun Way and the lack of maintenance in the surrounding assets. Merton has raised concerns regarding the functionality of the combined sewer system in Merantun Way due to siltation issues with the sewer. Runoff from surcharging gullies on Morden Road to the north of the junction may also have been increased if regular maintenance had not been undertaken prior to the incident by TfL, which is yet to be confirmed.

12.6 Recommendations

- Coordination between TfL and TWUL to evaluate the combined drainage system in Merantun Way and completion of any additional required works.
- Merton could add more gullies to the roads in the north of the junction and a more frequent clearance of the existing ones is required.
- TWUL should liaise with TfL to clarify and investigate whether the nearby foul pumping station at Colborne Court (north of the Morden Road and Merantun Way junction) has any effect on the surface water sewer network.
- TfL should confirm the frequency and location of their gully clearance programme in Morden Road and Merantun Way and re-evaluate its effectiveness.
- The vegetated central reservation on Merantun Way and open space in Abbey Recreation Ground could be considered as options where additional storage could be provided through SuDS features to increase the capacity of the local drainage system through a Merton, TfL and TWUL collaborative scheme.

13 Five Non-Section 19 Locations

13.1 Dorset Road

Dorset Road is located in the centre of the borough, in Merton Park ward. It is a location that was affected during all three rainfall events, without reaching Merton's Section 19 criteria. TWUL sewer rainfall records estimated the incidents as being 1 in 21, 1 in 2 and 1 in 5 year return periods respectively. The affected section of Dorset Road is the part between Kingston Road and Erridge Road. The surface water ponding experienced extends across the carriageway, with greatest depths adjacent to several dropped kerb crossovers.

Data provided by TWUL of the local sewer network shows two main surface water sewers. One starts at the junction with Kingston Road flowing to the south-east and the other starts close to the junction with Erridge Road and flows to the north-west. These two sewers converge at the junction of Dorset Road with Sheridan Road and then flow to westwards along Sheridan Road. The network in the southern part of the road is also split; part of it drains towards Erridge Road and the rest towards Morden Road. Prior to the 2016 incident, the majority of the gullies in Dorset Road were included in Merton's high priority cleansing programme, with the exception being the south-east section which added in the programme after the event.

The EA's RoFSW map shows that Dorset Road is generally at low risk of surface water flooding, except for the southern side of the road where there is at high risk. Small sections to the south of Dorset Road, between Sheridan Road and Melrose Road and to the junction with Kingston Road, are at medium risk. The EA's Flood Map for Planning shows that some properties on the southern part of the road are within Flood Zone 2, these being situated closer to the River Wandle.

Based on the limited available information, the specific cause of the flooding is not clear. It is believed to be a combination of the existing road levels, which causes localised ponding at the crossovers, and the number of surrounding trees which increases the potential for tree roots to get into the sewer network and highway drainage network. Merton has carried out a CCTV survey in parts of the local area in order to identify the main cause of the problem. Further actions recommended include:

- CCTV surveying by TWUL along the entirety of the road in order to identify the issues in the network that cause the flooding. Where necessary, a programme to remove tree roots and re-line or replace broken sections of drainage pipe should be created.
- Any future highway works by Merton should consider the topographic drainage issues of the location and look to implement solutions. Example solutions may include resurfacing to change the levels, the incorporation of SuDS features, and use of permeable materials.

13.2 Baltic Close and Colliers Wood Station

Baltic Close is located in the central north part of the borough, in Colliers Wood ward and close to the River Wandle. This location has flooded once but did not reach Merton's Section 19 threshold on the June 2016 incident.

Flooding at this location started at approximately 09:00 BST on the morning of 23rd June 2016 and lasted about 12 hours. It led to significant flooding in the basement of a commercial property and the main source is believed to be combined sewer flooding in the area following increased surface water runoff from High Street Colliers Wood. The maximum depth of the flooding experienced was approximately 600 mm. TWUL sewer rainfall records estimated the incident as being a 1 in 21 year return period.

There are several combined sewers in the location, generally flowing from the south or south-west to the north along High Street Colliers Wood and then diverted in Byegrove Road, with diameters varying from 450 to 1200 mm. The pipe that is diverted in Baltic Close is of 1219 by 1067 mm dimensions and then it reconnects with the other combined sewer pipes at the junction of Byegrove Road and Denison Road. As High Street Colliers Wood is a TfL managed road, there are no gullies on Merton's high priority cleansing programme. The gullies on most of the roads adjacent to High Street Colliers Wood were included in the programme prior to the 2016 incident, cleaned during November and December 2015. Those at the northern end of Christchurch Road and Walpole Road were not on the programme, but after the event the northern part of Christchurch Road was added to the programme.

The EA's RoFSW maps shows that High Street Colliers Wood, both sides of the junction with Baltic Close, is predicted to be at high risk of flooding from surface water. This junction, the private property that flooded in Baltic Close and the majority of High Street Colliers Wood are at medium risk of flooding. The EA's Flood Map for Planning shows that the whole area is within Flood Zones 3 and 2 from the River Wandle. Baltic Close is within Flood Zone 2 but very close to Flood Zone 3.

Merton's historic flood incident records includes flooding records along High Street Colliers Wood in 2000 and 2007, the latter being the more significant as it resulted in the closure of Colliers Wood London Underground station for nine hours and internal damage to a nearby library. Merton confirmed that the private property in Baltic Close has also flooded several times in the past.

Public realm improvement works have been completed on Baltic Close including a joint scheme between Merton and TfL where SuDS features were installed. This included rain gardens, permeable surfacing and linear drainage on Baltic Close (see *Figure 13.1*) and a swale at the entrance of Wandle Park. This swale acts as an overflow from the raingardens and the permeable wooden cobbles in Baltic Close into the main sewer network. TfL has also undertaken highway works on High Street Colliers Wood, changing the levels of the carriageway between Baltic Close and Colliers Wood London Underground station. TWUL confirmed that they attended twice on site after the incident, checking a private sewer on 26th June 2016, which was found to be running clear, and checking a public sewer on 27th July 2016, which was running at high capacity, but no blockages were found in either sewer.

Figure 13.1: New rain gardens on Baltic Close

TfL identified Colliers Wood London Underground station as being one of their most at risk sites from flooding as part of their *Comprehensive Review of Flood Risk* project in 2016. This led to a *Quantified Flood Risk Assessment* being undertaken in 2018 which modelled the risks of flooding from various sources, including surface water, fluvial and sewers. The modelling and associated cost benefit analysis work concluded that the risk was sufficiently low enough to manage through minor active and passive defence works.

The expected cause of the flooding is the combined sewer network that back flowed into the basement of the private property. Additionally, the existing flow path from the highway diverts the runoff toward the private property, entering into the basement. The large number of connections to the combined sewer network in this area further increases the risk of potential flooding, particularly at the junction of Baltic Close with High Street Colliers Wood and the junction of Christchurch Road and Colwood Gardens.

Actions recommended to decrease the risk of flooding include:

- Closer cooperation of Merton and TfL in order to identify solutions. A potential example of remedial work that could be undertaken includes the changing of the footway levels on High Street Colliers Wood, in order to reduce the risk of flows entering the commercial property in Baltic Close. The adjacent land to Baltic Close which is owned by TfL could also be used for SuDS incorporation to increase the capacity of the local drainage network, reducing the

amount of surface water runoff entering into the combined sewers. Any future work by TfL for Colliers Wood London Underground station will also increase the resilience of their network to flood risk.

- TWUL should investigate the numerous connections to the combined network on and around Baltic Close and the junction of Christchurch Road and Colwood Gardens to ensure maximum capacity is being utilised. TWUL should work collaboratively with Merton and TfL to further decrease surface water runoff entering the combined sewer network, in this location and in upstream contributing catchments.

13.3 Lower Morden Lane

Lower Morden Lane is located in the south west of the borough in the Lower Morden ward. This location was affected during all three events but did not reach Merton's Section 19 criteria. TWUL sewer rainfall records estimated the incidents as being 1 in 30, 1 in 2 and 1 in 4 year return periods respectively. The flooding was constrained to the highway only with no properties affected.

TWUL sewer information shows two surface water sewers discharging into the Pyl Brook at this location, one on the eastern side (of 900 mm diameter) and one on the western side (of 600 mm diameter). Surface water runoff from Lower Morden Lane drains into these sewers. There are sewers both upstream (150 mm diameter) and downstream (225 mm diameter) of this location which also discharge into the Pyl Brook.

The EA's RoFSW map shows that this location is at high risk of surface water flooding. The EA's Flood Map for Planning shows that the area is within Flood Zone 2 due to the nearby Pyl Brook. It is possible at this location that the flooding was increased by the interaction of both surface water and fluvial sources, although the information available does not suggest this to be the case for this incident. Instead, Merton has identified that the TWUL surface water sewer network, adjacent to Hatfeild Primary School, is completely blocked with silt and tree root ingress, preventing runoff from discharging into the East Pyl Brook.

It is recommended that TWUL provide further information following attendance of the surface water sewer blockage incident. To prevent this from occurring again, a routine maintenance programme should be assessed for this location to ensure runoff can discharge into the Pyl Brook channels.

13.4 Kenley Road car park

Kenley Road car park is located in the Merton Park ward in the central part of the borough. This location was affected during all three events but did not reach Merton's Section 19 criteria. TWUL sewer rainfall records estimated the incidents as being 1 in 21, 1 in 2 and 1 in 5 year return periods respectively. The lack of information available means it is not possible to determine the impact of the flooding during these incidents.

TWUL sewer information shows a 225 mm diameter surface water sewer running southwards under the car park access road. This drains into a 300 mm diameter sewer which runs in an easterly direction along Kenley Road and discharges into the River Wandle. The EA's RoFSW shows the car park to be at low risk of flooding.

Information provided by Merton's LLFA suggests there may be concrete in the TWUL sewer line, although there is no evidence or confirmation of this from TWUL. It is recommended that TWUL investigate the possibility of concrete or a blockage in the sewer line and remove it if found. SuDS should be considered as a drainage method in the car park. The car park is currently impermeable therefore a retrofitting exercise should be programmed. Improving the permeability of the car park through the additional of permeable paving or considering options such as rain gardens or swales could improve the drainage of the car park and would also bring additional amenity or biodiversity benefits. Merton's LLFA should explore these options.

13.5 Burlington Road and Shannon Corner junction

The junction of Burlington Road and Shannon Corner (underneath the A3 flyover) is located in the south west side of the borough, in West Barnes ward. It is adjacent to Merton's border with the Royal Borough of Kingston upon Thames. This location was affected during all three rainfall events, without reaching Merton's Section 19 criteria, but is known to flood regularly. TWUL sewer rainfall records estimated the incidents as being 1 in 30, 1 in 2 and 1 in 4 year return periods respectively. No properties have been recorded by Merton as affected by the flooding.

Data provided by TWUL of the local sewer network shows four main surface water sewers. Two drain the A3 (Malden Way / Beverley Way) sliproads (south to north, of diameters 300 or 375 mm) and two in Burlington Road drain westwards in the western side of Shannon Corner and eastwards in its eastern side (predominantly 225 mm diameter but increasing to 305 or 375 mm away from the junction). Manholes at the underpass junction connect the A3 and Burlington Road surface water sewers before each continues north or westwards. The sewers on the western side of Burlington Road discharge into the Beverley Brook, while those on the eastern side discharge into the Pyl Brook. Prior to the 2016 incident, the gullies on both sides of Burlington Road and those on the west side of Beverley Way were included in Merton's high priority cleansing programme (2015/16). This continued into the 2016/17 and 2017/18 programmes as well.

The EA's RoFSW map shows that both sides of Burlington Road, adjacent to the junction with Shannon Corner, are at high and medium risk of surface water flooding. Small sections on the west side of Beverley Road and east side of Malden Way are also at similar risk of flooding. The EA's Flood Map for Planning shows that the location is within Flood Zone 2, as it is situated between the Beverley Brook and the Pyl Brook.

Based on the available information, the cause of the flooding is understood to be the combination of the heavily silted sewers at Shannon Corner and the limited gradient of the sewer in Burlington Road, which discharges in Pyl Brook. These mean the location is susceptible to issues related to surcharges and back flows. Merton and TfL have investigated the network and confirmed the siltation issues in the sewer network. TWUL attended a nearby property on Burlington Road on 27th June 2016, but there was no evidence of blockages found and all of their foul sewer assets were found to be free flowing. Merton have confirmed that the silted sections are under the central island on the roundabout beneath the A3 flyover, therefore TWUL should reinvestigate the surface water sewer at this location.

It is recommended that clearance of the sewer network, particularly where siltation has been previously identified, should be carried out by TWUL. This should also identify the preferential flow

route between the A3 surface water sewers and those under Burlington Road (and across the underpass junction). A Merton, TfL and TWUL collaborative highway SuDS retrofit scheme could also be introduced at the available green space on the east side of Shannon Corner, providing additional storage capacity for runoff during high intensity rainfall events.

14 General Recommendations

Recommendations for each specific location have been identified within the relevant chapters. Additional recommendations that would be suitable for all the locations have been identified below. The LLFA should prioritise them and, where necessary, incorporate them into Merton's Local Flood Risk Management Strategy's action plan when this is next updated.

- Improved communication between Merton and TWUL officers to share asset and investigative data in addition to reports during flooding incidents.
- Increased public awareness work should also be promoted between Merton, TfL and TWUL so that residents know which authority should be contacted when, based on the source(s) of the flooding, and how. Blocked highway gullies, cement in drains, or blockages from leaves should be reported online via Merton's '*Report It*' tool, and where potentially a wider sewer issue, reported to TWUL's 24 hour customer service team on 0800 316 9800. In line with their responsibilities set out in *Section 2*, reports to both Merton or TfL and TWUL may be necessary.
- Cooperation between Merton and TWUL with TfL for the locations close to London Underground stations and their Strategic Road Network, in order to identify projects that could be co-funded and provide flood risk reduction measures.
- Increased awareness raising work to local residents, contractors and businesses about the problems caused by pouring waste materials into highway gullies either during any construction works or commercial operations, to reduce the number of blockages in the highway drainage pipes and receiving sewer network.
- The use of permeable materials (for example permeable asphalt) by Merton in new highways projects should be the default preferable option, if it can be demonstrated that the road integrity will not be compromised.
- Incorporation of retrofit SuDS features in as many locations as possible, would increase the capacity of the drainage network, while providing environmental and health benefits.
- Householders and businesses should increase their resilience to flooding through better preparation. Online resources, including Merton, EA and National Flood Forum websites provide information on how householders can protect their properties against flooding.

15 CONCLUSIONS

This document provides a summary of the actions taken by the relevant RMAs before, during and after the flooding events of June 2016, July 2017 and August 2017 which caused numerous flooding incidents across fourteen locations within the borough. Nine locations witnessed at least one flooding incident which reached the Merton's Section 19 threshold, and a further five flooded during the same events but did not reach the threshold. The relevant RMAs and stakeholders involved in the incidents should familiarise themselves with the identified drainage network, flooding mechanisms and review and complete the future recommendations for each location.

For the 23rd June 2016 event, comparisons for each of the nine locations which reached Merton's Section 19 threshold showed a general inverse relationship between the total amounts of rainfall received and the maximum rainfall intensities. Typically, locations where more rainfall was recorded were of lower intensity, and those of highest intensity received less rainfall. For example, the Merantun Way and Morden Road location only received 39 mm of rainfall between 22:00 BST on the 22nd June and 08:00 BST on the 23rd June but witnessed a rainfall intensity of 143 mm/hour between 01:15 and 01:20 BST. Seven of the nine locations witnessed the maximum rainfall intensity during latter time period, with the other two occurring in the five minutes between 01:10 and 01:15 BST.

The flooding experienced was beyond design capacities for typical surface water sewer systems, but were exacerbated by other factors, such as network configuration, misconnections and blockages. Each of the flooding incidents displayed similarities of complex interactions between flooding sources, predominantly surface water runoff and sewers. Despite the majority of the locations having separate surface water and foul water sewers some of the incidents displayed interactions, suggesting potential misconnections. The response of the relevant RMAs was found to vary during each event and location, however in most cases, closer cooperation between the relevant RMAs was required. The exchanging of flooding data (flooding reports, investigations and asset survey information), planned maintenance work programmes and regular updates would improve the management of the interlinked flood risks in areas across the borough.

Across all 14 locations, the main causes of the flooding were the lack of appropriate maintenance of the assets, misconnections within the foul or surface water network or the local topography of the areas resulting in drainage systems being overwhelmed sooner than expected. The impact of sewers being at hydraulic capacity is a key issue throughout each of the three flooding events. Many of the flooded locations could have had lessened effects through the closer cooperation of the relevant RMAs.

Improved public understanding would ensure residents are aware of the correct RMA that they should contact in the event of flooding or prior to any flooding incident. This can help RMAs prioritise where resources should be focused before and during extreme rainfall events.

The third cause should be addressed through the location and borough-wide recommendations for RMAs to work collaboratively to identify SuDS retrofit opportunities to increase capacity in the drainage networks across the borough's catchments.

The amount of rainfall experienced during the events led to the sewer network, which is typically designed for up to 1 in 30 year rainfall events across London, being unable to handle the capacity. The June 2016 event experienced was reported as being a 1 in 60 year event, therefore a fully functioning drainage system would have been overwhelmed. Consequently, every opportunity should be taken to re-evaluate the whole drainage network holistically on a catchment-basis to ensure potential capacity is at its greatest for when such extreme rainfall events occur.

APPENDICES

A.1 Appendix A – Environment Agency Rain Gauge Data

Table A.1: June 2016 rain gauge data

Time (BST)	22nd – 23rd June 2016 Depth of rainfall (mm)				
	Mitcham Station	Hogsmill	Beddington	Norwood Reservoir	Putney Heath
21:00	0.00	0.00	0.00	0.00	0.00
22:00	3.40	4.43	6.00	2.60	2.50
23:00	1.20	3.31	1.00	1.30	1.90
00:00	16.80	13.60	6.00	13.50	8.00
01:00	9.20	12.50	15.60	9.00	10.60
02:00	5.40	7.44	4.20	5.20	12.30
03:00	0.00	0.13	0.00	0.10	0.30
04:00	0.00	0.70	0.00	0.00	0.70
05:00	9.00	4.67	4.60	8.50	4.60
06:00	1.80	1.80	3.60	5.50	1.60
07:00	0.60	0.74	0.00	0.10	0.40
08:00	0.00	0.00	0.20	0.00	0.00
09:00	0.00	0.00	0.00	0.00	0.00
10:00	0.00	0.00	0.00	0.00	0.00
11:00	0.00	0.00	0.00	0.00	0.00
12:00	0.00	0.00	0.00	0.00	0.00
13:00	0.00	0.00	0.00	0.00	0.00
14:00	0.00	0.00	0.00	0.00	0.00
15:00	2.40	10.47	0.00	0.20	8.00
16:00	0.60	0.15	2.00	1.00	0.40
17:00	0.80	0.46	0.80	0.90	0.50
18:00	0.20	1.19	0.00	0.10	0.00
19:00	0.00	0.18	0.20	0.30	0.60
20:00	0.00	0.00	0.00	0.00	0.00
21:00	0.00	0.00	0.00	0.00	0.00
22:00	0.00	0.00	0.00	0.00	0.00
23:00	0.000	0.00	0.00	0.00	0.00

Table A.2: July 2017 rain gauge data

Time (BST)	29th – 30th July 2017 Depth of rainfall (mm)				
	Mitcham Station	Hogsmill	Beddington	Norwood Reservoir	Putney Heath
13:00	0.00	0.00	0.00	0.00	0.00
14:00	0.46	0.27	0.60	0.40	0.20
15:00	0.38	0.28	0.40	0.40	0.70
16:00	0.88	1.74	0.60	0.60	1.60
17:00	1.55	1.12	1.60	1.30	1.20
18:00	1.01	0.35	1.00	1.20	0.40
19:00	0.00	0.17	0.00	0.00	0.10
20:00	0.20	0.12	0.00	0.00	0.30
21:00	0.00	0.00	0.00	0.00	0.00
22:00	0.00	0.00	0.00	0.00	0.00
23:00	0.00	0.00	0.00	0.00	0.00
00:00	0.25	0.45	0.60	0.10	0.40
01:00	12.33	24.98	6.20	9.50	23.20
02:00	3.71	2.81	3.60	3.60	2.80
03:00	0.00	0.00	0.00	0.10	0.00
04:00	0.00	0.00	0.00	0.00	0.00
05:00	0.00	0.00	0.00	0.00	0.00

Table A.3: August 2017 rain gauge data

Time (BST)	9th August 2017 Depth of rainfall (mm)				
	Mitcham Station	Hogsmill	Beddington	Norwood Reservoir	Putney Heath
05:00	0.00	0.00	0.00	0.00	0.00
06:00	0.00	0.00	0.00	0.00	0.30
07:00	0.00	0.10	0.00	0.00	0.00
08:00	0.73	0.00	0.00	0.90	0.60
09:00	0.74	1.21	0.40	0.80	2.20
10:00	8.18	4.07	4.40	5.70	6.90
11:00	3.87	3.42	3.60	3.50	3.20
12:00	1.64	1.37	2.00	2.00	0.90
13:00	1.30	2.12	2.20	1.50	1.50
14:00	2.19	2.78	3.20	2.20	2.80
15:00	2.65	2.66	4.00	4.10	2.20
16:00	4.08	5.02	3.80	3.30	4.10
17:00	3.26	2.72	3.40	3.20	2.30
18:00	2.05	1.84	1.80	2.10	1.80
19:00	1.48	2.14	1.20	1.50	1.80
20:00	2.25	2.10	2.00	2.50	2.00
21:00	1.00	0.92	1.40	1.30	0.70
22:00	0.00	0.00	0.00	0.00	0.00
23:00	0.00	0.00	0.00	0.00	0.00

B.1 Appendix B – June 2016 Rainfall HydroMaster Data

Table B.4.1: June 2016 data – total rainfall

Location	Total rainfall between 20:00 (22/06/16) and 01:00 (24/06/16) (mm)	Total rainfall between 22:00 (22/06/16) and 08:00 (23/06/16) (mm)
Whatley Avenue and Martin Way	43.00	39.20
Apostles Area (including Dupont Road)	47.60	43.90
Coombe Lane (by Raynes Park Railway Bridge)	50.50	46.60
Abbott Avenue (including Dundonald Church)	47.60	43.90
Worple Road and Wimbledon Hill Road	46.30	43.20
Effra Road	44.70	41.70
West Barnes Lane	46.90	43.30
Mount Road, Acuba Road and Brooklands Avenue	50.70	46.30
Merantun Way and Morden Road	42.50	39.00

Table B.5.2: June 2016 data – total rainfall intensity

Location	Total rainfall intensity between 20:00 (22/06/16) and 01:00 (24/06/16) (mm/hr)	Total rainfall intensity between 22:00 (22/06/16) and 08:00 (23/06/16) (mm/hr)
Whatley Avenue and Martin Way	1.48	3.92
Apostles Area (including Dupont Road)	1.64	4.39
Coombe Lane (by Raynes Park Railway Bridge)	1.74	4.66
Abbott Avenue (including Dundonald Church)	1.64	4.39
Worple Road and Wimbledon Hill Road	1.60	4.32
Effra Road	1.54	4.17
West Barnes Lane	1.62	4.33
Mount Road, Acuba Road and Brooklands Avenue	1.75	4.63
Merantun Way and Morden Road	1.47	3.90

Table B.6.3: June 2016 data – maximum rainfall intensity over 5 minute duration

Location	Maximum recorded 5 minute duration rainfall intensity	
	(mm/hr)	Time period(s) (23rd June 2016) (BST)
Whatley Avenue and Martin Way	52.30	01:15 - 01:20
Apostles Area (including Dupont Road)	45.20	01:15 - 01:20 and 02:35 - 02:40
Coombe Lane (by Raynes Park Railway Bridge)	39.20	01:10 - 01:15 and 06:15 - 06:20
Abbott Avenue (including Dundonald Church)	45.20	01:15 - 01:20 and 02:35 - 02:40
Worple Road and Wimbledon Hill Road	80.50	01:15 - 01:20
Effra Road	92.90	01:15 - 01:20
West Barnes Lane	45.20	01:10 - 01:15 and 02:30 - 02:35
Mount Road, Acuba Road and Brooklands Avenue	60.30	01:15 - 01:20 and 02:35 - 02:40
Merantun Way and Morden Road	143.10	01:15 - 01:20

B.2 Appendix B – June 2016 Rainfall HydroMaster Figures

C.1 Appendix C – Report Figures