Westwood Recreation Ground

Section 19 Flood Investigation

Prepared for the London Borough of Redbridge

Authored by Ella Walsh
Reviewed by: Emma Rowlands
Approved by Mike Mair
Date October 2023
Version 2.0

Metis Consultants Ltd.
2 Sheen Road, Richmond
London, TW9 1AE
United Kingdom
t. 020 8948 0249
e. info@metisconsultants.co.uk
w. metisconsultants.co.uk

Revision History

Version	Date	Description	Prepared	Approved
1.0	August 2023	Draft for client and stakeholder review	EW	MM
2.0	October 2023	Final version issued to client	EW	MM

Limitations

Metis Consultants Limited (Metis) have prepared this Report for the sole use of the Client. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by Metis. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of Metis.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by Metis has not been independently verified by Metis, unless otherwise stated in the Report.

The work described in this Report is based on the conditions encountered and the information available during the period of production. The scope of this Report and the services are accordingly factually limited by these circumstances.

Metis disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to Metis' attention after the date of the Report.

Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. Metis specifically does not guarantee or warrant any estimate or projections contained in this Report.

The Client should take appropriate professional legal advice prior to implementing any recommendations made within this Report that may impact on the legal exposure of the Client.

Copyright

Contact Details

Metis Consultants Ltd.
2 Sheen Road, Richmond
London, TW9 1AE
t. 020 8948 0249
e. info@metisconsultants.co.uk
w. metisconsultants.co.uk

EXECUTIVE SUMMARY

This Section 19 flood risk investigation has been written as part of the London Borough of Redbridge's (Redbridge) duty as a Lead Local Flood Authority (LLFA) under Section 19 of the Flood and Water Management Act (2010). Heavy rainfall on the evening of the 16th November 2022 and the morning of the 17th November 2022 caused significant flooding within Westwood Recreation Ground. Westwood Recreation Ground is in the south-east of the borough and is part of the Seven Kings Water catchment. This flooding extended into the properties backing onto the recreation ground, with eight recorded reports of internal flooding and ten reports of external flooding. This investigation has been carried out in response to the event, with the aims to investigate the source of the flooding, the actions of the relevant Risk Management Authorities (RMAs) before, during, and after the flooding occurred, and to identify potential ways to mitigate future flooding. These RMAs include Redbridge, the Environment Agency (EA), and Thames Water Utilities Limited (TWUL).

This investigation has established that the site is at particular risk from groundwater, surface water, and fluvial flooding. Based on the analysis of the hydrological catchment, flooding reports, the return period of this event, and the historic flooding incidents at this site, it was deemed that the most likely cause of this flood event was fluvial flooding. The watercourse within Westwood Recreation Ground exceeded its hydrological capacity and overtopped its banks. The trash screen within Westwood Recreation Ground, at the point where the watercourse enters a culverted system, was also reported to be blocked at the time of the flood event as a result of flood waters carrying additional debris, detritus, branches and leaves from further upstream to the trash screen. This exacerbated the fluvial flooding within the site, and it was reported that the flood waters receded once the trash screen was cleared.

The RMAs responsible for managing flood risk to Westwood Recreation Ground are Redbridge and the EA. Both RMAs carried out an emergency response to the flood event, with staff from both agencies attending the site and liaising with affected residents. Once Redbridge contractors were successful in clearing the screen, flood waters were observed to recede.

Since the flooding event on the 17th November 2022, Redbridge has taken several actions to mitigate the effects of future flood events. This includes desilting the pond within the recreation ground, pruning vegetation surrounding the waterway to prevent trash screen blockages, and installing flood sensors within the river. Work has been undertaken with other RMAs, such as the EA, to work together to deliver these actions, amongst others, which are being developed to increase the site's resilience to future flood events.

In order to reduce the risk of another flood incident occurring in Westwood Recreation Ground, several short, medium, and long-term recommendations have been proposed. The key recommendations include maintaining a frequent maintenance schedule of the waterway and trash screen, investigating sustainable drainage system (SuDS) opportunities within both the recreation ground and surrounding catchment, and investigating options to renaturalise Seven Kings Water within Westwood Recreation Ground.

CONTENTS

FIGURES AND TABLES

ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AEP	Annual Exceedance Probability
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
FWMA	Flood and Water Management Act (2010)
GIS	Geographic Information System
LFB	London Fire Brigade
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
Redbridge	London Borough of Redbridge
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

1.1 Background Policy and Information

This Section 19 flood risk investigation has been prepared by Metis Consultants Ltd for the London Borough of Redbridge (Redbridge).

Redbridge is a unitary authority, and thus is also the Lead Local Flood Authority (LLFA) for the area. LLFAs are defined as a Risk Management Authority (RMA) under Section 6 of the Flood and Water Management Act (FWMA) (2010). Under Section 19 of the FWMA (2010), LLFAs are required to investigate flood incidents, and must, to the extent that they find necessary or appropriate, investigate:

- Which RMAs have relevant flood risk management functions, and
- Whether each of these RMAs have exercised, or are proposing to exercise, those functions in response to the flood incident.

Upon completion of the flood investigation, Redbridge must publish the results and notify the relevant RMAs.

Redbridge, in its role as the LLFA, has specific criteria that determines which events trigger a Section 19 investigation. These criteria are published in the Local Flood Risk Management Strategy (LFRMS) (2023) and states that flood incidents requiring investigation are defined as when:

- A single property floods internally on repeated occasions (at least three times) within two years of the initial flood incident
- Five or more properties are flooded internally during a single flood incident in the same location.
- A major highway or major rail link becomes impassable, or minor highway or minor rail link becomes impassable to emergency vehicles.
- Critical infrastructure is affected by flooding.
- The source of flooding is ambiguous and meets the above criteria.

Westwood Recreation Ground has flooded previously, with occurrences in 1980, 2000, 2016 and 2022. This report will solely assess the 2022 flooding incident. The 2022 flooding incident resulted in the internal flooding of eight properties, along with ten reports of external flooding. The recreation ground also experienced significant flooding, with flood water extending across both the eastern and western sides of the park. The most significant area of flooding was in the western section of the recreation ground, just beyond the pond and trash screen.

This investigation will also cover:

- An identification of the cause(s) of the flooding, and what Redbridge, Thames Water (TWUL), the Environment Agency (EA), and any other relevant RMAs or key stakeholders can or should do to manage flood risk.
- Recommendations for the short, medium, and longer term to alleviate the risk of flooding to properties in the vicinity of the site.

1.2 Methodology

The initial stage of this investigation was a data collection exercise, involving requesting and reviewing relevant data from RMAs. The data obtained during this stage is summarised in *Table 1.1*.

Table 1.1 Data sources

Data	Source
Assets significant to flood risk	EA / Redbridge / TWUL
Geological information	British Geological Survey
Groundwater information	EA
Blocked gully reports	EA/Redbridge
Historic flood records	EA/Redbridge
Light Detection and Ranging (LiDAR) topographical data	EA
Photos of the flooded sites	Redbridge
Rainfall data	EA
Sewer network data	TWUL / Redbridge
Surface water, fluvial and artificial flood maps	EA
Detailed River Network	EA
Actions taken before, during, and after the rainfall event	EA / TWUL / Redbridge

On Tuesday 5th June 2023, Redbridge held a flooding roadshow at Westwood Recreation Ground, where a survey was taken of attendees asking whether they experienced internal and / or external flooding during the 2022 flooding incident. A letter drop was carried out prior to this roadshow to all surrounding properties, inviting them to participate in an online survey to record their flooding experience. The information collected in the survey was analysed using GIS mapping in a desktop study to investigate the flood mechanisms of the recreation ground. The available historical, topographical, drainage, geological, and land use data was assessed to establish the flood risk sources, hydrological catchments, and overland flow routes. A site visit was conducted to collect any local data and verify the desktop findings. The responsibilities of each RMA for the different flood risks posed to the site were identified, along with their key actions taken, before, during, and after the flooding incident.

Finally, the results of the investigation were compiled and delivered in this report. Recommendations on flood risk mitigations and next steps are provided in *Section 5*.

2 Risk Management Authorities

There are several different RMAs responsible for managing the risk of flooding. The RMAs responsible for a specific flooding incident largely depends on its source. *Table 2.1* provides an overview of the different RMAs within the borough, and their area of responsibility.

Table 2.1 Relevant Risk Management Authorities

RMAs	Borough-specific Authority	Risk Management Responsibilities
EA	EA	Main rivers, the sea, and reservoirs greater than 25,000 m^3
LLFA	Redbridge	Surface water, Ordinary Watercourses, and groundwater
Water and Sewerage Company	TWUL	Surface water, foul and combined sewer systems (sewer flooding)
Highway Authority	Redbridge & Transport for London (TfL)	Public highway drainage

2.1 Environment Agency

The EA is an RMA in flood risk management, with responsibilities for managing flood risk from Main Rivers, reservoirs, and the sea. They are also a Category One responder, as defined by the Civil Contingencies Act (2004). As the national flood risk authority for the UK, they oversee and work with other RMAs on projects to manage fluvial flood risk. The EA also issues consent for works on or near Main Rivers and advises Local Planning Authorities (LPAs) on how development proposals may influence flood risk. This is informed by the Flood Map for Planning. Fluvial flood risk is mapped in different Flood Zones, with the following definitions:

- Flood Zone 1: Land with less than 0.1% Annual Exceedance Probability (AEP) of fluvial flooding.
- Flood Zone 2: Land with between 1% to 0.1% AEP of fluvial flooding and between 0.5% to 0.1% AEP of tidal flooding.
- Flood Zone 3: Land with a greater than 1% AEP of fluvial flooding or greater than 0.5% AEP of tidal flooding.

Seven Kings Water, which runs north to south through Westwood Recreation Ground, is classified as a Main River. Subsequently, the EA is responsible (alongside riparian owners) for managing the flood risk associated with the river.

The EA also perform regular maintenance and inspection tasks on their flood risk assets, take part in emergency planning, and respond to flooding incidents where their involvement is required.

2.2 London Borough of Redbridge

Redbridge has multiple RMA roles and responsibilities, including as an LLFA, Highway Authority, LPA, landowner, and Category One responder.

As a Highway Authority, Redbridge is responsible for maintaining all highway assets that are not part of Strategic Road Network, which is managed by TfL. Highway assets include drains, kerbs, road gullies, and pipes, all of which must be regularly inspected and maintained to ensure runoff is well managed.

Redbridge's authority extends to the point where the network connects to the public sewer, which lies under TWUL responsibility.

As an LLFA, Redbridge is responsible for managing the flood risk from surface water, groundwater, and Ordinary Watercourses. Under the FWMA (2010) and Flood Risk Regulations (2009), their duties include:

- Developing, implementing, and maintaining a LFRMS.
- Maintaining a register of assets and features that have a significant effect on the flood risk within the borough.
- Undertaking Section 19 flood risk investigations as per the FWMA (2010).
- Acting as a statutory consultee in reviewing and consulting on surface water drainage proposals for major developments, providing comments to the LPA.
- Regulating works within the proximity of Ordinary Watercourses (consenting and enforcement).

Under the FWMA (2010), all other RMAs have a duty to cooperate with the LLFA where necessary to undertake the above responsibilities. Redbridge can also carry out work to help alleviate surface water, groundwater, and Ordinary Watercourse flooding in collaboration with other RMAs.

As a landowner, Redbridge has a responsibility to safeguard their own land and property against flooding. Landowners are required under Common Law to not increase the risk of flooding to a neighbouring property, through carrying out maintenance tasks of their assets, such as drain cleaning and maintaining existing flood defences. As a riparian owner, Redbridge has the responsibility of carrying out maintenance tasks for the Main Rivers and Ordinary Watercourses that fall within their land, including Westwood Recreation Ground.

The London Borough of Redbridge are also a Category One Responder under the Civil Contingencies Act (2004) (see *Section 2.6*). The Council and its services have a lead role in responding to incidents and emergencies that occur within the borough, of which flooding is one such potential emergency. The Council must have plans in place to respond to emergencies such as a flooding event, and liaise with other relevant stakeholders to manage and, where possible, reduce the impacts of the event.

2.3 Thames Water Utilities Limited

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

2.4 Landowners

Landowners have the primary responsibility of safeguarding their own land and property, including private roads, against flooding. Under Common Law it is required that landowners do not take any action within their property that increases the flood risk of a neighbouring property. It also allows landowners to take any reasonable measures to protect their property from flooding, as long as this does not cause harm to others. Riparian landowners are responsible for ensuring that any structure on their land or within a neighbouring watercourse is kept clear of debris so that the watercourse can

flow naturally. They are also responsible for maintaining the banks and bed of an Ordinary Watercourse or Main River if it passes through or lies adjacent to their land. As Redbridge is the landowner of Westwood Recreation Ground, they hold these responsibilities for the land.

2.5 Transport for London

TfL are responsible for operating and maintaining the public transport network across London, and the drainage of surface water from the red routes in their Strategic Road Network. These roads are London's main routes, which account for 5% of the total road length but carry more than 30% of London's traffic. The red routes within the Westwood Recreation Ground catchment are:

- A12
- A406

2.6 Category One Responders

Schedule 1 of the Civil Contingencies Act (2004) categorises all blue light emergency services as Category One Responders. For flood incidents within the borough, the most relevant services are the London Fire Brigade (LFB), the Metropolitan Police Service (MPS) and the EA. The MPS co-ordinates emergency services and can assist with evacuations, whilst the LFB is responsible for saving lives and can also assist with the pumping of floodwaters.

3 Flood Incident Details

3.1 Location

Westwood Recreation Ground is a green space of approximately 4.3 hectares, located in the south-east of the borough and part of the Seven Kings Water catchment. The grounds include a small playground, two hardstanding areas for sports use, several footpaths and access points for pedestrians, and a watercourse. The watercourse (Seven Kings Water) runs from north to south, from the northern boundary of the site into a small pond in the centre of the recreation ground. At the southern end of the pond Seven Kings Water flows through a trash screen, beyond which it is culverted underneath the southern half of the recreation ground and beyond. Properties along Chester Road, Spencer Road, and Westwood Road back on to the recreation ground. The layout of the recreation ground and the location of the trash screen are shown in *Figure 3-1*.

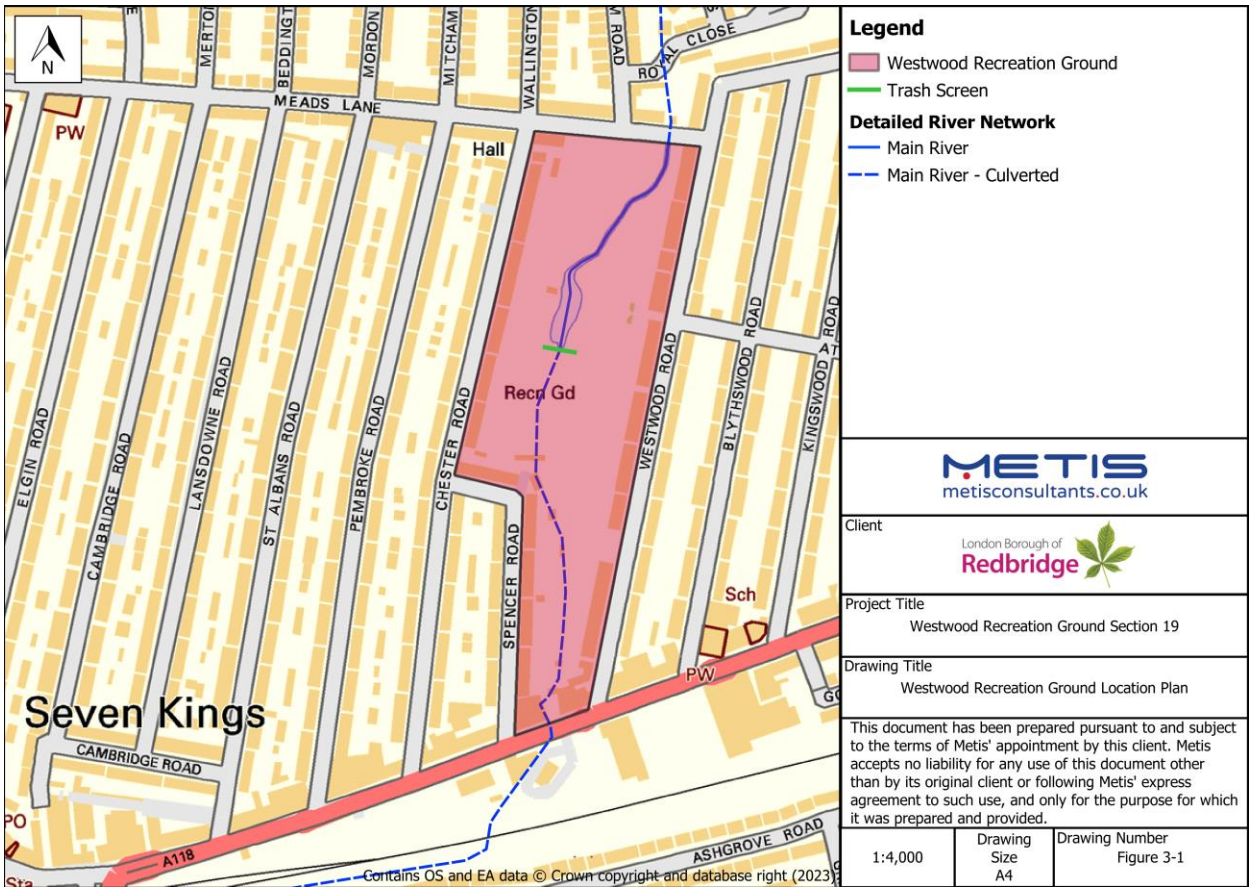

Figure 3-1 Layout of Westwood Recreation Ground

3.2 Rainfall Event

On Thursday 17th November 2022, heavy rainfall over Essex and north-east London caused river levels to rise throughout the area. Rain gauge data shows several periods of heavy rainfall beginning on the evening of the 16th of November, until the early morning of the 17th November. The EA issued a flood alert at 14:00 on the 17th November, and this alert remained in place until 10:00 on the 20th November.

This heavy rainfall caused significant flooding to Westwood Recreation Ground and the surrounding properties. Seven Kings Water overtopped its banks on both sides, covering the pathway to the east of the watercourse and extending towards the houses bordering the western side of the park. There

was also flooding in the south-western section of the park, beyond where the stream is culverted. *Figure 3-2* and *Figure 3-3* show the flooding in the park as of 13:00 on the 18th of November.

All timings referenced in this report are in Greenwich Mean Time.

Figure 3-2 Flooding north of the culvert looking towards Chester Road. Source: EA

Figure 3-3 Flooding downstream from the trash screen, looking towards Chester Road. Source: EA

There were ten reports of external flooding to properties, along with eight reports of internal flooding.

Figure **3-4** shows the general location of both the internal and external reports of flooding for the 17th November flood event.

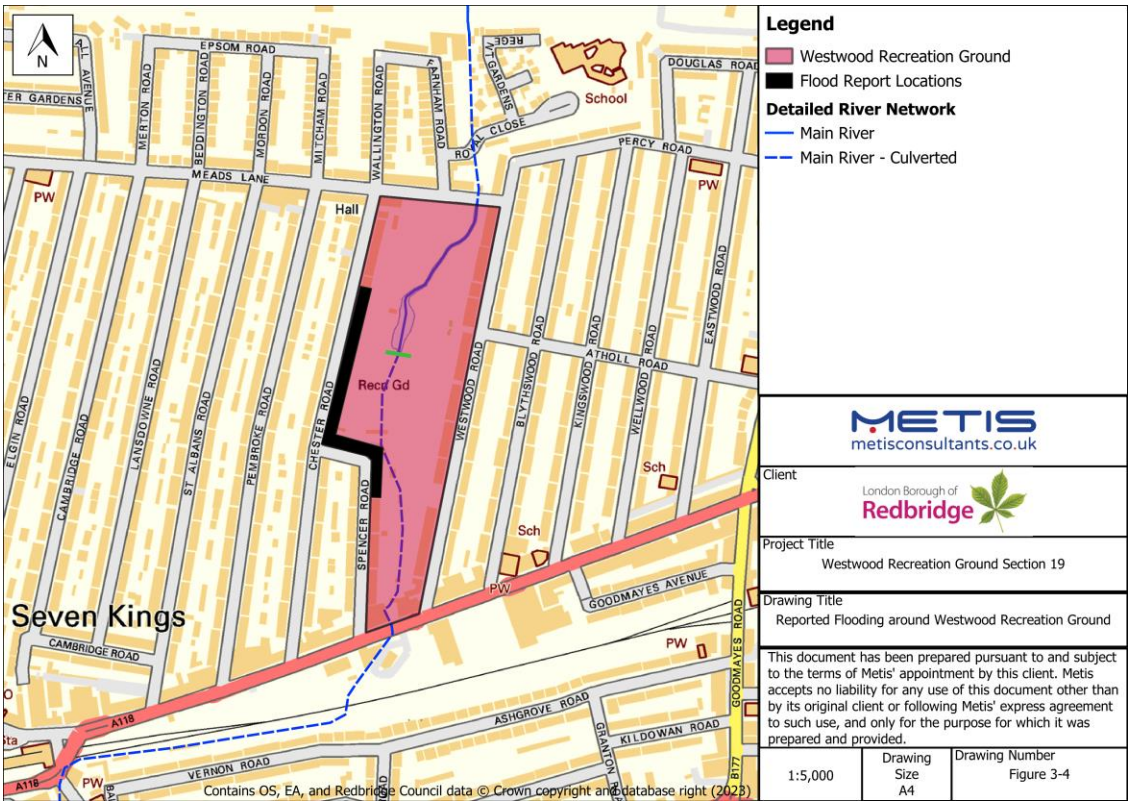

Figure 3-4 Locations of reported flooding around Westwood Recreation Ground

There were several reports that the trash screen at the downstream end of the pond was blocked with debris carried from upstream by flood water, exacerbating the flooding within Westwood Recreation Ground. Contractors initially attempted to clear the trash screen but were unsuccessful due to health and safety concerns. Later that day Redbridge contractors were able to clear the screen, and flood waters were observed to recede. Figure 3-5 shows the water level at the trash screen, at approximately 13:00 on the 18th of November, as Redbridge contractors were working to clear debris from the screen.

Figure 3-5 Water level at the trash screen while being cleared by Redbridge contractors. Source: EA

3.3 Rain Gauge Data

The EA has provided rainfall data, recorded by rain gauges, for the period before, during, and after the 17th November flood event. *Figure 3-6* shows the locations of three rain gauges in proximity to the site. As evident from this map, there are no rain gauges in close proximity to Westwood Recreation Ground. Each rain gauge indicates a similar scale of event, however the distance to the site location introduces some uncertainty into the data.

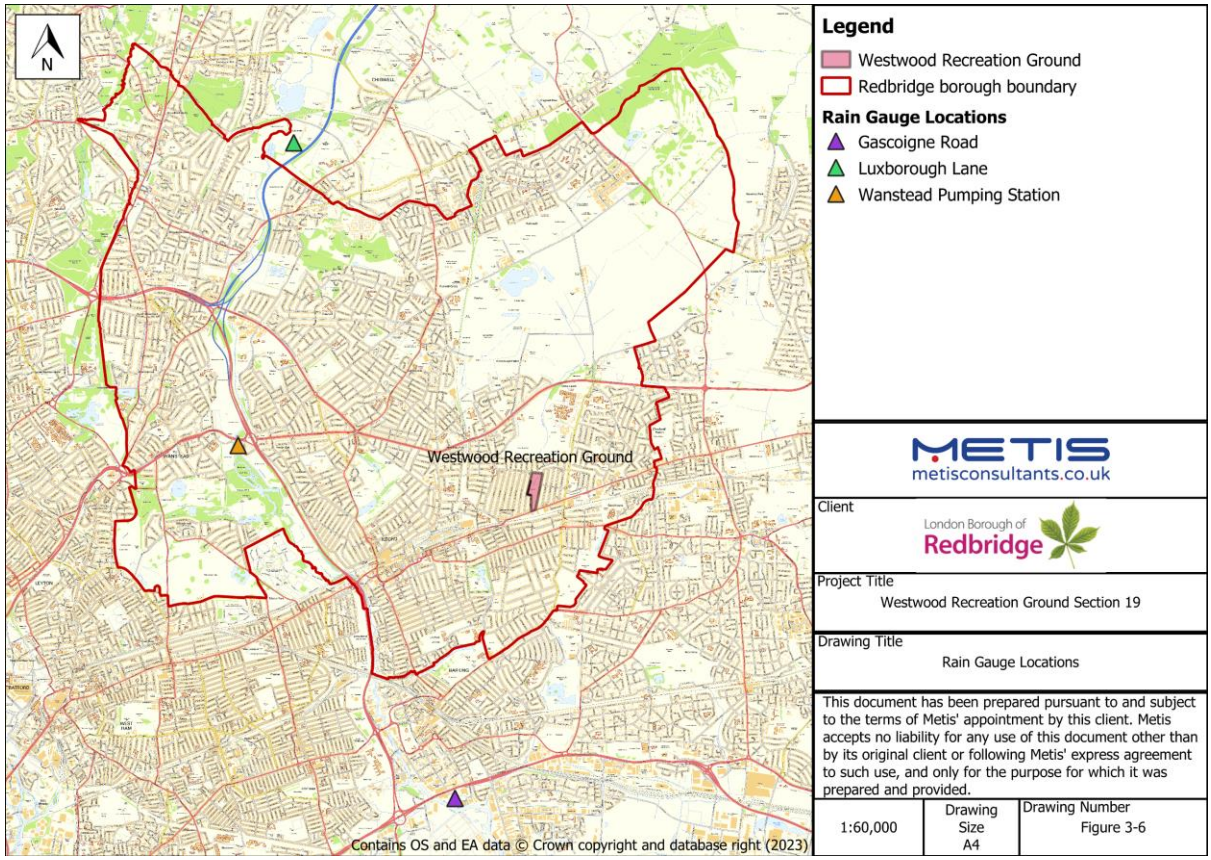

Figure 3-6 Locations of three rain gauges in proximity to the site

Figure 3-7 shows the rainfall depths recorded at each of the three rain gauges across the key time period for this event, and *Table 3.1* summarises the peak rainfall periods during this time frame by averaging the data from the three rain gauges. The approximate rainfall return periods for Westwood Recreation Ground were calculated through an analysis of the hydrological catchment properties. The rain gauge data was then used to compare to these return periods, through which an approximation of this storms return period could be made. The data from this rainfall event indicates that the peak rainfall return period does not exceed a 20% AEP event (greater than a 20% probability of this magnitude of rainfall event in any given year). The rainfall return period calculations can be found in *Appendix 1*.

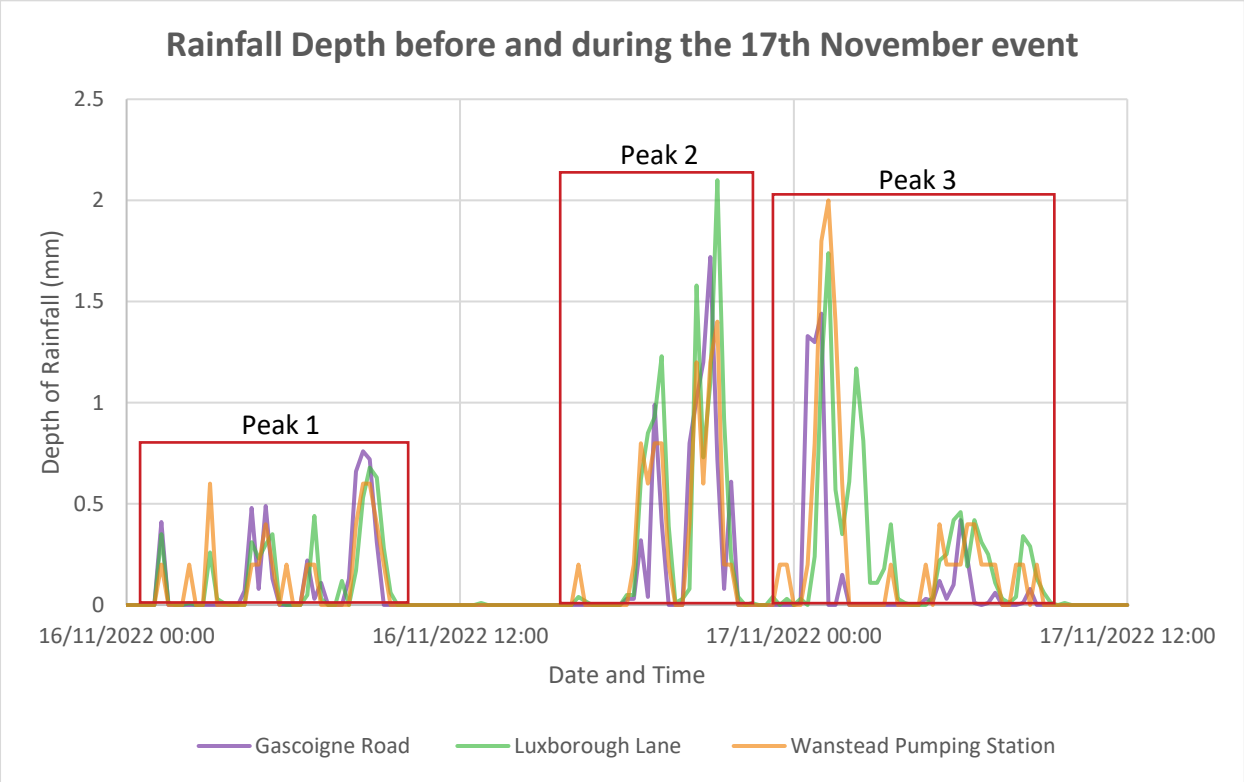

Figure 3-7 Rainfall depth before and during the 17th November flood event

Table 3.1 Summary of rainfall event

Peak Number	Rainfall Period	Peak Time	Rainfall Peak (mm/15 min)	Cumulative Rainfall Over Rainfall Period (mm)
1	01:15 – 09:45 16th November	08:45 16th November	0.72	4.75
2	18:00 – 22:30 16th November	21:15 16th November	2.10	9.17
3	23:15 16th November – 09:15 17th November	01:15 17th November	2.00	9.04

4 FLOOD MECHANISMS

4.1 Local Drainage Network

The TWUL sewer network in the Westwood Recreation Ground catchment is shown in *Figure 4-1*.

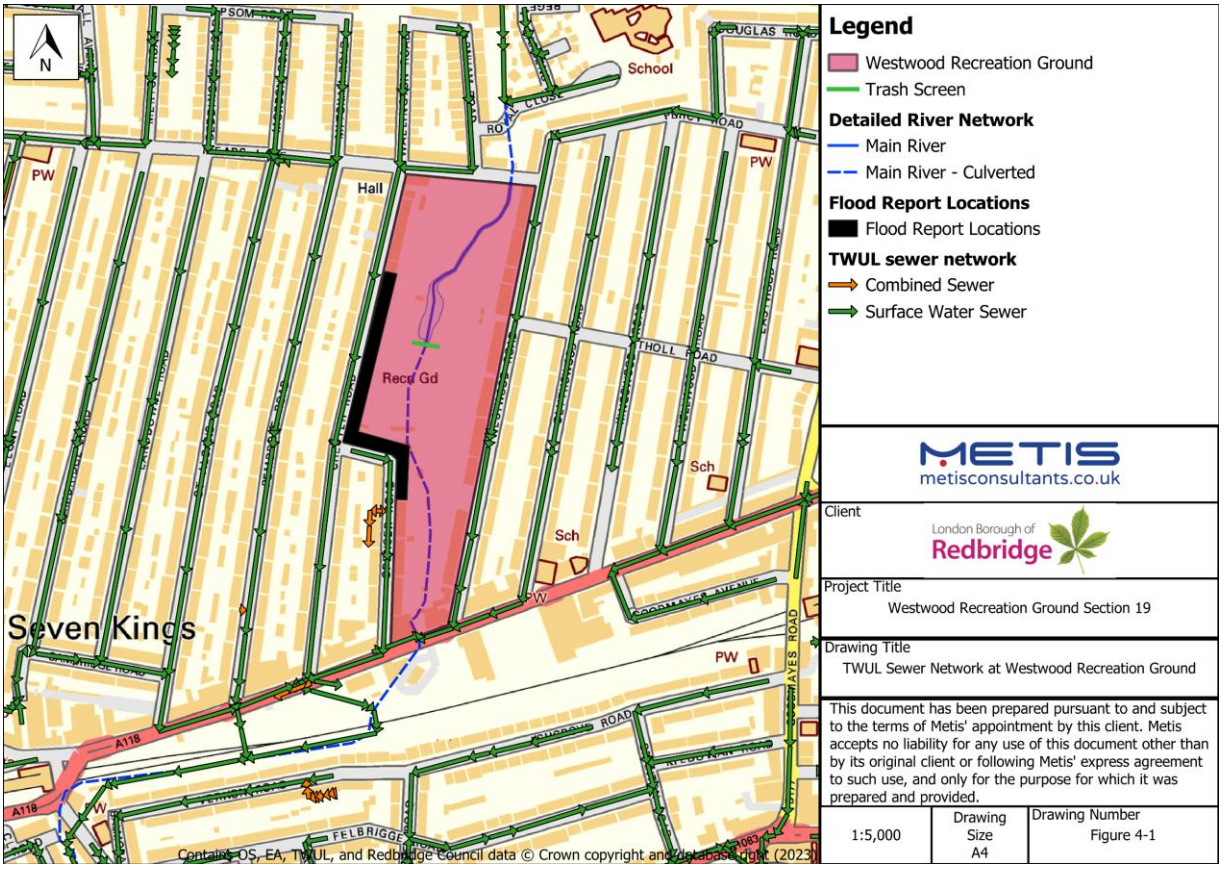

Figure 4-1 Westwood Recreation Ground Sewer Network

A 2,100mm x 1,050mm culverted watercourse discharges into Westwood Recreation Ground at the northern boundary of the site, where it becomes an open watercourse (Seven Kings Water). Seven Kings Water continues for approximately 230m southwards through the recreation ground, where it widens into a pond before reaching a trash screen in the centre of the site. The watercourse is then culverted beneath the southern half of the recreation ground towards High Road to the south of the site. Seven Kings Water initially discharges to a 1,400mm by 1,050mm pipe, which then expands to 2,100mm by 1,050mm after approximately 120m. This surface water sewer then discharges to a 2,400mm by 1,200mm sewer on the opposite side of High Road. The sewer network then continues in a south-western direction until it discharges into the lake within South Park, approximately 1,500m south-west of the site.

4.2 Hydrological Catchment

In order to understand the potential causes of flooding within Westwood Recreation Ground, the hydrological catchment area has been defined. The hydrological catchment is an area of land in which all rain falling on the surface drains towards the same waterbody, flow path, or topographical low point. There can be more than one topographical low point in a catchment and more than one hydrological catchment within a site area, although that is not the case with Westwood Recreation Ground. The catchment area in which Westwood Recreation Ground is situated was established

through analysis of the topography of the site and the wider area using QGIS and Light Detection and Ranging (LiDAR) data (*Figure 4-2*). This was done as part of the 2016 Section 19 flood investigation (*Appendix 2*) and was also completed as part of the ongoing Surface Water Management Plan (SWMP). Westwood Recreation Ground lies within the Seven Kings and Loxford catchment area.

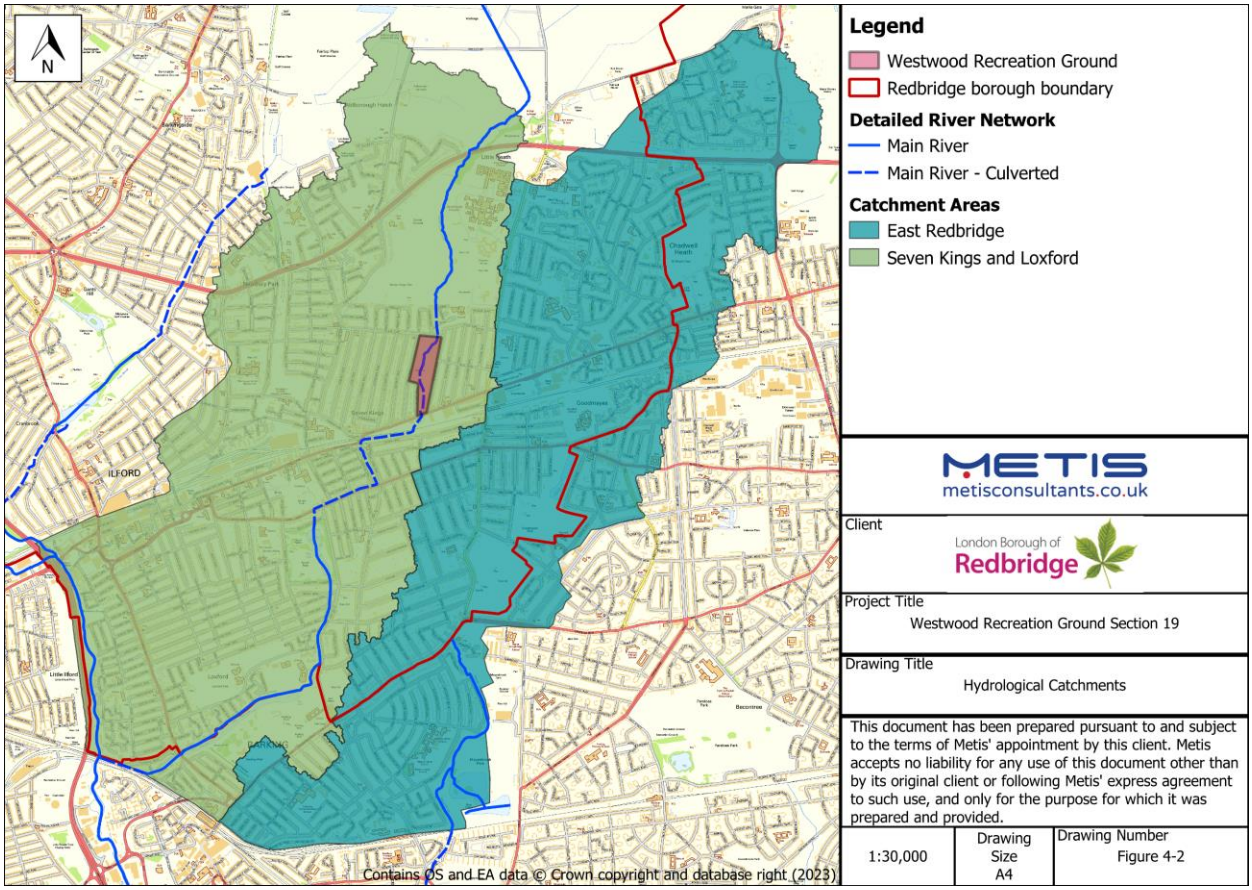

Figure 4-2 Hydrological catchment map of the Westwood Recreation Ground area

4.3 Local Flood Risk

There are several flooding mechanisms that could have contributed to the flooding event on the 17th November 2022. To gain a true understanding of the cause of the flooding, it is necessary to analyse the local flood risks from surface water, Ordinary Watercourses, Main Rivers (fluvial flooding), groundwater, and sewers.

4.3.1 Surface water flood risk

Surface water flooding occurs during heavy or prolonged periods of rainfall, when the volume of surface water exceeds the capacity of the drainage network, and the water cannot drain away at a sufficient rate via infiltration. This results in ponding and overland flows.

A review of the EA's Risk of Flooding from Surface Water (RoFSW) data shows a significant portion of the western side of the recreation ground and surrounding properties are at risk from a 0.1% AEP event. The properties that reported flooding during the November 2022 event are all located within the 0.1% AEP extent of surface water flooding, as displayed in *Figure 4-3.*

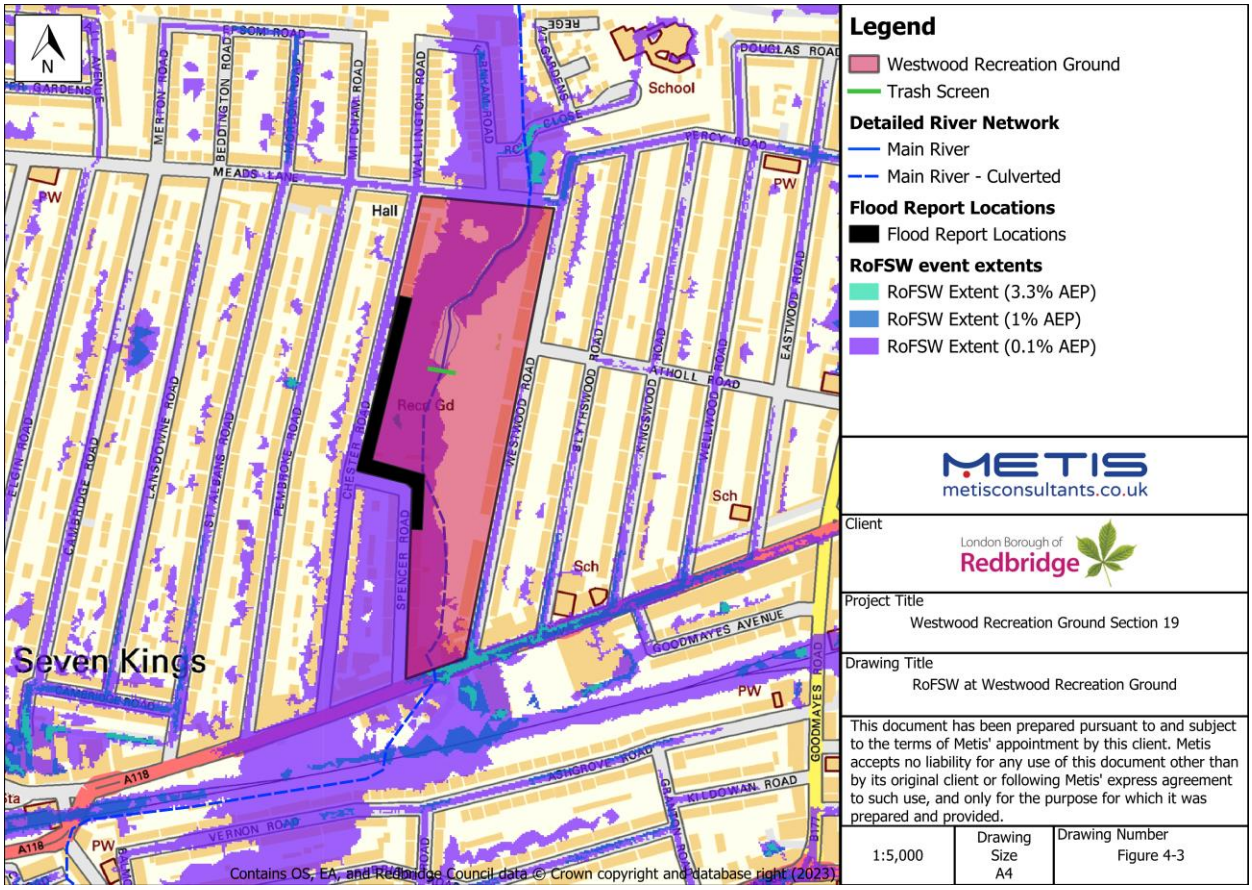

Figure 4-3 RoFSW within Westwood Recreation Ground

As shown in *Section 3.3*, the rain gauge data indicates that this flooding event had an AEP of more than 20%. The urbanised nature of the catchment, combined with a limited infiltration capacity due to the likely high water-table (See *Section 4.3.4*), increases the risk of surface water flooding in the area. However, given the low rainfall return period of this event, it is unlikely that surface water was the source of the flooding on the 17th November 2022.

4.3.2 Ordinary Watercourse flood risk

An Ordinary Watercourse is a river, stream, or ditch that is not designated as a Main River by the EA. Significant rainfall events can lead to an Ordinary Watercourse exceeding their hydraulic capacity and rising above their banks or retaining structures, causing surface water flooding on the surrounding land.

The EA's RoFSW extents include the risk of flooding from Ordinary Watercourses. A review of the EA's Detailed River Network confirms that the open channel within Westwood Recreation Ground is classified as a Main River. There are no Ordinary Watercourses in the vicinity of the site. Therefore, Westwood Recreation Ground is not at risk of flooding from Ordinary Watercourses.

4.3.3 Fluvial flood risk

Fluvial flood risk occurs when watercourses designated as 'Main Rivers' by the EA exceed their hydraulic capacity as a result of heavy or prolonged rainfall. A 'Main River' is usually a larger river or stream, which are shown on the EA's Main River Map. A principal criterion for defining a watercourse as a Main River is if there are a significant number of people and / or properties liable to flood consequences from the watercourse.

Seven Kings Water, which runs through Seven Kings Park to the north of the site, is designated as a Main River by the EA. This watercourse is then culverted under Royal Close and Meads Lane, where it then discharges into the northern part of Westwood Recreation Ground. Seven Kings Water is also designated as a Main River within the recreation ground. It is then culverted beyond the trash screen, through the southern half of the recreation ground.

The EA's fluvial flood zone mapping shows that a large portion of Westwood Recreation Ground is located within Flood Zones 2 and 3, with all the properties that reported flooding being located within Flood Zone 3 (*Figure 4-4*).

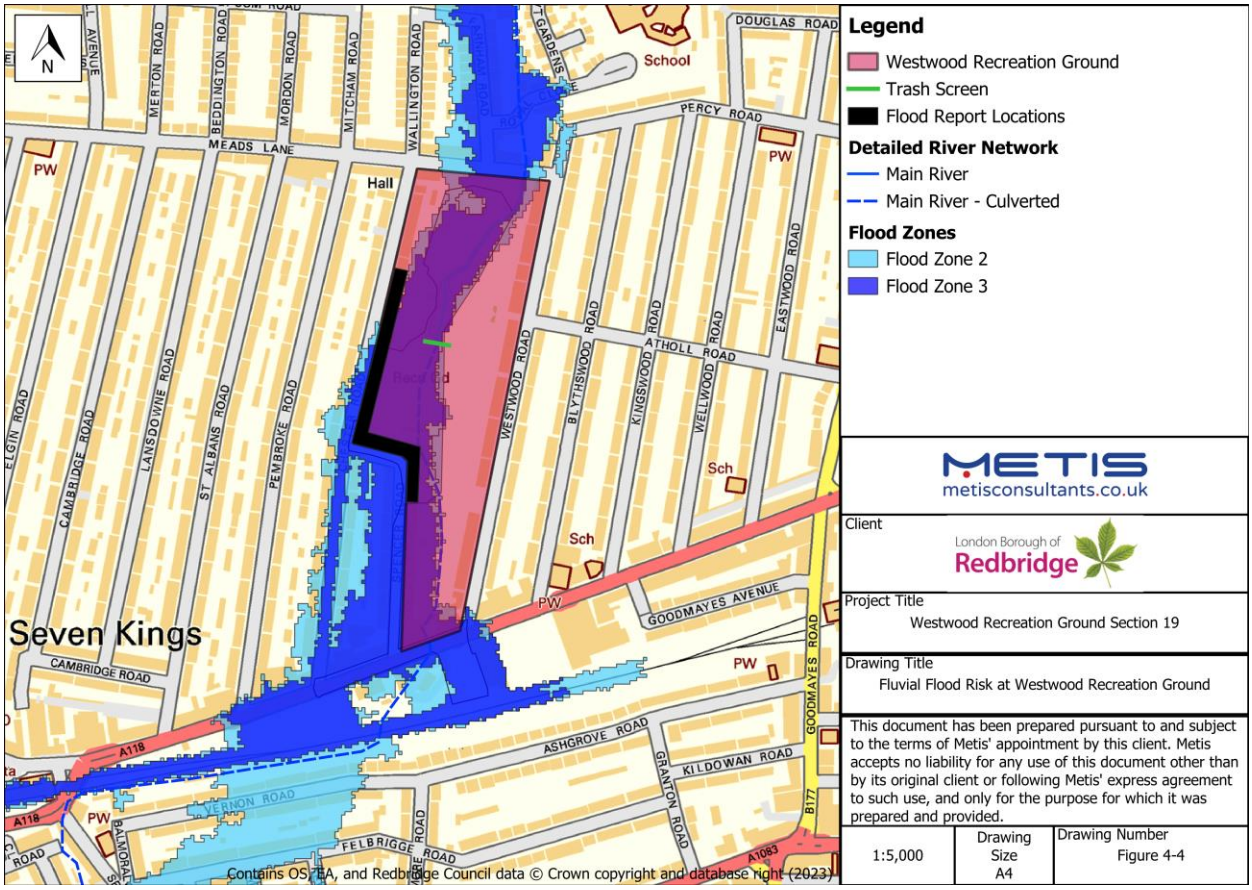

Figure 4-4 Fluvial flood risk zones of the Westwood Recreation Ground area

There were several reports of the trash screen being blocked as a result of flood waters carrying additional debris, detritus, branches and leaves from further upstream to the trash screen, and the watercourse within the recreation ground overtopping its banks. The majority of the flooding occurred beyond the trash screen, which indicates that the water had overtopped the banks of Seven Kings Water and flowed into the low-lying area beyond the trash screen. This is consistent with historical flooding events at Westwood Recreation Ground, which have also been due to fluvial flooding from this watercourse. Therefore, it can be concluded that the fluvial flooding was most likely the main cause of the flooding incident on 17th November 2022.

The low return period of the event (greater than 20% annual exceedance probability) corroborates the accounts of the trash screen being blocked as a result of debris carried by flood water. The blocked trash screen would have reduced the hydraulic capacity of the watercourse, which explains the scale of the flooding that occurred during a lower return period rainfall event. Once the trash screen was cleared, flood levels were observed to recede.

4.3.4 Groundwater flood risk

Groundwater flooding occurs when prolonged rainfall causes the groundwater table to rise. If the groundwater table is too high, surface water is no longer able to infiltrate into the ground, causing flooding. In extreme circumstances, flooding can be caused by groundwater emerging directly from the ground. An area's risk of groundwater flooding is closely tied to the ground composition and presence of aquifers.

Based on the EA's Areas Susceptible to Groundwater Flooding data, Westwood Recreation Ground lies within the greater than or equal to 75% risk class (*Figure 4-5*).

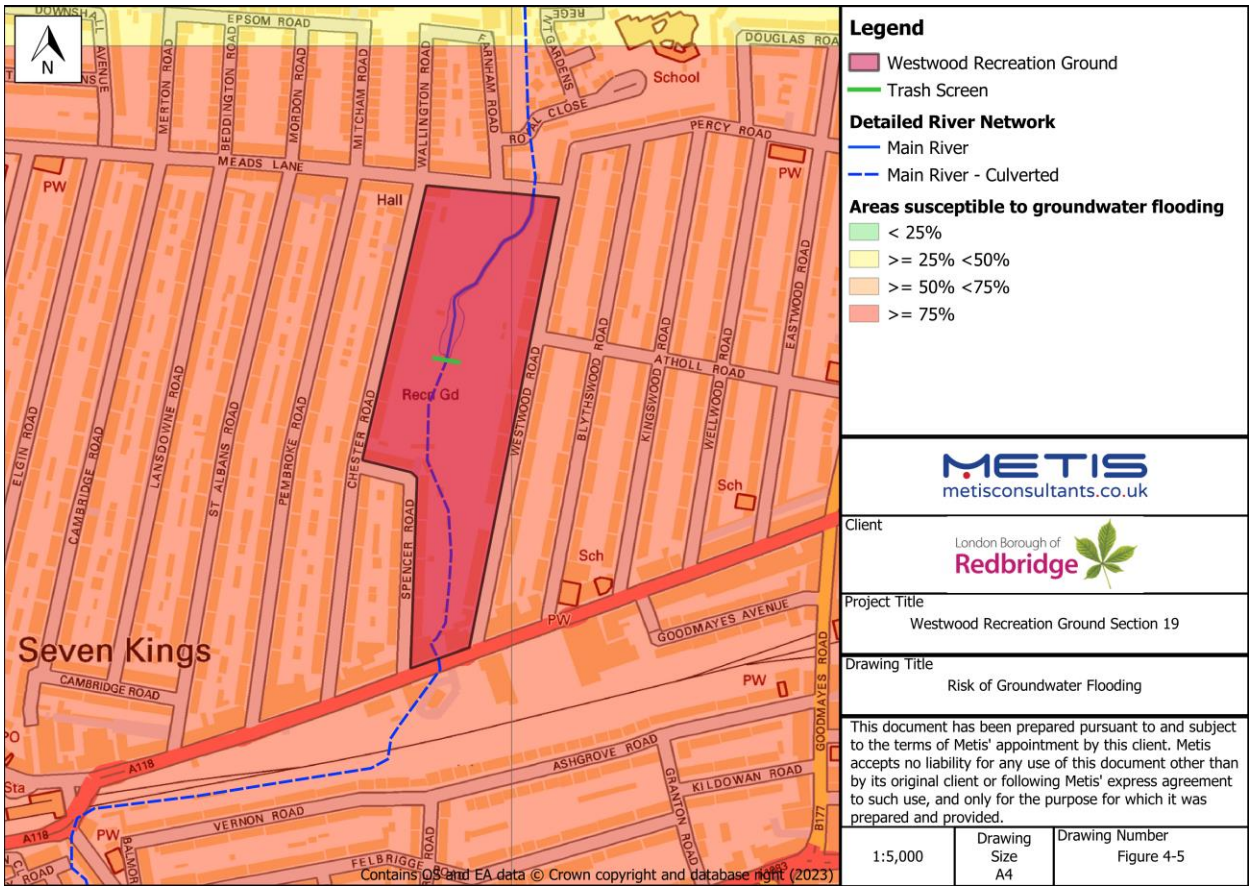

Figure 4-5 Groundwater flood risk zones of the Westwood Recreation Ground area

Although the flood reports do not mention groundwater as a source of the flooding, a high groundwater table could have exacerbated the effects of flooding, as this would have significantly decreased the rate of infiltration of surface water.

4.3.5 Sewer flood risk

Sewer flooding can occur when the volume of rainfall exceeds the design capacity of the sewer system, resulting in the system surcharging and flooding the area. A blockage in the sewer system downstream can also cause water to back up within the network, causing flooding.

Surface water sewers run north to south down both Chester Road and Spencer Road, and feed into a sewer running east to west along the A118, to the south of Westwood Recreation Ground (See *Figure 4-1*). This sewer then connects to the culverted watercourse, just beyond High Road. There

were no reports of sewer flooding during the 17th November 2022 flood event. However, it was noted by Redbridge officers that the water level in a manhole chamber on Spencer Road was very high, suggesting a partial blockage. This has been reported to TWUL. Although there were no reports of sewer flooding during this incident, there is still a risk that this sewer network could become overwhelmed and cause flooding in future incidents. There is also a risk of the culverted watercourse backing up into the sewer system and causing sewer flooding in the area.

4.3.6 Flood risk from other sources

The EA's Risk of Flooding from Reservoirs map shows that Westwood Recreation Ground lies within the predicted reservoir flooding extent of the Hainault Forest Lake Reservoir, 5km north-east of the site. Westwood Recreation Ground is therefore at risk of flooding from reservoirs, however no reservoir flood incidents occurred at the time of the 17th November flood event. It is therefore unlikely that this flood event can be attributed to reservoir flood sources.

4.4 Summary of Flooding Sources

Through analysis of each different flood mechanism, it can be concluded that the main cause of the flooding on the 17th November 2022 was likely to be fluvial. The watercourse within Westwood Recreation Ground exceeded its hydraulic capacity and overtopped its banks, causing flooding to the recreation ground and surrounding properties. The blocked trash screen due to flood waters carrying additional debris, detritus, branches and leaves from further upstream exacerbated the severity of the flooding by reducing the capacity of the culverted watercourse.

There were no reports of groundwater flooding during the event, however the area is at high risk of groundwater flooding, indicating a high groundwater table. The high groundwater table would have reduced the infiltration capacity of the recreation ground, increasing the impact of the fluvial flooding. Although there were no reports of sewer flooding, capacity issues or a blockage in the sewer system cannot be ruled out as contributor to the flooding event on the 17th November.

4.5 Actions Taken by Relevant RMAs (and other stakeholders affected)

The actions taken by relevant RMAs before, during, and after the flooding event on the 17th November are summarised in *Table 4-1*.

Table 4.1 RMA actions before, during, and after 17th November 2022 flood event

Authority	Authority Contributing Action to Flooding Incident
Redbridge	***Before:*** A previous Section 19 investigation was completed following the flood event in 2016 (*Appendix 2*). Following on from the 2016 Section 19 investigation's recommendations, Redbridge completed modelling on the hydrological flows within Westwood Recreation Ground, and potential flood alleviation measures to alleviate flood risk. Following this modelling and option appraisal work, Redbridge applied for national government funding for flood alleviation schemes within the ground. However, none of the potential mitigation measures met the national government funding requirement, due to a low cost-benefit ratio. The culvert and trash screen were cleaned on the 15th October 2022.
	During: Redbridge officers visited the site at approximately 09:20 to assess the situation. The water levels were deemed too high for contractors to safely unblock the trash screen. Pumps were ordered and water was pumped out of the recreation ground from the 17th until the 20th November. Redbridge officers were on site to help residents who had been affected by flooding, assessing accommodation and welfare needs.
	After: Tree removal was undertaken around the trash screen, and the pond was desilted. The frequency of cleaning of debris and rubbish from the trash screen and grounds was immediately increased from monthly to fortnightly, specifically during the autumn and early winter months when there is increased foliage and debris risk. Three river flood sensors were purchased and installed, to provide warning of river height increases both upstream and at the trash screen. Plans have been made to increase the height of the bund around the park to increase the protection of the surrounding properties. Discussions have also been had around reducing the hardstanding areas to improve infiltration. In addition to these works, an environmental improvement scheme is being developed in partnership with Redbridge and the Greater London Authority. Redbridge have hosted several flooding roadshows in flooding hotspot areas across the borough. A flooding roadshow was held at Westwood Recreation Ground on Tuesday 6th June 2023, where Redbridge presented their planned works for the recreation ground, before the session opened for discussion, providing residents with an opportunity to ask questions about the planned works and raise any other queries or concerns. This also coincided with the public consultation period of Redbridge's new LFRMS.

Authority	Authority Contributing Action to Flooding Incident
EA	***Before:*** A low-risk Flood Guidance Statement was issued at 10:30 on the 16th November. A flood alert for the Middle River Roding area was raised at 14:00 on the 17th November, and this alert remained in place until the 20th November.
	During: A Field Team attended the site during their flood rota and attempted to clear the trash screen, however, they were unable to completely clear it due to health and safety concerns.
	After: Community Information Officers and a drone operator attended the site to record flood extent and flooded property data. EA officers attended the flooding roadshow held at Westwood Recreation Ground on the 6th June 2023. The EA has been in discussion with Redbridge around the plans to raise the height of the bund around the park. The EA has introduced a new flood warning system in the Westwood Recreation Ground area, which residents can sign up to.
TWUL	***Before:*** No known actions taken
	During: No known actions taken
	After: No known actions taken
LFB	***Before:*** No known actions taken
	During: The LFB reported flooding along Spencer Road, Westwood Road and Chester Road and requested attendance from the EA.
	After: No known actions taken

5 Conclusions and Recommendations

5.1 Conclusions

This Section 19 flood risk investigation for Westwood Recreation Ground was triggered after a flood event on November 17th 2022, which resulted in the internal and external flooding of multiple properties surrounding the recreation ground. Rainfall began in the early morning on the 16th November and peaked in the early hours of the 17th November. This investigation assesses hydrological catchment and the source of flooding, as well as providing a summary of the actions taken by the relevant RMAs before, during, and after the flood event.

The data collection and investigation has established that the site is at risk from groundwater, surface water, fluvial flooding, and artificial sources. Based on the flooding reports, the return period of this event, and the historic flooding incidents at this site, it was established that this flood event was likely to be caused by fluvial flooding. The watercourse within Westwood Recreation Ground exceeded its hydrological capacity and overtopped its banks. The trash screen within Westwood Recreation Ground, at the point where the watercourse enters a culverted system, was also reported to be blocked. This exacerbated the fluvial flooding within the site.

In order to reduce the risk of another flood incident occurring in Westwood Recreation Ground, several short, medium, and long-term recommendations have been proposed. These are outlined in *Section 5.2.*

5.2 Recommendations

Recommendations for the short term are as follows:

- Redbridge should maintain the increased frequency with which the trash screen is cleared, especially in times of increased flood risk such as autumn, where increased leaf debris could block the trash screen, and winter, where increased rainfall and a higher groundwater table may reduce infiltration capacity.
- Redbridge should ensure there is an adequate maintenance schedule in place for the pond upstream of the trash screen, to ensure that silt build up is minimised and any major blockages are removed.
- Redbridge should increase site monitoring and enforcement of fly tipping in area, to decrease the quantity of debris such as tyres and mattresses ending up in the watercourse.
- Redbridge should follow up with TWUL on how the investigations into the sewer network blockage on Spencer Road are progressing.
- The EA should continue publicising the new flood warning system covering the area and encourage residents to sign up to this service.
- Increased public awareness of flooding should be further promoted between Redbridge, the EA, and the residents. Residents should be aware of who to contact in the event of a flood, as well as the resources available and measures they can take themselves to mitigate flood risk.

Recommendations for the medium term are as follows:

- Redbridge and the EA should continue to work together and identify the potential for and invest in flood alleviation schemes within the recreation ground and / or across the wider catchment. For example, removing the concrete basketball court to increase the permeable area within the recreation ground, and increasing the height of the bund downstream of the trash screen.
- Redbridge should seek to introduce sustainable drainage system (SuDS) features throughout the catchment, to provide resilience and decrease the pressure on the watercourse in flood events.

Recommendations for the long term are as follows:

- Redbridge and the EA should investigate options to renaturalise Seven Kings Water within the recreation ground, and in doing so increase the hydrological capacity of the watercourse. The watercourse is currently confined to a rectangular concrete channel through most of the recreation ground and culverted underneath the southern section. Renaturalising this watercourse by deculverting the southern section, extending the banks, and incorporating aquatic vegetation would increase the resilience of the watercourse as well as adding amenity value to the recreation ground.

APPENDICES

Appendix 1 – Rainfall Return Period Estimations

Appendix 2 – 2016 Westwood Recreation Ground Section 19 Flood Investigation