

LONDON RESILIENCE PARTNERSHIP

Strategic Flood Response Framework

London Resilience Partnership Strategic Flood Response Framework

Version: 3.2

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Version Control			
Version	Date	Owner	Changes
V1.2	September-October 2012	Joe Cuthbertson	Significant amendments from previous flood framework, incorporating updates to flood warning codes, weather products and references to plans and organisations.
V1.3	January 2012	Joe Cuthbertson	Incorporation of comments from across the Partnership (virtual flooding task & finish group) who supplied comments between October and December 2011.
V1.4	March 2012	Joe Cuthbertson	Final series of amendments following further consultation in February and March 2012 for approval by LRPB.
V1.5	March 2012	Joe Cuthbertson	Final minor amendments to produce version for LLRF sign-off.
V2	18 April 2012	Joe Cuthbertson	Version number changed to reflect LLRF sign-off on 16 April 2012.
V2.1	February 2015	Hayley Deakin	Draft revision following lessons learnt from Winter 2014 floods. Incorporation of comments from the LRP flooding sub group. Amendments include a comprehensive triggers and actions section, SCG considerations and improved flood risk contextualisation section.
V2.2	14 May 2015	Hayley Deakin	Incorporated feedback following London Resilience Partnership consultation period. Version for LRBP approval.
V2.3	21 May 2015	Hayley Deakin	Incorporated minor feedback following LRPB. Final version for London LRF sign off.
V3	10 June 2015	Hayley Deakin	Version number changed
V3.1	November 2019	Hayley Deakin	Draft version following lessons learnt from Heavy rainfall summit. Amendments to include triggers focussed on forecast impact level rather than colouration, added in example SCG flood strategy, updated risk register flooding outcome descriptions, moved into new LRG template.
V3.2	January 2020	Hayley Deakin	Amendments made from comments received from consultation.

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How to use the Strategic Flood Response Framework

This framework is split into two parts the Part 1 offers a quick reference guide for strategic decision-makers responding to a flooding incident in London. It should be used alongside the London Strategic Coordination Protocol.

Part 2 offers guidance relating to a Strategic Flood Response incident. It is intended to complement the preceding Strategic Summary of the response.

Introduction

This framework is aimed at members of the London Resilience Partnership and describes a coordinated strategic level planning for and response to a flooding incident in London.

The framework relates to the response to a flood event, causing or with the potential to cause significant and severe impacts. This includes flooding from rivers (fluvial), the sea (tidal), surface water, groundwater and reservoirs. This may be severe flooding in one or more locations or a greater number of less severe flooding in multiple locations within London.

This plan excludes flooding from burst water mains, as this is perceived to have local impacts only and should be captured within Borough level Multi-agency Flood Plans.

Aim and Objectives

This framework aims to provide strategic direction to London responders, before, during and after a significant flooding incident in London.

The objectives of the London Strategic Flood Response Framework are to:

- Identify triggers and mechanisms for invoking a London-wide strategic response
- Provide responders with some context around the impacts of each type of flood risk
- Confirm the actions responders should take at each stage of a flooding incident
- Provide the necessary links to existing plans and procedures.

Part 1 – Strategic Flood Response Framework

This section offers a quick reference guide for strategic decision-makers responding to a flooding incident in London. It should be used alongside the London Strategic Coordination Protocol.

1.1 Action Checklist

The following action list is for strategic leads to consider if there is a need to activate this plan.

Complete	Action	Section
	Activate the plan	Section 3 – Activation Process
	Determine the structure of the response and which sub-groups will be required.	Section 4 – Structure and Sub-Groups
	Assess the immediate / short term implications	Section 5 – Key Considerations
	Assess the medium term considerations	Section 5 – Key Considerations
	Consider the longer term implications	Section 5 – Key Considerations
	Determine the resources and support available	Section 6 – Resources and Support Available
	Set strategy	Section 7 – SCG – Considerations for Strategy
	Refer to the guidance document for further information	Part 2 – Capability Guidance

1.2 Activation Process

There are 1 – 4 Levels within this framework. These levels can aid decision making in the event of a flood. These are similar to those triggers identified in local borough Multi-Agency Flood Plans.

Escalation through the levels may not always be sequential. More details on what considerations and actions should be taken at each level can be found in section 9 - Triggers for Activation and Levels of Response.

Level 1 represents the routine operations such as long term flood mitigation, adaptation work, horizon scanning, monitoring and forecasting services. There is no trigger for Level 1 of this framework. London will continually operate at Level 1 as Business as Usual.

Level 2 represents the preparation and planning phase in the lead up to a potential flooding incident. It is activated on receipt of flood forecasting products from the Environment Agency, Met Office and Flood Forecasting Centre or reports from partner agencies of possible failing infrastructure that could cause flooding for example a reservoir.

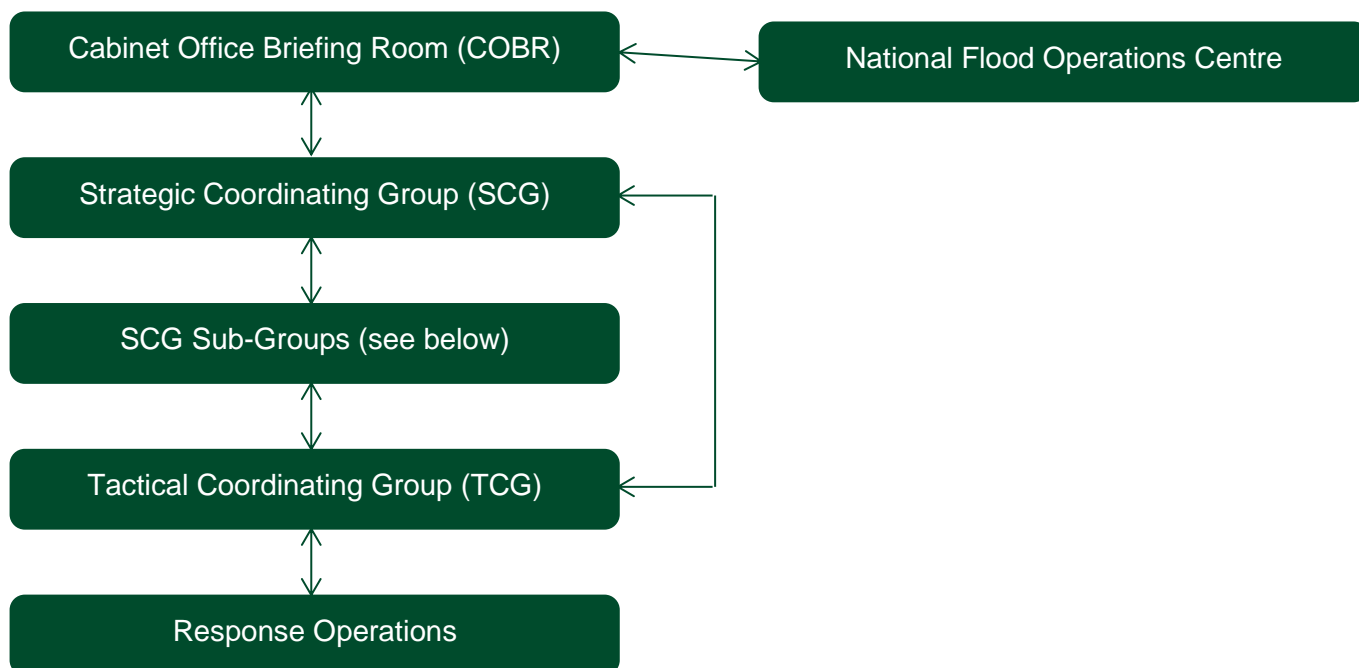
Level 3 represents the flood response phase. It is activated on receipt of flood warning products from the Environment Agency. Level 3 can also be activated by another partner agency that has received reports of failing infrastructure that is causing flooding.

Level 4 represents the strategic flood response which has either severe or wide reaching impacts across London and is activated through a tripartite discussion between the raising agency, London Resilience Group (LRG) and the Metropolitan Police Service.

1.3 Structure and Sub-Groups

The below diagram represents the command structure of a fully escalated flooding incident.

The National Flood Operations Centre is a specialist centre for Government Departments involved in responding to flooding to ensure they have joined up situational awareness to help advise COBR on the national situation. DEFRA as lead Government Department will decide in consultation with Civil Contingencies Secretariat when to open the National Flood Operations Centre.



Sub groups to be considered

An SCG will need to activate relevant sub groups to support the response. Below is a list (not necessarily extensive) of the sub groups an SCG might need in place to respond to a flooding incident.

Sub Group	Purpose	Lead organisation
Tactical Coordinating Group	Translate strategy into tactics and operations	Metropolitan Police Service
Communications Group	Ensure appropriate and consistent communications	Metropolitan Police Service
Humanitarian Assistance Steering Group	Facilitate psychosocial support to those affected	Local Authorities
Mass Casualties Coordinating Group	Coordinate the management of casualties	NHS
Mass Fatalities Coordinating Group	Coordinate the processes for managing fatalities	Metropolitan Police Service
Evacuation and Shelter Coordinating Group	Coordinate the processes for managing evacuation and shelter	Metropolitan Police Service
Scientific and Technical Advice Cell	Provides relevant health or environmental impact expert advice	Public Health England
Recovery Coordinating Group	Plan for and influence wider longer-term outcomes	Local Authorities

1.4 Key Considerations

The below table is a list of key considerations for operational, tactical and strategic responders when responding to flooding. It is to be used as an early guide of possible key issues to put in place arrangements for. The table may not be extensive.

Operational Responders	Tactical Responders	Strategic Responders
Initial Operational Response	Tactical command, control and coordination structures	Strategy
Threat and hazard assessment	Resource management	Multi-agency consequence management
Rescue and recovery	Contamination risks	International/national media
Triage, treatment and transportation	Any impact on water supply and other utility services	Communications and press strategy
Environmental protection	Warning and Informing	National reporting
Evacuation and shelter	Logistics (i.e. of evacuation and shelter)	Political sensitivities
Survivor Reception Centres, Rest Centres and Humanitarian Assistance (including access to services)	Impact on infrastructure	Impact on infrastructure
Decontamination of buildings and the environment	Vulnerable areas (schools, hospitals, basement dwellings etc.)	Vulnerable areas (schools, hospitals, basement dwellings etc.)
Contaminated waste disposal (used sandbags)	Casualty bureau	Critical National Infrastructure
Health and wellbeing (public and operational response staff)	Public Health impacts and advice	Threats to strategically significant locations and events
	Health and wellbeing (public and operational response staff)	Recovery planning (e.g. needs of communities)
		Economic and financial implications
		Legislation and policies
		Public health impacts and advice
		Loss of River Thames navigation due to consecutive barrier closures (e.g. impacts to construction projects)
		VIP visits

1.5 Resources and Support Available

Resources and support can be requested from across the London Resilience Partnership through the strategic coordination structures.

Resource / Support	Provider(s)
Temporary barriers / demountable*	EA / LFB
Pumping equipment*	EA / LFB / Contractors
Sandbags**	LAs / LFB / EA

Boats	LFB / RNLI
Military aid*	Military
Mutual aid (equipment or people)*	Any agency providing mutual aid

*National resources may not be available at the time of flooding incident

**Sandbags may be prioritised for internal organisational use

1.6 SCG objectives - Considerations for Strategy

An indicative set SCG Strategy is contained within the Strategic Coordination Protocol. The following are additional flood specific strategic objectives for consideration by the SCG:

- Be proactive and act early

When flooding hasn't happened yet but is forecast to potentially have catastrophic impacts SCG attendees will need to make decisions based on very little information i.e. a weather forecast alone. This might be before any rain has started to fall, and before we know which areas in London are likely to be the worst impacted. Strategic actions to consider are proactive evacuation and agreeing appropriate warning messages early etc.
- Protect and mitigate flooding to critical infrastructure

Flooding in London could happen quickly. Proactive deployment of equipment to help defend critical infrastructure or key assets should be assessed and the establishment of an appropriate sub group should be considered.
- Collaborative Flood Warning messaging

The Environment Agency's flood alerts and warnings are explained in appendix B3. These are issued to potentially thousands of Londoners directly if they live in flood zone.

The highest level of flood warning is a Severe Flood Warning which means danger to life. If time allows the Environment Agency will liaise with an SCG before issuing Severe Flood Warnings. The SCG can adapt the messaging and timing of these messages if they feel the need to.

The timing might need to be adapted to allow for extra resources in control rooms to answer a likely surge of 999 calls following danger to life messaging that has been issued (some flood warning areas will have thousands of properties registered).

Partners can add in additional messages in regards to where rest centres are or safe evacuation routes etc. There is however a word limit so all messages should be kept brief or act as signposts to further information. The SCG may want to use the communications sub group to advise or lead on carrying out on these actions.

See section 5 for further SCG considerations.

Part 2 – Capability Guidance Purpose

This section offers guidance relating to a Strategic Flood Response incident. It is intended to complement the preceding Strategic Summary of the response.

2.7 Links to other frameworks and plans

This guidance should be considered alongside the following resources as appropriate. Each regional framework listed has a capability lead in the partnership and can be used to assist any sub group in its formation.

This framework should also be used alongside Borough level Multi-agency Flood Plans (MAFP). A London Borough may want to activate their Borough MAFP locally if a Strategic local Partnership group has been activated to prepare for or respond to flooding.

National Documentation	<ul style="list-style-type: none"> National Flood Emergency Framework¹
Multi-LRF Framework²	<ul style="list-style-type: none"> The River Thames Scheme Maidenhead to Teddington emergency response plan³
Regional Frameworks	<ul style="list-style-type: none"> London Strategic Coordination Protocol LESLP Major Incident Procedure Manual Enfield Multi-agency Offsite reservoir Plan Recovery Management Protocol Mass Evacuation Framework Mass Shelter Framework The London Resilience Communication Group (LRCG) Emergency Plan Identification of the Vulnerable Severe Weather and Natural Hazards Framework Humanitarian Assistance Framework Mass Casualty Framework London Power Supply Disruption Framework Scientific and Technical Advice Cell Water Supply Disruption Plan
Local or Organisational Plans	<ul style="list-style-type: none"> London Borough Multi-Agency Flood Plans Environment Agency's What to do before, during and after a food guidance for the public Flooding health guidance and advice from Public Health England (PHE)

¹ The London Flood Response Framework sits below the National Flood Emergency Framework for England written by DEFRA.

² Flooding will usually stretch across administrative boundaries. Therefore it is important the LRF shares plans and maintains good relationships with its other neighbouring areas – Essex, Hertfordshire, Thames Valley, Surrey and Kent.

³ This plan outlines the arrangements for Thames Valley, Surrey and relevant London Boroughs (Richmond and Kingston) to respond to flooding together for one of the largest, most developed, undefended flood plains in England.

	<ul style="list-style-type: none"> • Frequently asked flooding health questions from PHE • Individual organisational and community flood plans
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2.8 Levels of Response: triggers and actions

LEVEL 1: Routine operations

Level 1 is a routine ongoing level which is business as usual, there is no trigger to activate level 1. Routinely Risk Management Authorities will work to mitigate flooding. This includes regular maintenance work (removing debris from watercourses or clearing out drainage systems etc), improving flood modelling, designing flood alleviation schemes, implementing sustainable urban drainage techniques and consenting on building works in flood zone, to name a few.

Emergency planning peacetime activities should include flood response planning, training, exercising and promotion of flood risk.

Horizon Scanning

Ongoing risk assessment and horizon scanning is integrated into category 1 and 2 responder's business as usual arrangements.

This includes keeping a watching brief over forecasts, Met Office weather warnings, Environment Agency flood alerts and warnings and the Flood Forecasting Centres Flood Guidance Statements.

It is important to be mindful of the potential for flooding in neighbouring counties to impact upon London.

Climate change and adaption

Climate change is causing rising sea levels and more extreme weather events such as flooding, droughts and heatwaves to occur. Climate change alongside London's population growth means that flood risk will increase, unless that risk is carefully managed.

The [Thames Estuary 2100 \(TE2100\) Plan](#) provides strategic direction for the management of tidal flood risk in the Thames estuary, from now until the end of the century. It is a plan that is adaptable to a changing climate and changing conditions along the estuary. The plan includes maintaining and raising current tidal flood defences, protecting land needed for future improvements to flood defences and monitoring how the estuary is changing.

The second [National Adaptation Programme 2018 to 2023](#) sets out a strategy for dealing with the effects of a changing climate.

The [Climate Change Act 2008](#) introduced the UK's first legally binding target for 2050 to reduce greenhouse gas emissions by at least 80% compared to 1990 levels. On 27 June 2019 the UK government [amended the Climate Change Act](#) and set a legally binding target to achieve net zero greenhouse gas emissions from across the UK economy by 2050.

Further information on climate change can be found on the GOV.UK pages here <https://www.gov.uk/government/policies/adapting-to-climate-change>

LEVEL 2: Flood Preparation

TRIGGERS FOR FLOOD PREPARATION:

1. London is issued a minor, significant or severe impact forecast via the Flood Guidance Statement
2. Environment Agency issues Flood Alerts for multiple locations in London
3. Problems have been identified with a reservoir that has not yet failed but has the potential to impact on London
4. There are issues with utilities infrastructure which has a possible secondary consequence of flooding i.e. rupturing water main

WHEN ONE OR MORE OF THE TRIGGERS HAVE BEEN MET SEE ACTIONS BELOW

ACTIONS FOR FLOOD PREPARATION:

Environment Agency, Met Office and London Resilience Group:

Severe impact forecast on Flood Guidance Statement (FGS):

- Call a partnership teleconference and communicate this to London Resilience Group.

Significant impact forecast on FGS:

- Jointly review the need to call a partnership teleconference and consult with London Resilience Group

Minor impact forecast on FGS:

- Consider sending a joint Met Office and EA email to the partnership outlining the current weather forecast, the hydrological situation, risk, possible impacts and level of plan

Risk Management Authorities:

- Pre-emptively clear and remove any debris from watercourses or drainage systems to ensure water can flow freely
- Operate any flood defence assets as necessary

All organisations:

- Report any observations of properties or infrastructure flooding to the relevant London Borough and the Environment Agency (appendix C includes guidance on reporting properties flooded)
- Assess the severity of primary and secondary impacts of flooding for their own organisation and decide whether response should be escalated to Level 3 or Level 4
- Manage staff to deal with a potential flooding incident, this may involve placing staff on standby or briefing key operatives internally
- Prepare to implement operational response plans including borough Multi-agency Flood Plans (MAFPs)
- Communicate any concerns or issues over critical infrastructure early so London Fire Brigade or Environment Agency can assess whether they can help by deploying temporary barrier equipment
- Escalate or open organisational control centres
- Check your business continuity plans to ensure your organisations critical business activities can still be met in the event of a flood

- Prepare for potential media interest. Consider issuing proactive press releases providing advice to public on how to prepare for flooding
- Keep a watching brief on the situation and up to date with the latest forecasts.

Escalating from LEVEL 2 Flood Preparation to LEVEL 3 Flood Response:

There may be a period of inactivity between the preparation phase and the response phase. This could range from hours to days depending on the detail and confidence of the weather/flood forecasts.

There will be occasions when the preparation phase (Level 2) is activated but response phase (Level 3) is not necessary. Activating the preparation phase ensures responders stay ahead of the incident, instead of trying to catch up during the response phase.

LEVEL 3: Flood Response - Triggers and Actions

TRIGGERS FOR FLOOD RESPONSE

1. There are Flood Warnings in force in London
2. Any organisation becomes aware of widespread disruption to transport or other infrastructure due to flooding from any source
3. Reports of properties flooding internally in multiple locations (Boroughs) across London
4. A reservoir which has the potential to impact on London is failing
5. A flood defence structure has been breached or has failed with significant impact for London
6. Cabinet Office Briefing Room (COBR) is opening due to flooding in London or flooding has the potential to affect London

WHEN ONE OR MORE OF THE TRIGGERS HAVE BEEN MET, SEE ACTIONS BELOW

ACTIONS TO CONSIDER FOR FLOOD RESPONSE:

London Resilience Group, Environment Agency or other affected organisation:

- Ensure regular partnership teleconferences are scheduled
- Continually review the need to establish pan London TCG or SCG

All Organisations:

- Assess the severity for their own organisation and decide whether response should be escalated to Level 4 (strategic flood response)
- Activate emergency response plans and/or BCM plans where appropriate
- Communicate any concerns or issues over critical infrastructure early so London Fire Brigade or Environment Agency can assess whether they can help by deploying temporary barrier equipment
- Scale up. Open control centres / incident rooms where appropriate to provide coordination for your organisation and a central point of contact
- Check the status of key sites and infrastructure that are known to be in flood risk areas.
- Media messages need to be agreed and circulated on a regular basis. A flooding situation can change rapidly.
- Report all details of any flooded properties or infrastructure and pass them to the Environment Agency and relevant London Borough or LLACC (if open) on a regular basis.

LEVEL 4: London Strategic Flood Response - Triggers and Actions

TRIGGER FOR STRATEGIC RESPONSE:

1. A Severe Flood Warning is planned to be issued or has been issued by the Environment Agency.
2. Any partner agency decides they need to escalate the response to SCG level and calls a tripartite discussion between a raising agency (any agency), the Metropolitan Police and London Resilience Group to consider activating an SCG.

ACTIONS TO CONSIDER FOR FLOOD RESPONSE:

London Resilience Group:

- Inform all partners that a Strategic Coordinating Group for London is being held.

The full arrangements for activating strategic response in London are contained in the London Strategic Coordination Protocol.

Refer to Part 1: Strategic Summary, in particular:

- Action Checklist (section 2)
- Structure of the response and which sub-groups will be required (section 4)
- Strategic key considerations (section 5)
- SCG - Considerations for Strategy (section 7)

De-escalating from Level 4 Strategic Flood Response:

Following a Level 4 response, before returning back to level 1 there will be a period of recovery and de-escalation. It is possible that following a de-escalation from Level 4 to Level 2/3, there could be further escalations dependant on the forecast/conditions.

2.9 Roles & Responsibilities

[London Emergency Services Liaison Panel \(LES�P\)](#) describes the generic roles and responsibilities of its members within London. The Cabinet Office [Emergency Response and Recovery](#) guidance describes specific responsibilities across the full range of Category 1 and 2 responders and other response organisations. The [National Flood Emergency Framework for England](#) describes the specific roles of lead government departments, the Environment Agency, Flood Forecasting Centre and other national organisations in the response to flooding.

Lead agency throughout a flood event

The lead agency during a flood depends upon the level of the flood event, impacts, flood type and response actions.

During a smaller scale flood event (Level 3) the Local Authority or Police may lead dependant on the impacts and which organisation has the primary response actions to manage the impacts.

The response phase of a widespread pan-London flood event (Level 4) would be the Police. Recovery stage is led by the Local Authority

Flood Risk Management - Who is responsible?

The Environment Agency has a strategic overview of all types of flood risk and works closely with Lead Local Flood Authorities and other Risk Management Authorities in order to manage the risk. The below table shows which organisations manages flood risk day to day, this is not to be confused with which organisation might lead during the response and recovery phases, which is outlined in the previous page. Flooding is a complex hazard and so it is worth bearing in mind that different sources of flooding often happen together and impact one another with many different Risk Management Authorities.

For example highway flooding caused by a blocked sewer is not the responsibility of the Highways Authority. Reservoir responsibility is explained in appendix A.5.

Flood Risk Type / Organisation	Main rivers (large rivers)	Ordinary watercourses	Surface water	Ground water	Sewer flooding	Road drainage	Offsite reservoir	Onsite reservoir	Canals and artificial waterways
Environment Agency	X								
London Boroughs (Lead Local Flood Authorities and Highways Authorities)		X	X	X		X Non Motorway or TLRN (Transport for London Route Network) roads	X		
Highways England						X Motorway Roads			
Transport for London (TfL)						X Red route roads TLRN			
Utility companies					X				
Canal and Rivers Trust									X
Reservoir owner								X	

APPENDIX A: Flood Risk in London

This section provides a summary of the types of flooding, risk and possible impacts in London.

A 1. Surface Water Flooding

Hazard description

Surface water flooding occurs where rainfall exceeds natural and highway drainage capacity and therefore lies or flows over the ground instead. Surface water flooding can occur very quickly with little or no warning.

This will often result from intense downpours over small localised areas and also from more prolonged rainfall over a wide area where the ground becomes saturated.

Road networks are affected most frequently from seemingly small amounts of rainfall and properties are affected in the more severe events.

London's built-up land surface does not allow rainwater to soak away into the ground. Therefore there is an increased risk that severe rain will lead rapidly to flooding. A major surface water flood would cause great property damage, with a high chance of loss of life, especially in basement dwellings.

There are more properties and infrastructure at high risk of surface water flooding in London than from any other source of flooding with over 68,000 properties at high risk. The below maps show the high, medium and low likelihood of surface water flooding, indicating numbers of postcodes at risk. It highlights Westminster, Hammersmith and Fulham and Kensington and Chelsea as being the most at risk London boroughs.

London Risk Register Reasonable Worst Case Scenario Outcome Description

- Severe impact but low likelihood thunderstorm forecast is in place across the South East in the Summertime. The certainty is low and specific locations are unknown. There is very little lead time, less than 1 day.
- High intensity rainfall in London begins to fall recording exceptional levels of rainfall over a very short duration.
- Flooding of up to 87,000 properties and 21,000 businesses (108,000 properties in total).
- Just over 40 fatalities and thousands of casualties.
- Evacuation of up to 314,000 people (25,000 of which may require additional assistance).
- Short to medium term shelter requirements for 117,000 residents.
- Infrastructure is impacted including roads, railway lines, gas, electricity and water. Closure of schools in affected area for over 1 month.

Warning lead times

In very intense storms, typical in summer months, localised flooding can occur within minutes of the rain starting. More widespread flooding could happen within a few hours. In general to implement any operational response to reduce impacts (for example erecting temporary barriers) would need to be carried out on the basis of a forecast. Multi Agency Flood Plans should have identified critical or vulnerable areas that would merit protection.

It is important to note that a heavy rainfall weather forecast is unlikely to be able to pinpoint specific areas in London that might be worst affected. Often forecasts of this nature cover all of London.

Warning methods

Warnings for surface water flooding will be via Flood Guidance Statements and Met Office severe weather warnings. There may be low confidence of precise impacts and locations especially for thunderstorm events.



Heat map showing surface water risk by London Boroughs based on postcodes

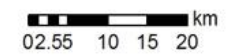
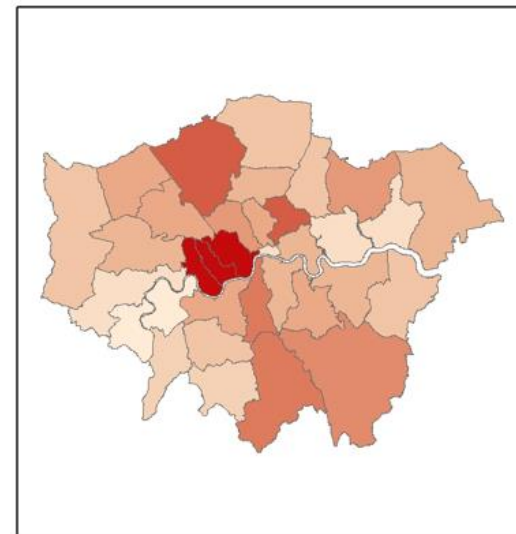
1 in 30 (3.3%)



1 in 100 (1%)



1 in 1000 (0.1%)



A 2. Groundwater Flooding

Hazard description

Flooding from groundwater can happen when the level of water within the rock or soil that makes up the land surface (known as the water table) rises and reaches ground level. The level of the water table changes with the seasons due to variations in long term rainfall and water abstraction.

There are some key features of flooding from groundwater:

- Flooding will usually occur days or even weeks after heavy or prolonged rainfall.
- Flooding may occur for a long time, often lasting several weeks.
- The water doesn't always appear where you would expect it to (i.e. valley bottoms). It may also emerge on hillsides.
- Water may rise up through floors rather than coming in through doors.
- Flooding from groundwater is most common in areas where the underlying bed rock is chalk (see London geology diagram on following pages).
- Groundwater flooding causes an increased risk to sewer flooding.

London Risk Register Reasonable Worst Case Scenario Outcome Description

- Extended amounts of above average rainfall has led to exceptionally high groundwater levels. The main areas of concern are in the South East of London where the geology is predominately chalk (see below map).
- With the rising water table, basements start to flood and water comes up through floor boards. Water from the ground emerges in low lying areas resulting in flooding of up to 1000 domestic and commercial properties for up to 3 months.
- Infrastructure is also impacted including roads, railway lines, gas, electricity and water.
- Groundwater fed rivers that are usually dry have re-emerged are high and out of banks flooding the surrounding areas. In some areas fluvial flooding and groundwater flooding combine.
- Impacted communities will need assistance with sheltering for up to 1 year.

Warning lead times

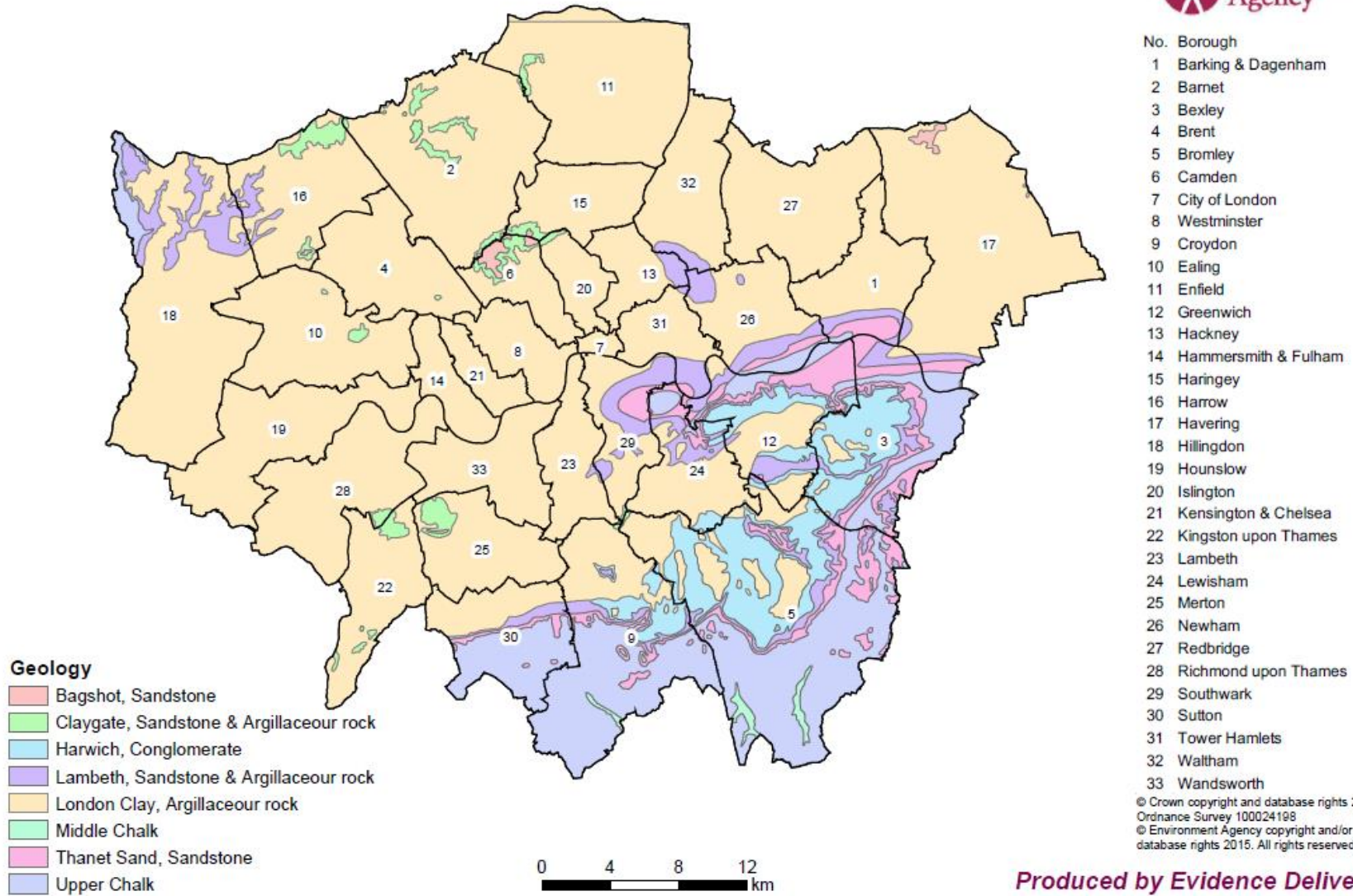
There is generally a long lead time for the conditions where groundwater flooding can occur - several days or longer. It is however, difficult to predict precisely where the location of flooding will happen.

Warning methods

Groundwater flooding warnings will be issues via flood guidance statements, water situation reports (Environment Agency) and flood alerts and warnings.

There will be a high confidence of impacts however it may be difficult to predict precisely where the location of groundwater flooding will happen.

Geology underlying London Boroughs



A 3. Fluvial (river) Flooding

Hazard description

Fluvial flooding happens when a river cannot cope with the amount of water draining into it from the surrounding land. The result is often water overtopping or breaching of a river bank or defence. River flooding can also occur from a blockage in the channel.

Rivers respond to rainfall at different rates according to several factors such as land use, catchment size and topography. In some areas of London, fluvial flooding can occur within 30 minutes following the onset of rain. Some other larger rivers can take several days to reach their highest level following a rainfall event. A map of London Rivers can be found on the following page.

London Risk Register Reasonable Worst Case Scenario Outcome Description

- Successive bands of rainfall saturate river catchments (soil moisture deficit⁴ is at zero) and fill river channels to full capacity. Further high intensity heavy rainfall causes fluvial rivers in London (tributaries to the Thames) to exceed channel capacity.
- Flooding happens quickly with little warning and time for evacuations.
- Flood defences, gates and alleviation channels may be overtopped or fail. Blockages occur in the river channel from debris causing further flooding.
- Rivers are out of banks and flooding up to 25,000 domestic and commercial properties. Up to 30 fatalities and up to 1000 casualties. Infrastructure such as roads, railway, underground, water treatment works, electricity, water supply etc could be disrupted.
- There is a build-up of surface water on roads where flooded rivers have backed up and overwhelmed local drainage systems causing a combined flood event.

Warning lead times

The Environment Agency aims to provide a two hour warning of property flooding (flood warning). However, there are some rivers in London that can react very quickly to heavy rainfall; particularly smaller tributaries.

As flooding can happen incredibly quickly in some London catchments the Environment Agency will issue pre-emptive flood alerts to some areas in London before any rain has fallen. These areas are:

- | | |
|--|---|
| 1. Brent Brooks including Silk Stream, Deans, Edgware, Dollis, Mutton & Wealdstone Brooks | 6. Beverley Brook area in Merton, Sutton, Kingston upon Thames, Richmond upon Thames and Wandsworth |
| 2. Lower Lee Tributaries incl Ching, Cobbins, Nazeing, Pymmes, Rags, Salmons, & Turkey Brooks, Small River Lee and Trinity Marsh Ditch | 7. River Wandle area in the London Boroughs of Wandsworth, Merton, Lambeth, Croydon and Sutton |
| 3. Yeading Brooks | 8. Ravensbourne area in the London Boroughs of Lewisham, Bromley, Greenwich and Croydon |
| 4. River Pinn and Wood Ridings Stream | 9. River Hogsmill area from Ewell to Kingston upon Thames |
| 5. Rivers Beam and Rom | 10. Shuttle and Cray |

Warning methods

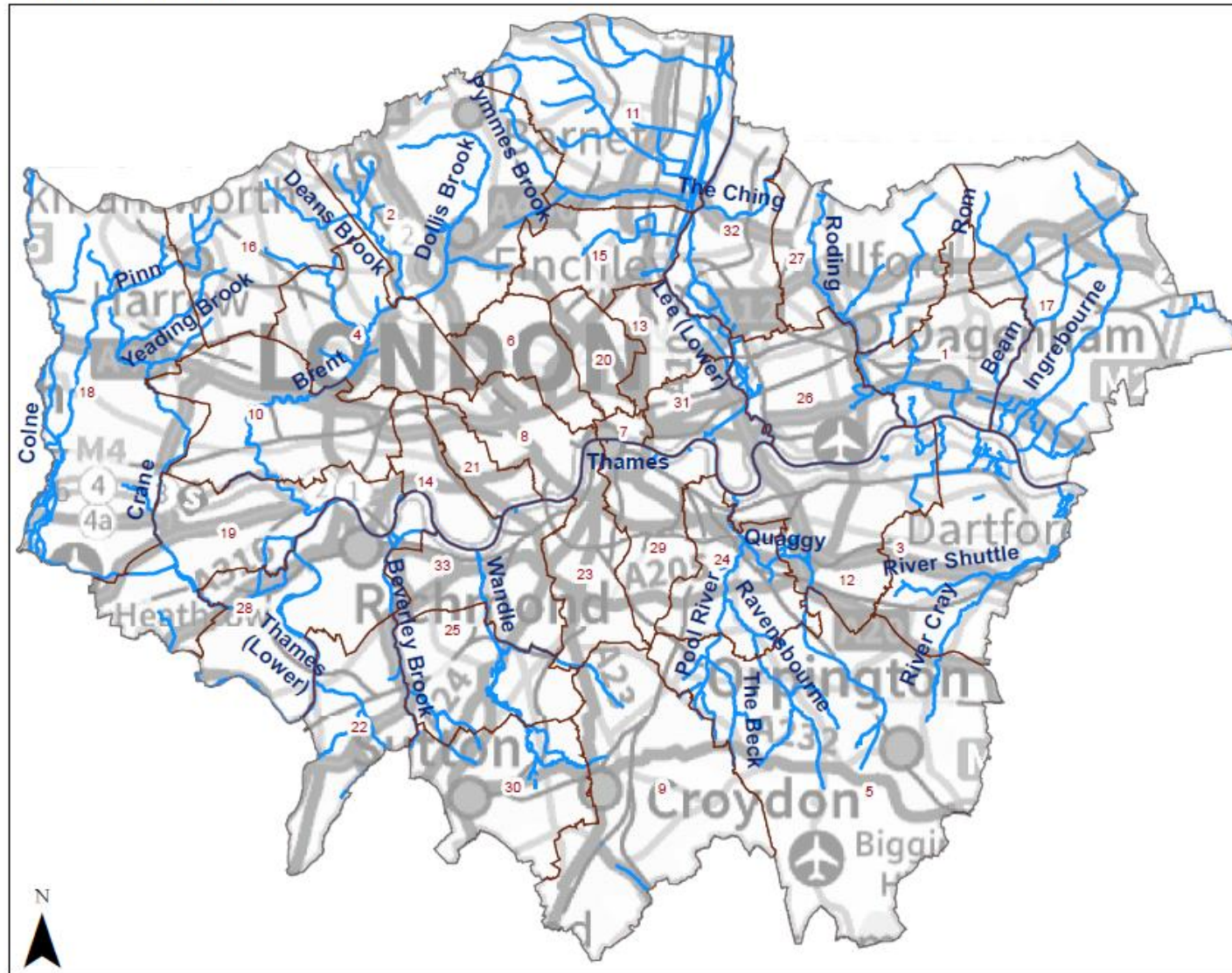
Fluvial flood alerts and warnings will be issued via Flood Warning Service (Environment Agency), Flood Guidance Statements, and Met Office Severe Weather Warnings.

⁴ Soil moisture deficit is the amount of rain needed to bring the soil moisture content back to field capacity

There is likely to be a low certainty on any forecast of fluvial flooding five days before an event and a higher certainty of fluvial flooding 1 to 2 days before an event. There will be less confidence for rainfall from thunderstorms.



London Boroughs

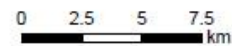


Legend

— Main Rivers

- | No. | Borough |
|-----|----------------------|
| 1 | Barking & Dagenham |
| 2 | Barnet |
| 3 | Bexley |
| 4 | Brent |
| 5 | Bromley |
| 6 | Camden |
| 7 | City of London |
| 8 | Westminster |
| 9 | Croydon |
| 10 | Ealing |
| 11 | Enfield |
| 12 | Greenwich |
| 13 | Hackney |
| 14 | Hammersmith & Fulham |
| 15 | Haringey |
| 16 | Harrow |
| 17 | Havering |
| 18 | Hillingdon |
| 19 | Hounslow |
| 20 | Islington |
| 21 | Kensington & Chelsea |
| 22 | Kingston upon Thames |
| 23 | Lambeth |
| 24 | Lewisham |
| 25 | Merton |
| 26 | Newham |
| 27 | Redbridge |
| 28 | Richmond upon Thames |
| 29 | Southwark |
| 30 | Sutton |
| 31 | Tower Hamlets |
| 32 | Waltham |
| 33 | Wandsworth |

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Produced by Evidence Delivery

A 4. Tidal Flooding

Hazard description

Tidal flooding results from an incoming tide coming from the sea, raising river levels above the level of defences or from a breach in defences. The river Thames in London is tidal.

Tidal Defence System including walls, embankments, tidal gates and the Thames Barrier

The Thames Barrier and its associated gates are operated and maintained by the Environment Agency. It is used to protect London from large incoming tides. It is one of the largest movable flood barriers in the world, spanning 520 metres across the Thames near Woolwich and protecting 125 square km of central London.

The Thames Barrier and its downstream defences have a 0.1% annual exceedance probability (AEP). This is equivalent to providing protection against a 1 in 1000 year surge event or smaller. The upstream walls and embankments are lower to allow greater use and enjoyment of the river. Thames Barrier is closed when surge conditions threaten to overtop these defences, increasing central London's level of protection to that of the downstream defences.

The Thames Barrier may also be closed during periods of high flow over Teddington Weir to reduce the risk of river flooding in some areas of South West London including Richmond and Twickenham.

The barrier has no individual trigger level for closure. The closing process is partly guided by a mathematical matrix that considers these 3 major factors:

- the height of the tide (usually a spring tide) measured at the Thames Estuary
- the height of the tidal surge, which naturally accompanies each tide
- the river flow entering the tidal Thames, measured as it passes over Teddington Weir

When required, the Thames Barrier is closed on an incoming tide to hold back any surge activity. The nearer to low tide the Thames Barrier is closed, the lower the upstream river levels remain and the greater capacity there is to cope with high fluvial flows. The Thames Barrier will remain closed over high water until the water level downstream of the barrier has reduced to the upstream level. The Thames Barrier is then opened, allowing the water upstream to flow out to sea with the outward-bound tide.

The Environment Agency has closed the Thames Barrier 186 times since it became operational in 1982. Of these closures, 87 were to protect against tidal flooding and 99 were to alleviate river flooding (correct as of Nov 2019). The frequency of closures is expected to increase over future decades.

London Risk Register Reasonable Worst Case Scenario

The Thames Barrier is designed with numerous back-up systems and undergoes a rigorous maintenance programme. However, London's tidal flood risk cannot be completely removed and, although very unlikely, inundation could still occur as a result of extremely high surge activity, a breach in the walls and embankments or barrier and gate failure.

The reasonable worst case scenario for tidal flooding in London is based upon a no notice breach of a wall or embankment.

- Localised tidal flooding resulting from sudden breach of a section of the Thames tidal wall or embankment caused by a vehicle collision or construction incident or a failure of a tidal flood gate coinciding with high tides on the river Thames.
- Water would rapidly pour through the breach site flooding surrounding properties and impacting infrastructure such as roads, railway, electricity, gas and water.
- No notice rapid flooding of up to 10,000 domestic and commercial properties with little time to evacuate or mitigate the impacts.

- Up to 10 fatalities and 500 casualties.
- Water may pool and stay behind breach site for some days prolonging recovery time.

Warning lead times

There is a generally a few days warning of tidal flooding. The scale of any impacts will be refined closer to the actual event. London is protected from tidal flooding by the Thames Barrier but on tides that are high (but not high enough to trigger a closure of the Barrier) some riverside locations in West London are vulnerable to local flooding. In these circumstances timely Flood Alerts are issued to the places impacted.

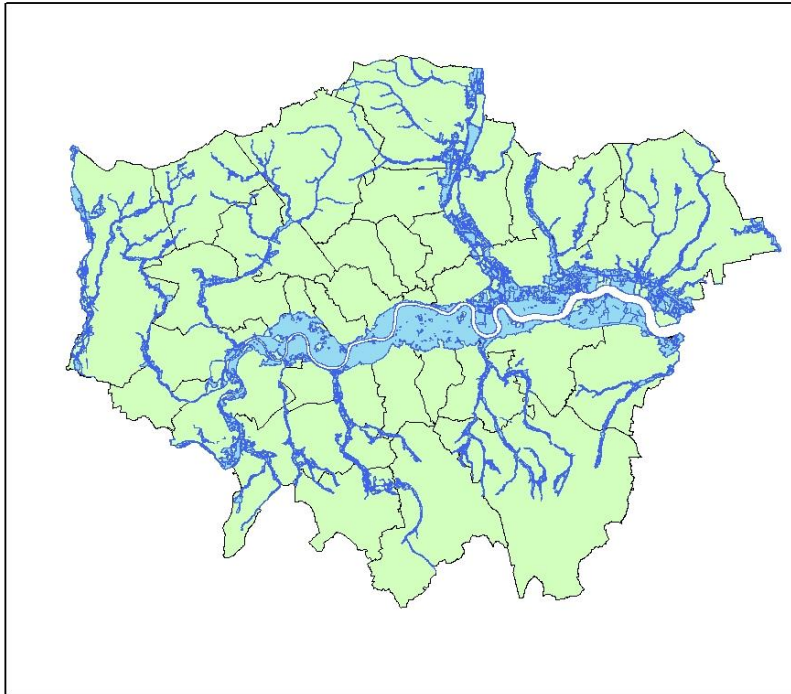
For tidal breaches there may be little or no warning.

Further information

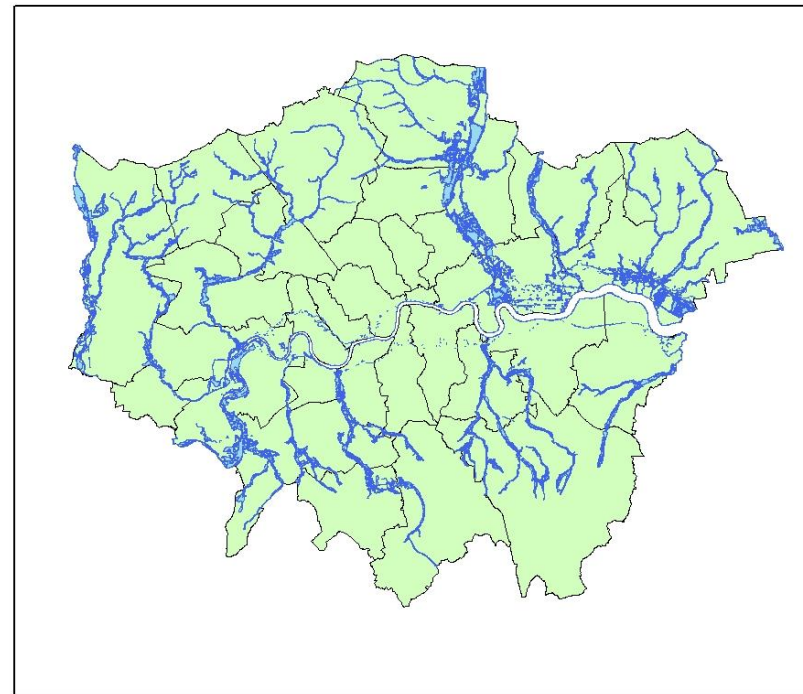
Impacts, risks, warning mechanisms and confidence of forecasting are outlined in the following tables and mapping.



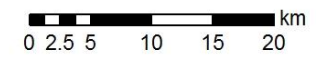
These maps display the flood extent of tidal and fluvial flooding in all probability bands with and without flood defences.



Undefended



Defended



A 5. Reservoir Flooding

Reservoir flooding may occur from a catastrophic failure, this could be due to a plane crash, structural instability or a calculated threat. This type of reservoir flooding could be potentially life threatening.

Reservoir flooding could also occur in a slower manner due to structural damage, causing a small trickle or steady flow of water into the surrounding areas.

The Reservoirs Act 1975

A large raised reservoir is defined as: capable of holding more than 25,000 cubic metres of water above the natural level of any part of the land adjoining the reservoir. Some reservoirs that fall under the Reservoirs Act might be dry flood storage areas.

The Act ensures all reservoirs that fall under its jurisdiction are maintained and structurally safe. Undertakers (reservoir owners) employ a supervising and inspecting engineer. The undertaker will then carry out any safety works recommended by the last inspecting engineer within the report.

Roles and Responsibilities

The reservoir undertaker (owner) has a responsibility to write on-site reservoir plans, appoint inspecting and supervising engineers and to ensure the reservoir is in a good working order. They have a responsibility to manage their own assets and structures accordingly ensuring their activities do not to increase the risk of flooding.

The Environment Agency is the enforcement body for the Reservoirs Act and regulates reservoir safety.

London Boroughs have the responsibility to write emergency plans for reservoirs. Reservoir flood risk should be detailed within a MAFP or if necessary a specific off site reservoir plan.

London Risk Register Reasonable Worst Case Scenario Outcome Description

- Collapse without warning resulting in almost instantaneous flooding. Significant movement of debris (including vehicles) and sediment.
- Complete destruction of some residential and commercial properties and serious damage of up to 500 properties. Several thousand other properties could be flooded.
- Up to 200 fatalities, up to 1000 casualties. Up to 50 missing persons and people stranded.
- Hazardous recovery amongst collapsed infrastructure and debris. Water supply to homes and businesses is lost.
- Up to 200 people need temporary accommodation for 2 – 18 months.

Reservoir Flood Maps

Detailed reservoir inundation mapping (ready to go PDF maps and shape files) are shared on Resilience Direct by the Environment Agency. Each individual reservoir has speed, depth, extent, velocity and hazard mapping available. It is advised all responders use this detailed mapping for their own planning purposes. It is important to note that the maps show the worst case scenario.

Simplified reservoir mapping is also available publicly on GOV.UK [flood risk information maps](#).

London specific overview reservoir inundation maps are saved on Resilience Direct.

Offsite Reservoir Plans

King George V reservoir located in London Borough Enfield is the biggest reservoir located in London, if it were to breach the consequences could be catastrophic and it's for this reason that the reservoir has an offsite reservoir plan in place.

If a local authority deems their reservoir risk as substantial then they can also write an offsite plan for their reservoir or collective of reservoirs.

Warning Lead Time

There is no official forecasting or warning mechanism for reservoir failure. However, the Environment Agency may be able to issue flood warnings to the affected area if the reservoir impact enters main river. The limitations in doing this is that flood warning areas are not drawn to reservoir inundation outlines, so some communities or properties may be missed off. It also relies on the EA being notified quickly of reservoir breach.

If a problem has been identified with the reservoir potentially leading to failure the undertaker should contact the Environment Agency, Local Authority and Police.

Cross boundary working

It is important to note that reservoirs located outside of London boundaries may also have a significant impact into London. It is important that the London Resilience Partnership is aware of this risk. A map on the following page details which reservoirs are located outside of London that would have an impact within London if they failed.

APPENDIX B: Flood Information and Warning Products

There are a number of methods to warn, inform and advise the public, professional partners, media and businesses of flood risk. The flood risk products listed below are designed to be used during the preparation and response phase of a flooding incident as well as beforehand to gain local knowledge of potential flood risk. Below is a description of the products available from the EA, Met Office and Flood Forecasting Centre, designed to aid responders with incident response decisions.

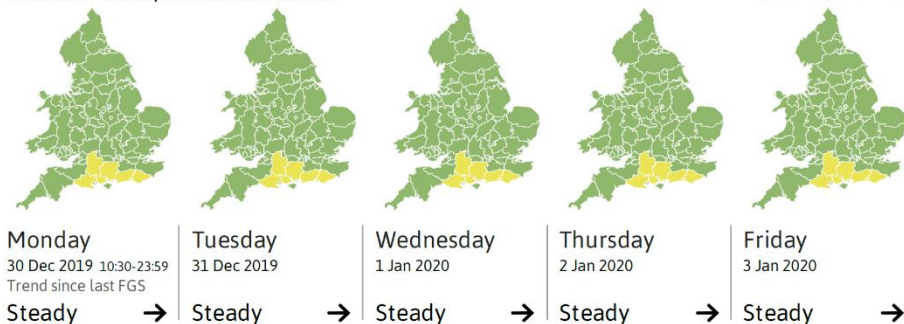
B 1. Flood Guidance Statements (FGS)

The Flood Forecasting Centre (FFC – a joint Met Office and EA centre) is responsible for providing guidance on the likelihood of flooding across England and Wales over the next five days.

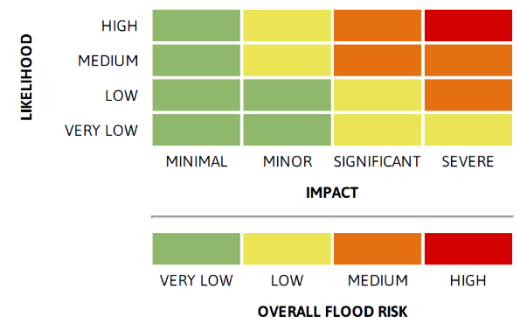
Purpose	Further Details:
To provide professional partners with a 5 day overview of flood risk – daily risk assessment at a county level for England and Wales.	All types of natural flood risk is assessed – river, coastal, groundwater and surface water. This is generally the only warning partners will receive regarding potential surface water flooding. Each flooding type is given a green, yellow, amber or red risk rating (see flood risk matrix below)
Delivery Method	Information the FGS displays:
Email or Met Office Hazard Manager. Category 1 and 2 responders need to register with the Flood Forecasting Centre to receive FGS.	<ul style="list-style-type: none"> • General summary of flood risk • Overview of each type of flood risk (river, coastal, groundwater and surface water) • Specific areas of concern (county scale) • Warnings/alerts currently in place • Contact details for further information or clarification
Lead Agency	FGS is issued everyday at 10:30am; it will also be issued at other times of the day if the situation warrants and/or the flood risk changes. Category 1 and 2 responders can amend the service so flood guidance statements are only sent when their county/counties of interest are issued yellow or above.
Flood Forecasting Centre (joint EA and Met Office service)	The assessment is based on weather forecasts, flood forecasts and catchment conditions.
Time Scale	
Up to 5 days notice	

Flood Guidance Statement

10:30hrs Monday 30 December 2019



Flood risk matrix



The following is reviewed for each FGS:

- The likelihood of an adverse flood event where likelihood bands are described as very low <20%, low 20-40%, medium 40-60%, high 60% or greater.
- Recent weather conditions – is the event shortly after an earlier period of prolonged rain or other high impact weather?
- Area and duration – is it expected to be short and localised or will it affect a large geographical area over several hours?
- Knowledge about the condition of the catchments within the counties – how saturated are the catchments, how high are the rivers and what are the underlying conditions?
- Detailed flood forecast models for the coast, showing surges and large waves, and flood flows for rivers are evaluated.
- Seasonal factors, for example snow cover or leaf fall.
- The combined effect of river flow and high tides – if a river flood is being assessed, does this coincide with high tides, which could cause problems?




B 2. Met Office Hazard Manager

Met Office Hazard Manager, a website available specifically for the emergency response community, provides a wide variety of information that could be of use before or during a flooding incident, including the Flood Forecasting Centre services. The features listed below are available on the Met Office Hazard Manager:

- The rainfall radar function provides the ability to see the intensity and coverage of rainfall over the last 24 hours and where it is forecast to fall over the next 5 days. This is available 24 hours a day, with actual data being updated every 5 minutes.
- The ability to see current and forecast information for other types of weather hazards including any warnings that have been issued for rain, wind, snow, ice and fog. Through Hazard Manager it is possible to sign up to receive warnings directly via Email, Fax or SMS.
- The Flood Forecasting Centre's Flood Guidance Statement can be found as a Product Layer.

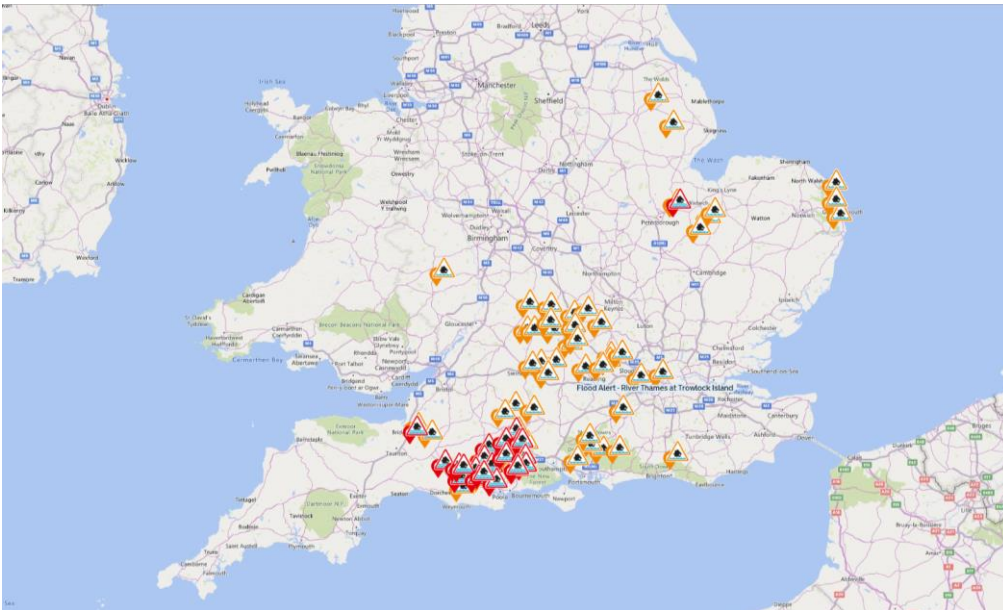
B 3. Flood Warning Service

The EA is responsible for issuing warnings to the general public, businesses, emergency responders and media relating to tidal, fluvial and groundwater flooding. The warning codes are issued using the Flood Warning Service system which can send bulk messages to a mass audience via several formats. The formats are automated phone calls, email and SMS text message. The flood warning service is an opt out service whereby everyone with a telephone registered to an address within flood zone is automatically registered. Messages issued also update flooding information on the Environment Agency website and the Floodline (0345 988 1188) service.

Warning Code	Meaning
 <p>FLOOD ALERT FLOODING IS POSSIBLE. BE PREPARED.</p> <p>PREPARE</p>	<p>Flooding is possible. Be prepared</p> <p>The impact on the ground will be flooding to roads, gardens, fields, recreation grounds, etc. Detail included with each Flood Alert will indicate the likelihood of escalating to Flood Warning.</p>
 <p>FLOOD WARNING FLOODING IS EXPECTED. IMMEDIATE ACTION REQUIRED.</p> <p>ACT</p>	<p>Flooding is Expected. Immediate action required</p> <p>Impacts on the ground will be flooding to homes and businesses, infrastructure (roads / underground stations / utilities etc) which will have a major impact. Expect significant transport disruption and a high level of local media interest.</p>
 <p>SEVERE FLOOD WARNING</p> <p>SURVIVE</p>	<p>Severe Flooding. Danger to life</p> <p>Impacts on the ground include deep and fast flowing water, potential collapse of structures, critical resources disabled, large towns/communities isolated, and large volumes of evacuees. Expect significant transport disruption and a high level of local and national media interest.</p> <p>These are only issued in exceptional circumstances and are likely to only be issued once a certain level of flooding has already occurred.</p>
<p>Flood Alert / Flood Warning / Severe Flood Warning, no longer in force</p> <p>(No icon)</p>	<p>The flood alert / warning / severe flood warning is no longer in force for this area.</p> <p>Used to inform that the situation is improving.</p> <p>Even when a Flood Warning or a Severe Flood Warning is removed it may still mean that there are flooded properties, damaged infrastructure and standing water where flooding has occurred.</p>

B 4. Live Flood Warning Map

The live flood warning map is available on the Environment Agency website [link here](#). The map shows locations of flood alerts, warnings and severe flood warnings that are in force as well as looking at live river level at gauging stations.



B 5. Water Situation Reports

The Environment Agency writes monthly water situation reports. These reports can be used if organisations want to keep an eye on rainfall data, soil moisture deficits, river flow, groundwater levels and reservoir stocks.

Organisations can sign up to receive these via email or they also located online: [link here](#)

APPENDIX C: Properties Flooded Data

During a widespread flood event the need for real time properties flooded data is key for reporting, obtaining shared situational awareness, allocating resources, evacuating communities, mobilising flood rescue efforts and planning recovery to name a few.

Although collating properties flooded data is an operational and tactical responsibility, it features within this plan for two reasons. To ensure that across London we have a consistent way to define and record property flooding. And to put in place a mechanism for sharing this information and reporting it centrally during a pan London flood event.

As per the Flood and Water Management Act it is the responsibility of the local authority to collate properties flooded information for their London Borough. London Boroughs, the Environment Agency and other Risk Management Authorities need to work together to share this information with one another during the response and recovery phases.

During a widespread flood event across London there will be a need for this information to be pulled together to provide a pan-London picture. When this is necessary the London Local Authority Coordination Centre (LLACC) will ask London Boroughs to start filtering in properties flooded information to them so it can be collated centrally.

When recording properties flooded it is important to capture:

1. **The address or location**

2. **Flooding type:** fluvial (river), surface water, groundwater, tidal, reservoir, sewers, canals, highways drainage etc.

3. **Flooding extent:** internal, basement, garage (attached or not attached onto main building), occupied caravans, park homes, gardens, driveways, outhouses and sheds

These can then be separated out into the following categories:

Internal property flooding: water has entered the property. This includes basements and below ground level floors. Garages are included if attached onto the main building. Occupied caravan and park homes are also included.

External property flooding: where water has entered gardens, driveways, outhouses, garages (that are separate from the main building) and sheds.

(National Flood Emergency Framework, DEFRA, 2015)

It is important to capture as much information as possible when recording and reporting properties flooded data.

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LONDON RESILIENCE GROUP

The London Resilience Group is jointly funded and governed by the Greater London Authority, London Local Authorities and the London Fire Commissioner. We are hosted by the London Fire Brigade. Our work, and that of the London Resilience Partnership, is overseen by the London Resilience Forum.