Lincoln Drive Section 19 Flood Investigation Report

Final Report

June 2025

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This report describes work commissioned by Wigan Council, by an instruction dated 14 January 2025. The Client's representative for the contract was Laura Morrison of Wigan Council. Elsa Holm and Helen Dawson of JBA Consulting carried out this work.

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Acknowledgements

We would like to acknowledge the assistance of Wigan Council, the Environment Agency, United Utilities, and local residents.

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Abbreviations

AGMA	Association of Greater Manchester Authorities
CIO	Chief Information Officers
CSO	Combined Sewer Overflow
DDF	Depth Duration Frequency
Defra	Department for Environment, Food, and Rural Affairs
FEH	Flood Estimation Handbook
GMRF	Greater Manchester Resilience Forum
JBA	Jeremy Benn Associates
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LRF	Local Resilience Forum
mALD	Metres Above Local Datum
mAOD	Metres Above Ordnance Datum
MP	Member of Parliament
NFM	Natural Flood Management
NHS	National Health Service
PFR	Property Flood Resilience
POT	Peaks Over a Threshold
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water

Definitions

Annual probability: The chance that a flood event of the specified magnitude or larger will occur in any given year.

Combined sewer system: A type of drainage system where both wastewater (sewage) and stormwater (rainwater runoff) are collected and conveyed through the same pipes to a sewage treatment plant.

Combined Sewer Overflow (CSO): When untreated or partially treated combined wastewater discharges from an outfall directly into a watercourse. They were developed as overflow valves to reduce the risk of sewage backing up during heavy rainfall.

Culvert: Where a watercourse flows through a pipe, often underground.

Flap valve: Hinged valve placed on a pipe outlet into a river. Stays open during normal flow but closes when it is submerged, to prevent flow from backing up the pipe.

Flood defence: Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific Standard of Protection.

Foul sewer: The underground pipe system that carries wastewater, including sewage and greywater, from homes and businesses to a sewage treatment plant for treatment.

Groundwater: All water which is below the surface of the ground and in direct contact with the ground or subsoil (as defined in the Flood and Water Management Act 2010).

Gully: A drainage point, typically covered by a metal grate, located at the side of the road to collect and remove excess water from the highway, directing it into the surface water sewer or other drainage systems.

Lead Local Flood Authority (LLFA): As either the unitary authority or the County Council for the area, leads on managing local sources of flood risk.

Main river: A watercourse shown as such on the statutory main river map held by the Environment Agency. They are usually the larger rivers and streams. The Environment Agency has permissive powers (not duties) to carry out maintenance and improvement works on main rivers.

Ordinary watercourse: Any river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows but which does not form part of a main river. The local authority or Internal Drainage Board has permissive powers (not duties) on ordinary watercourses.

Risk Management Authority (RMA): The Environment Agency; a Lead Local Flood Authority; a District Council in an area where there is no unitary authority; an internal drainage board; a water company and a highway authority.

Risk: In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.

Stakeholder: A person or organisation affected by the problem or solution or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.

Surface water sewer: A system designed to collect and channel rainwater and other uncontaminated surface runoff, typically from properties, roads, and pavements. The system directs the water to a stream, river, soakaway, or a combined sewer.

Executive Summary

Background

Lincoln Drive was impacted by the widespread flooding which occurred in the North West of England on 1 January 2025. The area was also previously impacted by flooding on other occasions, most recently on 30 September 2024. It is Wigan Council's statutory duty as Lead Local Flood Authority (LLFA) to investigate the flooding in the Lincoln Drive area, as set out under Section 19 of the Flood and Water Management Act 2010 (legislation.gov.uk). Wigan Council has appointed JBA Consulting to undertake this investigation on its behalf.

Stakeholder engagement

As part of the Section 19 flood investigation, multiple local stakeholders were engaged in Lincoln Drive. These stakeholders included residents, Local Resilience Forums (LRFs), and Risk Management Authorities (RMAs). This reinforced the partnership working group which has been in place since the flood event. The objectives of the engagement were to:

- gather evidence and data to aid the understanding of the investigation;
- involve the community in the investigation; and
- review the flooding mechanisms and recommendations with RMAs and operational partners.

For further information see Section 1.3.

Study area

The Lincoln Drive study area for this Section 19 flood investigation is located on the eastern outskirts of the town Ashton-in-Makerfield. Lincoln Drive lies approximately 6.5km south of Wigan and is in Greater Manchester, close to the western boundary.

For further information see Section 1.4.

Flood risk understanding

Fluvial flood risk: According to the Environment Agency's 'Check the long term flood risk' (gov.uk), a small area of the rural land southwest of Chester Drive, and east of Blenheim Road, is at high risk of fluvial flooding. The medium risk extent covers a slightly greater area of this land, plus a few properties along the northeast of Monmouth Crescent adjacent to the Millingford Brook, Princess Road pumping station, part of the woodland area north of the brook, and a number of houses on Lincoln Drive east of the woodland.

A greater number of properties on Monmouth Crescent and a much larger area of the woodland to the northwest of the study area is at low risk of fluvial flooding. This area of low flood risk extends across Lincoln Drive, northwest of the bridge, and up to Norwich Avenue, encompassing Ripon Drive and Chester Drive. Compared to the high and medium risk extents, a larger area downstream of Lincoln Drive is in the low risk category.

Surface water flood risk: The Environment Agency's Risk of Flooding from Surface Water (RoFSW) (environment.data.gov.uk) data shows that there are several areas of surface water pooling across the study area in the 3.3% and 1% annual probability events, which

extend to a flow path in the 0.1% annual probability event. These flood extents include the woodland area in the northwest, parts of Lincoln Drive, Ripon Drive, and Ashton Heath. There are also isolated areas of ponding north of Tintern Avenue, Norwich Avenue, and Blenheim Road.

Groundwater flood risk: No groundwater flooding data was available for this Section 19 flood investigation, and there have not been any reports of groundwater emergence in the study area.

Historic flooding: This report has a record of four flood events impacting the area since 2002.

For further information see Section 3.

Hydrometric summary of the event

Antecedent conditions in the weeks and days leading up to the 1 January 2025 event were not particularly unusual. This points to the rainstorm event itself being the main driver of the observed flooding in the Lincoln Drive area. The double-peak nature of the rainstorm and its long duration were the combined main drivers of high fluvial flows. The first peak (around 10mm - 20mm) likely reduced soil storage in the catchment. The immediate occurrence of the second larger peak (30mm - 40mm) was therefore exacerbated by this initial peak. Applying standard Flood Estimation Handbook (FEH) methods to the rainfall data generates an annual probability of surface water flooding between 6% to 10%.

The derived result for fluvial flooding is less certain. River flows can be estimated at the Ivy Street gauge using a rating curve, but this rating is not reliable in high-flow conditions. As far as can be determined, there are no past high flow spot gauging records to provide any confidence in this rating in high-flow conditions. The rating is also not currently used for operational flood warning purposes. Flows from this rating are therefore not suitable for analysis in this study.

For further information see Section 5.

South-pathway-receptor analysis

The sources, pathways, and receptors of flooding were as follows:

- **sources** - extreme rainfall and the high water level in the Millingford Brook.
- **pathways** - the Millingford Brook overtopping followed by overland fluvial and surface flows. Pathways also included the backing up of the drainage network through the surface water sewer, combined sewer, and a culverted ordinary watercourse.
- **receptors** - confirmed internal flooding of at least 37 residential properties, resident's financial losses and displacement, negative impacts on mental health.

For further information, including mapping and photos of the sources, pathways, and receptors, see Section 6.

Incident response

Several agencies and authorities responded to the flood event in Lincoln Drive, including Wigan Council, the Environment Agency, United Utilities, Electricity North West, and Greater Manchester Fire and Rescue Service.

For further information, including a timeline of incident response, see Section 7.

Recommendations

The flood event in Lincoln Drive occurred as a result of a series of interacting flooding mechanisms and is not the result of a single source of flood risk. A number of recommended actions for the RMAs and wider organisations have been made in Section 8. These focus on partnership working to address the interacting flood risk mechanisms, rather than addressing different sources in isolation.

1 Introduction

1.1 Background to the investigation

Lincoln Drive was impacted by the widespread flooding which occurred in the North West of England on 1 January 2025. The area was also previously impacted by flooding on other occasions, most recently on 30 September 2024. It is Wigan Council's statutory duty as Lead Local Flood Authority (LLFA) to investigate the flooding in the Lincoln Drive area, as set out under Section 19 of the Flood and Water Management Act 2010 (legislation.gov.uk).

Section 19 states that:

- "(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers necessary or appropriate, investigate:
  (a) Which risk management authorities have relevant flood risk management functions, and
  (b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
- (2) Where an authority carried out an investigation under subsection (1) it must –
  (a) Publish the results of its investigation, and
  (b) Notify any relevant risk management authorities."

Wigan Council has outlined its criteria for undertaking a Section 19 flood investigation on their website and in the Association of Greater Manchester Authorities (AGMA) Policy for Investigating Flood Incidents (wigan.gov.uk). Definitions of a 'significant' flood event that would prompt a flood investigation are based on the following criteria:

- risk to life;
- weight of public, media, political and planning interest;
- impact on critical services;
- impact to either 5 or more residential buildings or 2 or more commercial properties;
- economic disruption;
- impact on critical infrastructure and installations; and
- frequency of flooding.

The flooding that occurred in the Lincoln Drive area on 1 January 2025 was deemed a significant event by Wigan Council, triggering an inquiry. Wigan Council has appointed JBA Consulting to undertake this investigation on its behalf.

Following feedback from the community, the occurrence of two flood events in four months was emphasised as particularly important for the flood investigation. Therefore, this report also includes details on the flood mechanisms and the incident response from 30 September 2024, sourced from an investigation conducted by Wigan Council (Section 3.2.1). The report also includes a hydrometric analysis of both events (Section 5). This is

not intended to be a separate investigation, but rather to provide context and a basis for comparison with the flooding that occurred 1 January 2025.

1.2 Data collection

A wide range of data has been collected and analysed to inform the Section 19 flood investigation. This has been used to understand the causes of flooding and establish the context of the area, and includes the following:

- open-source data from GOV.UK;
- residents' questionnaires;
- photographs from the site visit showing flood sources, pathways, and receptors;
- hydrometric data;
- information from Risk Management Authorities (RMAs) on drainage infrastructure; and
- other data such as photographs, videos, newspaper articles, and notes from the events.

1.3 Stakeholder engagement

As part of the Section 19 flood investigation, multiple local stakeholders were engaged in Lincoln Drive. These stakeholders included residents, Local Resilience Forums (LRFs), and RMAs. This reinforced the partnership working group which has been in place since the flood event. The objectives of engagement are to:

- gather evidence and data to aid the understanding of the investigation;
- involve the community in the investigation; and
- review the flooding mechanisms and recommendations with RMAs and operational partners.

A list of key stakeholders and how they were engaged is provided in inform: provide information;

- **consult:** receive, listen, understand and feedback;
- **involve:** decide together;
- **collaborate:** act together; and
- **empower:** support independent action.

Table 1-1, based on the following categories of engagement:

- **inform:** provide information;
- **consult:** receive, listen, understand and feedback;
- **involve:** decide together;
- **collaborate:** act together; and
- **empower:** support independent action.

Table 1-1: Key stakeholders.

Role	Organisation	Stakeholder engagement	Engagement details
LLFA	Wigan Council	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, online survey distribution, correspondence, public engagement meeting.
Residents	N/A	Consult/ Empower	Site visit, online questionnaire, correspondence.
Water and sewerage company	United Utilities	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, correspondence, data provision.
Environment Agency	Environment Agency	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, correspondence, data provision.
Charitable Trust	Canal and River Trust	Consult	Correspondence, data provision.
Resilience Forum	Wigan Borough Resilience Forum	Consult	Correspondence, data provision.
Resilience Forum	Greater Manchester Resilience Forum	Consult	Correspondence, data provision.
Emergency Services	Greater Manchester Fire & Rescue Service	Consult	Correspondence, data provision.
Emergency Services	North West Ambulance Service	Consult	Correspondence.

1.4 Resident questionnaire

A Microsoft Forms questionnaire was distributed to residents in the Lincoln Drive area. The purpose of the questionnaire is to help Wigan Council gain insights into how the flooding affected the local community. 30 households provided responses. The questions addressed the following:

- flood source(s) and pathways;
- impact on properties (e.g. flood depths, water ingress routes);
- event timing;
- whether relocation was necessary;
- whether residents used Property Flood Resilience (PFR) measures and, if so, whether these were effective;
- response from authorities;
- experiences of previous flood events; and
- overall impacts (e.g., mental health, property damage).

2 Study area

2.1 Investigation extent

The Lincoln Drive study area is mapped in Figure 2-1, and is situated on the eastern outskirts of the town Ashton-in-Makerfield. Lincoln Drive lies approximately 6.5km south of Wigan and is in Greater Manchester, close to the western boundary. Urban areas lie to the west and north of the study area, while the east and south are characterised by more rural land. The study area is predominantly residential, with an area of woodland in the north and along the eastern boundary.

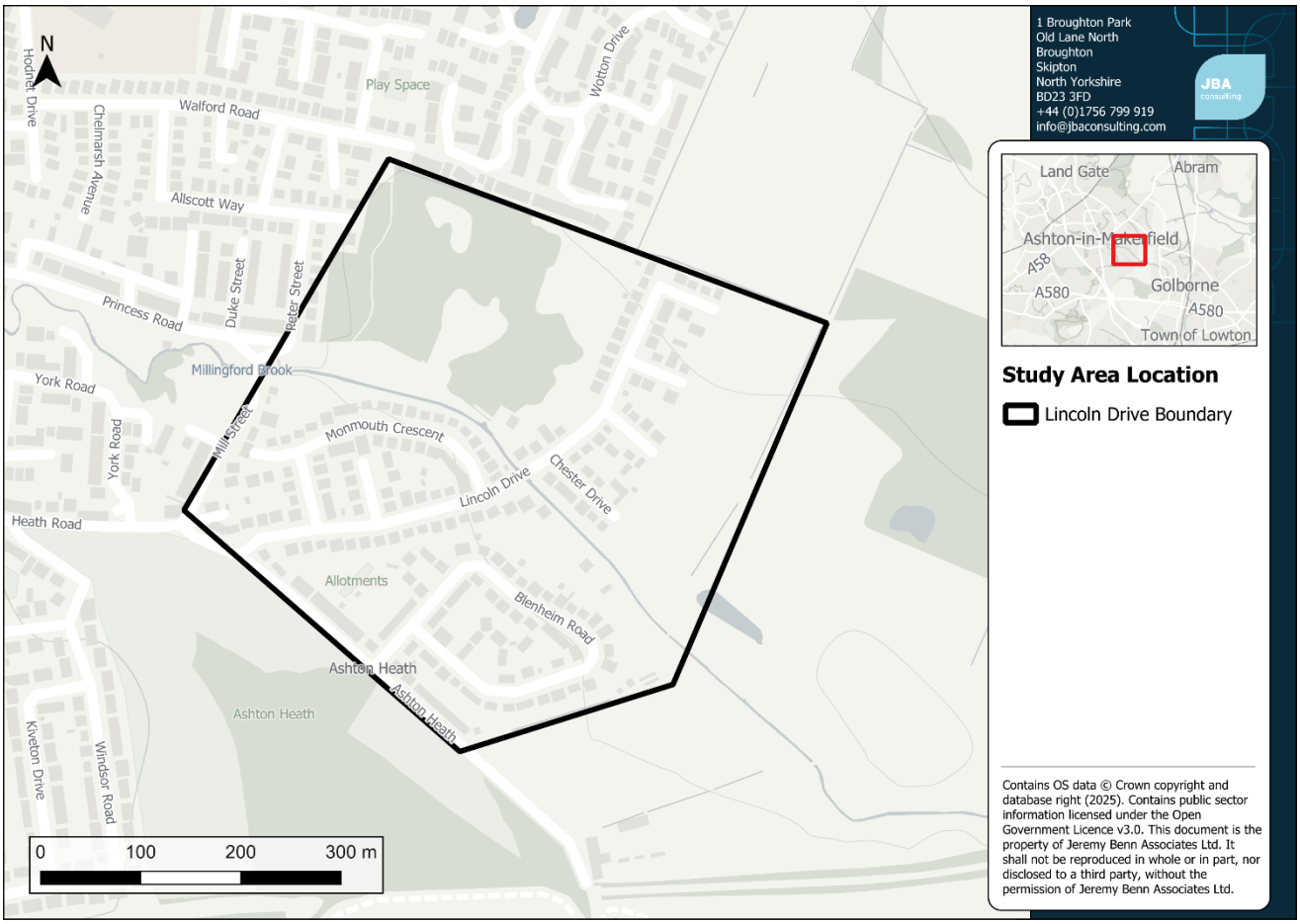


Figure 2-1: Lincoln Drive study area.

2.2 Topography

The Environment Agency's 1m resolution LiDAR shows that the topography of the Lincoln Drive area is generally low-lying, relative to the surrounding terrain. As shown in Figure 2-2, lower elevation areas are found across the north and southeast, with low points across the woodlands in the northwest, and by the eastern boundary. Parts of Monmouth Crescent, as well as Lincoln Drive and the adjoining streets north of the Millingford Brook, are also situated on lower ground. The lowest lying ground is associated with the Millingford Brook watercourse, which bisects the study area.

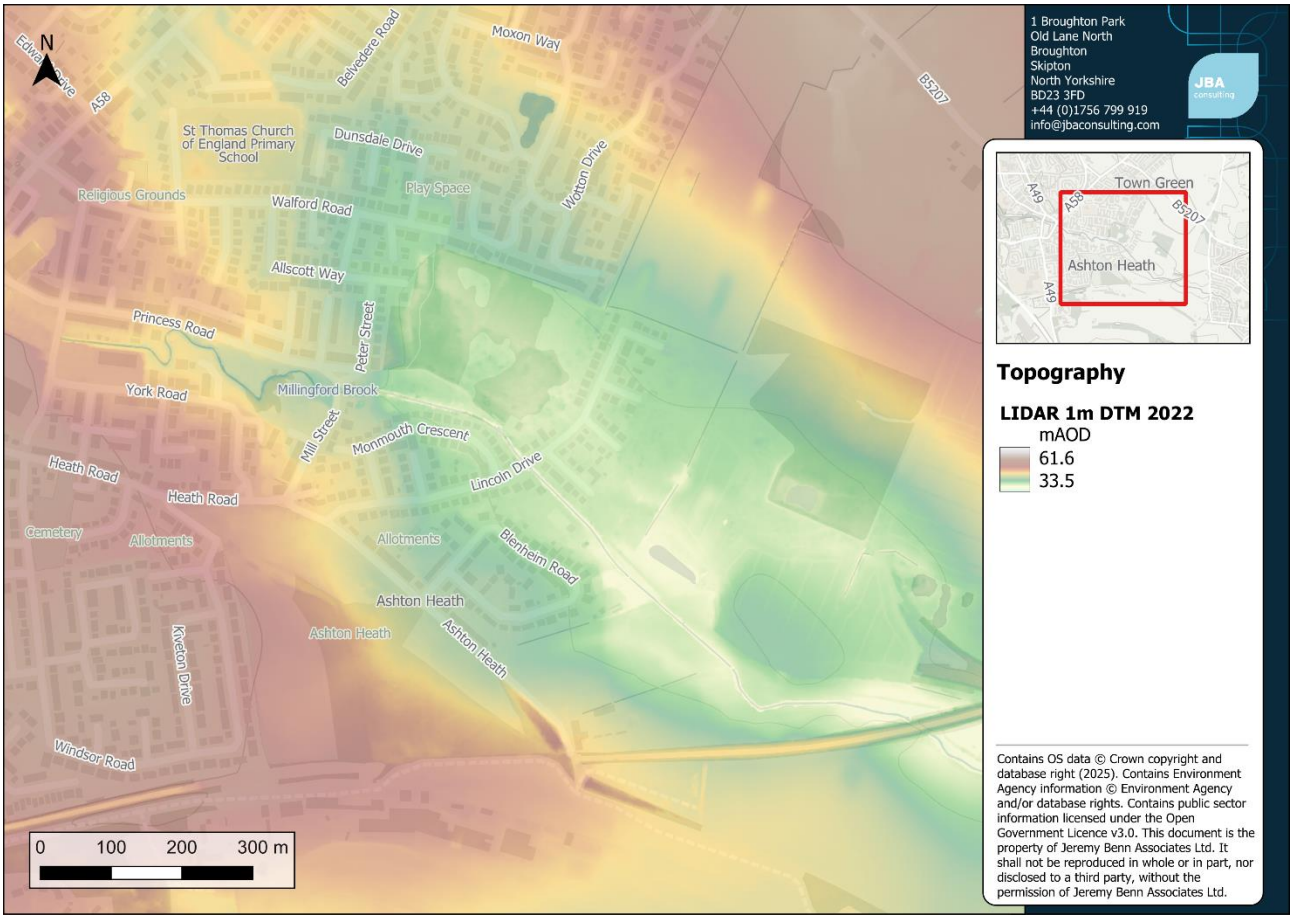


Figure 2-2: Topography of the Lincoln Drive study area.

2.3 Land cover and soils

The UK Soil Observatory Map (ukso.org) shows that soils across most of the study area are slowly permeable, which may limit infiltration rates of rainfall. However, given the urban nature of the catchment, it is likely that the amount of impermeable surfaces will have a greater impact on runoff rates than the underlying geology and soils.

2.4 Drainage system and river network

2.4.1 Watercourses

A watercourse can be any stream of water flowing in a defined channel, or through an underground pipe or culvert. In England there are two types of watercourses, 'main rivers' and 'ordinary watercourses'. Main rivers are designated by the Environment Agency and tend to be larger rivers and streams with the highest flood risk. However, in some cases main rivers can be small watercourses or drainage channels. All other watercourses are referred to as ordinary watercourses. There are different roles and responsibilities in relation to different types of watercourses, which are covered in Section 4.

Lincoln Drive has one main river, the Millingford Brook, which flows through the centre of the study area towards the southeast. The source of the Millingford Brook is northwest of

the study area and the catchment area upstream is 8.44 km^2. This main river continues flowing southwards and converges with the Sankey Brook south of Vulcan Village approximately 5.40km to the south of Lincoln Drive. There is also an unnamed culverted watercourse west of Lincoln Drive that flows south to the Millingford Brook.

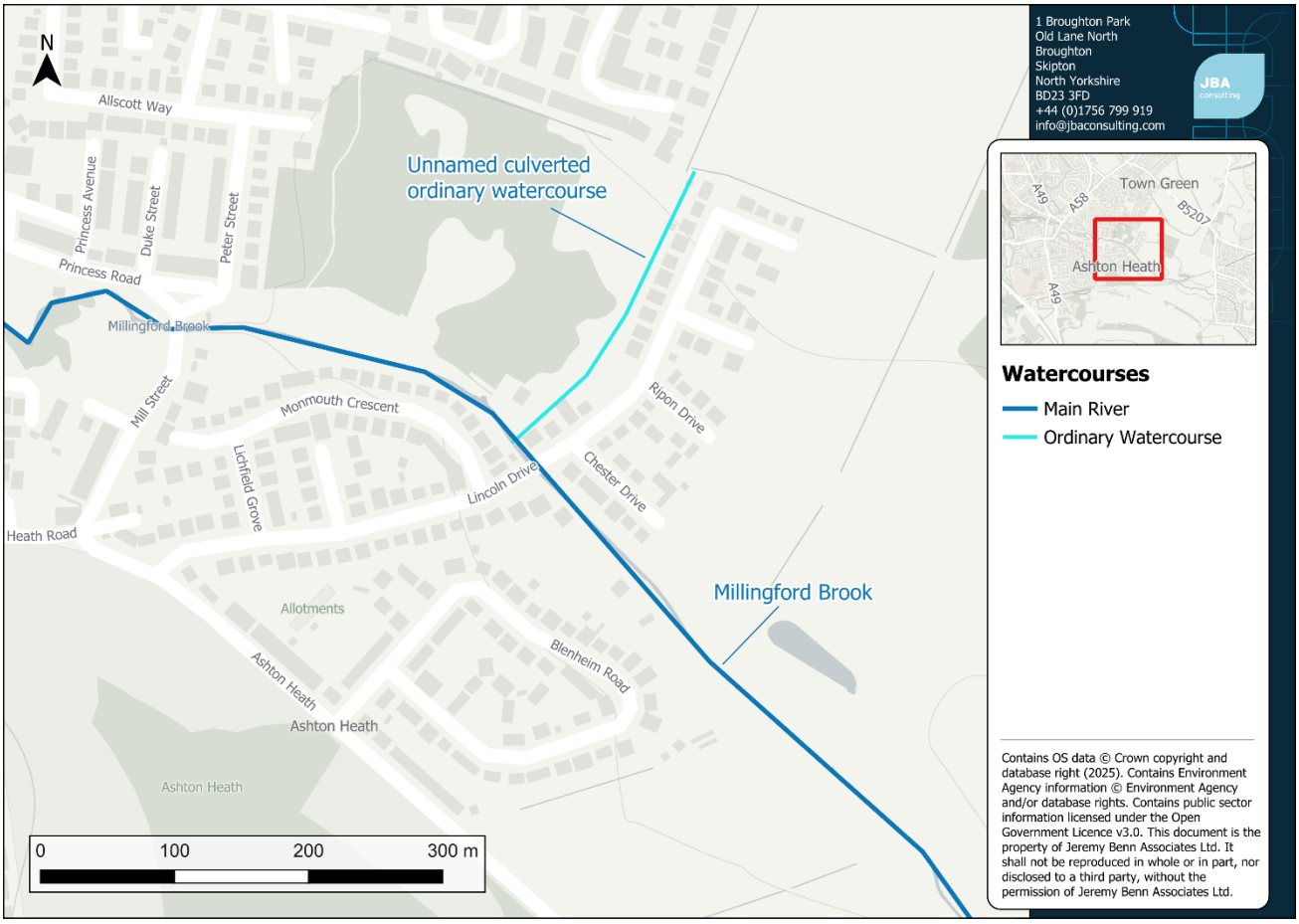


Figure 2-3: Main rivers and ordinary watercourses in Lincoln Drive.

In 2011, the Environment Agency spent just under £200,000 on improving their existing assets along the Millingford Brook. This included the installation of a 18m 1200x1500mm bypass box culvert underneath Lincoln Drive. The Environment Agency carry out inspections of the asset, but the maintenance and responsibility lies with Wigan Council. A redundant access bridge was also removed, as this was identified as an obstruction during periods of high flows.

2.4.2 Sewers

The United Utilities sewer network in the Lincoln Drive area is shown in Figure 2-4.

Two surface water sewers run along Lincoln Drive and outfall into the Millingford Brook by the bridge. On the north side of the brook, this surface water sewer flows from the north, and the residential streets (Tintern Avenue, Norwich Avenue, Ripon Drive, and Chester Drive) also feed into it. On the south side of the brook, the sewer flows northeast towards the watercourse. There is also a surface water sewer along Monmouth Crescent that flows into the Millingford Brook at an outfall higher upstream.

The foul sewers in the Lincoln Drive area connect into the combined sewers which run from the south and from the east, connecting into the Princess Road pumping station. This pumping station has a Combined Sewer Overflow (CSO) which discharges into the Millingford Brook. There is also a CSO located on the opposite bank of the Millingford Brook, at the back of Monmouth Crescent.

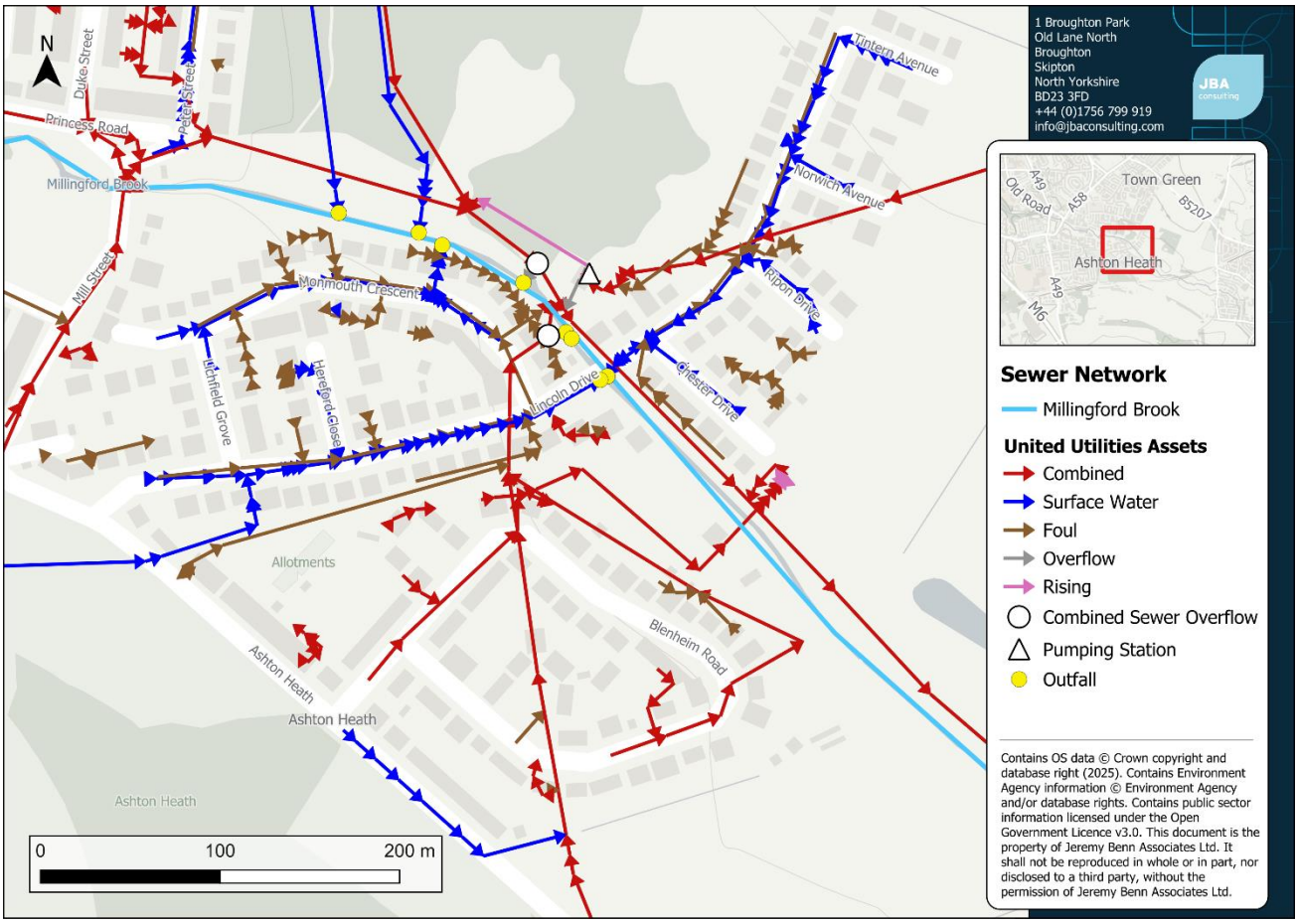


Figure 2-4: United Utilities sewer networks around Lincoln Drive.

2.4.3 Highway drainage

Roads across the study area are drained by a network of highway gullies which are maintained by Wigan Council Highways Department. These gullies are connected to the United Utilities surface water sewer network, which conveys water into Millingford Brook via an outfall underneath the bridge on Lincoln Drive.

There are two gullies on the turning circle located approximately 80m northeast of this bridge, on the western side of Lincoln Drive. These two gullies drain to a culverted watercourse which flows in a southwest direction under the properties on the north of Lincoln Drive, shown in Figure 2-3. This culverted watercourse discharges into the Millingford Brook a few metres upstream of the bridge on Lincoln Drive.

3 Flood risk understanding

3.1 Existing knowledge of flood risk sources

3.1.1 Fluvial flood risk

The Environment Agency's 'Check the long term flood risk' (gov.uk) can be used to understand the flood risk in an area. This shows the risk of flooding from rivers and sea, accounting for the presence and condition of flood defences, with the following probability of occurring in any given year:

- **high risk**: greater than a 3.3% annual probability;
- **medium risk**: between a 3.3% and 1.0% annual probability;
- **low risk**: between a 1.0% and 0.1% annual probability; and
- **very low risk**: less than 0.1% annual probability.

In the Lincoln Drive study area, the risk of fluvial flooding is from the Millingford Brook. As shown in Figure 3-1, a small area of the rural land southwest of Chester Drive, and east of Blenheim Road, is at high risk. The medium risk extent covers a slightly greater area of this land, plus a few properties along the northeast of Monmouth Crescent adjacent to the Millingford Brook, Princess Road pumping station, part of the woodland area north of the brook, and a number of houses on Lincoln Drive east of the woodland.

A greater number of properties on Monmouth Crescent and a much larger area of the woodland to the northwest of the study area is at low risk. This area of low flood risk extends across Lincoln Drive, northwest of the bridge, and up to Norwich Avenue, encompassing Ripon Drive and Chester Drive. Compared to the high and medium risk extents, a larger area downstream of Lincoln Drive is in the low risk category.

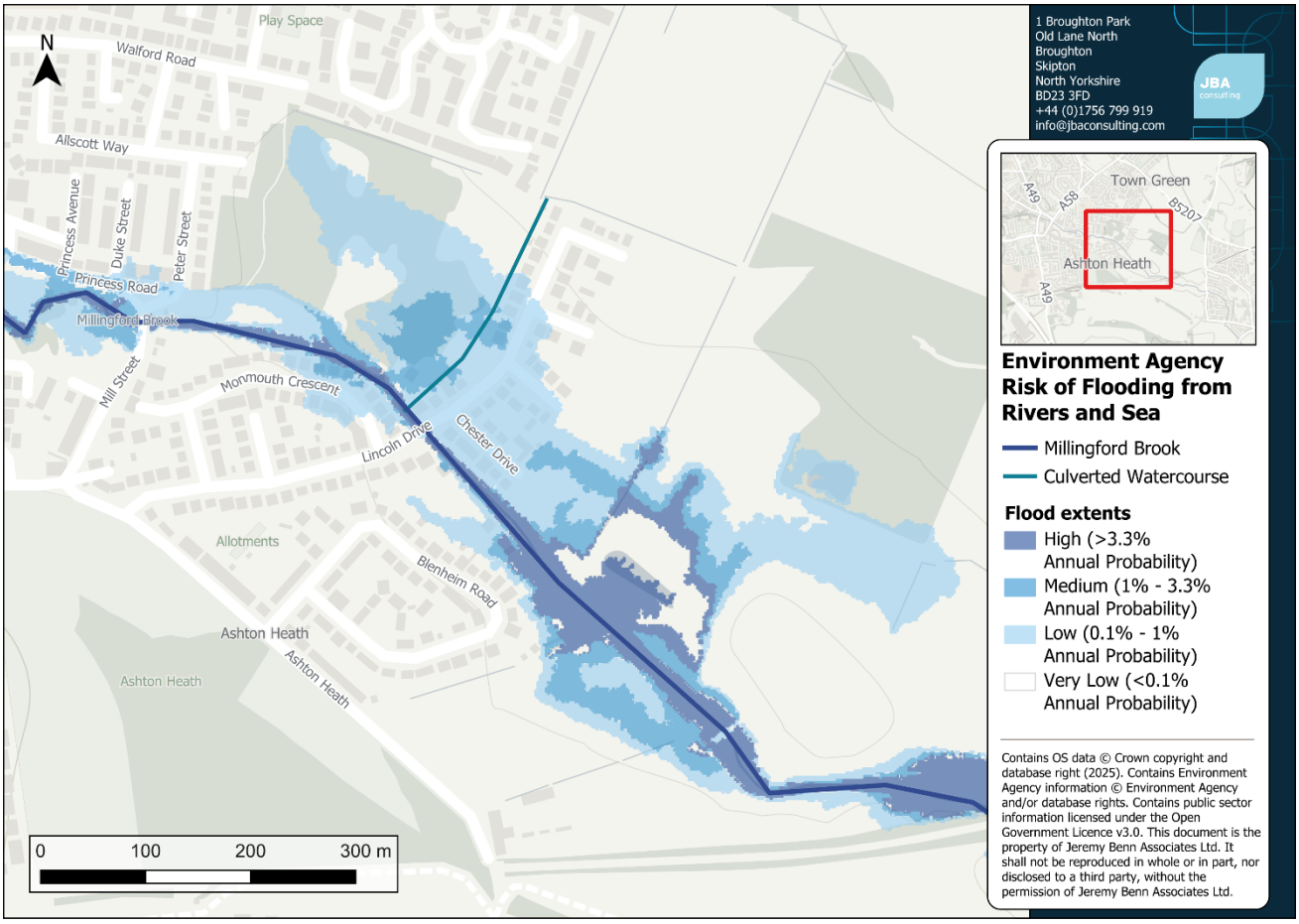


Figure 3-1: The Environment Agency's Risk of Flooding from Rivers and Sea mapping for the study area.

3.1.2 Surface water flood risk

Surface water flooding occurs when the volume and intensity of rainfall overwhelms local drainage systems. Surface water runoff often flows off hills and areas of higher ground, pooling in lower-lying flat areas and along roads and paths. The Risk of Flooding from Surface Water (RoFSW) data is national scale mapping showing the risk of flooding from surface water runoff, published by the Environment Agency. This can be viewed on the Environment Agency's 'Check the long term flood risk' (gov.uk) website. Figure 3-2 shows the areas at risk of flooding in response to rainfall events with the following probability of occurring in any given year:

- **high risk:** greater than a 3.3% annual probability;
- **medium risk:** between a 3.3% and 1.0% annual probability; and
- **low risk:** between a 1.0% and 0.1% annual probability.

In the 3.3% annual probability event, there are several areas of surface water ponding across the study area, particularly in the woodland area in the north. The flood extents in this event cover parts of Lincoln Drive and Ripon Drive in the north of the study area, and

Ashton Heath by the southern boundary. There are also isolated areas of ponding on properties north of Tintern Avenue, Norwich Avenue, and Blenheim Road.

In the 1% annual probability event, the extents increase in size, with new areas of ponding across several residential streets. In the 0.1% annual probability event, a flow path forms from the north of the study area through the woodland area and across Ripon and Chester Drive to the southeast boundary. In the 0.1% annual probability event, there is also flood risk along much of Ashton Heath, the western stretch of Blenheim Road, and covering the northern part of Lincoln Drive before it crosses the Millingford Brook.

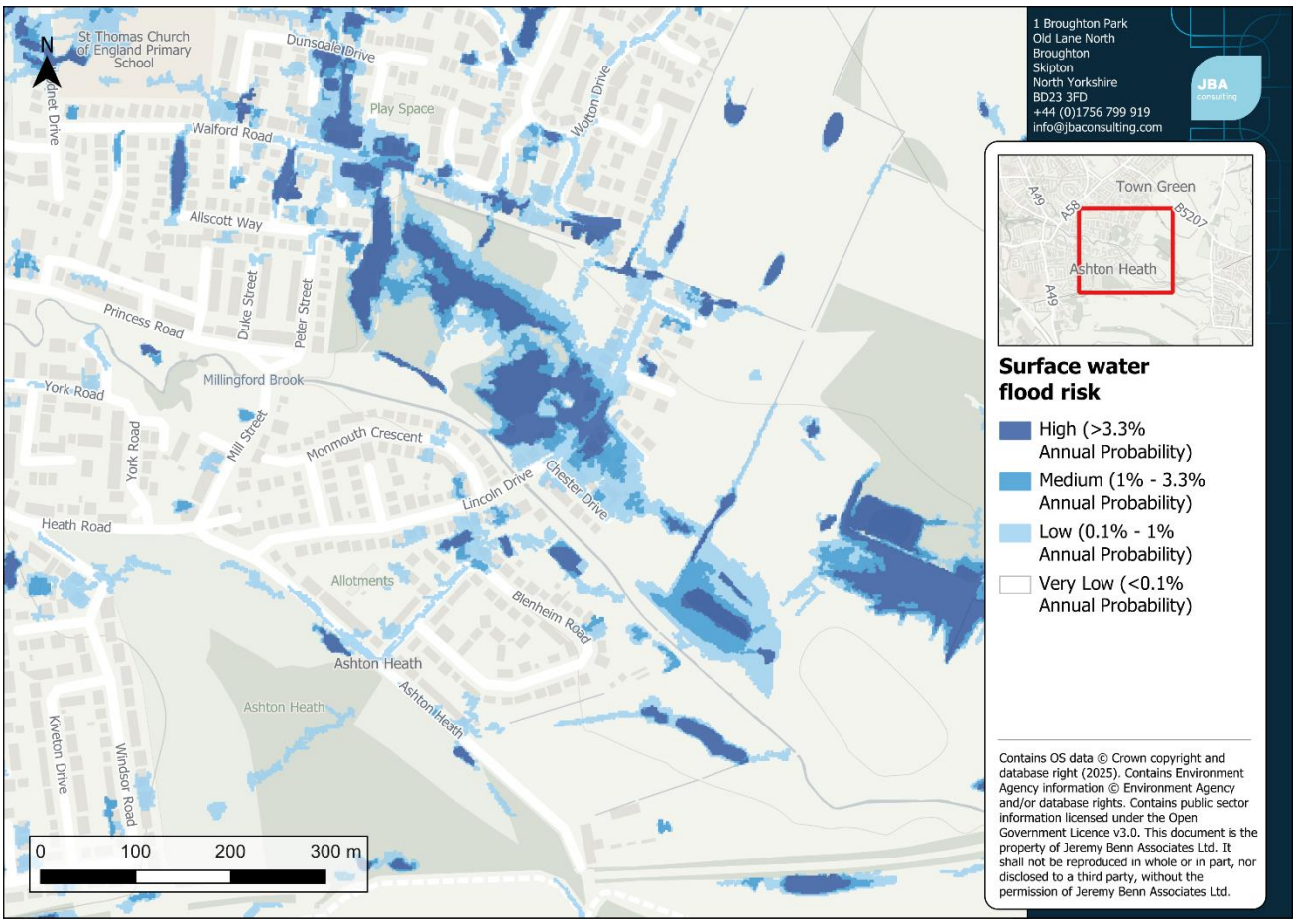


Figure 3-2: The Environment Agency's Risk of Flooding from Surface Water mapping for the study area.

3.1.3 Groundwater flood risk

Flooding from groundwater occurs when the water table within the underlying rock or soil rises above ground level or interacts with properties or infrastructure below ground level. Groundwater flood mapping has not been available for this Section 19 flood investigation, and there have not been any reports of groundwater emergence in the study area.

3.1.4 Sewer flood risk

Sewer flooding occurs when intense rainfall/river flooding overloads sewers (surface water or combined), which are not designed to accommodate these flows, and/or when sewers cannot discharge to watercourses due to high water levels. Sewer flooding can also be caused by blockages, collapses, equipment failure, or groundwater leaking into sewer pipes.

Since 1980, the Sewers for Adoption guidelines and subsequent Sewer Sector Guidance, mean that new surface water sewers have been designed to have capacity for a 3.3% annual probability rainfall event, although until recently this did not apply to smaller private systems. This means that the capacity of sewers can be exceeded in larger rainfall and flood events. These guidelines do not apply to sewers constructed prior to 1980, which includes those in Lincoln Drive, and therefore these sewers may have been designated to a lower capacity.

Details of the sewer system in the Lincoln Drive study area can be found in Section 2.4.2. United Utilities owns a pumping station to the west of Lincoln Drive which relies on electricity to function, which could lead to sewer flooding issues should it lose power.

There are several surface water sewers which outfall directly into Millingford Brook. During times of high flow in the watercourse, these outfalls can become submerged, limiting the rate at which they can discharge. This could lead to river water to backing up via the sewer system. Currently, a flap valve is installed on the larger (western) of the two surface water pipes. United Utilities is in the process of installing a flap valve to the other (eastern) surface water sewer. This will reduce the risk of the brook backing up the surface water sewers under the bridge.

3.2 Flood history

Table 3-1 details the known flood history in the Lincoln Drive area, since 2002. In addition to the events documented below, residents reported a number of near misses where the water receded just before entering their properties. 70% of residents who responded to the questionnaire answered that they had experienced flooding in the vicinity of their property, prior to 1 January 2025.

Table 3-1: Flood history for Lincoln Drive.

Date	Source of flooding	Description of impacts	Source of information
14 June 2002	Main River Overland flow (surface water runoff). Drains unable to cope/blocked.	Environment Agency's Recorded Flood Outlines dataset states the cause as the channel exceeding its capacity. Residents reported different sources, including the Millingford Brook overtopping, excess surface water flowing down from the fields, and drains being either blocked or	Environment Agency's Recorded Flood Outlines dataset. Questionnaire responses

Date	Source of flooding	Description of impacts	Source of information
		broken causing water to back up onto the streets. This event caused internal property flooding, with several houses fully surrounded and water entered from both the front and back. Ripon Drive, Lincoln Drive, and Chester Drive flooded. The Environment Agency data also says that stable blocks and gardens by the watercourse on Blenheim Road were affected. However, the exact extent and number of properties impacted are unknown.	from residents.
21 January 2008	Main River	Flooding from the Millingford Brook on Chester Drive, extent and impact unknown.	Environment Agency's Recorded Flood Outlines dataset.
30 September 2024	Overland flow (surface water runoff). Drains unable to cope/blocked.	Residents from Lincoln Drive reported highway flooding, which later in the evening resulted in five properties being internally flooded and a further eight being externally flooded. Although there is no evidence of flooding from the Millingford Brook overtopping, the water level was high during the event. This potentially led to the outfalls becoming submerged, leading to water being unable to discharge and backing up through the system. Residents noted surface water flooding from the gullies and manholes, and that the street was not draining.	Wigan Council. Questionnaire responses from residents.

Date	Source of flooding	Description of impacts	Source of information
16 October 2024	Overland flow (surface water runoff). Drains unable to cope/blocked.	Flooding was also reported following further heavy rainfall, but on this occasion no properties flooded internally. Residents reported that the grid was blocked, and the flood water was not draining away.	Wigan Council

3.2.1 Flood event on 30 September 2024

Following feedback from the community, the occurrence of two flood events in four months was emphasised as particularly important for the flood investigation. Therefore, this section includes information about what happened during the 30 September 2024 event. The report also includes a hydrometric analysis of this event (Section 5.2). This is not intended to be a separate investigation, but rather to provide context and a basis for comparison with the flooding that occurred 1 January 2025.

Wigan Council completed an investigation into the flood issues and responses during the 30 September 2024 flood event. This section presents the findings.

Timings and incident response

At 18:41 on 30 September 2024, residents reported a build-up of water in the street. They reported that gardens were underwater, and that the floodwater levels were rising and threatening to breach into the properties. Wigan Council first received a report of property flooding at 20:11. This report was received by Wigan Council's Single Point of Contact, Central Watch, who then contacted the Council's on-call Forward Incident Team to request attendance on site. The Forward Incident Officer arrived at Lincoln Drive at 20:47 and confirmed the properties affected, along with their initial thoughts on the cause of flooding following discussions with residents.

Following a request made by Forward Incident Officer, the Highways Team arrived at 22:05 to provide sandbags to residents. Residents began to protect their properties using sandbags, and some also created personal flood defences by digging up sections of garden. No Flood Warning from the Environment Agency, discussed further in Section 4.2.2, was issued for this event, as it did not reach the required level which is based on a gauge at Ivy Street.

Flooding causes

The residents noted overland flow coming from the open space to the west of Lincoln Drive. Although there was no fluvial flooding from the Millingford Brook overtopping, the water level was high. This high water level potentially led to the outfalls becoming submerged, meaning that the water was unable to discharge. It is likely this caused the water to back up

through the system, which then caused surface water flooding from surcharged gullies and manholes.

Site visits

There is also a culverted watercourse running adjacent to the properties, shown in Figure 2-3. Following a site walkover, there was no residual evidence that water had surcharged from this system.

Both the culverted watercourse and the public surface water sewer discharge directly into the Millingford Brook, as discussed earlier in Section 2.4. A site investigation, conducted by United Utilities on 17 October 2024, found that the outfall to the surface water sewer was clear of obstruction. However, it was entering at invert level. This outfall shown in Figure 3-3.

Figure 3-3: Photograph of outfall into the Millingford Brook from United Utilities' network.

The inspection found that the manhole prior to discharging to the Brook, was holding some siltation. Further works have been carried out to investigate, jet, and camera the surface water sewer and highlight any operational issues prior to its discharge into the Brook.

Whilst on site United Utilities also noted the culvert outfall was in a state of disrepair, see Figure 3-4. The culvert is owned by the Council's Corporate Land Management team who

are carrying out works to investigate the culvert and jet the system to check for any blockages or collapses.

Figure 3-4: Photograph of outfall of culverted watercourse.

3.3 Existing flood risk management activities

3.3.1 Existing defences

There are no formal flood defences in place along the Millingford Brook within the Lincoln Drive study area.

3.3.2 Property Flood Resilience

PFR includes a range of measures, such as flood barriers and automatically closing airbricks, that can be installed around the perimeter of a building to reduce the risk of internal flooding. PFR can also be used within a building, to minimise damage if internal flooding stills occurs. PFR aims to help households and businesses reduce the damage caused by flooding, helping to speed up recovery and reoccupation.

3.3.3 Maintenance regimes

In the absence of any formal defences, the existing maintenance regimes consist of watercourse and surface water/sewer network maintenance. The frequency of gully cleansing may impact surface water flood risk as blocked gullies prevent water from entering the drainage network. Wigan Council maintain the highway gullies on Lincoln Drive on an annual cycle, while the ones on Ripon Drive and Chester Drive are maintained on a three-year cycle. They also undertake reactive maintenance following reports of issues.

4 Roles and responsibilities

For the purposes of this investigation, responsibilities for flood risk are divided into 'flood risk management' and 'emergency response'. Section 4.1 describes the roles of the agencies and authorities involved in flood risk management and Section 4.2 covers the roles and responsibilities for those involved in emergency response.

It should be noted that the following sections provide a high-level overview of the flood risk management roles and responsibilities that are relevant to this Section 19 Flood Investigation. They do not provide a comprehensive review of all roles and responsibilities.

4.1 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different RMAs as set out in the Flood and Water Management Act 2010 (gov.uk). The Flood and Water Management Act places a duty on all RMAs to co-operate with each other, act in a manner that is consistent with the National Flood and Coastal Erosion Risk Management Strategy for England (gov.uk) and the local flood risk management strategies developed by LLFAs, and exchange information.

The Flood and Water Management Act defines a "Flood risk management function" which are functions set out within the Act which may be exercised by an RMA for a purpose connected with flood risk management.

4.1.1 Environment Agency

The Environment Agency is sponsored by the Government's Department for Environment, Food & Rural Affairs (Defra), and is tasked with the protection and conservation of the water environment in England, the natural beauty of rivers and wetlands and the wildlife that lives there.

The Environment Agency's responsibilities include water quality and resources; fisheries; conservation and ecology; and operational responsibility for managing the risk of flooding from main rivers (usually large streams and rivers), reservoirs, estuaries and the sea.

The Environment Agency has powers to carry out maintenance of watercourses when it is affordable and in the public interest. This includes work to prevent environmental damage, or to restore conditions where damage has already been done. However, the Environment Agency do not have a duty to maintain watercourses, as this responsibility lies with the landowner (see Section 4.1.5).

Flood risk management work can include constructing and maintaining 'assets' (such as flood banks or pumping stations); works to main rivers to manage water levels and to make sure flood water can flow freely; operating flood risk management assets during a flood; channel maintenance on the river; issuing flood warnings; and responding to incidents.

The Environment Agency also has a strategic overview of all sources of flooding and coastal erosion (as defined in the Flood and Water Management Act 2010). As part of this role they develop long term approaches to flood and coastal erosion risk management in

England which includes developing and applying the National Flood and Coastal Erosion Risk Management Strategy for England (gov.uk). The strategy shows how communities, the public sector and other organisations can work together to manage this risk.

4.1.2 Lead Local Flood Authority

LLFAs were established under the Flood and Water Management Act 2010, which sets out their roles and responsibilities. They are county councils or unitary authorities and are responsible for managing the risk of flooding from surface water, groundwater, and ordinary watercourses (non-main rivers) and lead on community recovery.

The LLFA has powers under the Land Drainage Act 1991 to regulate ordinary watercourses to maintain a proper flow. They can do this by issuing consents for altering, removing or replacing certain structures of features, as well as enforcing obligations to maintain flow and repair watercourses, bridges, and other structures.

The LLFA has powers to carry out maintenance of ordinary watercourses when it is affordable and in the public interest. However, the LLFA do not have a duty to maintain watercourses, as this responsibility lies with the landowner (see Section 4.1.5).

The LLFA is also responsible for developing, maintaining, and applying a strategy for local flood risk management in their area, and for maintaining a register of flood risk assets.

Wigan Council is the LLFA for Lincoln Drive.

4.1.3 Water and sewerage company

Water and sewerage companies are responsible for managing the risks of flooding from surface water and foul or combined public sewer systems providing drainage from buildings and yards.

United Utilities is the water and sewerage company for Lincoln Drive.

4.1.4 Highway Authority

Highway Authorities are responsible for providing and managing highway drainage and roadside ditches and must ensure that road projects do not increase flood risk. They are also a riparian owner and responsible for sections of watercourses where these are crossed by a highway bridge.

The Highway Authority for Lincoln Drive is Wigan Council.

4.1.5 Riparian landowners

Riparian landowners who own land or property next to a river, stream or ditch, (including where this runs through a pipe or culvert), have rights and responsibilities over the management of the land including:

- a responsibility to let water flow through the land without any obstruction;
- prevent pollution;

- keep the banks clear of anything that could cause an obstruction and increase flood risk;
- maintain the bed and banks of the watercourse;
- control invasive species; and
- keep structures clear of debris.

There is more information on these rights and responsibilities in the Environment Agency online guidance 'Owning a watercourse' (gov.uk) and the Environment Agency publication Your watercourse: rights and roles (engagementhq.com).

4.1.6 Community

Property owners are responsible for looking after their own property, including the risks of water entering it and causing damage.

It is good practice for local residents to find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings/alerts where available and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help after a flood.

4.2 Emergency response

Wigan Council, the Environment Agency, and the emergency services are Category 1 responders for flooding incidents across England, as defined by the Civil Contingencies Act 2004 (legislation.gov.uk). As Category 1 responders they are required to:

- assess the risk of emergencies occurring and use this to inform contingency planning;
- put in place emergency plans;
- put in place business continuity management arrangements;
- put in place arrangements to make information available to the public about civil protection matters and maintain arrangements to warn, inform and advise the public in the event of an emergency;
- share information with other local responders to enhance co-ordination;
- co-operate with other local responders to enhance co-ordination and efficiency; and
- provide advice and assistance to businesses and voluntary organisations about business continuity management (local authorities only).

Category 2 responders (which include transport and utility companies) are 'co-operating bodies'. They are less involved in the emergency planning work but heavily involved in emergencies which relate to their own services. They have a duty to co-operate and share relevant information with other Category 1 and Category 2 responders.

The Local Government Association (local.gov.uk) provide further information on the key roles and responsibilities during and after a flooding emergency.

4.2.1 Local Resilience Forum

LRFs are multi-agency partnerships made up of Category 1 responders, including the emergency services, local authorities, the National Health Service (NHS), the Environment Agency and others. LRFs are supported by Category 2 responders, such as the Highways Agency and public utility companies. The geographical area the forums cover is based on police areas.

The LRF is not a legal entity, nor does a Forum have powers to direct its members. Nevertheless, the Civil Contingencies Act 2004 and its Regulations provide that emergency responders, through the Forum, have a collective responsibility to plan, prepare and communicate for emergencies in a multi-agency environment.

The LRF for Lincoln Drive is the Greater Manchester Resilience Forum (GMRF).

The Greater Manchester Resilience Strategy 2020-2030 (greatermanchester-ca.gov.uk) prepared by the GMRF identifies flood risk as one of the top risks in Greater Manchester.

The GMRF leads multi-agency emergence planning across the city-region through multi-agency joint working, co-ordinated through a clear shared structure. The Resilience Oversight Group oversees several sub-groups including the Commissioning Group for Training and Exercising and the Risks, Plans and Lessons Group.

The GMRF and supported by and work in partnership with the:

- Greater Manchester Local Authorities Chief Officers Group;
- Greater Manchester Local Health Resilience Partnership;
- Health Economy Resilience Group;
- Borough Resilience Groups; and
- Voluntary Sector and Community Forum.

Wigan Borough Resilience Forum are the Borough Resilience Group for Lincoln Drive and work closely with Wigan Council as LLFA regarding flood risk issues in the area.

4.2.2 Flood warning service

The Environment Agency is the lead organisation for providing warnings of main river flooding. The Environment Agency's Flood Warning Service provide flood warnings and alerts based on constant monitoring and forecasting of flooding from rivers and sea. The Environment Agency sign up for Flood Warnings (gov.uk) page provides further information on how to sign up for these warnings.

The Environment Agency's Flood Warning Duty Officers are updated with forecasting information regularly each day via their Monitoring and Forecasting Duty Officers, whose role it is to interpret their local forecasting flood models. Where forecasting models predict that Flood Warning thresholds will be reached, these are passed to the Flood Warning Duty

Officers for action. Other forecast updates are given as appropriate through the flood event, or when requested.

4.2.2.1 Flood Alerts

Flood Alerts are issued when there is water out of bank for the first time anywhere in the catchment, signalling that 'flooding is possible', and therefore Flood Alert Areas usually cover the majority of main river reaches.

There is currently one Flood Alert Area covering the Lincoln Drive study area, named 'River Sankey catchment with St Helens and Warrington' (code: 013WAFSA). The extent of this Flood Alert Area is shown in Figure 4-1, and covers Monmouth Crescent, Chester Drive, and parts of Lincoln Drive and Ripon Drive. It also encompasses the woodland area in the northwest and parts of the land around the Millingford Brook, north of Blenheim Road.

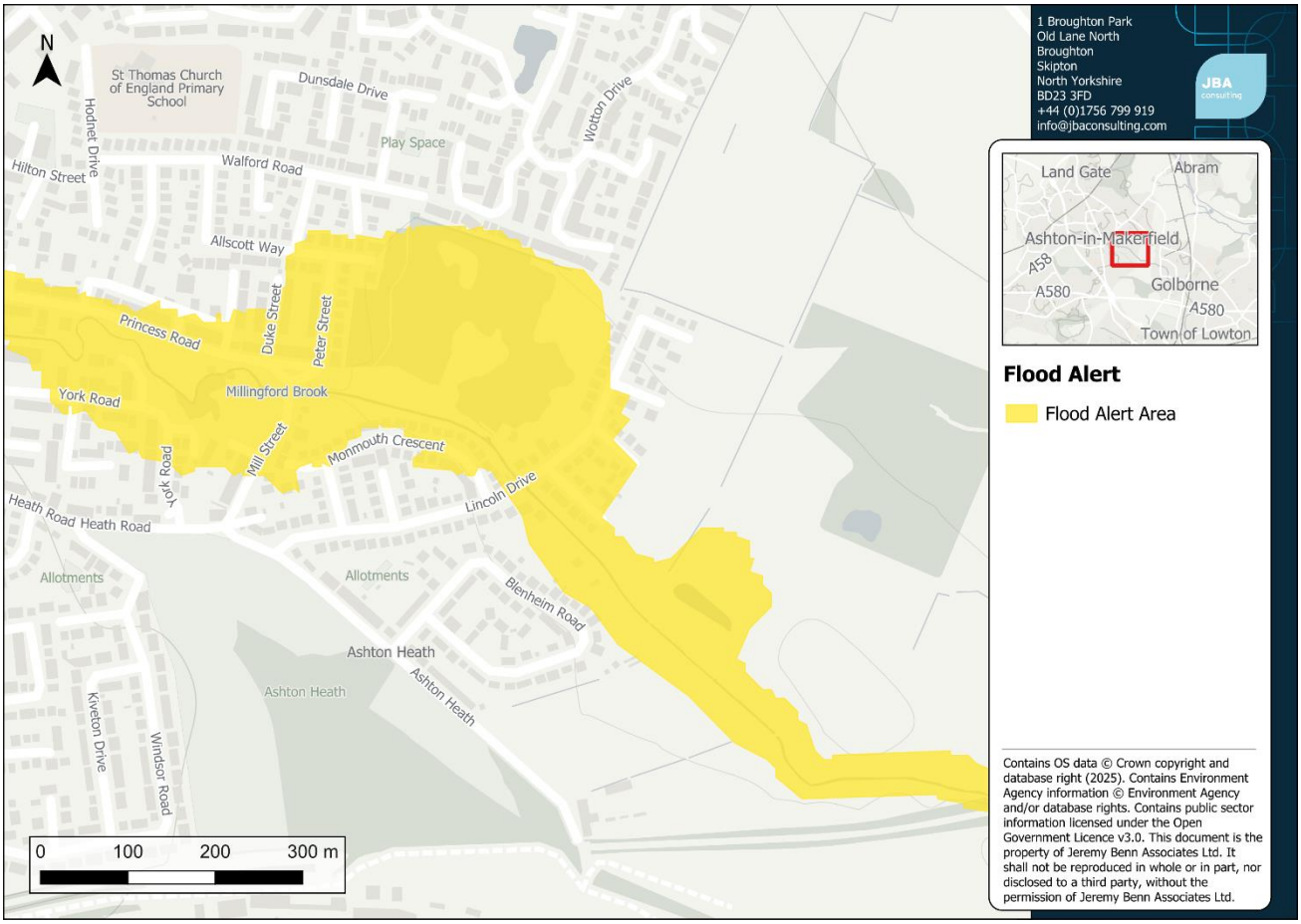


Figure 4-1: Extent of the Environment Agency's Flood Alert Area.

4.2.2.2 Flood Warnings

Flood Warnings are issued to designated Flood Warning Areas (properties within the extreme flood extent which are at risk of flooding), when the river level hits a certain threshold; this is correlated between the Flood Warning Area and the gauge, with a lead time to warn that 'flooding is expected'.

There is one Flood Warning Area covering the study area, named 'Millingford Brook at Ashton in Makerfield' (code: 013FWFGM84). The extent of this Flood Warning is shown in Figure 4-2, and covers Chester Drive as well as parts of Lincoln Drive, Monmouth Crescent, and Lincoln Drive. It also encompasses a part of woodland area in the northwest and the land around the Millingford Brook, north of Blenheim Road.

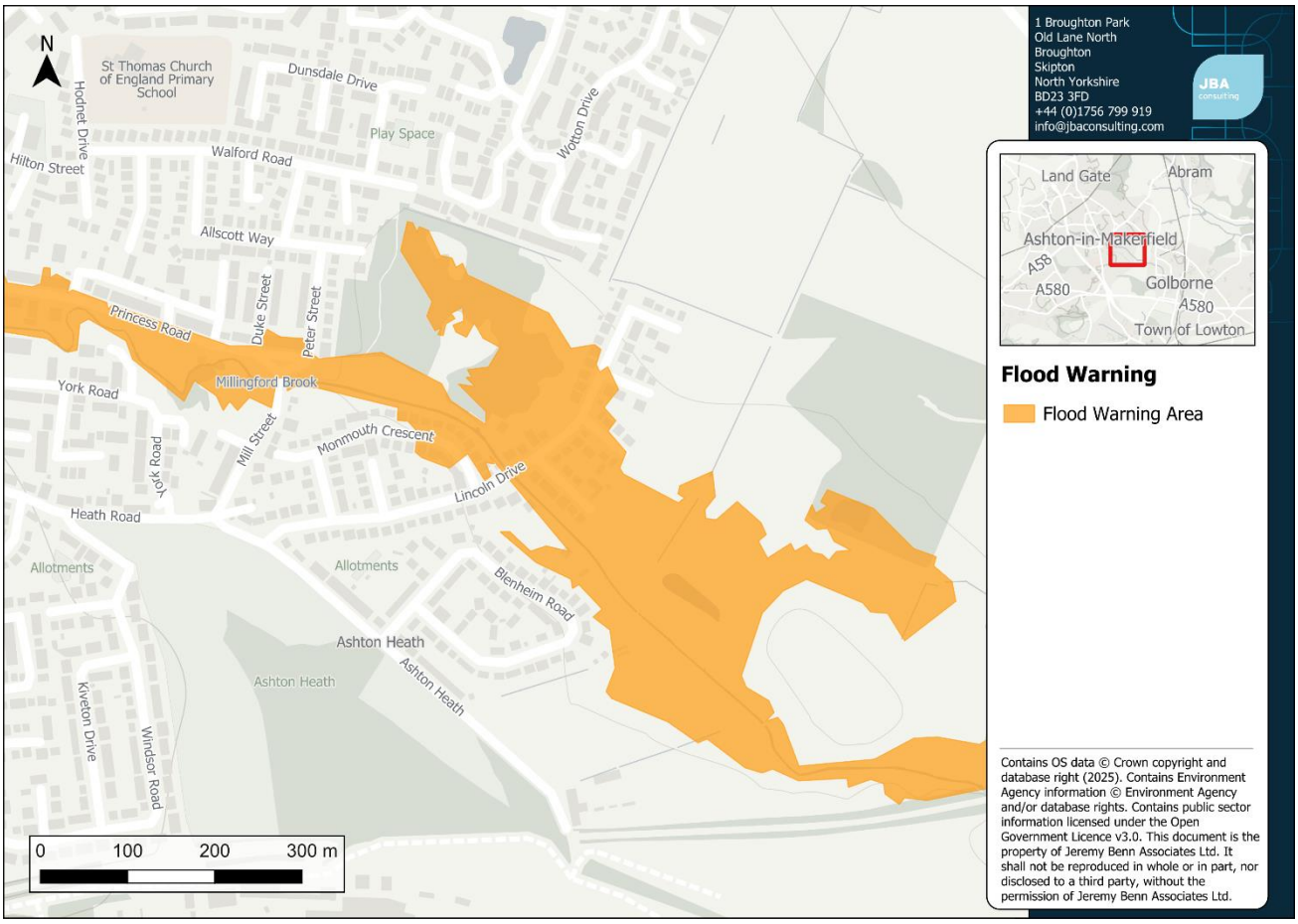


Figure 4-2: Extent of the Environment Agency's Flood Warning area.

5 Hydrological summary of the events

Following feedback from the community, the occurrence of two flood events in four months was emphasised as particularly important for the flood investigation. Therefore, this report also includes information about what happened during the 30 September 2024 flood event (Section 3.2.1), and a hydrometric analysis. This is not intended to be a separate investigation, but rather to provide context and a basis for comparison with the flooding that occurred 1 January 2025.

The following sections provide a summary of the two events. This includes the conditions leading up to the events, the rainfall and corresponding fluvial response during the events, and an estimation of the rainfall and fluvial return periods. Full details of the hydraulic analysis of the events can be found in Appendix A.

Figure 5-1 shows the locations of hydrometric data from river level and rain gauges in the vicinity of the flooded site assessed in this report. These include:

- five rain gauges within a 15km radius of the study area; and
- two level gauges on Millingford Brook:
  - Ivy Street, 1.0km upstream of the flooded properties assessed here,
  - Lincoln Drive, adjacent to the site of interest in this report.

Millingford Brook drains a catchment area of 10.6km^2 to the Lincoln Drive level gauge.

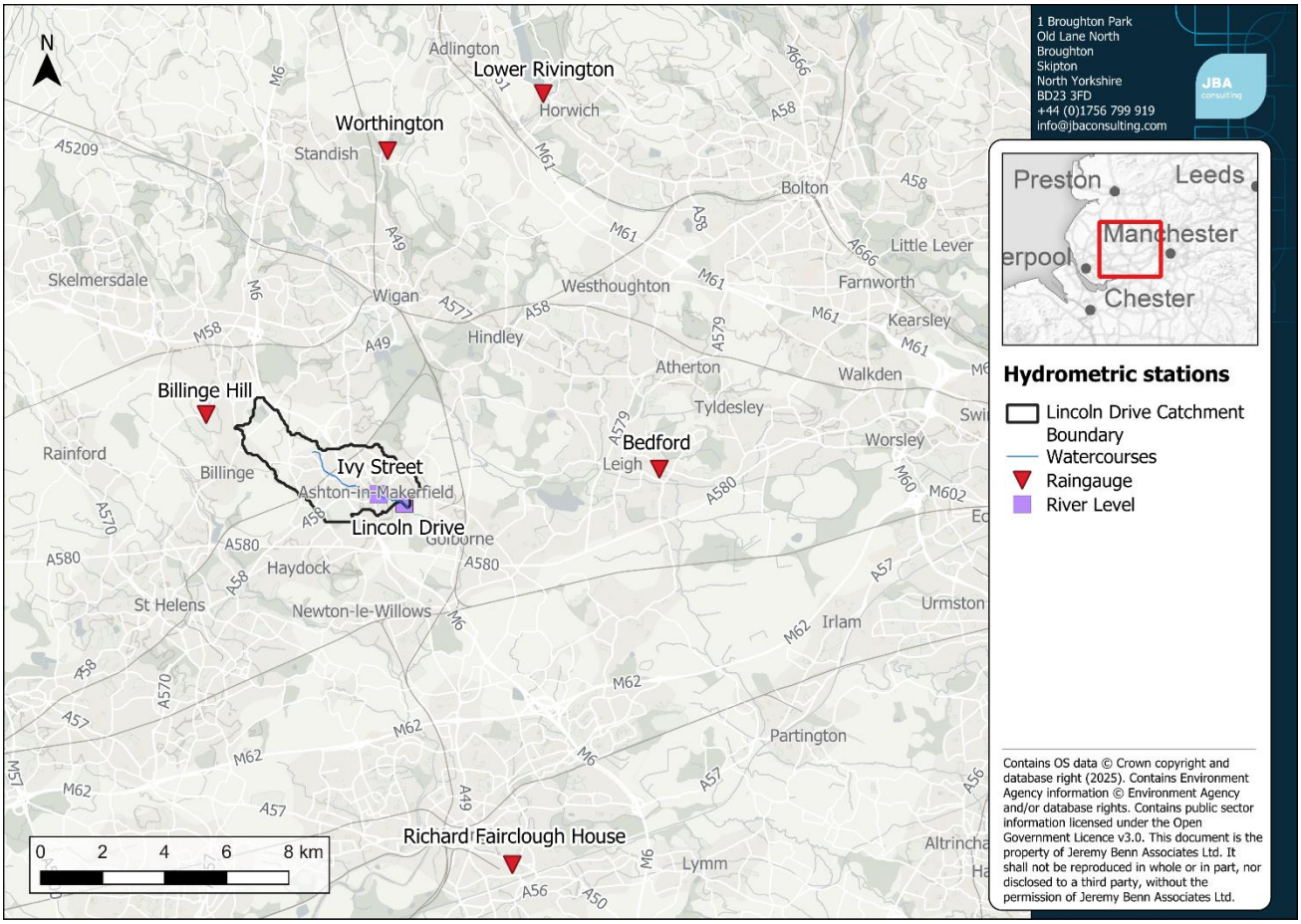


Figure 5-1: Hydrometric stations around Lincoln Drive.

5.1 1 January 2025 event

5.1.1 Conditions leading up to the event

A high-level review from the 'UK Water Resources Portal' (UK Centre for Ecology and Hydrology) indicates the overall average monthly rainfall and resulting river flows in December 2024 were 'Notably High' in the month leading to the 1 January 2025 flood event, relative to conditions in the long-term record for that time of year.

The local rain gauge data shows a more nuanced picture. Rainfall totals at the rain gauges show that the climatic antecedent conditions in the weeks and days leading up to the flood event were not particularly unusual. Omitting the flood event itself, the remaining summed December 2024 rainfall is not particularly notable at any nearby rain gauge, falling slightly below the long-term December monthly average.

Despite the heavy rainfall during 31 December to 1 January period, the December 2024 monthly rainfall was exceeded in 2023, 2015, 2012, 2011, and 1999 over the prior quarter-century.

5.1.2 Rainfall and fluvial response

15-minute resolution rainfall for 31 December 2024 to 2 January 2025 generally shows a double-peak rainstorm profile. The first high-intensity peak occurred around 18:00 to 21:00 on 31 December. 10mm - 20mm fell in this initial period. Rainfall persisted through the night to the morning, with a second high-intensity peak around 02:00 to 04:00 on 1 January. This was a heavier and more prolonged rainstorm period, with 30mm - 40mm falling.

The majority of residents that reported internal flooding in the questionnaire stated that water entered their properties between 04:00 and 05:00, with some on Chester Drive reporting that the flooding started between 05:00 and 06:00.

United Utilities Princess Road (Peter St) CSO (50006) started discharging into the brook at 21:59 on the 31 December 2024 and stopped discharged at 15:43 on 1 January 2025.

Figure 5-2 shows the fluvial response of the Millingford Brook to the 1 January flood event, versus the closest rain gauge to the catchment (Billinge Hill). There was a short lag time between the rainfall and subsequent hydrograph peak.

- The rainstorm began around 12:00 on 31 December, with river levels showing a response from 18:00 onwards.
- River levels rose continuously in response to the persistent rainfall, peaking around 06:00 on 1 January.
- The hydrograph peak persisted for a longer time at Lincoln Drive relative to Ivy Street, likely due to the relative positions of these gauges. The Lincoln Drive

gauge is located lower in the catchment and captures a greater volume of runoff from the surrounding urbanised catchment, relative to Ivy Street.

- The rainstorm was less intense after 06:00, with river levels falling relatively quickly, returning to high baseflow conditions around 18:00 on 1 January.

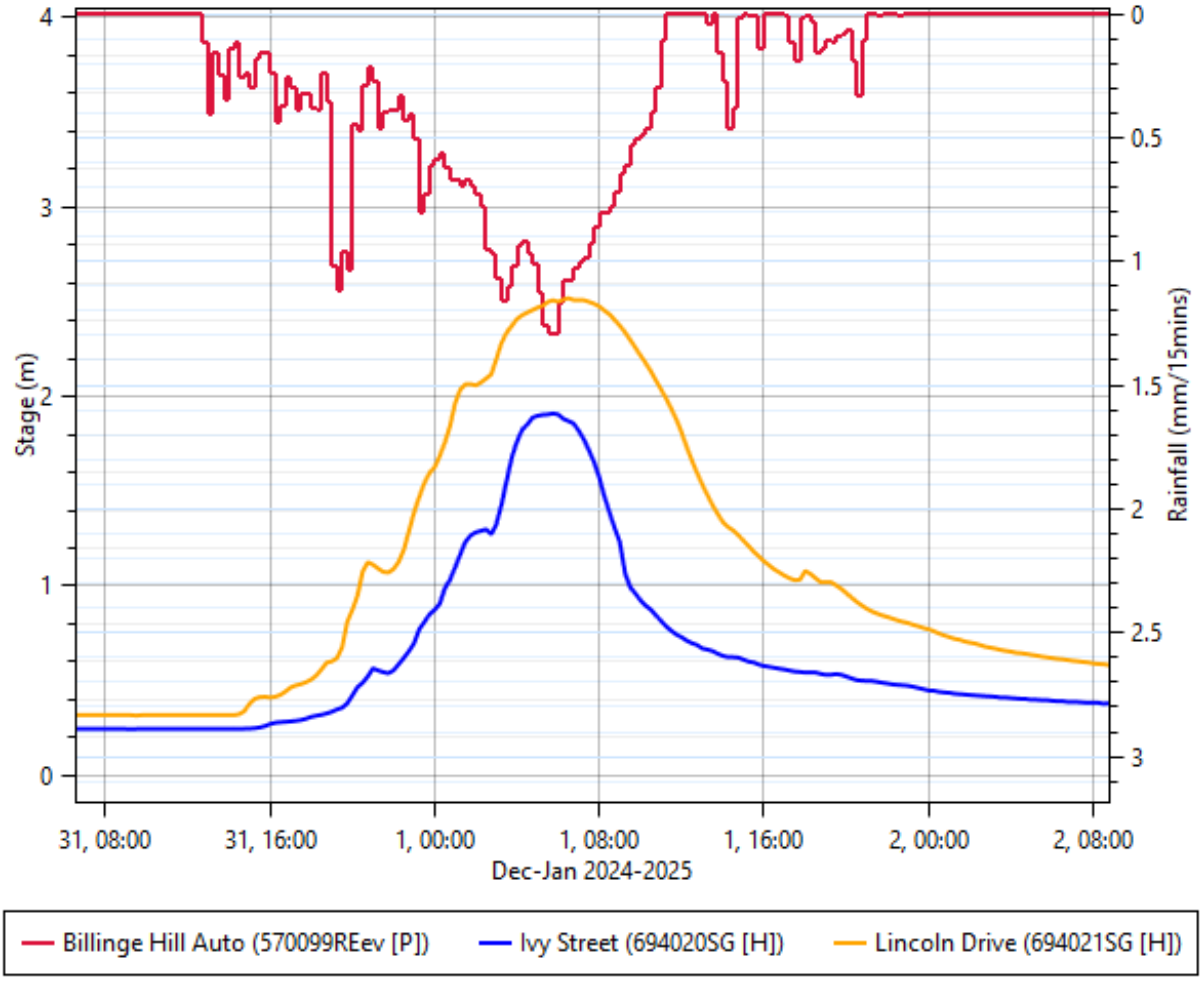


Figure 5-2: Fluvial response to the 1 January 2025 flood event at nearby river level gauges.

5.1.3 Rainfall return period estimation

The industry-standard Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) 2022 model (FEH22 model) estimates the rarity of observed rainstorms. The FEH22 model was applied in a rolling-window manner to the observed rainstorm data for the five nearby rain gauges, for various durations between 1 hour to 30 hours, applied to both the 1 January 2025 and 30 September 2024 events. The worst-case result was obtained for the 16-hour window across all gauges as shown in Table 5-1.

Table 5-1: Rainfall event rarity analysis for the 1 January 2025 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Lower Rivington	60.0mm	3.4%

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Worthington	61.2mm	2.1%
Billinge Hill	48.3mm	9.2%
Bedford	57.6mm	2.8%
Richard Fairclough House	64.5mm	1.5%

The result is less extreme at Billinge Hill due to the lower intensity / more prolonged nature of the recorded rainfall there, relative to the other nearby gauges. The remaining gauges give a consistent result, indicating a rainfall annual probability of around 1.5% - 3.5% for the 1 January event. The Billinge Hill gauge is geographically closer to the flooded properties near Lincoln Drive, and therefore likely gives a more representative result from the options presented above.

5.2 30 September 2024 event

5.2.1 Conditions leading up to the event

Surface water and sewer flooding was also reported in the locality on 30 September 2024. Similar to the 1 January 2025 event, weather conditions were also wet over this period, relative to the long-term past weather patterns. Overall, the rainfall on the 30 September 2024 alone made up a dominant fraction (roughly 25%) of the September 2024 monthly rainfall sum.

Rainfall totals at the rain gauges show that the climatic antecedent conditions in the weeks and days leading up to the flood event were relatively wet. Even if the 30 September 2024 rainfall is omitted, the monthly sum still shows as being significantly wetter versus an average September monthly rainfall. The September 2024 monthly rainfall ranks as one of the top three wettest values in the gauged time period at the gauges assessed here, when ranked versus September monthly rainfall totals in previous years.

5.2.2 Rainfall analysis

The rain gauges closer to the flooded sites near Lincoln Drive give a worst-case result for a 10-hour rolling window duration. Gauges further away from the site indicate worst-case results for a 20-hour rolling window duration.

Table 5-2: Rainfall event rarity analysis for the 30 September 2024 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Lower Rivington	45.7mm (10hr duration)	8.0%
Worthington	41.6mm (10hr duration)	9.9%
Billinge Hill	44.2mm (10hr duration)	7.1%
Bedford	49.2mm (20hr duration)	9.3%

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Richard Fairclough House	46.9mm (20hr duration)	9.6%

Table 5-2 indicates a rainfall annual probability of 7% - 10% for the 30 September 2024 event, if concentrating on the rain gauges closer to the site. The Billinge Hill gauge is geographically closer to the flooded properties near Lincoln Drive, and therefore likely gives a more representative result from the options presented above.

5.3 Summary

Antecedent conditions in the weeks and days leading up to the 1 January 2025 event were not particularly unusual. This points to the rainstorm event itself being the main driver of the observed flooding in the Lincoln Drive area. The double-peak nature of the rainstorm and its long duration were the combined main drivers of high fluvial flows in Millingford Brook. The first rainfall peak (around 10 mm - 20mm) likely reduced soil storage in the catchment. The immediate occurrence of the second larger peak (30mm - 40mm) was exacerbated by this initial peak. Applying standard FEH methods to the rainfall and level gauge data gives good agreement on the event annual probability, between 6% to 10%.

The derived result for fluvial flooding is less certain. River flows can be estimated at the Ivy Street gauge using a rating curve, but this rating is not reliable in high-flow conditions. As far as can be determined, there are no past high flow spot gauging records to provide any confidence in this rating in high-flow conditions. The rating is also not currently used for operational flood warning purposes. Flows from this rating are therefore not suitable for analysis in this study.

A rainfall-only analysis for the 30 September 2024 event gives a 7% to 10% annual probability for the rainfall that drove the observed surface water flooding in the Lincoln Drive area. Unlike the 1 January 2025 flood, the antecedent conditions of this event were relatively wet, which likely additionally contributed to the observed surface water flooding on that date.

6 Source-pathway-receptor analysis

The Source-Pathway-Receptor model is a concept that can provide an understanding of all aspects of a flood hazard. It breaks down a flood incident into three key elements:

- **source**: the origin of flood water;
- **pathway**: a route or means through which a receptor can be affected by flooding; and
- **receptor**: the entities that can be adversely affected by flooding (e.g. people, property, infrastructure).

Available information was analysed to determine the main sources of flooding impacting the study area, the pathways it took, and the main receptors. These are summarised in Figure 6-1 and described in the following sections.

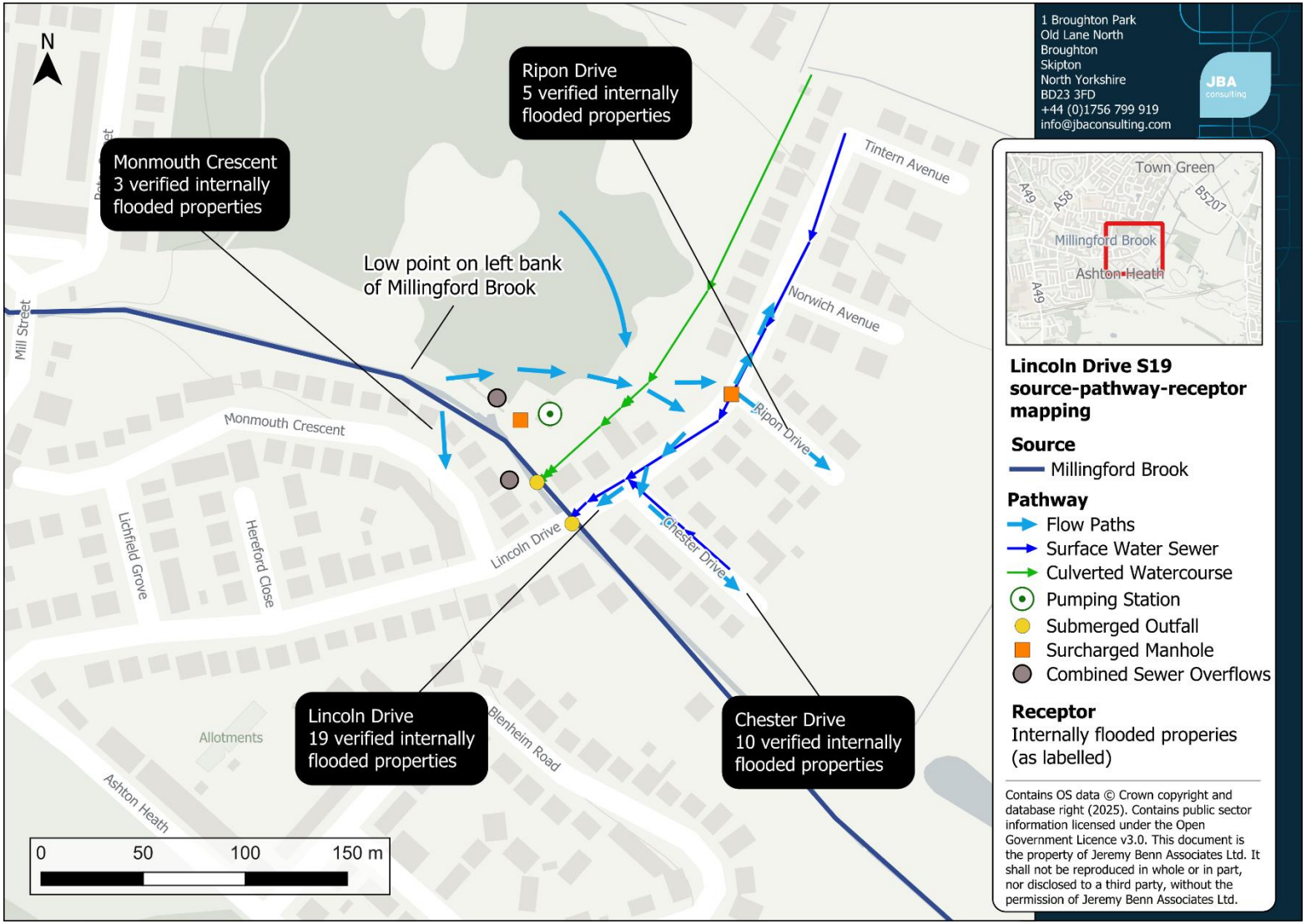


Figure 6-1: Map of the sources, pathways, and receptors in the Lincoln Drive Area.

6.1 Source

6.1.1 Extreme rainfall

Extreme rainfall falling in Lincoln Drive and the surrounding area contributed to increased fluvial flows and the drainage system becoming overwhelmed.

The rainfall event was observed to be double-peaked in nature and of a considerable duration with the first peak (around 10 mm - 20mm) likely reducing soil storage in the catchment and exacerbating the impact of the second larger peak (30mm - 40mm) which followed in quick succession. The rainfall event was calculated to have between a 6% and 10% annual probability (Section 5).

6.1.2 Millingford Brook (Main River)

The Millingford Brook overtopped its banks on 1 January 2025, upstream of the culvert located beneath Lincoln Drive. Water first came out of the channel at a low point of the northern bank, before overtopping the southern bank at the back of the houses on Monmouth Crescent. The high water level in the Millingford Brook also meant that the surface water sewer and culverted ordinary watercourse which discharge into the brook were unable to discharge.

6.2 Pathway

6.2.1 Overtopping and fluvial overland flows

Figure 6-1 shows the pathways of the floodwater during the event on 1 January 2025. The Millingford Brook overtopped both banks. Fluvial flooding resulted in one pathway where water flowed south onto Monmouth Crescent. A pathway also flowed eastwards from the Millingford Brook, towards the area around the pumping station at the back of the houses on Lincoln Drive. The questionnaire responses from residents also noted that the Millingford Brook overtopped further downstream, flowing into rear gardens and outbuildings on Blenheim Road.

6.2.2 Pumping station

Within the Lincoln Drive area there is a pumping station (Princess Road) owned by United Utilities, shown in Figure 6-2. The combined network flows into the pumping station, where it is then pumped away.

The depth of the floodwater reached the top of the concrete platform that the pumping station is built upon. Safety concerns caused Electricity North West to isolate the power supply to the wider area at 05:46 on 1 January 2025. This triggered United Utilities' Emergency Procedure, and they delivered an emergency generator. However, they could not immediately access the site to install it due to the water level. After the floodwater had receded sufficiently, the pumping station was restored to operational status at 15:31 on 1 January 2025.

Evidence provided by United Utilities suggests that whilst the pumping station did not directly contribute to the flooding, the Princess Road CSO was in operation for an extended period due to the large volumes of flood water entering the combined sewer system, as well as the loss of power to the Pumping Station, which caused flows to back up the system and spill over the CSO weir for 17 hours and 44 minutes contributing to high levels in the river.

Figure 6-2: United Utilities pumping station.

6.2.3 Surface water runoff

It was reported that surface water flowed southwards through the woodland to the north of the watercourse and contributed to the floodwater near the pumping station (Princess Road), west of Lincoln Drive. However, the exact flow paths during the event were not recorded.

The combined fluvial and surface floodwater then flowed into the backyards and into properties along Lincoln Drive. The water also flowed between the houses on Lincoln Drive, including where there is a turning circle, shown in Figure 6-3.

Figure 6-3: Flooding on Lincoln Drive with turning circle by van (source: Lincoln Drive residents).

6.2.4 Sewer and drainage networks

There is a surface water sewer outfall under Lincoln Road bridge that was unable to discharge during the flood event. This was due to the water level of the Millingford Brook exceeding the height of the outfall, meaning it was submerged. There is no flap valve at this outfall to prevent water/debris flowing back into the pipe. Therefore, it is likely that water flowed back up the system and came out at low spots of land. There is another unprotected outfall directly upstream of the bridge on Lincoln Drive, but this one is from a non-main watercourse. It is probable that a similar issue occurred with this outfall being unable to discharge. The inability of water to discharge due to the submersion of these outfalls resulted in surface water flooding from the gullies and manholes. Two reported surcharged manholes are mapped in Figure 6-1.

Several residents from the questionnaire responded that the flood water was contaminated with sewage. There was no occurrence of sewer flooding directly. Rather, when a CSO discharges into a waterbody which subsequently floods, it is likely that the fluvial floodwater contains sewage. The United Utilities Princess Road (Peter St) CSO (50006) was discharging into the Millingford Brook for 17.75 hours, from 21:59 on 31 December 2024

until 15:43 on 1 January 2025. The Bryn Road CSO, located at the back of Monmouth Crescent was also operational from 05:48 until 14:10 on 1 January 2025.

The surface water flooding from the gullies and manholes that surcharged converged with the flow from the Millingford Brook and the woodland, adding to the volume of floodwater on Lincoln Drive. This pathway of converged floodwater continued southwest down Lincoln Drive towards the bridge over the Millingford Brook, flooding more properties, as seen in Figure 6-4, and southeast onto Chester Drive causing further internal flooding. The floodwater also travelled northwards along Lincoln Drive, and southwest onto Ripon Drive, flooding several more properties both internally and externally.

Figure 6-4: Flooding on Lincoln Drive, looking southwest (source: Lincoln Drive residents).

6.3 Receptor

6.3.1 Properties

The overtopping of the Millingford Brook and the surface water overflowing from the gullies and manholes resulted in internal and external property flooding on Monmouth Crescent, Lincoln Drive, Chester Drive, and Ripon Drive. The watercourse was also reported by residents to have overtopped further downstream, flowing into rear gardens and outbuildings on Blenheim Road.

Internal flooding (including to ground floor living accommodation, attached garages, and inhabited cellars) was recorded to have affected at least 37 residential properties. This number only includes properties that have been verified through site visits by Chief Information Officers (CIOs) at the Environment Agency, or through the questionnaire sent to residents (Section 1.4).

6.3.2 People

The event has caused significant disruption to the lives of the residents that were flooded. Financial losses have been incurred, with concerns raised about the impact of flooding on property values. The flooding caused damage and contamination of material goods, with residents also noting the irreplaceability of some of the belongings lost. Some explained that they are not eligible for insurance.

Just over 60% of residents who responded to the questionnaire reported having to move out of their homes, staying with family or in hotels, with some potentially facing six months or more of relocation. Dealing with the aftermath of the flood has also been mentally draining, requiring time and resources for the cleanup, administrative tasks, and communications with insurers and tradespeople. These undertakings required some residents to take time off work.

The flood event has had a detrimental effect on the overall wellbeing and mental health of those impacted. Many reported trauma, stress, poor sleep, and anxiety. Residents voiced their worries about the future, including the challenges of recovering from the damage and the fear that their homes might flood again. According to some responses, rainfall now generates feelings of panic.

Several residents also reported feeling unsupported and unheard both during and after the event, and that the damage caused could have been avoided. These views are compounded by the flood event that had occurred recently in September 2024.

7 Incident response

Several agencies responded to the flood event in the Lincoln Drive area including Wigan Council, Greater Manchester Fire and Rescue, United Utilities, Electricity North West, and the Environment Agency. A timeline of the incident response is given in Table 7-1.

7.1 Flood warnings

7.1.1 Met Office

The first indication of forecast flooding in Greater Manchester was at 10:30 on Monday 30 December 2024 when the Met Office Flood Guidance Statement indicated a Yellow (Low) flood risk for Greater Manchester on New Year's Eve and extended their existing Yellow warning of rain to include the Greater Manchester region. A post-flood report (greatermanchester-ca.gov.uk) from the Greater Manchester Combined Authority stated that the flood risk was never forecasted as Amber or Red (Medium or High) on the Met Office Flood Guidance Statement, so the Strategic and Borough Flood Plans were not triggered.

The Met Office Yellow warning of rain was further updated on the morning of Tuesday 31 December 2024, bringing forward the rain warning with a lead time of 4 hours. A Met Office Amber warning of rain was issued at 20:38 on Tuesday 31 December 2024, however this did not cover the Lincoln Drive area.

7.1.2 Environment Agency Flood Alerts and Flood Warnings

A Flood Alert was issued for the River Sankey catchment with St Helens and Warrington at 17:00 on 31 December 2024.

No Flood Warning was issued for this event as it did not reach the required level which is based on a gauge at Ivy Street. There is a gauging station at Lincoln Drive, which is an Environment Agency maintained asset, however it is not used for flood warnings. The last Flood Warning was issued to the designated Flood Warning Area on 20 December 2012.

7.2 Incident response

There was a Flood Advisory Service Teleconference at 21:30 on 31 December 2024 where the decision was made to escalate this to a Tactical Coordinating Group meeting. The Greater Manchester Tactical Coordinating Group was activated at 01:00 on Wednesday 1 January 2025. Greater Manchester declared a major incident at 06:45 and the Strategic Coordinating Group was activated. An hour earlier, Electricity North West had isolated supplies to the wider area at 05:46.

The Wigan Council Forward Incident Officer was deployed at Lincoln Drive at 08:10 and noted severe flooding with residents stranded upstairs in their homes. Greater Manchester Fire and Rescue Service had been requested in the morning, but they were initially unable

to come as they were attending Platt Bridge. The Fire and Rescue Service arrived a couple of hours later, but at this time water level was already rapidly dropping as the Millingford Brook level had sufficiently dropped.

The Council Highways attended Lincoln Drive to pump out water and redirect flows into a drain away from the affected area. Highways remained at Lincoln Drive to remove more water as the level was not dropping fast enough, despite having requests elsewhere.

Houses that had been underwater could not be reconnected and were isolated, and these houses needed to dry out before being reassessed. In the afternoon, Electricity North West checked all properties where access was possible. Properties without access (mainly on Lincoln Drive, and on parts of Ripon Drive) had to be disconnected at the street so that the rest of the dry houses could be supplied. Electricity North West advised that power to the affected area would be restored that night, following isolation of the flooded properties with no access. The Forward Incident Officer informed as many residents as possible.

United Utilities attended Lincoln Drive in the morning. United Utilities advised that they were not contacted by customers on the day of the incident, but they responded to an alarm at the pumping station that indicated it had lost power, after Electricity North West had isolated supplies. The pumping station had failed due to the power cut, and United Utilities delivered an emergency generator. However, due to the volume of water, their teams were only able to connect the generator and restore the pumping station at 15:31.

In the afternoon, Wigan Council conducted door-to-door visits to offer assistance to those affected, including the option to use the rest centre at Ashton Leisure Centre or to access emergency accommodation. The Forward Incident Officer also liaised with two councillors and a Member of Parliament (MP), who assisted with the door knocking. All responded that they were okay, and self-sufficient to arrange their own accommodation. The minibus was stood down, as none of the residents requested a lift.

7.2.1 Questionnaire responses

The majority of residents that reported internal flooding in the questionnaire stated that water entered their properties between 04:00 and 05:00, with some on Chester Drive reporting that the flooding started between 05:00 and 06:00. All of the respondents to the questionnaire who flooded internally answered that they did not have any PFR measures in place.

Respondents to the questionnaire were also asked if they received a response from emergency services, the Council, the Environment Agency or any other authority during, or after the event.

Residents noted that the Fire Service, Members of Parliament, Wigan Council, Environment Agency, United Utilities, and Northwest Electricity had all been present at various times. One respondent noted that Wigan Council had sent a van providing tea and coffee. Another respondent reported receiving a courtesy call one week after the event to check on their well-being, but noted that information about available support was not provided. Around one-third of the residents stated that they did not receive a response.

Table 7-1: Timeline of incident response at Lincoln Drive.

Date	Time	Location	Source	Details
01/01/2025	08:10	Lincoln Drive, Chester Drive, Rippon Drive, and Norwich Avenue	Wigan Council Action Logs	Forward Incident Officer deployed. The following streets were affected: Lincoln Drive, Chester Drive, Ripon Drive, and Norwich Avenue. The Millingford Brook was close to overspilling. The water level was dropping, but very slowly. Call to check United Utilities and Environment Agency were aware and responding. Checks if there are any vulnerable residents, and notes that some residents may need support. 'Here for you' tool to be utilised if appropriate.
01/01/2025	9:05	Lincoln Drive area	Wigan Council Action Logs	Forward Incident Officer notes Greater Manchester Fire and Rescue Service had been requested, but they were unable to come as they were attending Platt Bridge. Highways also requested to attend, to ensure drains are clear and to see if water can be pumped away. Water on Chester Drive and the Millingford Brook had dropped, but the other streets not so much.
01/01/2025	09:11	Chester Drive	Wigan Council Action Logs	Forward Incident Officer noted 6 to 8 inches of water at one property.
01/01/2025	11:50	Lincoln Drive area	Wigan Council Action Logs	Council Highways, United Utilities, and Greater Manchester Fire and Rescue Service attended. Discussion if reception was needed, but issue of people requiring to be home to let the electricity be inspected.
01/01/2025		Lincoln Drive Area	Wigan Council Action Logs	Attention was given to house damage. Houses that had been underwater could not be reconnected and were isolated. These houses needed to dry out before being reassessed. Electricity North West checked all properties

Date	Time	Location	Source	Details
				where access was possible. Properties where no reconnection was possible were identified to be mainly on Lincoln Drive, and on parts of Ripon Drive. Two properties were identified as vulnerable.
01/01/2025		Lincoln Drive area	Wigan Action Logs	There was a door knock to identify those requesting and/or needing emergency assistance.
01/01/2025		Lincoln Drive area	Wigan Council Action Logs	Forward Incident Officer liaised with two councillors and an MP, who assisted with the door knocking.
01/01/2025	15:31	Lincoln Drive area	United Utilities	United Utilities arranged their emergency procedures, which included delivering an alternative supply of power via generator. Due to the volume of water their teams were only able to connect the generator and restore the pumping station at 15:31.
01/01/2025		Lincoln Drive area	Wigan Council Action Logs	Electricity North West advised that power to the affected area would be restored that night, once the houses that needed to be isolated had been. The Forward Incident Officer informed as many residents as possible.
01/01/2025	17:30	Lincoln Drive area	Wigan Council Action Logs	Forward Incident Officer provided final update and left the scene.

7.3 Subsequent actions

Greater Manchester Fire and Rescue Service reported that they held tactical debriefs at the scene. Their crews attended affected properties in the area to carry out Home Fire Safety assessments, with focus on correct and safe use of heaters/humidifiers and checking for vulnerable residents. Local commanders attended Technical Coordinating Groups to assist with collaborating information, such as the number of dwellings, the number of persons, and the correct addresses etc. Their Organisational Learning and Operational Assurance Team are gathering information from crews that attended flooding across the whole of Greater Manchester in order to gather learning points and areas of notable practice that can be shared across the service to improve future response to incidents.

Wigan Council provided skips for flooded properties along Monmouth Crescent, Lincoln Drive, Chester Drive, and Ripon Drive.

Following the event, the Environment Agency conducted research to verify the flooded properties. The Environment Agency also inspected the Millingford Brook and removed debris and fallen trees.

8 Conclusions, lessons learnt, and recommendations

8.1 Conclusions and lessons learnt

The flooding that occurred in the Lincoln Drive area on 1 January 2025 is reported to have caused internal flooding to at least 37 residential properties. Wigan Council, as the LLFA for Lincoln Drive, has exercised their duty to undertake a Section 19 flood investigation, as the event fulfils the criteria set by Wigan Council. The Council has appointed JBA Consulting to undertake this investigation on its behalf.

Antecedent conditions in the weeks and days leading up to the 1 January 2025 event were not particularly unusual. This points to the rainstorm event itself being the main driver of the observed flooding in the Lincoln Drive area.

The double-peak nature of the rainstorm and its long duration were the combined main drivers of high fluvial flows. The first peak (around 10 mm - 20mm) likely reduced soil storage in the catchment. The immediate occurrence of the second larger peak (30mm - 40mm) was exacerbated by this initial peak. Calculations undertaken within the hydrometric analysis give good agreement on the event annual probability between 6% to 10%.

The derived result for fluvial flooding is less certain. River flows can be estimated at the Ivy Street gauge using a rating curve, but this rating is not reliable in high-flow conditions. As far as can be determined, there are no past high flow spot gauging records to provide any confidence in this rating in high-flow conditions. The rating is also not currently used for operational flood warning purposes. Flows from this rating are therefore not suitable for analysis in this study.

The Millingford Brook overtopped its banks on 1 January 2025, upstream of the culvert located beneath Lincoln Drive. It was also reported that surface water flowed southwards through the woodlands to the north of the watercourse and contributed to the floodwater near the pumping station (Princess Road), west of Lincoln Drive. There is a surface water sewer outfall under Lincoln Road bridge that was unable to discharge during the flood event. It is likely that water flowed back up the system and came out at low spots of land. There is another unprotected outfall directly upstream of the bridge on Lincoln Drive, but this one is from a culverted ordinary watercourse. It is probable that a similar issue occurred with this outfall being unable to discharge. The inability of water to discharge due to the submersion of these outfalls resulted in surface water flooding from the gullies and manholes.

Fluvial flooding resulted in a pathway flowing south from the Millingford Brook onto Monmouth Crescent, and another flowing eastward, towards the pumping station. Surface water moving southwest from the woodland may have added to the flow at this location. Floodwater entered backyards and homes along Lincoln Drive, converging with surface water from gullies and manholes. This combined flow continued southwest down Lincoln Drive, flooding more properties, and southeast onto Chester Drive, causing further internal

flooding. Additionally, floodwater travelled north along Lincoln Drive and southwest onto Ripon Drive, causing more internal and external flooding. The watercourse was reported by residents to have overtopped further downstream, flowing into rear gardens and outbuildings on Blenheim Road.

Electricity North West isolated the power supply to the wider area at 05:46 on 1 January 2025. United Utilities delivered an emergency generator, but they could not immediately access the site to install it due to the water level. The pumping station was not running for 9.75 hours. The Princess Road CSO was in operation due to the large volumes of floodwater entering the combined sewer system as well as the loss of power to the Pumping Station. The power cut caused flows to back up the system and spill over the CSO weir.

The event caused a significant disruption to the lives of the residents that were flooded. Financial losses have been incurred, several residents reported having to move out of their homes, and many reported trauma, stress, poor sleep, and anxiety.

The previous flood event to impact Lincoln Drive was on 30 September 2024. This event resulted in five properties being internally flooded and a further eight being externally flooded. While some of the flood mechanisms are similar across both the September 2024 and January 2025 events, Millingford Brook was only reported to have overtopped during the January event. However, the water level in the brook was high in the September 2024 event, which potentially led to the outfalls becoming submerged. It is likely this caused the water to back up through the system, which then caused surface water flooding from surcharged gullies and manholes. Furthermore, in contrast to the normal antecedent conditions leading up to the January event, for the September event, the monthly sum of rainfall shows as being significantly higher than an average September monthly rainfall.

The flood events in the Lincoln Drive study area occurred as a result of interacting flood risk mechanisms and are not the result of a single source of flood risk. A series of recommended actions for the RMAs and stakeholder organisations have been made in Section 8.2. These focus on partnership working to address the interacting flood risk mechanisms, rather than addressing different sources in isolation.

8.2 Recommendations

Based on the identified causes and mechanisms of flooding, potential actions and the responsible stakeholders to mitigate flood risk and/or damages have been considered.

It should be noted that several of the actions identified may require further investigation on asset networks by a particular authority.

United Utilities should conduct a review of the Princess Road CSO, which is upstream of the Princess Road pumping station and discharges excess flows to the river when the combined sewer capacity is exceeded.

Timescale: by Summer 2026

During the 1 January 2025 flood event, the Princess Road CSO was in operation from 21:59 on 31 December 2024 to 15:43 on 1 January 2025 due to the large volumes of floodwater entering the combined sewer system as well as the loss of power to the Pumping Station. The power cut caused flows to back up the system and spill over the CSO weir. United Utilities should therefore conduct a review of the Princess Road CSO. United Utilities should also consider opportunities to separate surface water from the combined system in this area to reduce CSO spills from both the Princess Road CSO and the Monmouth CSO which also operated for a period of 8 hours and 22 minutes on 1 January 2025.

United Utilities should install a flap valve at the outfall of the surface water sewer under Lincoln Drive.

Timescale: by end of 2025 (actioned during the drafting of this report)

During the flood event, the high water level in Millingford Brook is reported to have submerged the outfall of the surface water sewer, leading to floodwater backing up along the system and surcharging manholes and gullies on Lincoln Drive. This is anecdotal evidence and should be confirmed through drainage connectivity surveys. A flap valve would reduce the risk of floodwater backing up along the system however the residual risk of water being unable to drain away should also be considered.

Wigan Council should investigate the condition of the culverted ordinary watercourse to the west of Lincoln Drive and review its contribution to the flooding. The owner should be identified. This is necessary to improve its condition, to install a flap valve at the outfall of the watercourse into Millingford Brook, and/or to provide upstream attenuation in the woodland area.

Timescale: by Summer 2026

During the flood event, the high water level in the Millingford Brook is reported to have submerged the outfall of the culverted ordinary watercourse, leading to floodwater backing up along the system and emerging at low points in the woodland area. This is anecdotal evidence and should be confirmed through drainage connectivity surveys. Wigan Council

should investigate the condition of the culverted ordinary watercourse and its contribution to the flooding, and ensure that necessary improvements are made.

A flap valve would reduce the risk of floodwater backing up along the system. However, the residual risk of water being unable to drain away should be considered. Therefore, attenuation upstream in the woodland area, to the north of the Millingford Brook, could be considered as an alternative option. Part of this could involve undertaking a survey of the drainage network in the woodlands, by the relevant authorities in conjunction with the riparian owners. This area is a historic landfill site, meaning any considerations to use this land for attenuation require an analysis to determine existing drainage routes and need careful consideration of potential disturbances of subsoil contaminates.

The Environment Agency should review the existing modelling of Millingford Brook and update it to include the bypass box culvert, to better understand the modelled flood risk.

Timescale: by Spring 2026

In 2011, a bypass box culvert was installed under Lincoln Drive. The Environment Agency should review and update the Millingford Brook model to include blockage modelling and improve understanding of the impacts of the culvert on flood risk.

Wigan Council, United Utilities and the Environment Agency should work in partnership to undertake a feasibility study to explore potential actions for alleviating flood risk in the Lincoln Drive area, including options in the upstream catchment.

Timescale: by Summer 2026

The flood risk in this area is reported to result from both overtopping of Millingford Brook (main river) and surcharging of the surface water sewers and highway drains when the level in the brook rises. A contributing factor to the overtopping is reported to be eroded banks of the Millingford Brook. A feasibility study should explore actions to alleviate flood risk in this area, based on the updated modelling discussed in the previous recommendation. This could include bank stabilisation (working with riparian owners), raised defences and flood risk management infrastructure, increasing the drainage network capacity where required, and PFR measures for individual properties where a residual risk remains.

Measures in the upstream catchment should also be explored, such as Natural Flood Management (NFM), attenuation, rainfall capture, and land use management.

The Environment Agency should set a threshold on the level at the at Lincoln Drive gauging station to be used for the Flood Warning service.

Timescale: by the end of 2025

The current Flood Warnings for the area are issued based on levels at a gauge further upstream (Ivy Street). This resulted in no warning being issued during the January 2025 event because the river level upstream did not reach the required threshold. Setting a threshold for issuing warnings based on river levels at the gauge at Lincoln Drive would provide warnings based on more local river levels and this would help the community to take action in advance of a flood event and improve community resilience. If this is not possible, the Environment Agency should liaise with the Flood Action Group to assist the community in installing a gauge and provide guidance on setting appropriate thresholds and alerts.

The local Flood Action Group, supported by the National Flood Forum, Wigan Council (Resilience Team and the LLFA), the Environment Agency, and United Utilities, should create a community Flood Action Plan to formalise any existing emergency response plans.

Timescale: by the end of 2025

Residents in the Lincoln Drive area are already active in taking steps to improve their preparedness and resilience to flooding. Formalising a Flood Action Plan will allow all residents to take ownership of their flood risk, increase awareness, and improve community preparedness.

The Flood Action Plan should include information for use by the Emergency Services with details of the most vulnerable residents in the area. The Flood Action Plan could also investigate possible locations for a temporary barrier to be deployed by the community when flood events are expected, to divert floodwater back into the Millingford Brook. This should be linked to the flood warning mechanism, to allow residents to erect the barrier and intercept flows.

Wigan Council should review their flood risk asset register and identify assets critical to flood management.

Timescale: ongoing

In line with Section 21 of the Flood and Water Management Act, Wigan Council should review and update their records of all flood risk assets in the area. Having an awareness of those that are particularly significant will help target maintenance and inspections of assets, so they are fully operational during flood events.

A Appendix: Hydrological summary of the events

A.1 Hydrometric data

Figure A-1 shows the locations of hydrometric data from river level and rain gauges in the vicinity of the flooded site assessed in this report. These include:

- five rain gauges within a 15km radius of the study area; and
- two level gauges on Millingford Brook:
  - Ivy Street, 1.0km upstream of the flooded properties assessed here,
  - Lincoln Drive, adjacent to the site of interest in this report.

Millingford Brook drains a catchment area of 10.6km^2 to the Lincoln Drive level gauge.

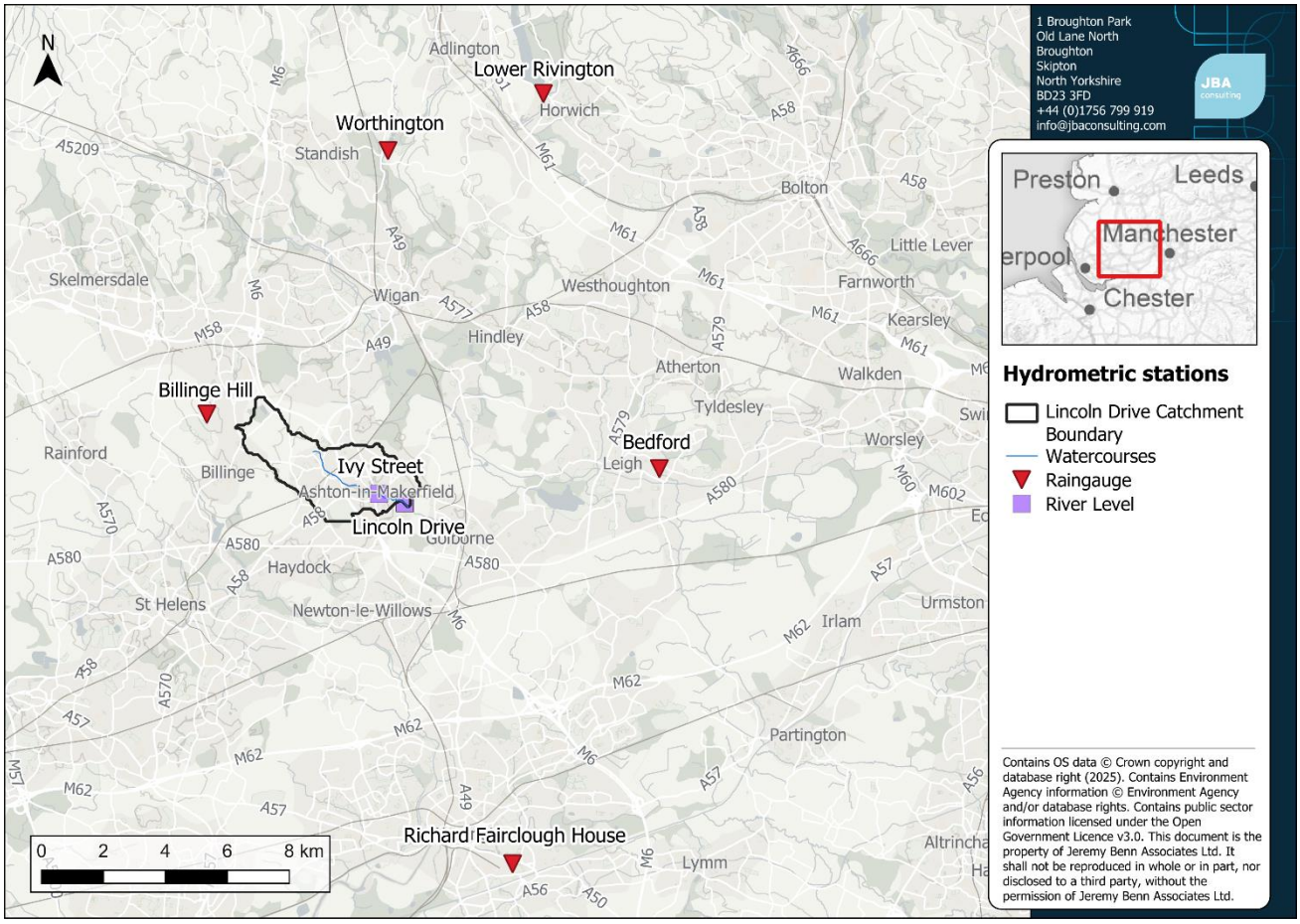


Figure A-1: Hydrometric stations around Lincoln Drive.

Table A-1 summarises the available hydrometric data at each gauge.

Table A-1: Hydrometric data summary.

Gauge name	Type	Period of record	Further notes
Lower Rivington	Sub-daily raingauge	April 1995 to March 2025	Located on high ground to the north of the catchment (118mAOD). Likely generally receives greater rainfall relative to the study area (circa 30mAOD).
Worthington	Sub-daily raingauge	June 1998 to March 2025	None
Billinge Hill	Sub-daily raingauge	July 1995 to March 2025	Located on high ground a short distance to the west of the catchment (165mAOD).
Bedford	Sub-daily raingauge	November 1990 to March 2025	None
Richard Fairclough House	Sub-daily raingauge	March 1996 to March 2025	12km south of the flooded study area, located in Warrington.
Ivy Street	Level-only	March 2002 to March 2025	Level record appears reliable from a brief review.
Lincoln Drive	Level-only	July 2013 to March 2025	Suspected inconsistencies over time present in the dataset.

A.2 1 January 2025 event

A.2.1 Conditions leading up to the event

A high-level review from the 'UK Water Resources Portal' (UK Centre for Ecology and Hydrology) in Figure A-2 indicates the overall average monthly rainfall and resulting river flows in December 2024 were 'Notably High' in the month leading to the 1 January 2025 flood event, relative to conditions in the long-term record for that time of year.

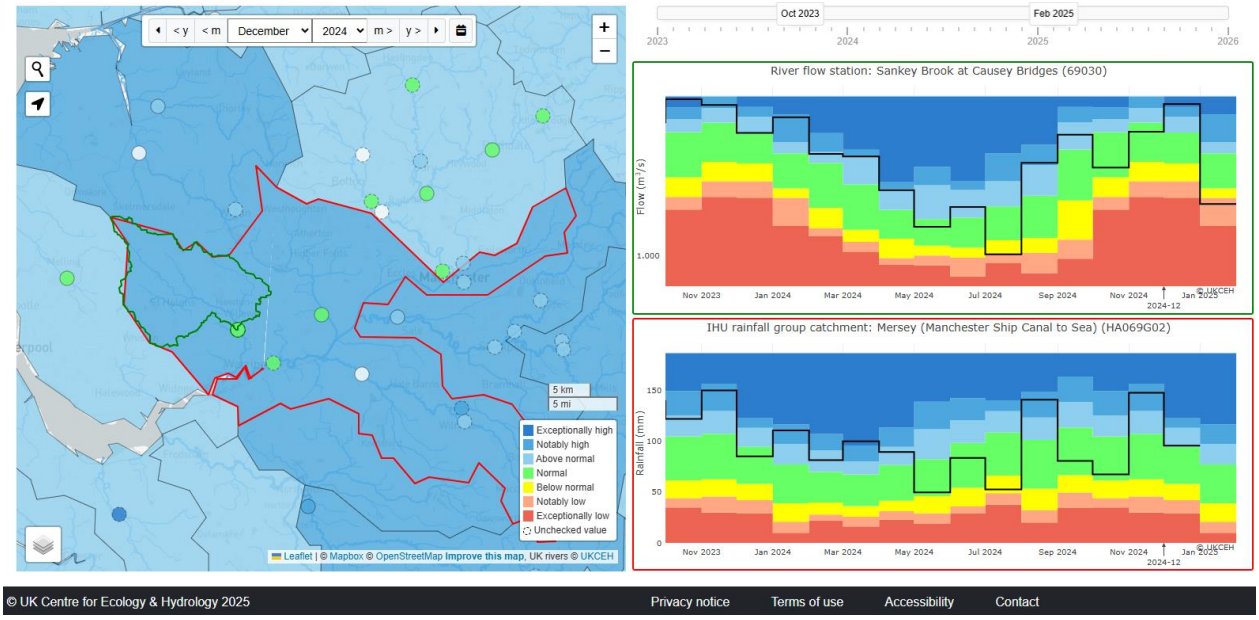


Figure A-2: Screenshot from the UK Centre for Ecology and Hydrology Water Resources Portal (© UK Centre for Ecology and Hydrology 2025).

The local rain gauge data shows a more nuanced picture. The plots in Figure A-3 show daily rainfall (09:00 to 09:00 the following day) over December 2024. The final bar highlighted in red includes the rainfall driving the observed flooding on 1 January 2025. These data indicate the rainfall between 31 December 2024 to 1 January 2025 makes up a dominant fraction (roughly half) of the December 2024 monthly rainfall sum.

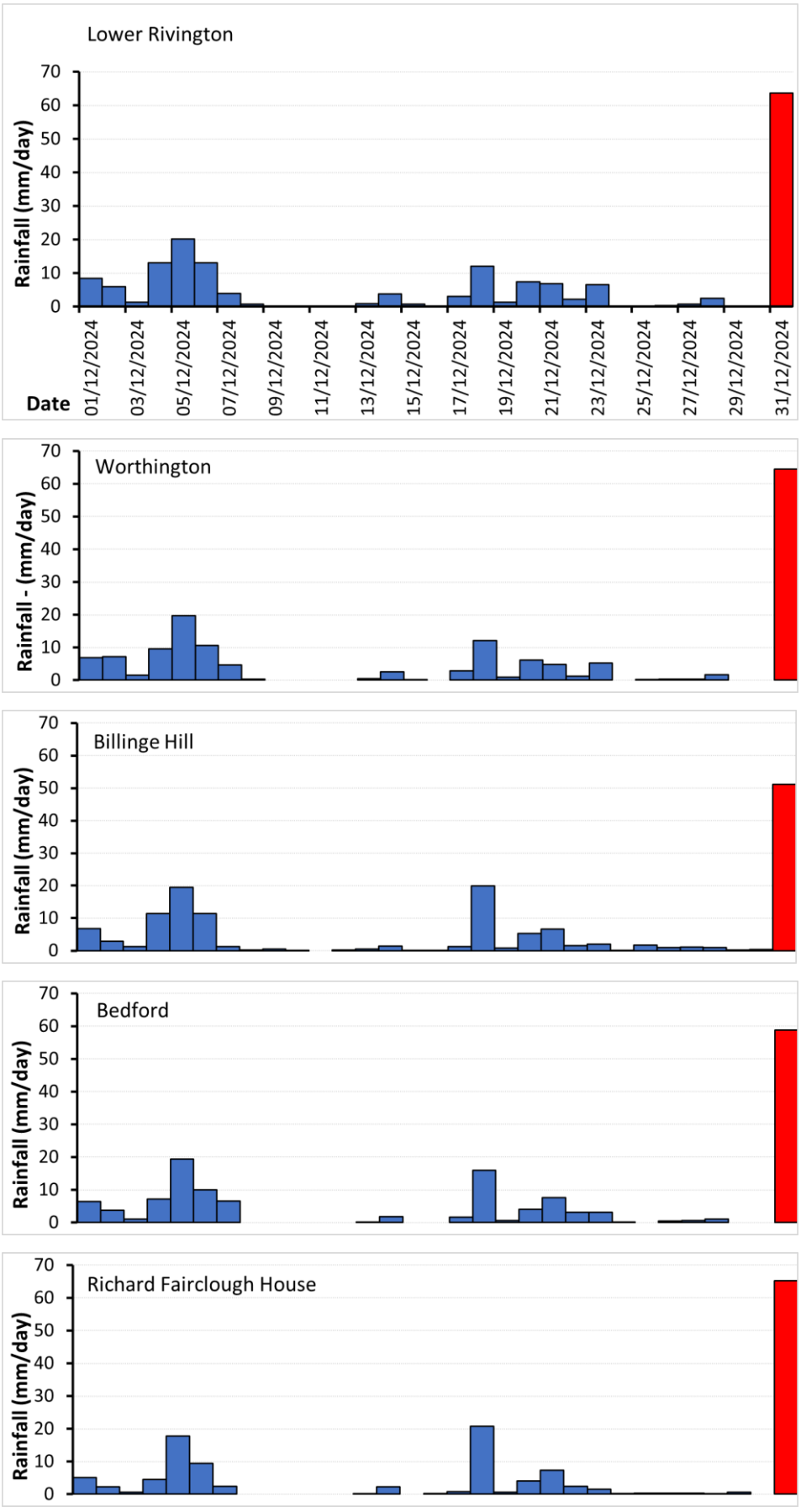


Figure A-3: Antecedent daily rainfall over December 2024.

Table A-2: Antecedent period rainfall review for December 2024.

Rain gauge	5-day summed rain prior to event (09:00 26 Dec to 09:00 31 Dec)	Daily rainfall (09:00 31 Dec to 09:00 1 Jan)	December 2024 rain as a % of long-term monthly average
Lower Rivington	3.6mm	63.6mm	133% including event 86% excluding event
Worthington	2.4mm	64.4mm	135% including event 82% excluding event
Billinge Hill	3.7mm	51.2mm	141% including event 93% excluding event
Bedford	2.0mm	58.8mm	155% including event 95% excluding event
Richard Fairclough House	1.5mm	65.2mm	153% including event 86% excluding event

Table A-2 shows that the climatic antecedent conditions in the weeks and days leading up to the flood event were not particularly unusual. Omitting the flood event itself, the remaining summed December 2024 rainfall is not particularly notable at any nearby rain gauge, falling slightly below the long-term December monthly average.

Despite the heavy rainfall during 31 December to 1 January period, the December 2024 monthly rainfall was exceeded in 2023, 2015, 2012, 2011, and 1999 over the prior quarter-century.

A.2.2 Rainfall and fluvial response

15-minute resolution rainfall for 31 December 2024 to 2 January 2025 generally shows a double-peak rainstorm profile. The first high-intensity peak occurred around 18:00 to 21:00 on 31 December. 10mm - 20mm fell in this initial period. Rainfall persisted through the night to the morning, with a second high-intensity peak around 02:00 to 04:00 on 1 January. This was a heavier and more prolonged rainstorm period, with 30mm - 40mm falling.

The majority of residents that reported internal flooding in the questionnaire stated that water entered their properties between 04:00 and 05:00, with some on Chester Drive reporting that the flooding started between 05:00 and 06:00.

United Utilities Princess Road (Peter St) CSO (50006) started discharging into the brook at 21:59 on the 31 December 2024 and stopped discharged at 15:43 on 1 January 2025.

Figure A-4 shows the fluvial response of Millingford Brook to the 1 January flood event, versus the closest rain gauge to the catchment (Billinge Hill). There was a short lag time between the rainfall and subsequent hydrograph peak.

- The rainstorm began around 12:00 on 31 December, with river levels showing a response from 18:00 onwards.
- River levels rose continuously in response to the persistent rainfall, peaking around 06:00 on 1 January.
- The hydrograph peak persisted for a longer time at Lincoln Drive relative to Ivy Street, likely due to the relative positions of these gauges. The Lincoln Drive gauge is located lower in the catchment and captures a greater volume of runoff from the surrounding urbanised catchment, relative to Ivy Street.
- The rainstorm was less intense after 06:00, with river levels falling relatively quickly, returning to high baseflow conditions around 18:00 on 1 January.

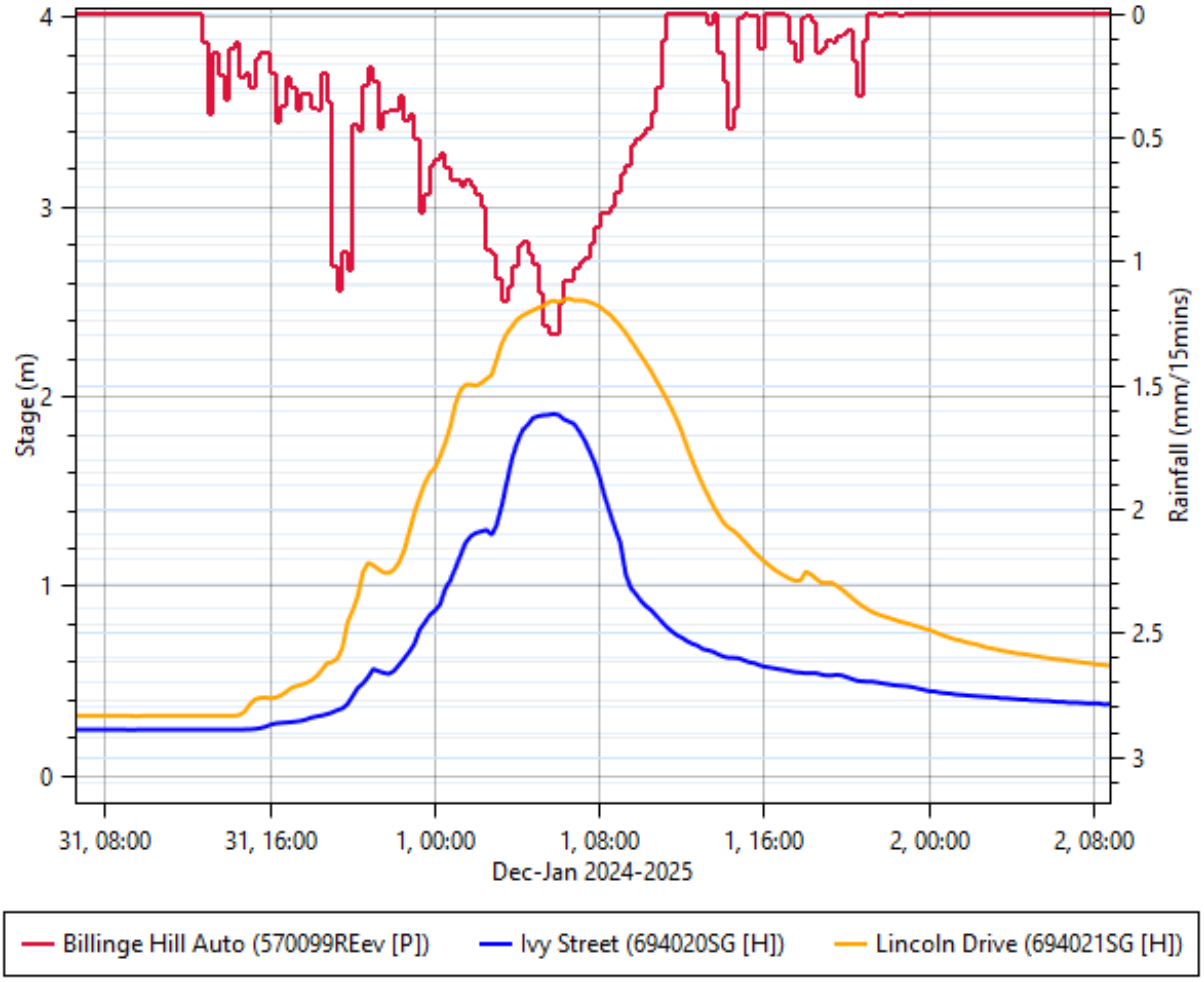


Figure A-4: Fluvial response to the 1 January 2025 flood event at nearby river level gauges.

A.2.3 Rainfall return period estimation

The industry-standard Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) 2022 model (FEH22 model) estimates the rarity of observed rainstorms. The FEH22 model was applied in a rolling-window manner to the observed rainstorm data, for various durations between 1 hour to 30 hours, applied to both the 1 January 2025 and 30

September 2024 events. The worst-case result was obtained for the 16-hour window across all gauges as shown in Table A-3.

Table A-3: Rainfall event rarity analysis for the 1 January 2025 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Lower Rivington	60.0mm	3.4%
Worthington	61.2mm	2.1%
Billinge Hill	48.3mm	9.2%
Bedford	57.6mm	2.8%
Richard Fairclough House	64.5mm	1.5%

The result is less extreme at Billinge Hill due to the lower intensity / more prolonged nature of the recorded rainfall there, relative to the other nearby gauges. The remaining gauges give a consistent result, indicating a rainfall annual probability of around 1.5% - 3.5% for the 1 January event. The Billinge Hill gauge is geographically closer to the flooded properties near Lincoln Drive, and therefore likely gives a more representative result from the options presented above.

A.2.4 Fluvial event probability estimation

This section concentrates on fluvial analysis for the 1 January 2025 event only, as the 30 September 2024 event was reported as a rainfall-dominated flood event.

The level-only gauges at Ivy Street and Lincoln Drive give an initial picture of the severity of the fluvial flood at Lincoln Drive. The absence of a formal river flow gauge in the locality makes it difficult to apply standard FEH methods in this case. Results from the simplified methods applied here to the level-only data are therefore indicative only. A peak-over-threshold (POT) analysis provides an initial check for the 1 January 2025 event severity, relative to historic conditions at the two nearby level gauges on Millingford Brook.

Figure A-5 shows the POT records at the Ivy Street gauge (period of record from 2002 to 2025) and Lincoln Drive gauge (period of record from 2013 to 2025). The red bar in these plots shows the 1 January 2025 event. There is greater confidence in frequency calculations at Ivy Street because:

- There is a much longer record length at Ivy Street (24 years at the time of writing).
- The post-June 2019 POT data at Lincoln Drive show a suspicious change in behaviour, with much more frequent POT events relative to the pre-June 2019 period and to the overall Ivy Street record. This is a possible indication of a physical change at the Lincoln Drive gauging site, such as increased blockage frequency for example.
- Potentially related to the above point, the Lincoln Drive data also shows a gradually increasing trend over time.

- On the other hand, a visual check shows no obvious trend over time in the POT levels at the Ivy Street gauge.

The Ivy Street gauge alone informs the following interpretations, as a result of the uncertainties listed above for the Lincoln Drive level gauge, which would unrealistically skew the event rarity assessment.

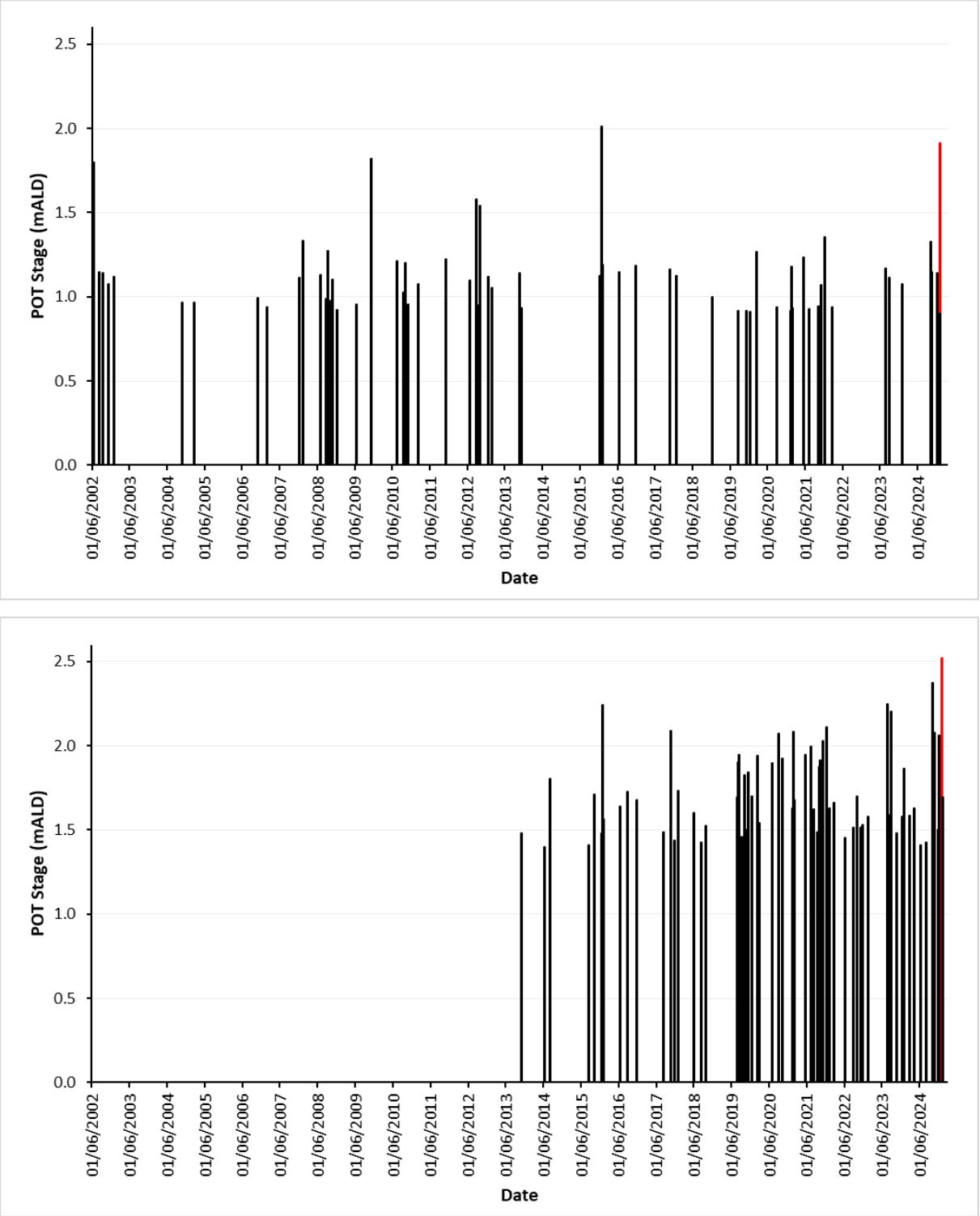


Figure A-5: POT level series for Ivy Street (upper) and Lincoln Drive (lower).

The 1 January 2025 event is the second-largest peak in the available 24-year record length at Ivy Street with a locally recorded peak level of 1.911m above local gauge datum (mALD). This was exceeded by 0.10m by the 26 December 2015 flood event, which was a widespread flood event seen at most gauges in northern England. The third-largest POT event was 0.09m lower, recorded on 4 November 2009.

A ranking assessment using the Gringorten formula gives an approximate 6.5% annual probability for the 1 January 2025 flood event (2nd largest peak observed in a 24-year record length).

A.3 30 September 2024

A.3.1 Conditions leading up to the event

Surface water and sewer flooding was also reported in the locality on 30 September 2024. Similar to the 1 January 2025 event, weather conditions were also wet over this period, relative to the long-term past weather patterns. Overall, the rainfall on the 30 September 2024 alone made up a dominant fraction (roughly 25%) of the September 2024 monthly rainfall sum.

Rainfall totals at the rain gauges show that the climatic antecedent conditions in the weeks and days leading up to the flood event were relatively wet. Even if the 30 September 2024 rainfall is omitted, the monthly sum still shows as being significantly wetter versus an average September monthly rainfall. The September 2024 monthly rainfall ranks as one of the top three wettest values in the gauged time period at the gauges assessed here, when ranked versus September monthly rainfall totals in previous years.

Figure A-6 shows daily rainfall (09:00 to 09:00 the following day) over September 2024. The final bar highlighted in red includes the rainfall driving the observed surface water flooding on 30 September 2024. Overall, the rainfall on that day alone made up a dominant fraction (roughly 25%) of the September 2024 monthly rainfall sum.

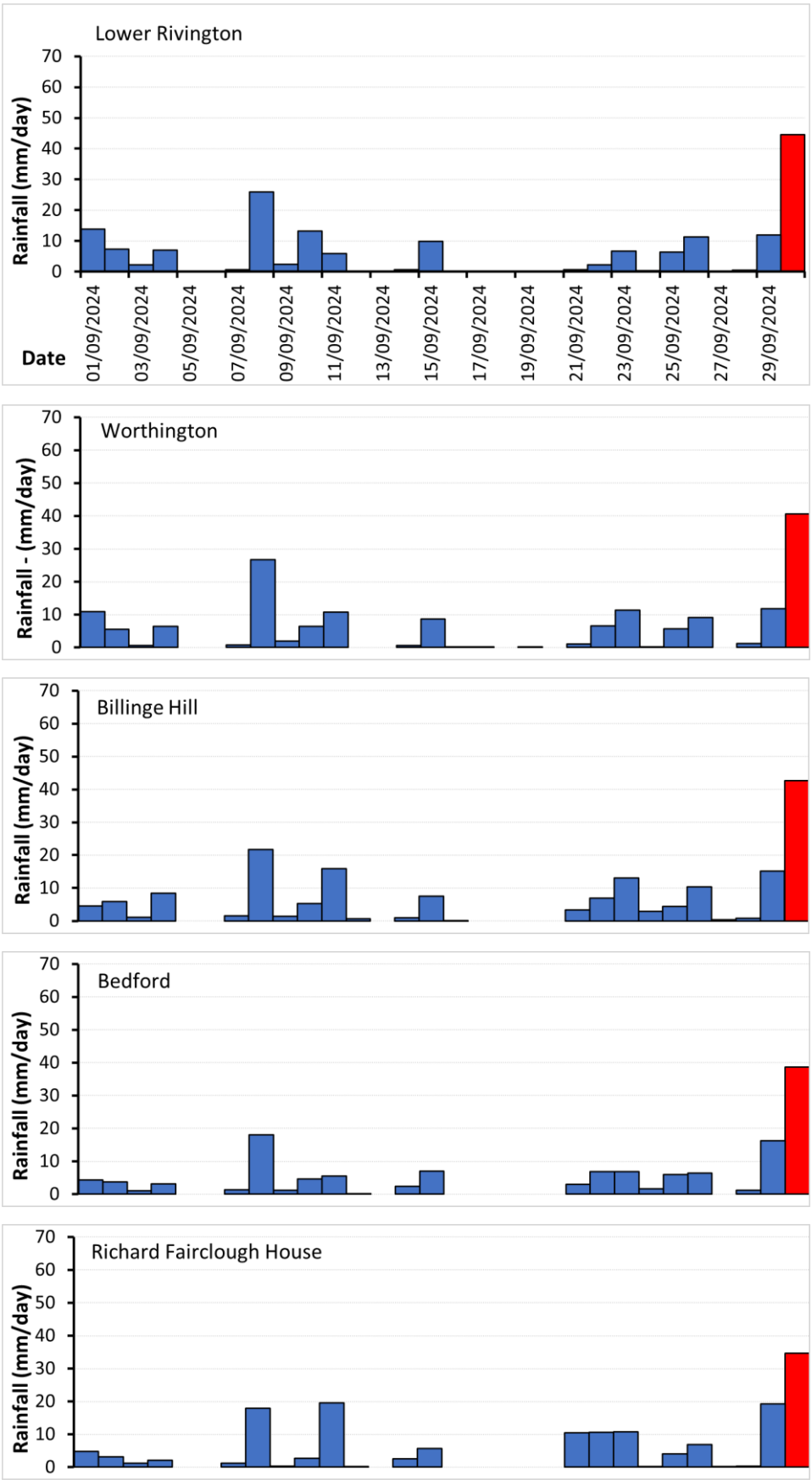


Figure A-6: Antecedent daily rainfall over September 2024.

Table A-4: Antecedent period rainfall review for September 2024.

Rain gauge	5-day summed rain prior to event (09:00 25 Sep to 09:00 30 Sep)	Daily rainfall (09:00 30 Sep to 09:00 1 Oct)	September 2024 rain as a % of long-term monthly average
Lower Rivington	30.1mm	44.6mm	163% including event 121% excluding event
Worthington	28.0mm	40.6mm	159% including event 120% excluding event
Billinge Hill	31.0mm	42.7mm	180% including event 136% excluding event
Bedford	29.8mm	38.6mm	182% including event 132% excluding event
Richard Fairclough House	30.7mm	34.6mm	201% including event 157% excluding event

Table A-4 shows that the climatic antecedent conditions in the weeks and days leading up to the flood event were relatively wet. Even if the 30 September 2024 rainfall is omitted, the monthly sum still shows as being significantly wetter versus an average September monthly rainfall. The September 2024 monthly rainfall ranks as one of the top three wettest values in the gauged time period at the gauges assessed here, when ranked versus September monthly rainfall totals in previous years.

A.3.2 Rainfall

15-minute resolution rainfall for 29 September 2024 to 1 October 2024 generally shows a single-peak rainfall pattern during the event. The persistent rainfall began around 00:00 on 30 September and gradually increased in intensity, up to 12:00 - 15:00. The storm intensity gradually reduced afterwards, ending around 18:00 - 21:00 on 30 September. The main rainstorm pulse contained around 50mm according to the local rain gauges. There also appears to be a spatial pattern present, with a slight increase in the storm intensity in the northern / eastern rain gauges (Lower Rivington, Worthington and Billinge Hill) compared to the southern / western gauges which are further from the Lincoln Drive properties (Bedford and Richard Fairclough House gauges).

A.3.3 Rainfall analysis

The rain gauges closer to the flooded sites near Lincoln Drive give a worst-case result for a 10-hour rolling window duration. Gauges further away from the site indicate worst-case results for a 20-hour rolling window duration.

Table A-5: Rainfall event rarity analysis for the 30 September 2024 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Lower Rivington	45.7mm (10hr duration)	8.0%
Worthington	41.6mm (10hr duration)	9.9%
Billinge Hill	44.2mm (10hr duration)	7.1%
Bedford	49.2mm (20hr duration)	9.3%
Richard Fairclough House	46.9mm (20hr duration)	9.6%

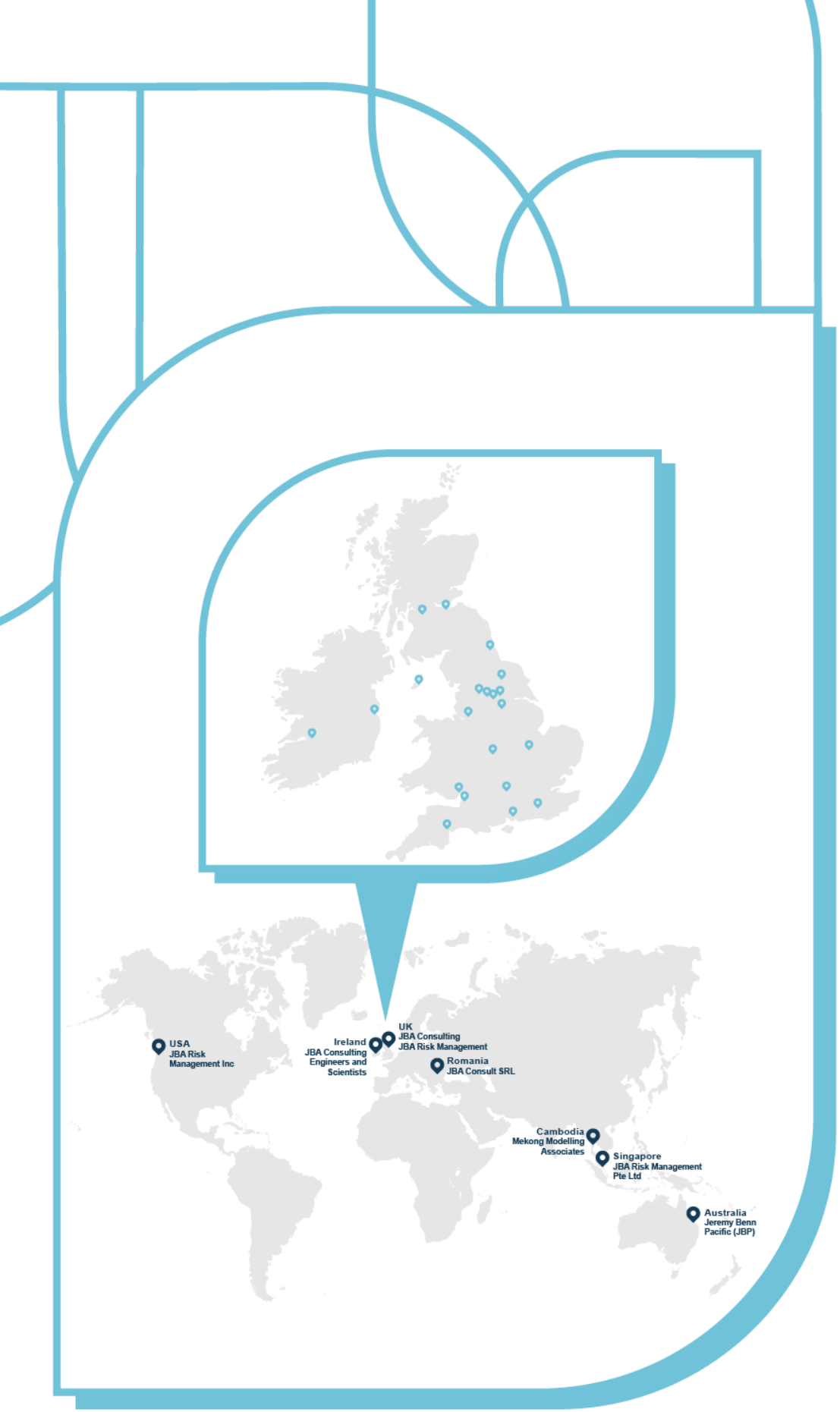
Table A-5 indicates a rainfall annual probability of 7% - 10% for the 30 September 2024 event, if concentrating on the rain gauges closer to the site. The Billinge Hill gauge is geographically closer to the flooded properties near Lincoln Drive, and therefore likely gives a more representative result from the options presented above.

A.4 Summary

Antecedent conditions in the weeks and days leading up to the 1 January 2025 event were not particularly unusual. This points to the rainstorm event itself being the main driver of the observed flooding in the Lincoln Drive area. The double-peak nature of the rainstorm and its long duration were the combined main drivers of high fluvial flows. The first peak (around 10 mm - 20mm) likely reduced soil storage in the catchment. The immediate occurrence of the second larger peak (30mm - 40mm) was exacerbated by this initial peak. Applying standard FEH methods to the rainfall and level gauge data gives good agreement on the event annual probability, between 6% to 10%.

The derived result for fluvial flooding is less certain. River flows can be estimated at the Ivy Street gauge using a rating curve, but this rating is not reliable in high-flow conditions. As far as can be determined, there are no past high flow spot gauging records to provide any confidence in this rating in high-flow conditions. The rating is also not currently used for operational flood warning purposes. Flows from this rating are therefore not suitable for analysis in this study.

A rainfall-only analysis for the 30 September 2024 event gives a 7% to 10% annual probability for the rainfall that drove the observed surface water flooding in the Lincoln Drive area. Unlike the 1 January 2025 flood, the antecedent conditions of this event were relatively wet, which likely additionally contributed to the observed surface water flooding on that date.



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