PRELIMINARY FLOOD RISK ASSESSMENT

DRAIN LONDON

LONDON BOROUGH OF HAVERING

GREATERLONDONAUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

Havering LONDON BOROUGH

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RELATED DOCUMENTS

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Executive Summary

This Preliminary Flood Risk Assessment (PFRA) has been produced on behalf of the London Borough of Havering by Jacobs and JBA Consulting as part of the Drain London programme.

A PFRA is a high level screening exercise that identifies areas of significant flood risk from all sources, and summarises the probability and harmful consequences of past (historical) and future (potential) flooding.

Lead Local Flood Authorities such as Havering have duties under the Flood Risk Regulations to manage local flood risk and are required to undertake a PFRA; the outputs of which consists of this report, the spreadsheet in Annexes 1-3 and the GIS layer of Flood Risk Areas in Annex 5.

In addition to fulfilling the regulatory requirements and establishing an evidence base of historic flood risk information to inform future local strategies, a key objective of this PFRA has been to establish an effective working partnership through ongoing stakeholder communication and engagement to ensure a coordinated and holistic approach to local flood risk management across London.

The PFRA reviews existing data to summarise past flood risk and predict how and where flooding may occur in the future taking into account the effects of climate change and long term developments. Based on that research, this PFRA proposes a minor amendment to the boundary of the Environment Agency's Indicative Flood Risk Area which broadly covers London, to include urbanised areas at Havering-atte-Bower, Harold Hill, Upminster and Rainham that are currently excluded.

The PFRA will be approved by the Internal Partnership Group of the Havering Flood Management Group before going to the Environment Agency for final review and submission to the European Commission (as appropriate).

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CDA	Critical Drainage Area
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.

Term	Definition
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LB	London Borough
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location
Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
LRF	Local Resilience Forum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PA	Policy Area

Term	Definition
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
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.
Risk Management Authority	As defined by the Floods and Water Management Act
RMA	Risk Management Authority
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
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.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
WaSC	Water and Sewerage Company

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1 Introduction

1.1 What is a Preliminary Flood Risk Assessment?

A Preliminary Flood Risk Assessment (PFRA) is a high level screening exercise. It identifies areas of significant flood risk, and summarises the probability and harmful consequences of past (historical) and future (potential) flooding.

The PFRA involves collecting readily derivable information on past and future floods from a number of existing and available sources. These include the Environment Agency's national datasets (e.g. Flood Map for Surface Water), and existing local products (e.g. Strategic Flood Risk Assessments [SFRAs] and Surface Water Management Plans [SWMPs]).

Information collected and analysed during the PFRA process - no new information is developed - is assembled into the following three outputs:

- Preliminary assessment report (this document);
- Preliminary assessment report spreadsheet detailing past and future floods, and identified Flood Risk Areas (included as **Annexes 1-3** – this spreadsheet is reported to the European Commission);
- GIS layer Flood Risk Area(s) (included as **Annex 5**).

1.2 Background

Lead Local Flood Authorities, including the London Borough of Havering, have duties under the Flood Risk Regulations to manage local flood risk. They are required to undertake a PFRA for local sources of flooding, primarily surface water, groundwater and ordinary watercourses. Although there is no requirement to consider flooding directly from the sea, main rivers and reservoirs, the PFRA does consider interactions between these and local sources.

This PFRA has been undertaken on behalf of Havering, by Jacobs and JBA Consulting as part of the Drain London programme.

The Drain London Forum was established in 2007 as a result of the severe flooding experienced in the UK during recent years, together with challenges of climate change, population growth and increasing urbanisation. The Greater London Authority (GLA), on behalf of the Drain London Forum, has employed consultants to deliver the Drain London programme which aims to manage and reduce surface water flood risk in London. The 33 London Boroughs form eight sub-groups; Jacobs and JBA are undertaking PFRAs for 'Group 5' which includes the three London Boroughs of Barking and Dagenham, Havering and Redbridge.

The Flood Risk Regulations set out four stages of activity for managing flood risk within a six year cycle (see **Figure 1.1**); this PFRA addresses the first two stages. Flood Hazard and Flood Risk Maps (which fall under stage 3 of the FRR requirements) are also being produced alongside this PFRA and the SWMP as part of the Drain London programme commission however these will need to be revisited prior to 2013 to take any emerging guidance from the EA into account.

Figure 1.1 Four stages of flood risk management activity in Flood Risk Regulations

1.3 Objectives

The objectives of the PFRA are to:

- Fulfil the requirements of the first two stages of the Flood Risk Regulations in producing PFRA outputs and identifying Flood Risk Areas that warrant further examination through the production of maps and management plans;
- Summarise the methodology adapted for the PFRA, particularly relating to data sources, review, sharing and storage;
- Establish an evidence base of historic flood risk information that will provide a useful reference point for all local flood risk management and help inform and support local strategies;
- Work in partnership with identified organisations involved in assessment of future flood risk, to ensure effective collection and sharing of data through ongoing stakeholder engagement.

1.4 Study Area

The study area for this PFRA is defined by the administrative boundary of the London Borough of Havering. As mentioned in section 1.2, Jacobs and JBA have prepared PFRAs for the three London Boroughs in Drain London Group 5 - the geographical extent of the study area for this PFRA for Havering is illustrated red in **Figure 1.2**.

Havering is an outer London Borough to the north east of Central London on the north bank of the River Thames and is part of the Thames Gateway area. Created in 1965 by the reorganisation of local government for Greater London, Havering is the third largest London Borough covering 11,227 hectares with a population of 226,200 (2007 estimate).

The River Thames forms the southern boundary to Havering and the Beam River the southern part of the western boundary. The Ingrebourne River bisects the Borough from north to south. Neighbouring London Boroughs are Redbridge, Bexley, and Barking and Dagenham. Havering is also adjoined by the Essex

Districts of Thurrock, Brentwood, and Epping Forest. Havering lies within the Thames River Basin District and is served by the Environment Agency Thames Region, with a small area on the eastern boundary in Anglian Region, within the Mar Dyke catchment.

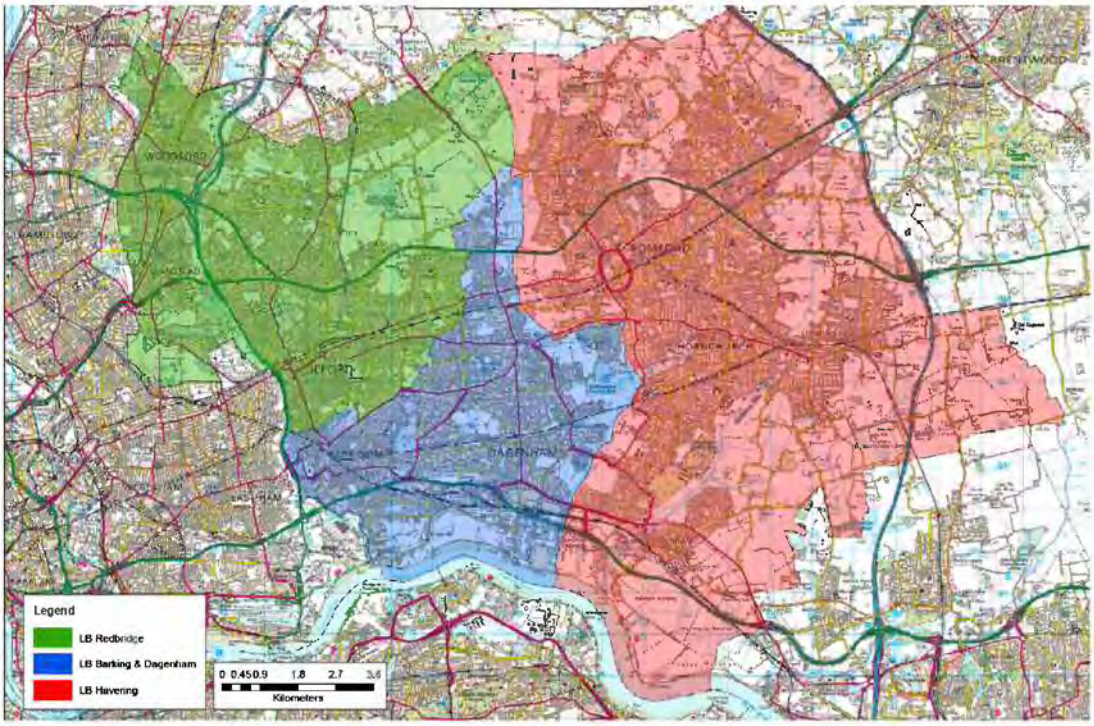


Figure 1.2 Map of study area showing Havering Borough boundary

2 LLFA Responsibilities

2.1 Legislative Background

The Flood and Water Management Act 2010 (FWMA) presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary watercourses). Lead Local Flood Authorities have been empowered to take the lead on managing local flood risk through new responsibilities for flooding from surface and groundwater.

The FWMA reinforces the need to manage flooding holistically and in a sustainable manner. This has grown from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007 floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt's Review of the Summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

The FWMA must also be considered in the context of the EU Floods Directive, which was transposed into law by the Flood Risk Regulations 2009 (FRR) on 10 December 2009. As set out in section 1.2, the FRR require four stages of activity of which the PFRA is one.

- **Preliminary Flood Risk Assessments** (maps and reports for Sea, Main River and Reservoirs flooding as well as 'other' relevant sources) to be completed by Lead Local Flood Authorities and the Environment Agency by the 22 December 2011. **Flood Risk Areas**, at potentially significant risk of flooding, will also be identified. Maps and management plans will be developed on the basis of these flood risk areas.

- **Flood Hazard Maps and Flood Risk Maps**. The Environment Agency and Lead Local Flood Authorities are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.

- **Flood Risk Management Plans**. The Environment Agency and Lead Local Flood Authorities are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

Figure 2.1 illustrates how this PFRA fits into the delivery of local flood risk management, and where the responsibilities for this lie.

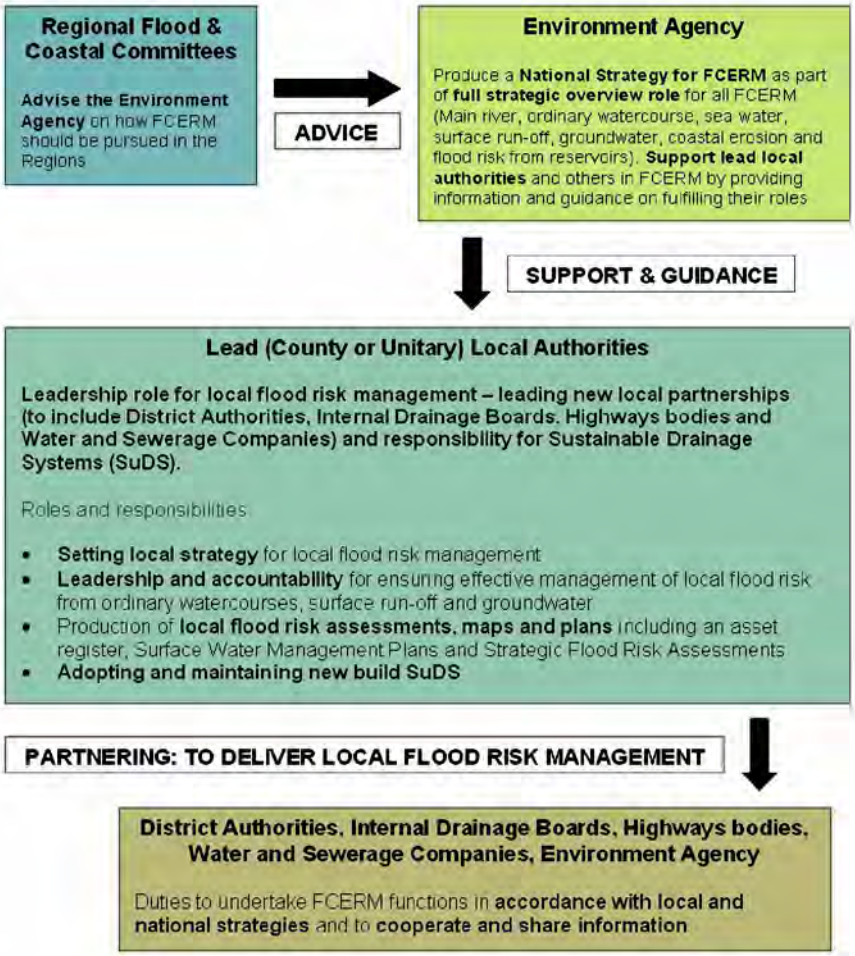


Figure 2.1 Roles and responsibility for local flood risk management delivery

2.2 Leadership and Partnership

As outlined in **Figure 2.1**, Havering, as the designated LLFA, has a responsibility for leading local flood risk management across the Borough.

Much of the local knowledge and expertise necessary for Havering to fulfil these duties lies with neighbouring London Boroughs and other partner organisations. Partnership working with these groups and organisations is therefore essential for effective and consistent management of local flood risk throughout Havering and for a holistic and coordinated approach across London.

As part of the Drain London programme (detailed in section 1.2), a **collaborative working framework** was established by the Drain London Forum to promote cross-organisational collaboration between Havering and all other relevant authorities in flood risk management in order to:

- Set out expectations for key partners and what actions each will take forward;
- Ensure the coordination of future investments for flood risk management in London across the relevant organisations;
- Avoid ad-hoc arrangements for flood incident response; and
- Avoid overlap in routine maintenance of essential flood risk infrastructure.

As well as the neighbouring boroughs of Barking and Dagenham and Redbridge, Havering also have a responsibility to partner with other key stakeholders and risk management authorities, who share the responsibility for decisions and actions. Ideally, the informal relationships established within the context of the Drain London programme should be formalised to ensure clear lines of communication and continued mutual cooperation through the development of a Memorandum of Understanding.

In order to assist with this, Havering has identified a number of groups, committees and forums both internally within the Borough and across the different partner organisations, and set up a **Flood Management Group** (consisting of internal and external partnership groups) to be the overarching lead flood group for Havering and to centralise current work.

The overall partnership structure, and how the Flood Management Group fits within the context of existing regional and London-wide flood-related groups, is illustrated in **Figure 2.2** and a brief description of the role of each group is provided in **Annex 6**.

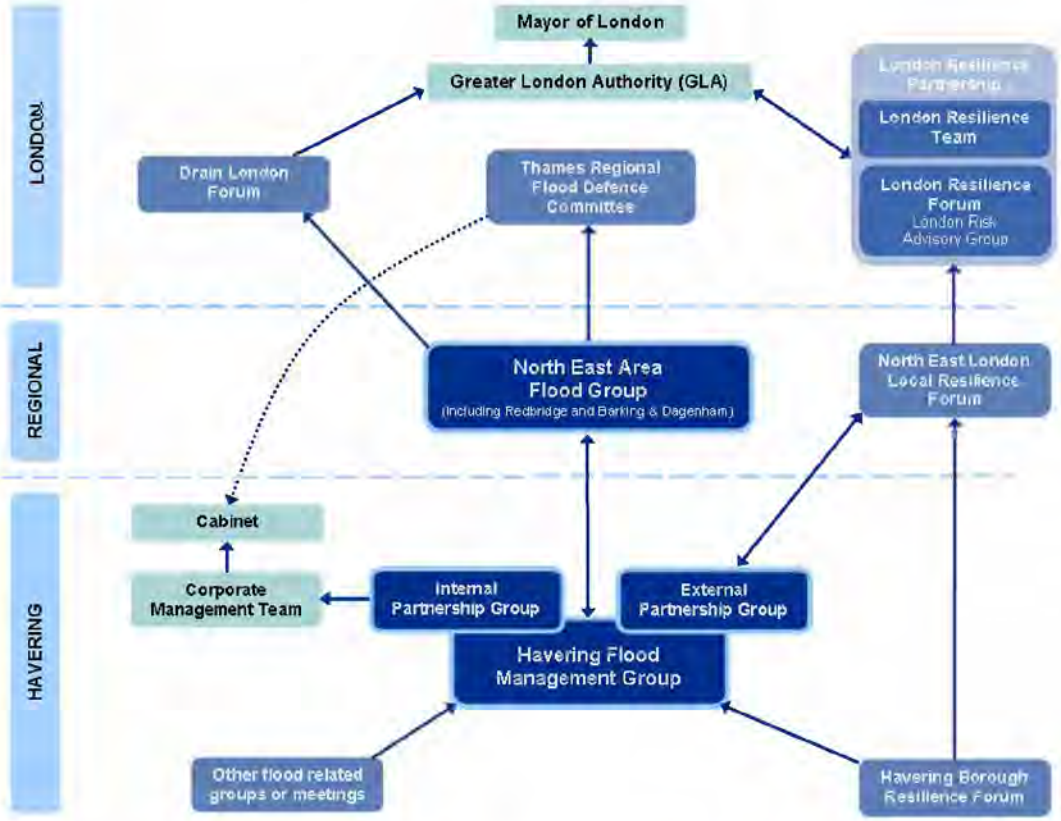


Figure 2.2 Partnership structure for flood risk management

This partnership structure is 'fluid' and evolving – as the Borough advances into the role of managing local flood risk in this new way, groups and committees may change in format, membership and frequency to reflect new requirements and ways of working, and partners and stakeholders may change. The partnership approach set out in this PFRA will need to be ratified over time and potentially adjusted as appropriate in the future to accommodate these changes, the most relevant and

immediate of which will be the effects of changes to the resilience forum structure under GLA.

2.3 Stakeholder Engagement

As part of the PFRA process Havering have engaged stakeholders representing the following organisations and authorities:

* *Stakeholders included as partners in the External Partnership Group as part of the Havering Flood Management Group.*

- London Borough of Barking and Dagenham (including development planning, engineering services, and emergency planning);
- London Borough of Redbridge (including development planning, engineering services, and emergency planning);
- Essex County Council * (including highways, emergency planning, engineering services, and heritage and conservation);
- Greater London Authority (also representing the Drain London partnership);
- Environment Agency *
- Thames Water *

Figure 2.3 illustrates the three tier process (set out by the GLA for London Boroughs) for delivering PFRAs and SWMPs under the requirements of the Flood Risk Regulations. The development of this PFRA falls under Tier 2.

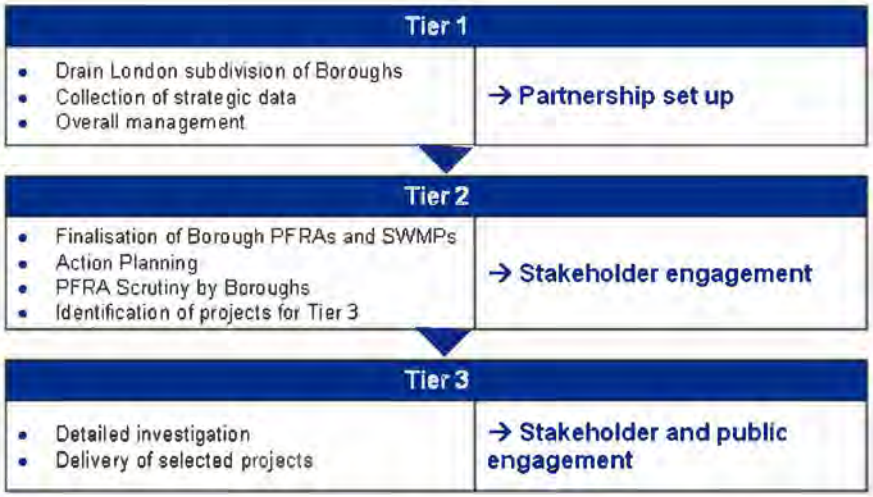


Figure 2.3 Three tiers of the Drain London programme and associated stakeholder and partner activity

In addition to the stakeholder engagement undertaken as outlined above as part of Tier 2 work, further engagement with stakeholders will be required during Tier 3 when local flood risk management plans are formulated for the Flood Risk Areas identified during this PFRA.

Stakeholders who will need to be involved in Tier 3 include:

- Transport for London *
- Highways Agency *

- Network Rail *
- London Fire Brigade *
- Anglian Water *
- Suffolk Water *
- British Waterways
- Natural England
- London Underground
- Chamber of Commerce and Retailers
- Association of British Insurers
- Homes and Communities Agency
- Riparian owners
- Developers or regeneration agencies
- Local community and interest groups
- General public (see section 2.4)

2.4 Public Engagement

The engagement of local people is vital. In addition to providing access to valuable local knowledge which can contribute to the PFRA and to local flood risk management more generally across Havering, building trust with local people increases the chances of public and stakeholder acceptability of proposals and decisions for managing flood risk.

As stated in section 2.3 and illustrated in **Figure 2.3**, the involvement of the wider public will need to be considered during Tier 3, and beyond when local flood risk management plans are formulated for the Flood Risk Areas identified during this PFRA.

Through effective Communications and Engagement Plans, Havering will ensure that meaningful engagement is undertaken to **inform** people of the risks, causes and probability of flooding; **engage** people and actively seek their views on what can be done to manage flood risk; and provide **feedback** on decisions and how stakeholder and public inputs have influenced the process. The Environment Agency's 'Working with Others' framework provides useful guidance for communicating with and engaging stakeholders and communities.

As the central hub of the partnership structure (see **Figure 2.2**) and overarching lead for local flood risk management within the Borough, the Havering Flood Management Group is responsible for driving the communication of risk to stakeholders and the public by producing and disseminating literature (such as Havering's Emergency Planning Handbook) and undertaking communication and engagement events and activities as appropriate.

2.5 Other Responsibilities

Lead Local Flood Authorities, as defined under the Flood and Water Management Act, are responsible for a number of important aspects in coordinating the management of local flood risk. Specific requirements are as follows:

- **The investigation of flood incidents** – a duty to investigate and record details of significant flood events within LLFA areas. This includes identifying which organisations have flood risk management functions and what will be done to

the investigate flood incidents, notifying risk management organisations where necessary and publishing the results of any investigations carried out.

- **Asset Register** – a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum must be maintained. The register must be available for inspection by the Secretary of State.

- **Sustainable urban Drainage systems (SuDS) Approving Body** – under the FWMA, LLFAs are designated the SuDS Approving Body for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area.

- **Local Flood Risk Management Strategy** – a requirement to develop, maintain, apply and monitor a local strategy for flood risk management in the LLFA area. This local strategy must build upon national and local information and will use consistent risk-based approaches across both local authority areas and catchments.

- **Powers to Undertake Works** – powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area have been designated under the FWMA.

- **Powers to Designate** – alongside district councils and the Environment Agency, LLFAs now have powers to designate structures and features that affect flooding or coastal erosion. This will safeguard assets that are relied upon for flood or coastal erosion risk management.

3 Methodology and Data Review

3.1 Data Sources

Existing data used to prepare this PFRA was collected in a consistent manner across London by Tier 1 of the Drain London programme. The following authorities and organisations were identified and contacted to share data for the preparation of the PFRA;

- 33 London Boroughs
- British Geological Survey
- British Waterways
- Environment Agency
- Greater London Authority
- Highways Agency
- London Fire Brigade
- London Underground
- Natural England
- Network Rail
- National Health Service
- Transport for London
- Thames Water

Full listings of all of the data requested and received are included in Appendix A of the Surface Water Management Plan. Additionally, the SWMP undertook additional modelling and surface water flood risk mapping for the entire Borough. The results from this modelling constitute the locally agreed surface water information.

Standard Information Request Forms were used to collect data and information from these organisations. The form also facilitated the consistent recording of any issues arising surrounding information sharing and availability.

3.2 Availability

Past flooding
Prior to the Floods and Water Management Act 2010, those local authorities now identified as Lead Local Flood Authorities were not required to collate records of flooding within their boundaries.

Records of sever flooding incidents related to sewerage or highway drainage are maintained in a spreadsheet register. No similar records were available for ordinary watercourse or main-river flooding.

Future flooding
National information on future flood risk was provided by the Environment Agency and was centrally collected for all London Boroughs through the Drain London programme. This data is also made freely available to LLFAs via the EA's Datashare website (http://www.geostore.com/environment-agency/).

Consequences
The National Receptor Database (NRD) has been developed by the EA to assist the assessment of the consequences of flooding. It contains point receptors (e.g. houses, commercial premises), polygons (e.g. SSSIs) and linear features (e.g. roads and railways). The National Receptors Database (NRD) version 1.0 was used for the counts of properties and other receptors in the preparation of this PFRA. Receptor information was prepared for all London Boroughs in December 2010 in order to undertake property counts required for the SWMP. Version 1.1 of the NRD has subsequently been issued and contains modifications and corrections since version 1.0. However, in order to avoid repetition of work, and ensure consistency between the SWMP and the PFRA, it was decided to complete the PFRA using NRD version 1.0.

The Borough's record of sever flooding incidents classifies the consequences of flooding as follows:

1. Internal flooding to private property
2. Flooding under floor of private property
3. Flooding to garages & external buildings
4. External flooding of private property
5. Highway flooding

3.3 Limitations

Data recording
The record of highway drainage and sewerage related incidents maintained by the Borough is not linked to a GIS system, although for the purpose of the SWMP indicative areas have been digitised. However there is not currently a single register for recording flood incidents, and in particular no records of flooding from Ordinary Watercourses were available in the preparation of this PFRA.

Data sharing
There are no significant known data sets required to produce this PFRA which have not been made available to the Borough by partner organisations, although limitations in the available data and restrictions on their use are noted above and in section 3.4.

Records of Consequences of Flooding
The spreadsheet record of severe flooding locations includes numbers of properties impacted and the type of flooding.

3.4 Security, Licensing and Use Restrictions

The security of data is a key consideration when it comes to collecting, collating and storing sensitive data.

Data licensing and usage restrictions were negotiated through Drain London Tier 1. As a general rule, a check should be made prior to any use of the supplied data for purposes other than preparation of the SWMP or PFRA. Where partner organisations have supplied data with restrictions on usage, these are saved with the data.

Data licenses are made out to the Greater London Authority, and hence a revised license may be required prior to use by LLFAs for work not under the umbrella of Drain London and/or the GLA. Table 3.1 summarises the restrictions on the use of this data.

Organisation	Restrictions on data use
British Geological Survey	Usage limited to work undertaken on behalf of GLA. Specific conditions relating to use of DIGMap
British Waterways	Canal network is only for use by Tier 2 Consultants for the SWMPs as part of Drain London programme.
Environment Agency	Data was supplied with the restriction "access only for: GLA, Local Authorities and their consultants for Geo-Portal. Only for surface water management plans, strategic flood risk assessments or preliminary flood risk assessments".
Greater London Authority	GLA owned dataset. Only to be used for Drain London programme and in accordance with OS Contractor License issued by GLA.
Highways Agency	Data provided to GLA for use under Drain London programme. Users must abide to the Memorandum Of Understanding.
London Fire Brigade	Only to be viewed by the Council and Tier 2 consultants
London Underground	Subject to LU conditions
Natural England	Standard Natural England terms of use apply (http://www.naturalengland.org.uk/copyright)
Network Rail	Only to be viewed by the Council and Tier 2 consultants
National Health Service	None stated
Transport for London	None stated
Thames Water	All data subject to conditions. Sewer flooding incidents (DG5 register) were supplied collated by 4 figure postcode area in order to prevent identification of individual properties at risk.

Table 3.1 Data restrictions by organisation

3.5 Quality Assurance

3.5.1 INSPIRE Directive

The INSPIRE Directive (2007/2/EC) is implemented in the UK by the INSPIRE Regulations 2009. Its main aim is to improve the quality, consistency and accessibility of spatial data sets and services for environmental data to ensure they can be shared and integrated seamlessly into applications with minimal manual intervention. Further information can be found in guidance produced by the Association for Geographic Information (2009).

The general principles of INSPIRE are:

1. Data should be collected only once and kept where it can be maintained most effectively.
2. It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.

3. It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes.
4. Geographic information needed for good governance at all levels should be readily and transparently available.
5. It should be easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.

Following the PFRA Guidance, this report has been prepared in accordance with the INSPIRE Directive. Specifically:

- The data produced for the SWMP, which is used to provide the locally agreed surface water information referenced in section 5, has INSPIRE compliant MetaData[1] associated with each layer of spatial data and with pieces of non-spatial data including reports.
- The data provided by flood risk management partners was collected once for the whole of London as part of the Drain London programme, and was supplied with MetaData detailing the source and format of each data set collated.

Subsequently review of data quality was conducted using the scoring system recommended in the Defra SWMP Guidance (2010), and this is recorded in Appendix A of the SWMP report.

[1] **MetaData** is data that serves to provide context or additional information about other data. For example, MetaData could include information about the subject, author, size, collection method or accuracy of a data file or document.

4 Past Flood Risk

4.1 Summary of Past Floods

This section presents a summary of past flooding events in the Borough. Events from all sources are considered. In order for events to be included within Annex 1 (the records of past floods and their significant consequences), they must be shown to have had "significant harmful consequences" (see section 4.2 for definition). Additionally, past floods of a kind that are not likely to occur now should not be included in Annex 1, for example where flood defences or drainage have been improved since the flood occurred.

Flood Event (refs in brackets indicate sources)	Source / Cause	Significant Consequences?	Likely to recur?	Included in Annex 1?
Rainham Marshes 1448: (4)	Tidal	Unknown	Unknown	No
Dagenham Breach, 17/12/1707. 1000 acres covered, including all of the Borough south of present day A1306 and west of the Ingrebourne River, plus an further extension north up the Beam valley. The inundation lasted until the 1720s when the breach was repaired, but, to the current day, remnants of that breach still survive in Dagenham. (1, 2, 3)	Main River - failure of a sluice gate	Yes (based on current land use in area of breach)	No - defences and sluice gates improved	No
Beam and Ingrebourne catchment - Romford, Upminster, Hornchurch 1888: (4)	Main River	Unknown	Unknown	No
Ingrebourne 1914: "Rainfall observer at Upminster (High House) noted p[7] "Heavy rain throughout the night amounting to 3.35 in. ... The fields along the banks of the Ingebourne, which flows through the lower part of the village, were flooded. The storm seems to have been a local one" (4)	Main River	Unknown	Yes	No
Widespread flooding in River Thames catchment 1947: No evidence of flooding within Havering(4)	Main River	Unknown	Unknown	No
South Hornchurch, Rainham and the marshes 1953: Extensive flooding of areas adjacent to the River Thames at South Hornchurch, Rainham and the marshes, extending up the valleys of the Beam and (4)	Tidal	Yes (based on current land use in area of breach)	Unknown	No
Ingrebourne 1968: Flooding in Harold Park, Harold Wood, Upminster, Hornchurch (1), (2), (4)	Main River	Unknown	Yes	No
Beam, Ravensbourne and Ingrebourne catchments – mostly Romford. 1974: (1), (2), (4)	Main River	Yes (based on present-day receptors within flood extents)	Unknown	No
Rom 1987: Intense thunderstorm caused flooding on River Rom at Romford. (3)	Main River	Unknown	Unknown	No
Ingrebourne – Isolated flooding in Upminster and Hornchurch 1992: (3)	Main River	Unknown	Unknown	No

Flood Event (refs in brackets indicate sources)	Source / Cause	Significant Consequences?	Likely to recur?	Included in Annex 1?
Lower Beam 2000: Flooding between Breton Hall and Beam Bridge (1), (2) (3)	Main River	No	Yes	No
Ingrebourne at Rainham (Dover's Corner) 2003: (3)	Main River	No	Yes	No
Romford and Hornchurch 2007: (3)	Sewer	Unknown	Unknown	No
Other surface water flooding incidents: The Borough holds records of other incidents of surface water flooding in the following locations: Abbs Cross Lane, Albany Road, Birch Crescent, Clyde Way, Cranham Road, Fairkytes Avenue, Great Gardens Road, Hall Road, Hazelmere Gardens, Hornchurch Road, Maybrick Road, Moray Way, Park Lane, Station Lane, Strathmore Gardens Warren Drive , Wingletye Lane. None are considered to have been of a magnitude requiring reporting within Annex 1. (5), (6)	Surface water (including pluvial, sewerage, highway drainage exceedance)	No	Varies by location	No
Thames Water has provided information extracted from their DG5 register of properties at risk of sewer flooding. This a statutory register that Thames Water are required to maintain and submit to OfWAT. The information is supplied as numbers of properties on the DG5 register considered to be at risk of flooding from sewers within each Postcode Sector, for example "RM5 2." Postcode sectors typically contain several thousand properties, and therefore the data provided in this manner only gives an approximate indication of areas at risk of sewer flooding. Additionally, many Postcode sectors overlap LLFA boundaries. RM5 2, for example, spans Redbridge, Barking and Dagenham and Havering. It is not therefore possible to identify in which Borough the 53 at-risk properties in this Postcode sector are located. In total, the postcode sectors wholly or partially within Havering have 676 properties on the DG5 register. (7) Note that the DG5 register does not include properties considered to be at risk in a 1 in >20 year (less than 5% Annual Event Probability) event.	Sewer	No	Yes	No
Sources: (1) Historic Flood Map (2) Flood Event Outlines (3) British Hydrological Society Chronology of British Hydrological Events (4) Havering Level 1&2 SFRA (5) Communications with Havering staff (6) Severe flooding locations spreadsheet (7) Thames Water DG5 register of properties at risk of sewer flooding				

Table 4.1 Summary of Past Floods in Havering

The following additional sources of information on past flooding have been consulted and have identified no flooding with the Borough:

- **British Waterways** map of BW canals in London, and note "Anecdotal Flood Records 20100622.doc" prepared for Drain London. There are no British Waterways canals within the Borough.
- **London Fire Brigade** incidents (flooddata.csv). A total of 565 incidents associated with flooding or person in water were provided for the Borough. The incidents are widely spread across the Borough, and the source of flooding is not attributed (and may for example include flooding due to burst water mains or even domestic plumbing). For this reason it was decided that this data set could not be used to identify past floods of significant consequence.
- **Greater London Council** (GLC historic storm reports.xls) - report on 19 storm events from 1956 to 1980 across London. Includes observed rainfall and river flows/levels, and commentary on flooding consequences. There is no reference to watercourses or flooding within the Borough.
- **Highways Agency** (Flooding_hotspots_Area_5.shp) GIS layer showing locations of flooding hotspots on the Motorway and Trunk network. No roads within the Borough are identified as being at risk by the Highways Agency.

Figure 4.1 Summary map of past floods (Surface Water incidents)
Figure 4.2 Summary map of past floods (Main River / Fluvial / Tidal incidents)
Figure 4.3 Summary map of past floods (Groundwater incidents)
Figure 4.4 Summary map of past floods (Sewer incidents)

4.2 Significant Harmful Consequences

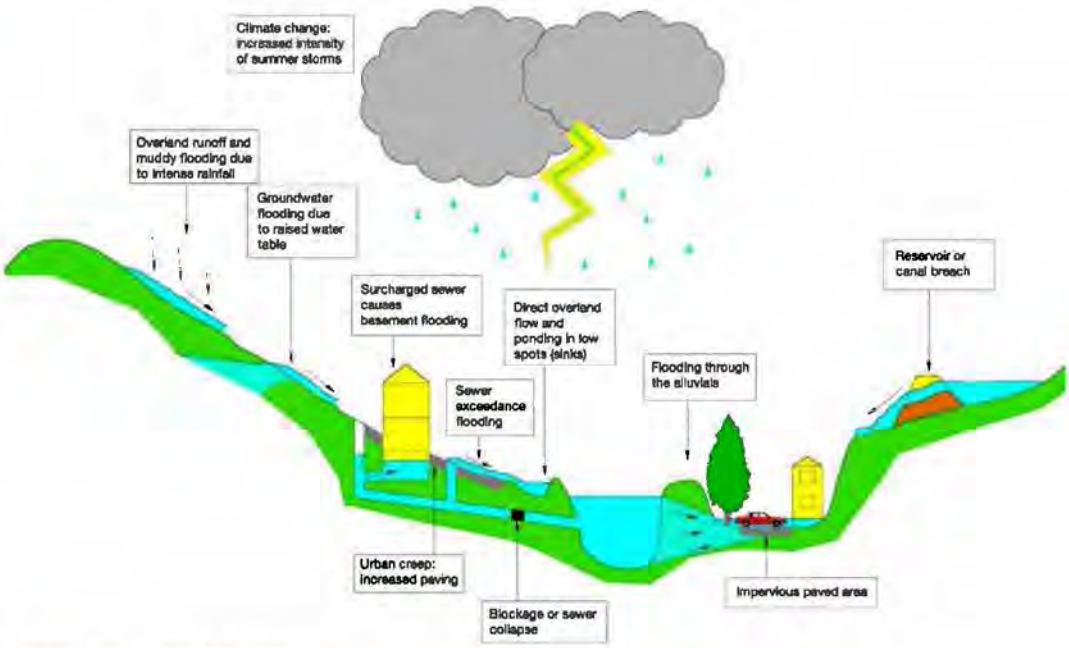
In order for a flood to be included within **Annex 1**, it must be shown to have had significant harmful consequences – i.e. those that impact on human health, the economy, the environment, cultural heritage or any combination of these.
There is no national definition of significant harmful consequences as local receptors respond in different ways. Guidance has been issued by the Environment Agency (2011b) and Greater London Authority (2011) which has been followed for this PFRA. This guidance can be summarised as:

- There is only a need to include information in Annex 1 if there is reliable information on past floods and there were significant harmful consequences.
- Floods reported in Annex 1 should be of a level of consequence sufficient to justify reporting to the European Commission. This would normally imply that they were memorable or otherwise registered on a national scale even if occurring over a relatively small area.

Based on the evidence available, the 1707 Dagenham Breach and 1953 event in Rainham Marshes had significant harmful consequences, or would be expected to if they reoccurred based on the existing receptors within the areas impacted. However, neither of these events have been added to Annex 1 as they are now all considered to be unlikely to occur due to improvements in tidal and fluvial defences.

4.3 Interactions with Other Flooding Sources

Flooding, particularly when it occurs in an urban context, can frequently be attributed to a number of sources. The interaction between these sources historically made it very difficult to specify a particular source. **Figure 4.5** provides a pictorial representation of potential flooding sources in an urban context.



Source: JBA Consulting (2006)

Figure 4.5 Interactions between flooding sources in an urban environment

Within the Borough, the following historic flooding interactions have been observed in the flood records;

- **Surface water / Sewer** – Birch Crescent, Station Lane, Hornchurch Road, Maybrick Road, Moray Way, Abbs Cross Lane, Cranham Road, Hazelmere Gardens, Park Lane, Strathmore Gardens, Clyde Way, Great Gardens Road, Warren Drive, Albany Road, Fairkytes Avenue and Hall Road.
- **Surface water / Fluvial** – Wingletye Lane

A full summary of flooding interactions is shown in **Table 4.2**.

Havering Flooding Interactions		LLFA Responsibility to Lead	
		Surface Water (including ordinary water courses)	**Groundwater**
Primary Responsibility of other party	**Sewer**	*Yes*	*Not recorded*
	Fluvial (Main river)	*Yes*	*Not recorded*
	Tidal	*Not recorded*	*Not recorded*

Table 4.2 Recorded Past Flooding interactions

5 Future Flood Risk

5.1 Summary of Future Flood Risk

Whilst analysis of past flooding provides valuable information on the nature and extent of flooding that has occurred in the Borough in the past, it does not necessarily inform us about how and where flooding may occur in the future. Predictions of future flood risk are produced using combinations of hydrological and hydraulic modelling and analysis of past hydrological records to make future predictions.

5.1.1 Surface water future flood risk

The Environment Agency has two national datasets showing surface water flooding available to LLFAs:

- Areas Susceptible to Surface Water Flooding (AStSWF);
- Flood Map for Surface Water (FMfSW).

These datasets, along with the National Receptors Database v1.0 were used nationally to select the 10 Indicative Flood Risk Areas in England.

The surface water maps are not designed to assess the risks from other sources of flooding. However, as these datasets use a 2D representation of the ground, they route surface runoff into channels and depressions. As flooding is dependent on topography and depressions, flooding from ordinary watercourses and groundwater may occur in the same places as flooding from surface runoff.

A national-scale assessment of properties at risk of surface water flooding within the Borough was provided by the Environment Agency, as shown in **Table 5.1**.

Mapping Source	Count for Havering	
Flood Map for Surface Water (FMfSW) - 1 in 200 rainfall - Flooding greater than 0.1m depth	NRD v1.0 - all properties	30,700
	NRD v1.0 - residential properties	27,000
	difference (non-residential)	3,700
Flood Map for Surface Water (FMfSW) - 1 in 200 rainfall - Flooding greater than 0.3m depth	NRD v1.0 - all properties	9,700
	NRD v1.0 - residential properties	8,500
	difference (non-residential)	1,200
Areas Susceptible to Surface Water Flooding (AStSWF) - Less	NRD v1.0 - all properties	26,100
	NRD v1.0 - residential properties	22,600
	difference (non-residential)	3,500
Areas Susceptible to Surface Water Flooding (AStSWF) - Intermediate	NRD v1.0 - all properties	10,800
	NRD v1.0 - residential properties	9,200
	difference (non-residential)	1,600

Source: LLFA_Property_Counts_Rounded_for_PFRA.xls supplied by the Environment Agency with Indicative Flood Risk Areas to Local Authorities. Note that values are rounded to nearest 100 properties.

Table 5.1 National assessment of the consequences of surface water flooding

An analysis of the receptors assessed to be at risk from the AStSWF and FMfSW was not undertaken, because the locally agreed surface water information on future

flooding is considered to be the best available source of this information (see section 5.2.1).

5.1.2 Groundwater future flood risk

There are four national datasets providing information on groundwater flooding (see Table 5.2). Each has limitations, which may include: cost, resolution, coverage (for example, England only), classifications (it may or may not be linked to an estimated flood probability) and hydrogeological coverage (for example, only chalk; or only consolidated aquifers).

As identified earlier, the mechanisms of overland flow and ponding in topographic depressions have an obvious relationship with surface water flooding. Above ground locations identified at risk of surface water flooding, that lie within an area susceptible to groundwater flooding, may also be susceptible to groundwater flooding. The consequences of future flooding from groundwater (in the areas susceptible to groundwater flooding) are therefore not additional to those counted and recorded for the future surface water flooding maps.

Source	Availability	Description
Groundwater Flood Susceptibility Map	British Geological Society – a licence fee may be payable. England & Wales.	This shows areas split into bands of susceptibility where groundwater flooding could arise from consolidated aquifers or permeable superficial deposits. The dataset does not attempt to assign a probability to flooding.
Groundwater Emergence Maps	Defra – free of charge to LLFAs for use in PFRAs. Covers England only.	This shows areas where groundwater levels in consolidated aquifers might be within 2m of the ground surface in a winter hydrologically similar to the very wet winter of 2000/01 verified against flood records from that winter. The dataset does not attempt to assign a probability to the flooding.
Groundwater Flood Map	JBA consulting – a licence fee may be payable. England & Wales.	This shows flood risk envelopes for a range of probabilities for groundwater flooding from chalk aquifers and permeable superficial deposits.
Areas Susceptible to Groundwater Flooding	Environment Agency. Available from Datashare. Free of charge for use in PFRAs. England & Wales.	This is a very broad scale map showing groundwater flood areas on a 1km^2 grid. This dataset is a simplified version of the top two susceptibility bands of the Groundwater Flood Susceptibility Map and is being provided to give a broader feel for the wider areas which might be at risk from groundwater flooding. It covers consolidated aquifers and permeable superficial deposits and shows the proportion of each 1km grid square susceptible to flooding. The dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

Table 5.2 National groundwater datasets

These four layers have been used to create new locally agreed information on future groundwater flooding (see section 5.2.2).

5.2 Locally Agreed Surface Water Information

Locally agreed information on future flood risk is information produced to inform a local study, such as an SFRA, SWMP or Drainage Action Plans (DAP). Two sources of locally agreed information on future flood risk have been developed for the SWMPs for all London Boroughs under the Drain London programme co-ordinated by the GLA:

5.2.1 Surface Water Flood Risk Mapping

Surface water flood risk modelling and mapping has been prepared for the entire Borough in support of the SWMP. Full details of the methodology used to produce the surface water flood risk mapping are provided in the SWMP report (London Borough of Havering, 2011), but in summary:

- Modelling was carried out in InfoWorks CS following a direct rainfall approach. A variable mesh was used to apply greater detail to the 2D model in urban areas.
- Net (effective) rainfall was variable according to land surface and to the capacity of the sewerage system, set by Thames Water at 6.5mm/hour. Where the capacity of the sewerage system is lower than this, it would be expected that sewer flooding would occur on a relatively regular basis and would be brought to the attention of Thames Water and/or the Borough.
- The 3.33% (1 in 30 year), 1.33% (1 in 75 year), 1% (1 in 100 year), 1% (1 in 100 year) allowing for climate change (at 30% increase in rainfall) and 0.5% (1 in 200 year) annual probability design rainfall events were calculated using the FEH CD-Rom and run through the models.
- Key 1D structures (in particular culverts inflowing from urban areas) were included where sufficient information was available. The sewerage system was not explicitly modelled.
- Main Rivers were assumed to be bank-full.

Model outputs include maps of extent, depth, speed, direction and probability of flooding. This locally produced information closely matches the extents of the Environment Agency's Flood Map for Surface Water (FMfSW) in most areas, but the modelling approach taken for the SWMP was more locally detailed than the national FMfSW, and therefore is presented here as the primary source of local surface water information on future flooding. Outputs are shown in Figures 5.1 and 5.2 for the 0.5% annual rainfall probability. The PFRA Guidance states that *"for the purposes of the PFRA process the rainfall event with a 1 in 200 chance of occurring in any year scenario is the most appropriate as this is equivalent to the chance of flooding on the ground in the order of a 1 in 100 chance in any given year"*. **Figure 5.1** shows surface water depth for a 1 in 200 chance of rainfall event occurring in any given year, and **Figure 5.2** shows the "Hazard to People" rating and direction of flow for the same event.

Within Havering, the river valleys of the Beam, Ravensbourne, Ingrebourne and Rom are indicated as important surface water flow pathways. Elsewhere, minor watercourses, now mainly subsumed into the urban drainage system, remain as important pathways during extreme flows, for example in South Hornchurch, Hornchurch and Cranham. In the flatter parts of the Borough (e.g. Elm Park, Rainham Marshes), flow pathways are generally less well defined, with ponding modelling many of the roads, though generally not to a depth where large numbers of properties would be internally flooded. Overall, it is important to note that surface

water flood risk is not confined to specific areas of the borough – all parts of the borough have some risk of surface water flooding.

Table 5.3 summarises the numbers of properties at risk in each borough, following the Drain London classification of receptors (consequences). Properties where the average flood depth across the building footprint exceeds 0.03m are assessed to be flooded[2].

Borough	Property Type	Flood Risk Vulnerability Classification	Total No. of units flooded
Havering	Infrastructure	Essential Infrastructure	14
		Highly Vulnerable	40
		More Vulnerable	59
	Households	Non-deprived (not basements)	14778
		Non-deprived (basements only)	1
		Deprived (not basements)	727
		Deprived (basements only)	0
	Commercial	Units (not basements)	2510
		Units (basements only)	0
	TOTAL		**18129**

Table 5.3 Predicted consequences of flooding, 0.5% Annual Rainfall Probability

Figure 5.1 Map showing Surface Water Depth (1 in 200 chance of rainfall event occurring in any given year)
Figure 5.2 Map showing Surface Water Hazard Rating (1 in 200 chance of rainfall event occurring in any given year)

5.2.2 Increased Potential for Elevated Groundwater Mapping

Background
Large areas within the Greater London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique described below aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment.

The four data sources listed in Table 5.2 have been utilised to produce the increased Potential for Elevated Groundwater map (iPEG). To produce the iPEG map for consolidated aquifers, an area was defined as having increased potential for elevated groundwater levels if at least two of the three mapping techniques listed in Table 5-1 produced a corresponding area. For the permeable superficial deposits, only Band 1 Very High of the BGS was used as this was judged to best represent the hazard.

The techniques used to generate the iPEG map produced some small areas of increased potential and some dry islands within increased potential areas. These

[2] This depth threshold was set as the property footprints had already been raised by 0.1m in the model. It was not possible to assume that buildings with a lower depth were "flooded" because all buildings (and all other surfaces) in the model are wetted by rainfall during the model simulation.

have not been cleaned in order to best represent the original data. Further information on the iPEG mapping is available in Appendix D of the SWMP.

How to Use and Interpret the Map

The increased Potential for Elevated Groundwater map shows those areas within the Borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface. Groundwater may become elevated by a number of means:

- Above average rainfall for a number of months in Chalk outcrop areas;
- Shorter period of above average rainfall in permeable superficial deposits;
- Permeable superficial deposits in hydraulic continuity with high water levels in the river;
- Interruption of groundwater flow paths; and
- Cessation of groundwater abstraction causing groundwater rebound.

With the exception of groundwater rebound which is not covered, the iPEG map will identify those areas most prone to the mechanisms described above. The map shows those areas considered to have the greatest potential for elevated groundwater. Additional areas within the London Boroughs have permeable geology and therefore could also produce elevated groundwater levels. However, to produce a realistic map, only where there is the highest degree of confidence in the assessment are the areas delineated. This ensures resources are focused on the most susceptible areas. In all areas underlain by permeable substrate, groundwater should still be considered in planning developments.

Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas. The localised nature of groundwater flooding and the different interpretation of the maps required are illustrated in the cartoon in **Figure 5.3**.

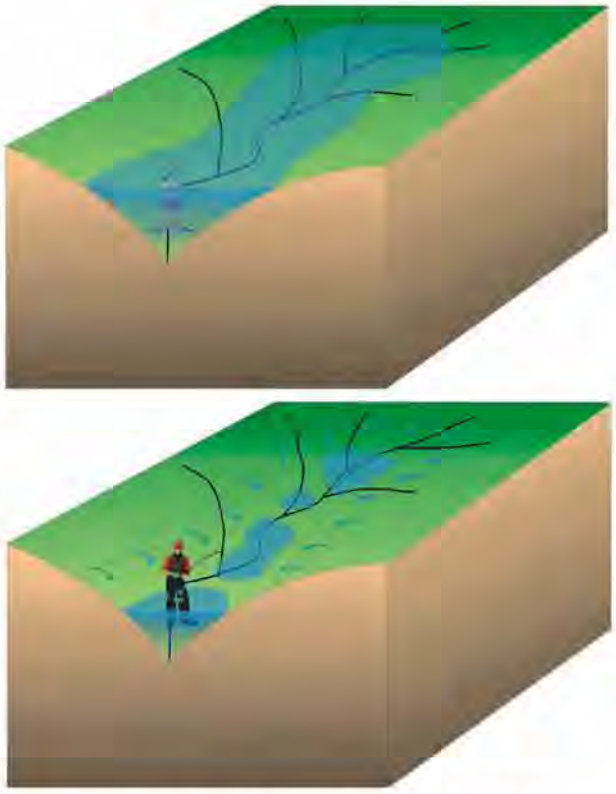


Figure 5.3 Cartoon illustrating the difference between fluvial (top image) and groundwater (bottom image) flood mapping

For this reason, within iPEG areas, locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the iPEG map should not be used as a "flood outline" within which properties at risk can be counted. Rather it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so what would be the major flow pathways that water would take.

Results

The iPEG mapping is presented in **Figure 5.4**. This indicates that significant areas of the Borough have a potential for elevated groundwater due to the presence of permeable, superficial deposits. The river valleys of the Rom, Beam, Ravensbourne, Ingrebourne and Mardyke are included, as is most of the east of Romford and extensive rural areas within the Mardyke catchment. Again it must be reiterated that these are not potential flood outlines and therefore this mapping should not be used to count receptors "at-risk".

Figure 5.4 Map showing areas of increased Potential for Elevated Groundwater

5.3 Impact of Climate Change

5.3.1 The Evidence

There is clear scientific evidence that global climate change is happening now. It cannot be ignored.

Over the past century around the UK we have seen sea level rise and more of our winter rain falling in intense wet spells. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

Greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

We have enough confidence in large scale climate models to say that we must plan for change. There is more uncertainty at a local scale but model results can still help us plan to adapt. For example we understand rain storms may become more intense, even if we can't be sure about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 annual chance, or rarer) could increase locally by 40%.

5.3.2 Key Projections for Thames River Basin District

If emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 15% (very likely to be between 2% and 32%);
- Precipitation on the wettest day in winter up by around 15% (very unlikely to be more than 31%);
- Relative sea level at Sheerness very likely to be up between 10cm and 40cm from 1990 levels (not including extra potential rises from polar ice sheet loss);
- Peak river flows in a typical catchment likely to increase between 8% and 18%.

5.3.3 Implications for Flood Risk

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability.

Wetter winters and more of this rain falling in wet spells may increase river flooding in both rural and heavily urbanised catchments. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected.

Rising sea or river levels may increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

There is a risk of flooding from groundwater-bearing chalk and limestone aquifers across the district. Recharge may increase in wetter winters, or decrease in drier summers.

Where appropriate, we need local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us adapt to climate change and manage the risk of damaging floods in future.

5.3.4 Adapting to Change

Past emission means some climate change is inevitable. It is essential we respond by planning ahead. We can prepare by understanding our current and future vulnerability to flooding, developing plans for increased resilience and building the capacity to adapt. Regular review and adherence to these plans is key to achieving long-term, sustainable benefits.

Although the broad climate change picture is clear, we have to make local decisions against deeper uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

5.3.5 Local information

The Locally Agreed Surface Water Information described in section 5.2.1 included simulations of the 1% annual rainfall probability for present day and with an additional 30% rainfall to allow for climate change. This uplift is in line with recommendations in PPS25 (based on research by Defra) and was applied as a standard uplift across London by the Drain London programme. A comparison of the results enables an estimation of the potential for increased flood risk due to climate change.

The results for Havering show no significant new areas of flood risk due to the increased rainfall as a result of climate change, but the flow pathways and accumulation areas at risk in the present day 1% annual rainfall probability are extended, in many areas leading to flooding of additional receptors and deeper flooding at those receptors also already considered to be impacted in this event.

An assessment of the change in consequences of flooding due to climate change was carried out. The Drain London methodology for identifying whether a property is flooded is to select properties where average depth (within the building footprint) is greater than 0.03m. Results are presented in **Table 5.4**. Overall they indicate a 21% increase in the number of properties flooded due to climate change.

Property Type	Flood Risk Vulnerability Classification	Total No. of units flooded (1 in 100)	Total No. of units flooded (1 in 100CC)	Percentage change
Infrastructure	Essential Infrastructure	14	14	0%
	Highly Vulnerable	35	40	14%
	More Vulnerable	54	60	11%
Households	Non-deprived (not basements)	13099	15346	17%
	Non-deprived (basements only)	1	1	0%
	Deprived (not basements)	662	742	12%
	Deprived (basements only)	0	0	
Commercial	Units (not basements)	2259	2582	14%
	Units (basements only)	0	0	
TOTAL		**16124**	**18785**	**17%**

Table 5.4 Predicted changes in flooding consequences due to climate change

There is no locally agreed information on changes to the risk of groundwater flooding due to climate change.

Figure 5.5 Map showing Surface Water Depth (1 in 100 chance of rainfall event occurring in any given year plus allowance for climate change)
Figure 5.6 Map showing Water Flood Hazard Rating (1 in 100 chance of rainfall event occurring in any given year plus allowance for climate change)

5.4 Impact of Future Development

5.4.1 Long term developments

It is possible that long term developments might affect the occurrence and significance of flooding. However current planning policy aims to prevent new development from increasing flood risk.

In England, Planning Policy Statement 25 (PPS25) on development and flood risk aims to "ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall."

Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria), but should be recorded here so that they can be reviewed in the future.

5.4.2 Local future development

The Core Strategy for Havering identifies the following future long term development opportunities in the Borough:

- **Thames Gateway**: the London Plan gives priority (among other areas) to the regeneration of north east London, especially the Thames Gateway. It recognises that the levels of growth in this area will depend upon substantial new and improved infrastructure to stimulate and facilitate investment and that special attention should be paid to long term flood risk. London Riverside, one of the 14 Government defined 'zones of change' within the Thames Gateway area, covers a large part of Havering, and Barking and Dagenham.

- **London Riverside**: as well as being a Thames Gateway 'zone of change', the London Plan identifies London Riverside as an Opportunity Area with the potential for 14,000 new jobs and a minimum of 20,000 new homes – the biggest development opportunity in the London part of the Thames Gateway.

- **Romford Town Centre**: along with London Riverside, Romford Town Centre will accommodate the greatest proportion of the Borough's employment, housing and development needs. A Romford Area Action Plan has been produced.

- **Strategic Industrial Locations**: Rainham Employment Area, which incorporates the Rainham West and Beam Park sites that have been identified

for residential and commercial development, is one of Havering's Strategic Industrial Locations.

- **London 2012 Olympics**: the Olympics are anticipated to have significant implications for the pace of regeneration within Havering.

Due to the scale of these developments, their impact on flood risk is potentially significant and will therefore need to be managed strategically (rather than on a site-by-site basis).

6 Review of Indicative Flood Risk Areas

6.1 Extent of FRA

The Environment Agency has identified London as one of ten Indicative Flood Risk Areas in England. The methodology applied to select these areas is described in Defra (2010). The Indicative Flood Risk Areas are illustrated in **Figure 6.1** and in more detail in **Figure 6.2**.

Figure 6.1 Environment Agency map of Indicative Flood Risk Areas (plus inset to show London detail)

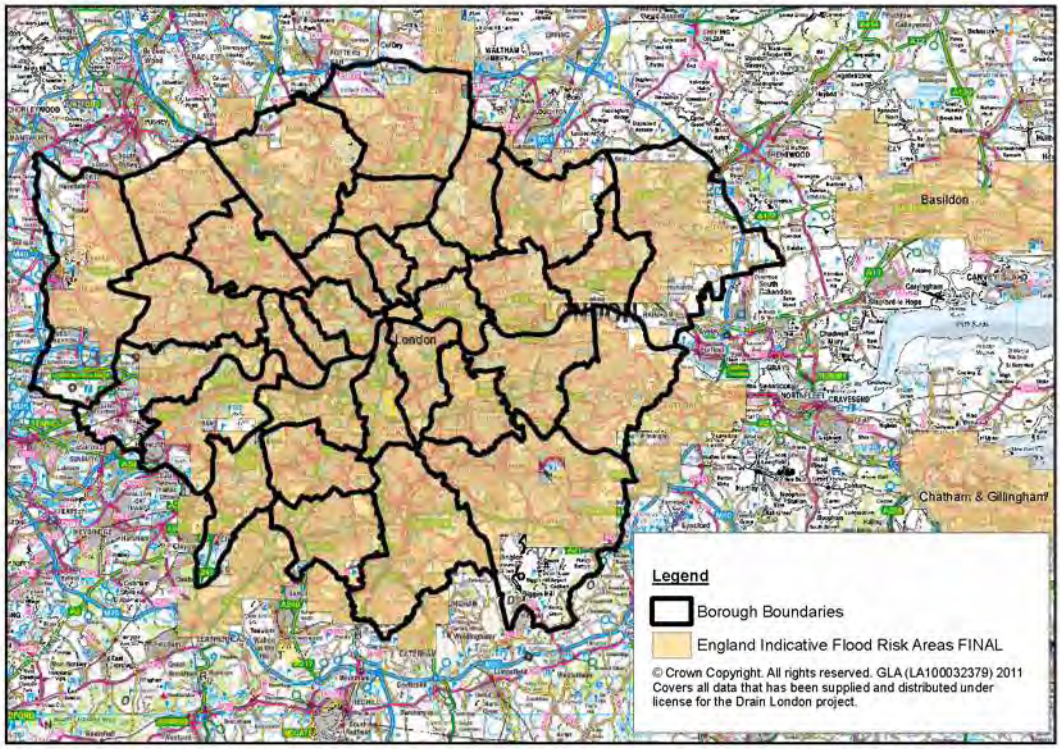
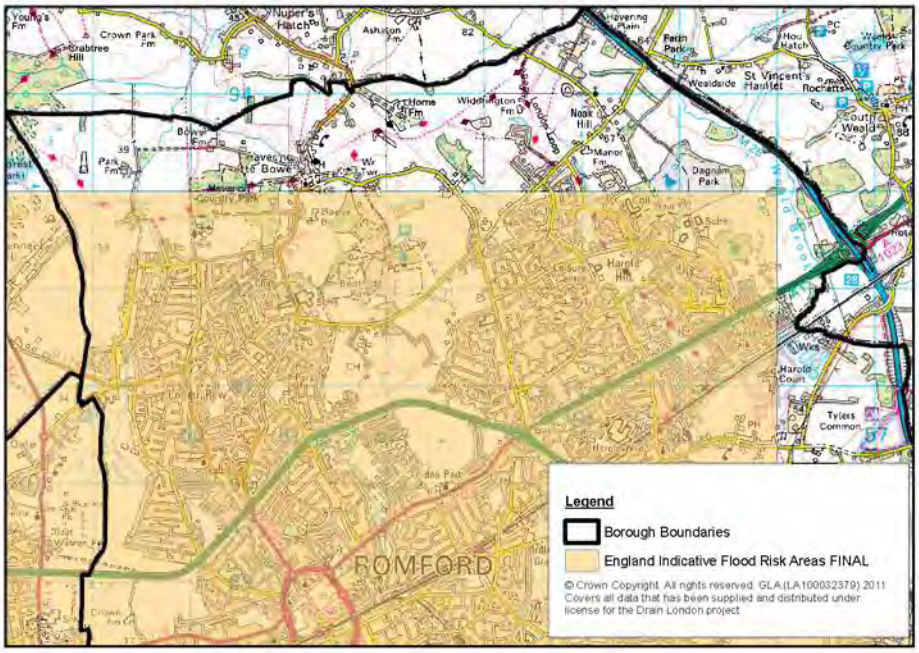


Figure 6.2 Map showing Indicative Flood Risk Areas in London

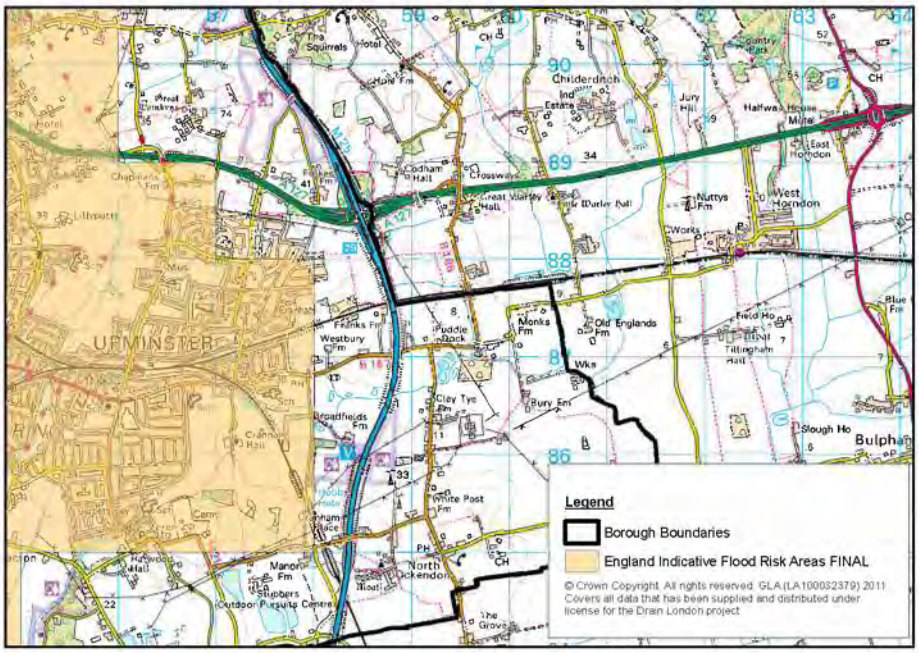
Not all parts of the Borough lie within the Indicative Flood Risk Area for London as defined by the Environment Agency. This is due to the screening and clustering method employed, which was carried out nationally by 1km squares. Where these squares are on the edge of a settlement and therefore do not contain many receptors, they did not meet the Flood Risk Thresholds used for the national assessment (number of people > 200 or critical services > 1 or number of non-residential properties > 20). These are reviewed in **Figure 6.3**, and where appropriate, recommendations made for amendments to the Indicative Flood Risk Area boundary.

Northern fringe



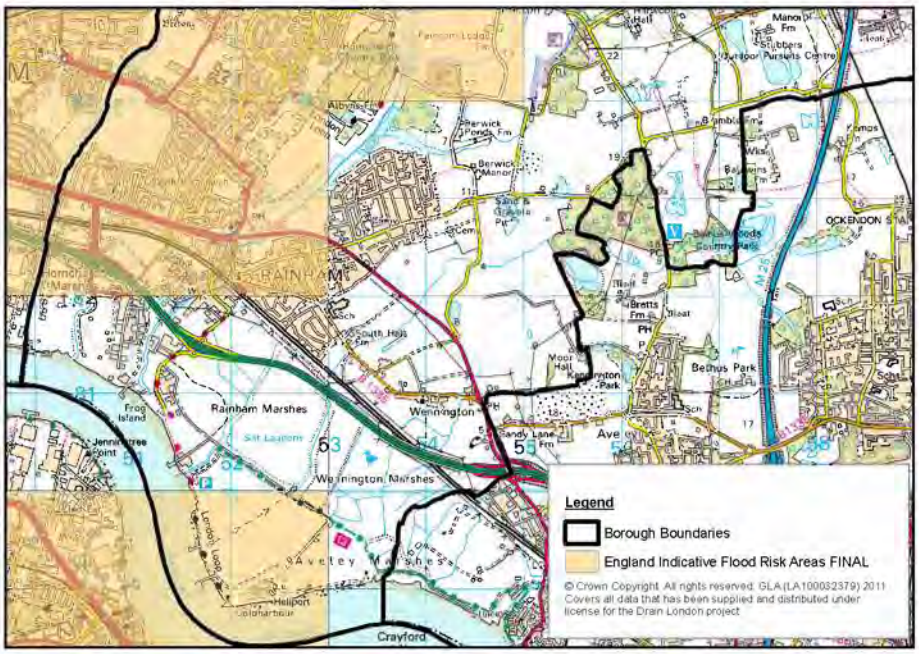
Recommended changes to Flood Risk Area: Geography: Minor Change in Boundary. Extend to Borough boundary to provide complete coverage of settlements of Havering-atte-Bower and Harold Hill.

Upminster



Recommended changes to Flood Risk Area: Geography: Minor Change in Boundary. Extend to high water mark to provide complete coverage of settlement.

Rainham



Recommended changes to Flood Risk Area: Geography: Minor Change in Boundary Extend to Borough boundary to provide complete coverage of settlement and key infrastructure (A13 and Channel Tunnel Rail Link).

Figure 6.3 Areas of Havering outside the London Indicative Flood Risk Area

6.2 Review Comments

Table 6.1 summarises the issues identified in reviewing the extent of Indicative Flood Risk Areas for Havering.

Reasons for Change		Explanation
Geography	Minor Change to Boundary	**Extension to settlement boundary to include all of Havering-atte-Bower, Harold Hill, Upminster and Rainham - extend to provide complete coverage of settlements.**
	Indicative Flood Risk Area Split	Not required as entire borough covered by one flood risk area.
	Indicative Flood Risk Area Combined	
Past/ Historic Flooding	Indicative Flood Risk Area Expanded	Not required as entire borough covered by one flood risk area.
	New Indicative Flood Risk Area	Not required as entire borough covered by one flood risk area.
Future Flooding	Indicative Flood Risk Area Expanded	**In line with extending the boundary to include Northern fringe, Upminster and Rainham, which currently fall outside the indicative flood risk area, reinforces the need for extending the IFRA to cover these urban areas. The locally agreed information on future surface water flooding shows several**
	New Indicative Flood Risk Area	

		areas of flooding up to 1m around the receptor in these areas.
	Indicative Flood Risk Area Reduced in Size	Not required as entire borough covered by one flood risk area.
	Indicative Flood Risk Area Deleted	

Table 6.1 Summary review of Indicative Flood Risk Areas

7 Identification of Flood Risk Areas

7.1 Amendments to FRA

As identified in **Table 6.1**, it is recommended that one amendment is made to the Greater London Indicative Flood Risk Area to include all of the settlements of Havering-atte-Bower, Harold Hill, Upminster and Rainham within the London Borough of Havering.

Table 7.1 summarises these recommended changes.

Location	Reason for change	Explanation
Havering-atte-Bower, Harold Hill, Upminster and Rainham	Geography - Minor Change in Boundary	Extend to settlement boundary to provide complete coverage of settlements.

Table 7.1 Summary of recommended amendments to Flood Risk Areas

Amendments to IFRAs must be provided as a polygon consisting of amalgamated Ordnance Survey 1km National Grid squares. Following this method three amendment areas to the London IFRA within Havering have been identified. This is shown below in **Figure 7.1**, and a GIS layer is provided in **Annex 5**.

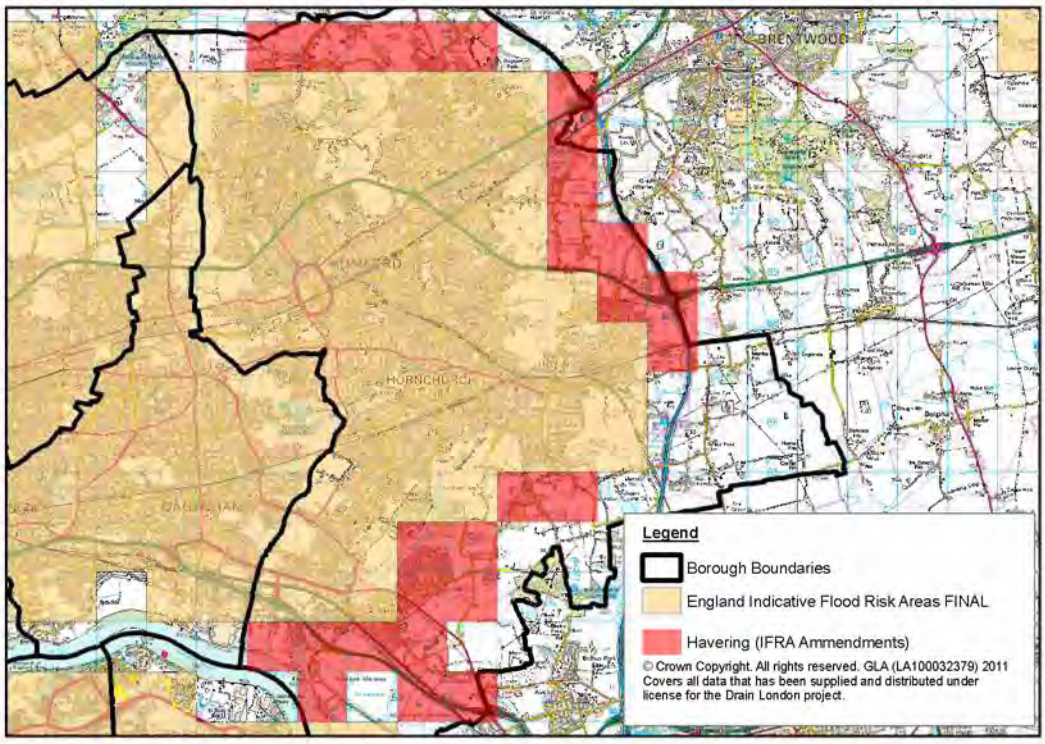


Figure 7.1 Map of amendments Flood Risk Areas

As discussed in section 5.2.1, the flood extents of the locally agreed surface water information for future flood risk are broadly similar to the national FMfSW and

AStSWF maps and therefore do not justify any reductions in size of the Greater London Indicative Flood Risk Area within the Borough.

7.2 New FRA

With the proposed amendments, the entire urbanised area of the Borough will be contained within the Greater London Indicative Flood Risk Area. Therefore no new FRAs are identified.

8 Next Steps

8.1 Scrutiny and Review

The PFRA review process is an important check that the requirements of the Flood Risk Regulations have been met, and ensures that the right areas (i.e. those with the most significant flood risks) are identified for attention in the next stages.

8.1.1 LLFA review

The purpose of this review is to ensure that the PFRA is fit for purpose in meeting the requirements of the Regulations.

The PFRA will be scrutinised by the Internal Partnership Group of the Havering Flood Management Group (see **Annex 6** for further details of this group's membership and role). The Cabinet will be presented with a report of the outcomes from this review, but will not be involved in the formal Scrutiny process.

8.1.2 Environment Agency review

The EA has a duty under the Regulations to review, collate and publish the PFRA to ensure it meets the minimum requirements of the European Commission and to ensure the selection of Flood Risk Areas is appropriate. The local Area review informs the national review which checks that any changes are justified and consistent nationally.

The Review Checklist included as **Annex 4** is used by all LLFAs and EA review teams to ensure a consistent review process is applied.

8.2 Data Collection and Management

Data will be collected in a centralised database, coordinated by the local flood risk lead in the Borough. This will establish a common baseline for flood data and information, in line with Environment Agency requirements. It is anticipated that by setting up a Borough wide 'one-stop-shop' for flood data and information it will enable efficient information consolidation and data sharing. This will be linked to the asset register required under the FWMA.

Existing data will be consolidated and linked to the new data management system, where it is in a suitable format or stored centrally in order to improve access. Historic data within Havering is currently fragmented and significant value could be gained through collating existing information.

As a LLFA, Havering have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. This register must be available for inspection by the Secretary of State.

8.3 Incident Recording

The Drain London Forum has issued to all Boroughs a standard specification for Flood Incident data reporting, in Excel spreadsheet format. The purpose of this spreadsheet is to provide a template for recording flood incident information in a consistent manner throughout Greater London.

As part of their new responsibilities as Lead Local Flood Authorities, each London Borough is required to monitor flooding within its area and investigate the causes. This Flood Incident Record template aims to provide a key tool in this process by providing a consistent means for recording incident information for future investigation. The fields provided are based upon the Environment Agency standards for flood event data collection, with some minor additions to retain extra related information where it is available.

This spreadsheet can be used as a stand-alone record or can be modified for use on any proprietary GIS platform.

In addition to setting up consistent systems, the Borough will need to define the processes by which a flood incident is reported and investigated.

8.4 Other FRA Requirements

The Flood Risk Regulations require three main types of assessments, maps and plans to be undertaken by LLFAs and approved by the Environment Agency between 2011 and 2015. These are outlined as follows;

- **Preliminary Flood Risk Assessments** (this document) - Completed by Lead Local Flood Authorities (LLFAs) and agreed by the Environment Agency by the 22nd December 2011. Flood Risk, Hazard Maps and Local Flood Risk Management Plans will be developed on the basis of identified flood risk areas. Under the Flood and Water Management Act, Surface Water Management Plans are required where there is a risk identified (a SWMP for Havering is being produced in parallel with this PFRA).

- **Flood Hazard Maps and Flood Risk Maps** - The Environment Agency and Lead Local Flood Authorities are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22nd December 2013. Draft maps will be developed as part of the Drain London Programme for all 33 London Boroughs during 2011. Some minor changes/enhancements to these products may be required once formal guidance is published by the Environment Agency.

- **Local Flood Risk Management Plans** - The Environment Agency and Lead Local Flood Authorities are required to produce Local Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22nd December 2015.

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Annexes

Annex 1: Past Floods

Annex 1 contains a record of past floods and their significant consequences. Please refer to Annex 1 of the Preliminary Assessment Spreadsheet attached with this report.

Annex 2: Future Floods

Annex 2 contains a record of future flood risk within Havering, including details of potential consequences of flooding to key receptors within the Borough. Please refer to Annex 2 of the Preliminary Assessment Spreadsheet attached with this report.

Annex 3: Flood Risk Areas

Annex 3 contains information and details about the identified Flood Risk Areas within Havering. Please refer to Annex 3 of the Preliminary Assessment Spreadsheet attached with this report.

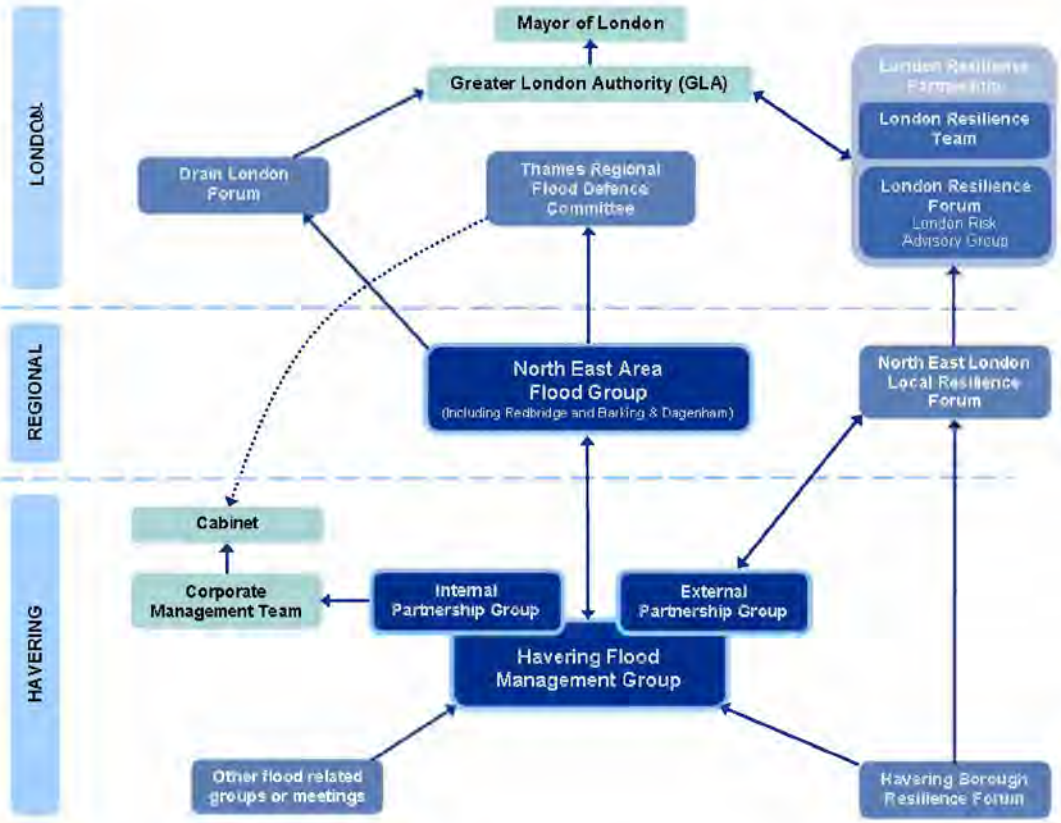
Annex 4: Review Checklist

Annex 4 contains the Review Checklist as provided by the Environment Agency to act as a checklist for reviewing PFRA submissions. Please refer to the Review Checklist spreadsheet attached with this report.

Annex 5: GIS layer of Flood Risk Areas

Annex 5 contains a GIS layer of Flood Risk Areas; please refer to the GIS layer attached with this report.

Annex 6: Partnership Structure



This partnership structure is 'fluid' and evolving – as the Borough advances into the role of managing local flood risk in this new way, groups and committees may change in format, membership and frequency to reflect new requirements and ways of working, and partners and stakeholders may change. The partnership approach set out in this PFRA will need to be ratified over time and potentially adjusted as appropriate in the future to accommodate these changes, the most relevant and immediate of which will be the effects of changes to the resilience forum structure under GLA.

Havering Flood Management Group

Led by Havering, this Flood Management Group is proposed as a structure of partnership working and consultation in order to manage flood risk and planning. The Flood Management Group consists of separate Internal and External Partnership Groups; Havering are keen to avoid sub-groups and their inevitable duplications and gaps that can weaken the process and lead to ineffective partnership. Chaired by the same person (to be appointed), the Internal and External Partnership Groups (which together make up the Flood Management Group) will meet quarterly to agree responsibilities, assign actions and monitor progress relating to local flood risk management. As the overarching lead within the Borough, the Flood Management Group is responsible for driving the communication of risk to stakeholders and the public by producing and disseminating literature (such as Havering's Emergency Planning Handbook) and undertaking communication and engagement events and activities as appropriate. The Havering Borough Resilience Forum will feed outputs and knowledge into the Flood Management Group.

Internal Partnership Group – includes representatives from Streetcare (e.g. highways and drainage), Development and Building Control (e.g. emergency planning), Parks, Regeneration (e.g. spatial planning), Culture and Leisure, Insurance and Communications. The Internal Partnership Group meets as often as required in addition to the regular quarterly Flood Management Group meetings. Members of the External Partnership Group (the Environment Agency and Thames Water in particular) are invited to join Internal Group meetings as appropriate, and separate one-to-one meetings with members of the External Group (e.g. riparian owners) may be undertaken by individuals from the Internal Group outside of the Flood Management Group format as appropriate. The Internal Group reports to the Havering Corporate Management Team which in turn reports to the Cabinet.

External Partnership Group – includes representatives from stakeholder and partner organisations including the Environment Agency, Thames Water, Network Rail, Essex and Suffolk County Councils, Anglian Water, London Transport, Highways Agency, London Fire Brigade and Transport for London. It is proposed that the External Partnership Group meet quarterly as part of the Flood Management Group and then 6 monthly in order to complete Asset Register requirements under the Flood and Water Management Act 2010. Members of the External Group may also occasionally to invited to attend Internal Group meetings, or separate individual meetings, as requested by Havering.

North East Area Flood Group

Led by John Martin (from Redbridge) this group acts as the overarching regional level hub of the partnership structure, combining outputs from Havering's Flood Management Group and the equivalent local level groups within Redbridge and Barking & Dagenham. For Emergency Planning purposes the North East Boroughs of Waltham Forest and Newham are also involved. The Group addresses cross boundary issues for the three neighbouring Boroughs and identifies opportunities for working together. Meetings are attended by representatives from Havering, Redbridge, Barking & Dagenham, and are planned to coincide with meetings of the Thames Regional Flood Defence Committee so that appropriate members can be briefed beforehand.

Thames Regional Flood Defence Committee

Regional Flood Defence Committees (RFDCs), of which there are 11 in England, carry out most of the Environment Agency's flood risk management functions under the Water Resources Act 1991, and deal with all land drainage matters and flood defence activities in their areas. The Thames RFDC consists of 23 members, 12 of which are nominated by local authorities in the Thames region, seven members and the Chairman appointed by Defra, and three by the Environment Agency. Councillor Barry Tebbutt (Cabinet Member for Environment) represents Havering on the Thames RFDC and provides a feedback link to the Council via the Cabinet (and ideally the Havering Flood Management Group). Councils within the region provide some funding for improvement and maintenance work through levies, usually to allow local projects to go ahead when they do not meet national funding priorities.

Havering Borough Resilience Forum

Havering Borough Resilience Forum, chaired by Havering's Emergency Planning and Business Continuity Unit, is responsible for co-operation, information sharing, emergency planning, communicating with the public, and assessing risk in relation to being adequately prepared for a major emergency (e.g. flooding). Priorities for emergency planning at a Borough level are fed down from the North East London Local Resilience Forum in the form of a Community Risk Register.

North East London Local Resilience Forum

The North East London Resilience Forum is one of the six London Local Resilience Forums (LRFs) and brings together the London Boroughs of Barking & Dagenham, Havering, Newham, Redbridge and Waltham Forest. The Forum, which meets quarterly, is responsible for overseeing the local implementation of the policy set by the London Resilience Forum. Tasked with identifying, assessing and managing local risks that could cause an emergency (of which flooding is one), the North East London Resilience Forum informs emergency planning teams within individual Boroughs of emergency planning priorities through Community Risk Registers. As well as local authorities, membership of the North East London Resilience Forum includes representatives from emergency services, government agencies, health, utilities, voluntary organisations, businesses and the military.

London Resilience Partnership

The London Resilience Partnership (the partnership between the Government, the Mayor and all of London's key responding agencies) consists of the London Resilience Forum (of which the London Risk Advisory Group is a sub-group) and the London Resilience Team.

London Resilience Forum - the London Resilience Forum reports to the Government and is composed of senior officials representing the main emergency organisations and key sectors within the partnership. The Forum, which is supported by a number of Panels to allowed focus on specific sectors (e.g. business, utilities, voluntary sector, blue lights), is responsible for defining the strategic direction for the London Resilience Partnership.

London Risk Advisory Group – a sub-group of the London Resilience Forum, the London Risk Advisory Group (previously run by London Fire Brigade) is led by Hamish Cameron (London Resilience Manager of the London Resilience Team at the GLA). The Group contains representatives from each of the six Local Resilience Forums, and key resilience and emergency planning organisations and agencies, and is responsible for assessing a range of risks across London (of which flooding is one of the most important) to inform planning priorities. Alan Clark (of Havering) is the representative for the North East London Boroughs.

London Resilience Team - the London Resilience Team was created following the events of 11 September 2001 which suggested that Government and local responders needed to plan for events on a previously unimaginable scale (hence the Team's early focus on terrorism). The Team supports the London Resilience Forum and is responsible for overseeing the work of the London Resilience Partnership. The team operates with a permanent core of civil servants who are supported by specialists seconded from partner organisations. Members include the Metropolitan Police Service, British Transport Police, City of London Police, London Fire Brigade, London Ambulance Service, National Health Service, Greater London Authority, Transport for London, London Underground, London Fire and Emergency Planning Authority (LFEPA) and London Councils.

Drain London Forum

The Drain London Project was set up to help LLFAs meet their responsibilities for managing local flood risk under the Flood Risk Regulations; part of this was done through the Drain London Forum which provided Boroughs with guidance on asset registers, helped to form multi-agency partnerships, and shared good practice, knowledge and expertise. When the Drain London Project finishes, the Boroughs are required to address remaining flood risk problems and continue the partnership

working established through the Drain London process; for this reason the Drain London Forum is ongoing and will continue to serve the purpose outlined above.

Havering Multi Departmental Flood Group (now subsumed into the Havering Flood Management Group)

This group was set up in 2009 to address the implications of the 92 recommendations from the Pitt Review and to distribute responsibilities across the appropriate Council departments. The group was also tasked with establishing a multi agency flood plan (as required by Defra and the London Resilience Team through the Environment Agency). This plan was a Borough wide assessment of all known flood risk areas, including cross-boundary areas from adjacent Boroughs and Councils. Prior to the FRR requirements, the group met every six months, however in light of recent LLFA responsibilities, this group (which now operates as the Internal Partnership Group of the Havering Flood Management Group) meets quarterly.