SURFACE WATER MANAGEMENT PLAN

DRAIN LONDON

LONDON BOROUGH OF REDBRIDGE

Document control sheet BPP 04 F8

Client:	Greater London Authority		
Project:	Drain London (Package 5)	Job No:	B1577800
Document Title:	Surface Water Management Plan for Redbridge	Revision	Final 01

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DATE **March 2011**	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
Document Status: D.01				

REVISION 1	NAME **M Tadhunter** **P Eccleston**	NAME **S Thompsett**	NAME **R Falconer**	NAME **S Thompsett**
DATE **July 2011**	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
Document Status: F.01				

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
Document Status				

Jacobs Engineering U.K. Limited

Quality page

DOCUMENT INFORMATION

Title:	Surface Water Management Plan
Owner:	John Martin, Redbridge
Version:	F.01
Status:	Final
Project Number:	B1577800
File Name:	SWMP REDBRIDGE Final Report. doc

REVISION HISTORY

Summary of changes	Completed by	Date of issue	Version
All sections updated to reflect client and peer review comments	M Tadhunter S Thompsett P Eccleston	July 2011	F 01

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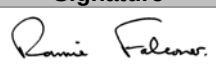
R Falconer	Project Principal		29/07/2011
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RELATED DOCUMENTS

Doc ref	Document title	Author	Date of issue	Version

Executive Summary

Overall Methodology

The following report summarises the risks and potential management solutions from Surface Water and Groundwater flooding in the Borough. A standardised method, developed for consistency across all 33 London Boroughs, has been followed throughout to include:

1) A review of existing data;
2) Hydraulic modelling to identify Critical Drainage Areas (CDAs) and local Flood Risk Zones (LFRZs) where surface water flooding or groundwater flooding could occur;
3) The recommendation of potential solutions for the mitigation or elimination of risks identified based on guidance provided by the Department for Environment, Food and Rural Affairs and the Environment Agency;
4) The development of a costed and prioritised 'Action Plan' and indicative Implementation Programme.

Collaboration and Engagement

The development of this study was undertaken collaboratively with the GLA (Drain London), Thames Water, the Environment Agency, other consultant representatives across the programme and the three Boroughs in Group 5 (Barking and Dagenham, Havering and Redbridge).

To gain early buy-in to the methodology and general agreement on the potential solutions available for the management of local flood risk. A number of face-to-face meetings and workshops were undertaken, both with the individual Borough and Group 5 collectively, during the study programme. This engagement was critical to capture both regional issues and local aspects in line with policy and national legislation.

Determining Risk

Using InfoWorks CS, a 2D pluvial model was developed to provide an indication of potential flow path direction, velocity and likely surface water ponding areas. The outputs of the model enabled the Borough to be subdivided into Critical Drainage Areas (CDAs), based on topography and piped drainage and Local Flood Risk Zones (LFRZs), flooding *'hot spot'* areas to be identified. Groups of Critical Drainage Areas were also brought together as 'Policy Areas', reflecting strategic issues. The combination of CDAs, LFRZs and Policy Areas, enabled complete prioritised coverage of the Borough.

Figure 1.0 Critical Drainage Area Index Map

The London Borough of Rebridge is considered to comprise; a) 2 Policy Areas b) 14 Critical Drainage Areas; and c) 26 Local Flood Risk Zones as shown in Figure 1.0.

Modelling also suggests that some 11,350 receptors are at risk in a 1 in 100 year event within the Borough.

Potential Solutions

Measures for the management of the risks identified in each CDA, have been considered on a Source, Pathway and Receptor basis, to provide an holistic approach across each CDA, both 'Generic' and 'Specific' measures were considered in each case. A number of CDAs cross the boundaries of neighbouring Lead Local Flood Authority areas, where this occurs the need for joint management has also been identified.

Potential measures that are technically capable of mitigating or eliminating the flood risks within LFRZs and those that require policy on a 'Borough Wide' basis are summarised below.

1) 'Borough Wide' generic 'policy driven' measures.
- Maintenance
- Planning Policies to Influence Development
- Social Change, Education and Awareness
- Policy Driven local Receptor Measures
  - Raising Doorway/Access Thresholds
  - Rain Water Harvesting, Water Butts and Soakaways
  - Permeable Paving
  - Green Roofs

2) LFRZ Generic measures.
- Rain Water Harvesting, Water Butts and Soakaways
- Road Side Rain Gardens
- Resistance and Resilience Measures

3) LFRZ Specific measures.
- Pond and Wetlands
- Detention Basins
- Temporary Demountable Barriers
- Swales

A number of investigations have also been recommended where Essential, Highly or More Vulnerable receptors are thought to be at risk in the Borough.

Recommendations and Action Planning

Costed recommendations for the mitigation/elimination of local flood risk and actions associated with requirements of the Lead Local Flood Authority under the Flood and water Management Act 2010 and Flood Risk Regulation 2009 are presented in a prioritised Action Plan as Appendix I.

Actions have been priorities as follows;

'High' Priority (colour coded Red)	Driven by legal requirements or funding 2011 onwards
'High' Priority (colour coded Dark Orange)	Priority investigations or implementation actions. (Short-term enabling activities) 2012 onwards
'Medium' Priority (colour coded Orange)	Investigations and solutions to be carried forward into Local Flood Risk Management Strategy/Plan. 2013 onwards

'Low' Priority (colour coded Yellow)	Measures Implemented as part of the Local Flood Risk Management Strategy/Plan. 2016 onwards

Glossary

Term	Definition
2D model	Two-dimensional hydraulic model
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 (Welsh Assembly Government) 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 (Welsh Assembly Government).
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.

Term	Definition
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
InfoWorks	A suite of hydraulic modelling software produced by Innovyze
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
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

Term	Definition
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 Surface Water Management Plan?

A Surface Water Management Plan (SWMP) is a plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall.

This SWMP study has been undertaken as part of the Drain London Project in consultation with key local partners who are responsible for surface water management and drainage in the London area – including Thames Water, the Environment Agency and Transport for London. The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

This document also establishes a long-term action plan to manage surface water and will influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

1.2 Background

In May 2007 the Mayor of London consulted on a draft Regional Flood Risk Appraisal (RFRA). One of the key conclusions was that the threat of surface water flooding in London was poorly understood. This was primarily because there were relatively few records of surface water flooding and those that did exist were neither comprehensive nor consistent. Furthermore the responsibility for managing flood risk is split between boroughs and other organisations such as Transport for London, London Underground, Network Rail and relationships with the Environment Agency and Thames Water and other sources of flood risk were unclear. To give the issue even greater urgency it is widely expected that heavy storms will increase in frequency with climate change.

The Greater London Authority, London Councils, Environment Agency and Thames Water commissioned a scoping study to test these findings and found that this was an accurate reflection of the situation. The conclusions were brought into sharp focus later in the summer of 2007 when heavy rainfall resulted in extensive surface water flooding in parts of the UK such as Gloucestershire, Sheffield and Hull causing considerable damage and disruption. It was clear that a similar rainfall event in London would have resulted in major disruption. The Pitt Review examined the flooding of 2007 and made a range of recommendations for future flood management, most of these have been enacted through the Flood and Water Management Act 2010 (FWMA).

DEFRA recognized the importance of addressing surface water flooding in London and fully funded the Drain London project to produce Surface Water Management Plans (SWMPs) for each London Borough. Through the subsequent enactment of the FWMA boroughs are also required to produce Preliminary Flood Risk Assessments (PFRA). The Drain London project has been adjusted to deliver both a PFRA and an SWMP for each London Borough. This will be a major step in meeting borough requirements as set out in the F&WM Act. Another key aspect of

the Act is to ensure that boroughs work in partnership with other Local Risk Authorities. Drain London assists this by creating sub-regional partnerships as set out in **Figure 1.1**.

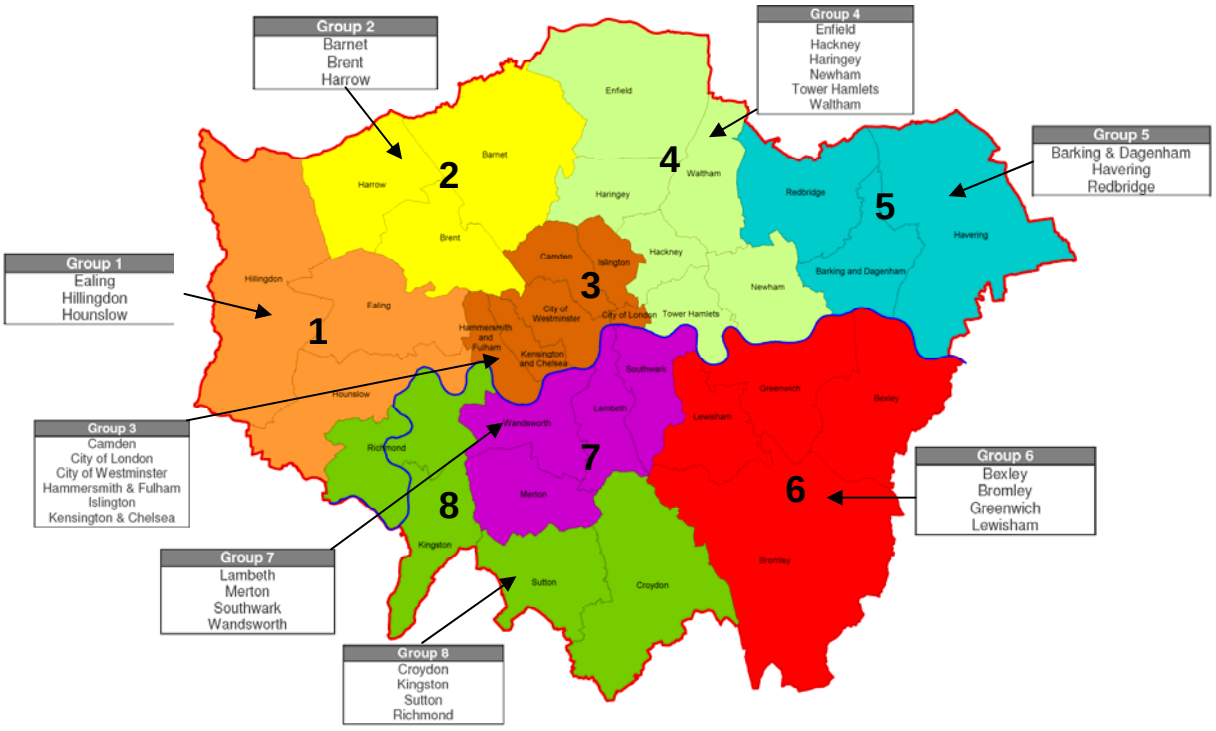


Figure 1.1 Drain London sub-regional partnerships

1.2.1 Project Delivery Terminology

The Drain London project is broken down using a 'tier' based approach as shown below.

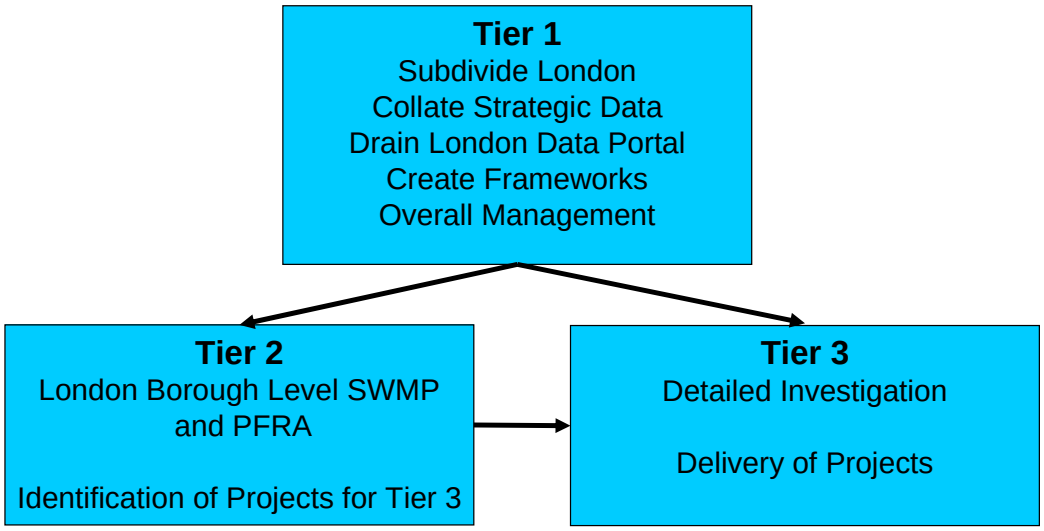


Figure 1.2 Drain London Project 'Tier' Structure

Table 1.1 further describes the activities undertaken in each of the Tiers. The management groups are shown in **Figure 1.2**. This SWMP report is a direct output from Tier 2.

Tier	Summary
Tier 1	a) A high level strategic investigation to group the 33 separate boroughs into a smaller number of more manageable units for further study under Tiers 2 and 3. b) Collection and collation of relevant information across all London Boroughs and strategic stakeholders including the Environment Agency, Thames Water and Transport for London. c) Development of a web based 'Portal' to provide data management, data storage and access to the various data sets and information across the 'Drain London Forum' (DLF) participants and to consultants engaged to deliver Tiers 2 and 3. d) Develop technical framework documents and prioritisation tools to guide delivery of Tiers 2 and 3.
Tier 2	a) Delivery of 33 Borough-level intermediate Surface Water Management Plans (SWMPs) within the management groups to define and map Local Flood Risk Zones, Critical Drainage Areas and flood policy areas and produce an Action Plan for each borough. b) Delivery of 33 Borough-level Preliminary Flood Risk Assessments to comply with the Flood Risk Regulations 2009 requirements for Lead Local Flood Authorities (LLFAs). c) Define a list of prioritised Critical Drainage Areas for potential further study or capital works in Tier 3, using the prioritisation tool developed in Tier 1.
Tier 3	a) Further investigations into high priority Local Flood Risk Zones/Critical Drainage Areas to further develop and prioritise mitigation options. b) Delivery of demonstration projects of surface water flood mitigation solutions identified in Tier 2 SWMPs. c) Funding or co-funding within the London area for green roofs and other types of sustainable urban drainage (SUDS). d) Set up of at least 2 community flood plans in local communities at risk from flooding

Table ***1.1*** ***Summary of 'Tier' Activities***

1.3 Objectives

The objectives of the SWMP are to:

- Develop a robust understanding of surface water flood risk in and around the study area, taking into account the challenges of climate change, population and demographic change and increasing urbanisation in London;
- Identify, define and prioritise Critical Drainage Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk;
- Make holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments;

- Establish and consolidate partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities;
- Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions;
- Deliver outputs to enable a real change on the ground rather than just reports and models, whereby partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions;
- Meet Borough specific objectives as recorded at the outset of the development of the SWMP (further details below);
- Facilitate discussions and report implications relating to wider issues falling outside the remit of this Tier 2 work, but deemed important by partners and stakeholders for effectively fulfilling their responsibilities and delivering future aspects of flood risk management.

Borough specific aims and objectives were discussed at the various meetings held throughout the development of the SWMP. These are summarised below:

1. **Clear and deliverable action plan**
   To achieve the best on a "value engineering" basis it is necessary to have a clear and costed plan that will enable us to develop a programme to make the best use of the Council's budget.

2. **Ensure others in addition to the immediate lead are informed and encouraged to participate**
   It is necessary that all service areas within the Council have a buy in to achieve a holistic approach to flood risk management in the Borough.

3. **Bring together the different partner and stakeholder drivers and objectives**
   It is essential for the delivery of effective flood risk management in the Borough that all partners and stakeholders work together and make a commitment to delivery – effort may be wasted if there isn't the will to do this.

These are the top priority outcomes for Redbridge and were recorded following the Phase 3 Options Workshop held on 25 January 2011.

1.4 Study Area

The study area for this SWMP is defined by the administrative boundary of the London Borough of Redbridge. Jacobs and JBA have prepared SWMPs for the three London Boroughs in Drain London Group 5 - the geographical extent of the study area for this SWMP for Redbridge is illustrated green in **Figure 1.3**.

Redbridge is an outer London Borough to the north east of Central London and is part of the Thames Gateway area. Created in 1965 by the reorganisation of local government for Greater London, Redbridge is a medium sized Borough covering 5,652 hectares, with a population of 267,700 (mid 2009 population estimate).

The River Roding bisects the Borough. Neighbouring local authorities are Waltham Forest to the west, Newham to the south west, Barking and Dagenham to the south east, Havering to the east, and Essex to the north. Redbridge lies within the Thames River Basin District and is served by the Environment Agency South East Region. **Figure 1.4** shows the location of Redbridge within London.

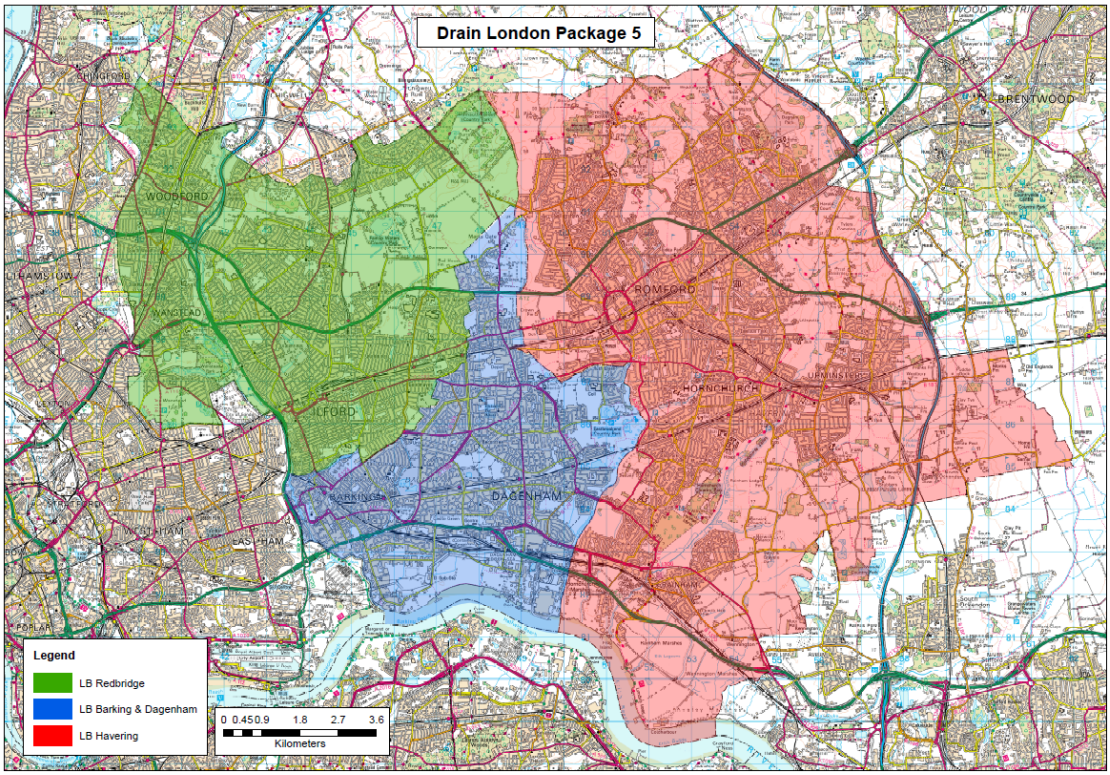


Figure 1.3 Map of study area showing Redbridge Borough boundary

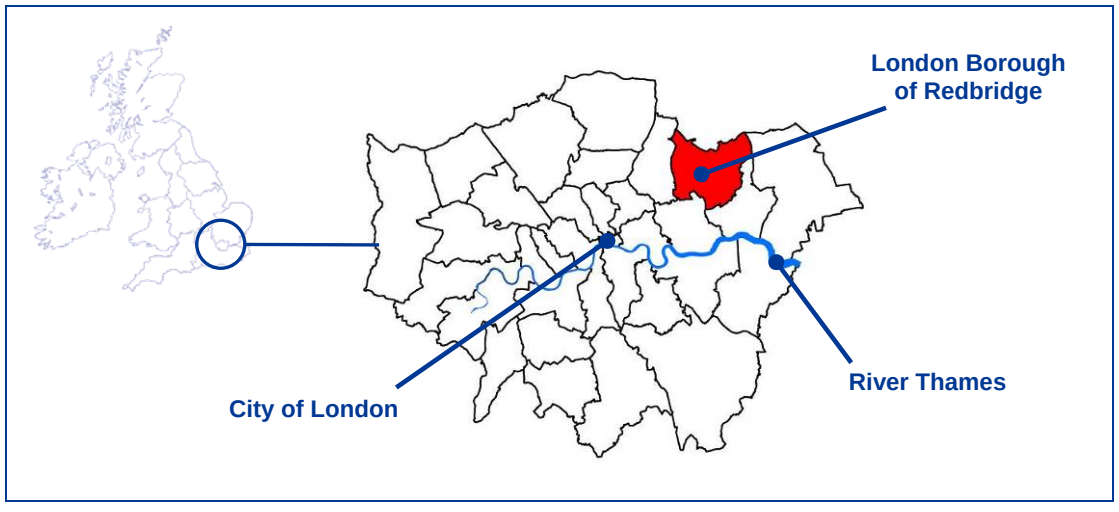


Figure 1.4 Location of Redbridge within London

1.4.1 General topography

The river valleys of the Roding, and its tributaries including Cran Brook and Loxford Water shape the topography of the borough. Parts of Hainault and Woodford form the areas of highest land within the borough. **Figure 1.5** shows the LIDAR Topographic Survey.

Figure 1.5 LIDAR Topographic Survey

1.4.2 General land use

The Land Use within the London Borough of Redbridge is predominantly urban. In the north east of the borough, to the south east of Hainault there are small swaths of grade 2 and grade 3 agricultural land. There are also small areas of non-agricultural land covering Wanstead Flats, Wanstead Park, Dog Kennel Hill and the area around Fairlop Waters. **Figure 1.6** shows the Land Use Areas and **Figure 1.7** shows Environmental Areas.

Figure 1.6 Land Use Areas
Figure 1.7 Environmental Areas

1.4.3 Significant infrastructure

Significant infrastructure within the London Borough of Redbridge includes:

- Major roads - M11, A12, A1400, A11, A406, A123, A1083, A118, A1112
- Railway lines – East Anglia main line, tube central line Epping Branch and Hainault loop
- 3 Fire / Ambulance Stations
- 8 Police Stations
- 2 Hospitals
- 138 schools / universities / colleges
- 139 surgeries / healthcare centres
- 21 Residential homes
- 77 Halls / Community Centres

1.4.4 Significant future development plans

The Core Strategy for the Borough identifies the following future development plans. 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).

- **Thames Gateway**: the London Plan gives priority (among other areas) to the regeneration of northeast 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 2012 Olympics:** although none of the Olympics 2012 sites fall within Redbridge, they are anticipated to have significant implications for the pace of regeneration within the borough.

- **Ilford Town Centre**: the London Plan identifies Ilford as an Opportunity Area and the Borough's primary area of growth and development opportunity, with the potential for additional housing for 11,000 to 13,000 people. An Ilford Town Centre Action Plan has been produced.

- **Strategic Industrial Locations**: Southend Road Business Area and Hainault Business Park have been identified for residential and commercial development as Redbridge's Strategic Industrial Locations.

1.4.5 Interactions with neighbouring Boroughs and County Councils

This section summarises cross-boundary interactions between the Group 5 Boroughs and their neighbouring Lead Local Flood Authorities. Intra-Group 5 interactions were discussed at two workshops with the Boroughs, and were initially also assessed using the national Flood Map for Surface Water (FMfSW) and Thames Water sewer maps.

Intra-Group 5 interactions

Redbridge / Havering
Redbridge and Havering share a common boundary at the north of both boroughs. A small, mainly undeveloped catchment flows east from Redbridge into Havering at Collier Row, contributing to an area of modelled surface water risk on Lodge Lane. London Borough of Havering does not report this as an area of significant known flood risk.

There are no cross-border sewerage or culverts recorded on the available records.

Redbridge / Barking & Dagenham
Working from north to south, there is potential risk in the Little Heath settlement (Redbridge). The contributing catchment is a mainly undeveloped area on the boundary of the two boroughs.

Further south, the Chadwell Heath and Goodmayes Park areas are drained by the Mayes Brook. In its upper reaches this appears to have been completely subsumed into a separate surface water sewerage system which follows the natural drainage paths through Goodmayes Park, discharging into the open channel Mayes Brook at Mayesbrook Park. This catchment has significant cross-border drainage (both topographic and piped), and any source-control type interventions in this area would need to involve both councils.

The boundary between Loxford (Redbridge) and Barking is defined by the Loxford Water, a Main River, the catchment of which is primarily within Redbridge but does receive sewered flows from part of Barking.

Interactions with London Boroughs outside Group 5
Redbridge shares a common boundary with London Borough of Waltham Forest (Drain London Group 4). To the north (Hatch Forest, Friday Hill) this boundary is formed by the River Ching, here a main river. A small area of Redbridge drains into

the Ching. Through Woodford to the A406 the boundary follows high ground and there is little cross-boundary interaction.

Further south, the Snaresbrook catchment originates within Waltham Forest (mainly within park land), flowing into Redbridge at Eagle Pond. There is significant predicted risk downstream of here, and some reported flooding at Hermon Hill. The southern boundary of Redbridge adjoins Newham. There is minor surface and piped drainage from Redbridge into Newham, possibly contributing to flood risk in the City of London Cemetery. South of here the boundary runs close to the west bank of the Roding. Small areas of Newham drain to the Roding, and this continues along the boundary between Barking & Dagenham and Newham. Along this reach the Roding is a relatively large main river: any source control interventions to manage flooding on the Roding would involve the Environment Agency, Redbridge, Barking & Dagenham and Newham.

Interactions with Essex County Council and District Councils
Thames Water and Anglian Water sewer maps outside of the London Boroughs have not been provided to Drain London, so it has not been possible to determine the extent of cross-boundary sewer systems. However, in most cases these are believed to be minor, except in the Buckhurst Hill and Chigwell areas which are closely integrated with drainage in Redbridge. Redbridge also receives main river inflows from the Roding and Chigwell, but has no significant inflows from ordinary watercourses.

	Interactions with:					
	Redbridge	Barking & Dagenham	Havering	Waltham Forest	Newham	Essex CC
Redbridge	N/A	Significant	Minor	Significant	Minor	Minor

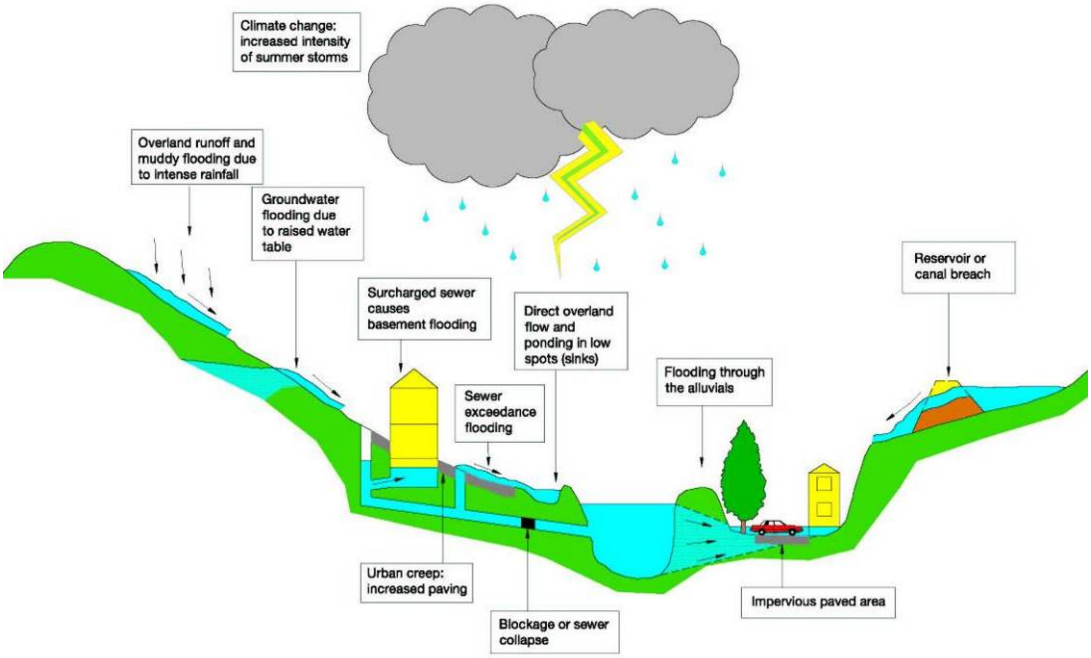
Key
N/A: No boundary
Significant: Areas of predicted and/or reported flood risk likely to require cross-border co-operation
Minor: Specific predicted and/or reported flood risk but some cross-border flow transfers which may require co-operation to manage
None: No interactions

Table 1.2 Summary of cross-boundary interactions

Group 5 is a more hydraulically discrete area than many of the other Drain London groups. However, there are some significant cross-boundary flooding issues between the three boroughs and their neighbours. These require co-operation between operations staff and may also require collaborative interventions, particularly where source control type interventions are considered.

1.5 Flooding Interactions

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 1.8** provides a pictorial representation of potential flooding sources in an urban context.



Source: JBA Consulting (2006)

Figure 1.8 Interactions between flooding sources in an urban environment

The main sources of flood risk within the Borough are Tidal, Fluvial, Surface Water, Sewer and Groundwater. The interaction between these sources of risk can be complex. Interaction between sewer and surface water will occur in situations where the sewer system is exceeded or blocked resulting in surface water flooding. Tidal and Fluvial interactions in the London area are often the result of increased water levels in the associated watercourses resulting in diminished capacity to accept and store surface water runoff. In defended situations, such as along the Thames and tidal reaches of main rivers, surface water can pond behind defences, and high water levels in the watercourse can cause flap valves present in defence walls to not discharge water, resulting in further ponding. In areas where groundwater flooding could be an issue, the ground will not have capacity to allow rainfall to infiltrate through resulting in increased flooding.

Within Redbridge, interactions have been observed between surface water and sewers (along the Roding Valley), also between surface water and fluvial sources (River Roding, Seven Kings Water). The Roding is also known to be tidally influenced at least within the southern half of the Borough, and is believed to have exacerbated the “locking” of surface water sewer outfalls in previous events. There have been no recorded interactions between groundwater and surface water.

1.6 Linkages with Other Plans

The increased focus on flood risk over recent years is an important element of adaptation to climate change. The clarification of the role of London boroughs as Lead Local Flood Authorities (LLFA) is welcomed. The creation of a number of new documents can at times be confusing. Drain London links into all of these:

Regional Flood Risk Appraisal (RFRA)

This is produced by the Greater London Authority and gives a regional overview of flooding from all sources. The RFRA will be updated in 2012 to reflect the additional information on local sources of flood risk (surface water, groundwater and ordinary

watercourses) from Drain London. This may also generate new policies that would be incorporated into the London Plan when it is reviewed.

Thames Catchment Flood Management Plan (CFMP)

The Thames Catchment Flood Management Plan was published in 2008 by the Environment Agency and sets out policies for the sustainable management of flood risk across the whole of the Thames catchment over the long-term (50 to 100 years) taking climate change into account. More detailed flood risk management strategies for individual rivers or sections of river may sit under these.

The Plan emphasises the role of the floodplain as an important asset for the management of flood risk, the crucial opportunities provided by new development and regeneration to manage risk, and the need to re-create river corridors so that rivers can flow and flood more naturally.

This Plan will be periodically reviewed, approximately five years from when it was published, to ensure that it continues to reflect any changes in the catchment. There are links to Drain London where there are known interactions between surface water and fluvial flooding

Preliminary Flood Risk Assessment (PFRA)

These are required as part of the Flood Risk Regulations which implement the requirements of the European Floods Directive. Drain London is producing one of these for each London Borough (LLFA), to give an overview of all local sources of flood risk. In London PFRAs will benefit from an increased level of information relating to surface water from the Drain London SWMPs. Boroughs will need to review these PFRAs every 6 years.

Surface Water Management Plans (SWMP) (this document)

Drain London is producing one of these for each London Borough. They provide much improved probabilistic 2-dimensional modelling and data on what has been made available at a national scale by the Environment Agency. In addition they contain an Action Plan that has been developed in conjunction with both the borough and relevant other Risk Management Authorities. This data and actions and associated policy interventions will need to feed directly into the operational level of the borough across many departments, in particular into spatial and emergency planning policies and designations and into the management of local authority controlled land.

Strategic Flood Risk Assessments (SFRA)

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25). This provides an important tool to guide planning policies and land use decisions. Current SFRAs have a strong emphasis on flooding from main rivers and the sea and are relatively weak in evaluating flooding from other local sources including surface water, groundwater and ordinary watercourses. The information from Drain London will improve this understanding.

Local Development Documents (LDD)

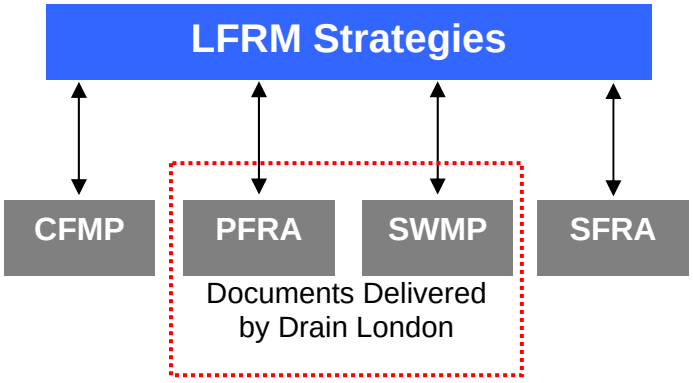
LDDs including the Core Strategy and relevant Area Action Plans (AAPs) will need to reflect the results from Drain London. This may include policies for the whole borough or for specific parts of boroughs, for example Critical Drainage Areas. There may also be a need to review Area Action Plans where surface water flood risk is a particular issue. The updated SFRA will assist with this as will the reviewed RFRA and any updated London Plan policies. In producing Opportunity Area

Planning Frameworks, the GLA and boroughs will also examine surface water flood risk more closely.

Local Flood Risk Management Strategies

The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce one of these by December 2012. Whilst Drain London will not actually produce these, the SWMPs, PFRAs and their associated risk maps will provide the necessary evidence base to support the development of LFRMS. No new modelling is anticipated to produce these strategies.

The schematic diagram below illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.



1.7 Existing Legislation

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 water courses). 'Upper Tier' local authorities have been empowered to manage 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 (the Regulations) on 10 December 2009. The Regulations require three main types of assessment / plan:

1) Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) 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.

2) 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.

3) 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 1.9 illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

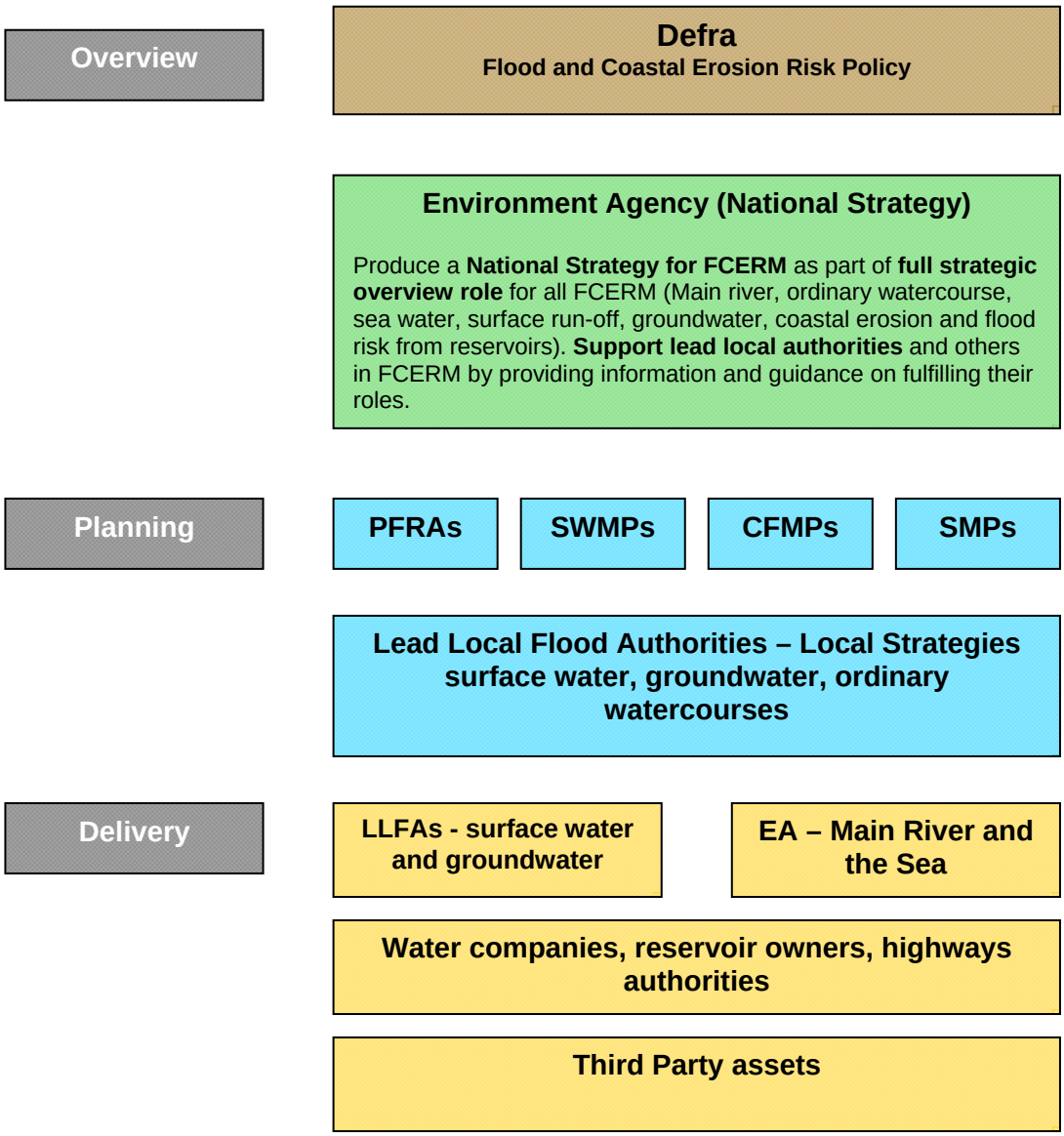


Figure 1.9 Roles and responsibility for local flood risk management delivery

1.8 Peer Review

It is essential for the Drain London Project that SWMPs are consistent and comparable across Greater London. This is to facilitate

- Fair, transparent and rapid allocation of funds to identified high priority flood risk areas within London
- Collaborative working practices between stakeholders
- Building of local capability (Council officers and consultants doing work in the future will be able to make use of outputs regardless of who produced them for each Borough)

To ensure consistency and comparability between London Borough SWMPs produced, a Peer Review process has been used. The process involved the four consultant teams working on the Drain London SWMPs independently reviewing each others work. This has ensured that all outputs result from a consistent technical approach, are of a high technical quality and are communicated in the specified formats. The peer review report for this SWMP is included in **Appendix F**.

2 Phase 1: Preparation

2.1 Partnership

Collaborative working and effective communication are essential in SWMP preparation. The communications and engagement activities undertaken throughout the development of the SWMP were designed to consolidate the partnership that was previously established as part of the Tier 1 work.

2.1.1 Partners

Partners can be defined as people or organisations with responsibility for the decision or actions that need to be taken; their involvement is critical, particularly at the early stage of the SWMP development process. For the purposes of the stakeholder mapping exercise, partners are categorised as primary stakeholders (see section 2.1.3).

The SWMP partnership consists of representatives from:

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

During SWMP 'Phase 1 - Preparation', as well as building on the work already undertaken by the Tier 1 consultants to pull the above partners together for the purposes of this SWMP, we also utilised the existing partnership structure within the Borough. Established primarily as part of the PFRA, **Figure 2.1** (fully explained in PFRA Annex 6 and repeated in this SWMP as **Appendix J**) illustrates the wider partnership for managing local flood risk in Redbridge.

Of particular relevance are the Redbridge Internal and External partnership groups which report into a designated Flood Risk Manager; these include many of the stakeholders and potential partners for the SWMP.

The (Group 5) North East London Flood Group (NELFG) was established to facilitate the coordination of LLFA issues across the three Boroughs. The Group has met on a number of occasions during the development of this SWMP and is considered an important mechanism for managing local flood risk issues collaboratively. The Group has strong links with the RFCC member and will look to develop this relationship further to ensure a coordinated approach.

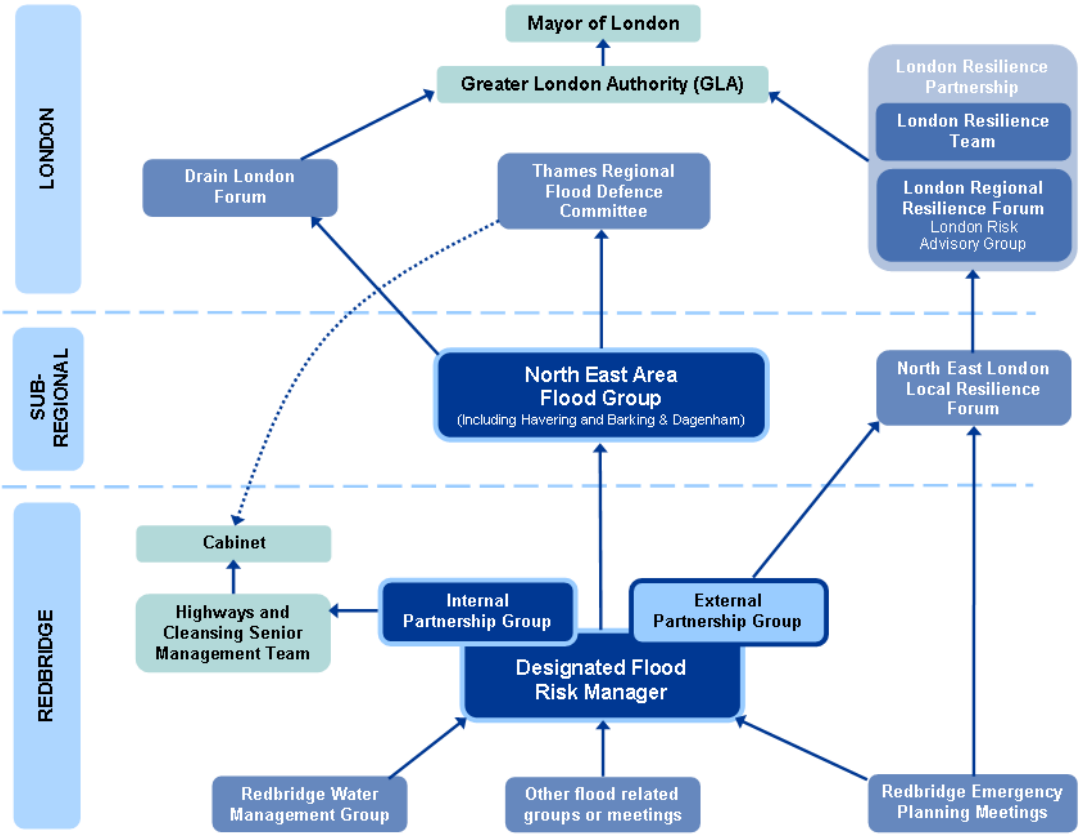


Figure 2.1 Partnership structure for local flood risk management

A Communications and Engagement Plan was produced (section 2.1.2) and a stakeholder mapping exercise was undertaken (section 2.1.3); both crucial for effective ongoing communications and engagement throughout the SWMP process. Important tasks during SWMP 'Phase 1 - Preparation' were consolidating the SWMP partnership, clarifying roles and responsibilities (section 2.1.4) and setting objectives (section 2.1.5).

2.1.2 Communications and Engagement Plan

A Communication and Engagement Plan was produced to:

- Set out the importance of robust and appropriate communications and engagement;
- Establish communications and engagement objectives to support the wider SWMP objectives;
- Generate key communication messages;
- Set out our four phase approach to communications and engagement;
- Identify who we need to involve and how we will engage them;
- Plan key events and engagement activities.

The four phase approach set out in the Communications and Engagement Plan is aligned with the four SWMP technical phases as stated in the Defra guidance:

	SWMP technical phase (as per Defra guidance)	Communications and engagement phase
Phase 1	**Preparation** • Identify the need for SWMP • Establish partnership • Scope the SWMP study	**Information giving and seeking** • Initial contact with Group Champions • Build on existing relationships to help engender a more robustly owned Action Plan • Develop **Communications and Engagement Plan** • Introduce communications approach and determine ranges of understanding and information • **Objectives and Outcomes Workshop (**12 Nov 2010**)** – borough specific aims and objectives discussed and recorded • **Newsletter One (Oct 2010)** – introduced team, communication goals and engagement event timetable
Phase 2	**Risk Assessment** • Undertake strategic assessment • Undertake intermediate assessment • Undertake detailed assessment • Map and communicate risk	**Data validation and assessing risk** • Ongoing engagement through meetings to share learning and information, develop techniques, and shortlist options • **Risk Outcome Workshop (**17th & 22nd Dec 2010**)** – discussions around identified hotspots and validate technical work undertaken
Phase 3	**Options** • Identify measures • Assess options	**Agreeing options and priorities** • Ongoing engagement through **meetings** to share learning and information, and discuss roles and responsibilities for Action Plan delivery • **Options Workshop (25 Jan 2011)** – options and measures for CDAs discussed; initial agreement on likely preferred options • **Newsletter Two (Mar 2011)**
Phase 4	**Implementation and Review** • Prepare Action Plan • Implement and review action plan	**Agreeing Action Plans and obtaining commitment** • **Action Plan Workshop (13th April 2011)** – gain commitment for delivery and agreement on final Action Plan

Table 2.1 Four phase communication and engagement approach

2.1.3 Stakeholder mapping

Stakeholders – any individual or organisation affected by or interested in the problem or solution – in addition to partners, also provide relevant information and important inputs. Stakeholders must be engaged in a meaningful way from the outset of the process to ensure that actions emerging from the SWMP are feasible, appropriate and have the buy-in of those who will be helping the Borough to implement them, and those who will be living with the solutions.

A stakeholder identification and mapping exercise was undertaken to compile a list of both internal and external stakeholders that needed to be involved in the development of the SWMP. **Table 2.2** lists the stakeholders, categorises them as

'primary' or 'secondary', and suggests the extent of their involvement in the SWMP and what form this could take. Appropriate engagement activities and methods of communication were designed and carried out according to this output of the stakeholder mapping exercise.

- Primary stakeholders – 'must have' stakeholders requiring close and regular contact, and who need to be involved as early as possible; whose ongoing contributions are key to successful delivery, and whose buy-in to the Action Plan is crucial.
- Secondary stakeholders – potentially influential stakeholders whose objectives may be affected by the SWMP and whose support may be needed; close contact may not be necessary but they need to be kept informed and involved in the journey.

As SWMP actions are implemented and the Borough advances into the role of managing local flood risk in this new way, stakeholders and partners will change; new stakeholders may become interested as the process develops, other stakeholders may just be involved at the initial stages, and others may become involved to a greater extent, perhaps as partners.

Internal stakeholders *(Teams and departments within the Borough Council including Elected Members)*	
Primary stakeholders	
Designated Flood Risk Manager (Internal Partnership Group)	• Central access point to all relevant internal departments (as listed below). • Engagement through the designated Flood Risk Manager enables clear and effective engagement and prevents duplication of effort and messages.
Emergency Planning and Business Continuity	**Part of Internal Partnership Group** • Emergency Planning is the focal point for flood risk management; involvement is key to adoption of Action Plan.
Development and Building Control	**Part of Internal Partnership Group** • Development is a key issue for consideration in managing local flood risk; involvement of Spatial Planning is key to adoption of Action Plan.
Highways and Transportation	**Part of Internal Partnership Group** • Access is a key issue in flooding; this team are likely to have historic knowledge of local flooding incidents and critical assets. • Water and Sewerage Companies do not have responsibility for dealing with flood events for this infrastructure; involvement of this team is key to adoption of Action Plan.
Drainage Engineers and Maintenance	**Part of Internal Partnership Group** • Likely to have historic knowledge of local flooding incidents and critical assets; their buy-in is needed for implementing Action Plan.
London Boroughs of Havering and Barking & Dagenham	**Part of North East Area Flood Group** • Although not strictly 'internal', neighbouring Boroughs (within Drain London package 5) are considered internal for the purposes of the SWMP, demonstrating the strong commitment to holistic, consistent and boundary-less local flood risk management. • Involvement is vital to developing robust Action Plans and exploring opportunities for shared resource going forward.
Secondary stakeholders	
Elected Members	• Involvement not required however buy-in is crucial; elected members need to sign off the Action Plan. • Timing of involvement should be agreed and understood.

	• *Suggested involvement:* regular briefings by Borough lead officers (especially to enable feedback through relevant representative on Resilience Forum), newsletters.
Regeneration	**Part of Internal Partnership Group** • Involvement desirable in early stages as at front line of local vitality and social equity; buy-in and understanding important to adoption of Action Plan • *Suggested involvement:* workshop attendance, newsletters, electronic communication.
Environment	**Part of Internal Partnership Group** • Desirable at early stages to ensure relevant environmental issues and opportunities are captured and understood. • *Suggested involvement:* workshop attendance, newsletters, electronic communication.
Communications	**Part of Internal Partnership Group** • Involvement not essential but a bonus to help with understanding communications issues (particularly at an early stage) and communicating risk. • *Suggested involvement:* possible workshop attendance, newsletters, electronic communication, invite to comment on draft Action Plan.
Property and Asset Management	**Part of Internal Partnership Group** • Need to determine role and influence in the Borough in respect of the Action Plan; likely to have historic knowledge of local flooding incidents and critical assets.
Parks	**Part of Internal Partnership Group** • Early input very desirable; likely to contribute to wider understanding of hotspots and risk. • *Suggested involvement:* possible workshop attendance, newsletters, electronic communication, invite to comment on draft Action Plan.
Culture and Leisure	**Part of Internal Partnership Group** • Early input and view seeking desirable. • *Suggested involvement:* possible workshop attendance, newsletters, electronic communication, invite to comment on draft Action Plan.
Risk and Insurance Management	**Part of Internal Partnership Group** • Regular involvement not necessary but need regular contact following initial briefings and early inputs; important for understanding and communicating risk. • *Suggested involvement:* newsletters, electronic communication.
External stakeholders *(All stakeholders outside of the Borough Council organisation)*	
Primary stakeholders	
External Partnership Group (through designated Flood Risk Manager)	• Central access point to all relevant external organisations and stakeholders (as listed below). • Engagement through the designated Flood Risk Manager enables clear and effective engagement and prevents duplication of effort and messages.
Environment Agency	**Involved as a partner – part of External Partnership Group** • Involvement at a partnership level is essential throughout SWMP development for data sharing, guidance and peer review processes; buy-in is key to adoption of Action Plan.
Thames Water	**Involved as a partner – part of External Partnership Group** • Involvement at a partnership level is essential throughout SWMP development; buy-in is key to adoption of Action Plan.
Essex County Council	**Involved as a partner** • Involvement at a partnership level is desirable throughout SWMP development; important to work with departments (i.e. same as those identified in the Internal Partnership Group and listed above), and to understand cross-boundary interactions.

GLA and Drain London	**Involved as partners** • Involvement to be via a scheduled programme of meetings; important guidance role.
Secondary stakeholders	
Emergency 'blue light' services (inc. London Fire Brigade)	**Part of External Partnership Group** • Involvement not required but they need to understand the process and have opportunity to input; contact via existing communication channels such as Borough Emergency Planning leads and Flood Resilience Forums. • London Fire Brigade to be involved via the External Partnership Group.
Resilience Forums (North East London and pan-London levels)	**Part of External Partnership Group** • Involvement not required but they need to understand the process and have opportunity to input; contact via existing communication channels such as designated Flood Risk Manager and Borough Resilience Forum.
Transport for London **Highways Agency** **Network Rail** **London Underground**	**Part of External Partnership Group** • Involvement will be required as SWMP progresses and Action Plan is implemented
British Waterways **Natural England** **Chamber of Commerce and Retailers** **Association of British Insurers** **Homes and Communities Agency** **Riparian owners** **Developers or regeneration agencies**	• Involvement will become increasingly important towards the latter stages of SWMP development, as the Action Plan is implemented. • May want to include in the External Partnership Group as appropriate and involve through the designated Flood Risk Manager.
Local community interest groups **General public**	• Involvement beneficial for gauging public opinion, obtaining public acceptance, determining potential levels of local level funding (or fundraising) and for building trust with communities. • *Suggested involvement:* public activities (e.g. exhibitions, community workshops), newsletters, electronic communication.
British Geological Survey	• To be contacted for data collection purposes; no further involvement required.

Table 2.2 Stakeholder mapping table

2.1.4 Partnership roles and responsibilities

Partnership roles and responsibilities were discussed throughout the development of the SWMP; our communications and engagement process and technical work identified a clear 'three-pronged' method for deciding the degree of responsibility for delivery of the Action Plan and SWMP recommendations (see **Figure 2.2**).

Assigning responsibilities for specific measure and option related actions during the options appraisal process (detailed in section 4) was relatively simple for areas where flood risk was either solely Surface Water derived or Main River (with some Surface Water interaction) derived. For areas of combined risk and mutual responsibility, a greater degree of cooperative working was required, both in terms of deciding the best approach to managing the risk, and in planning how the preferred solution should be delivered and managed in the future. This also has a direct relationship to the development of local flood risk policy setting and with whom policy needs to be developed.

Stakeholder and partner roles and responsibilities were discussed at the Objective and outcome Workshop, clarified at the Options Workshop and embedded in subsequent one-to-one Action Planning meetings with Boroughs.

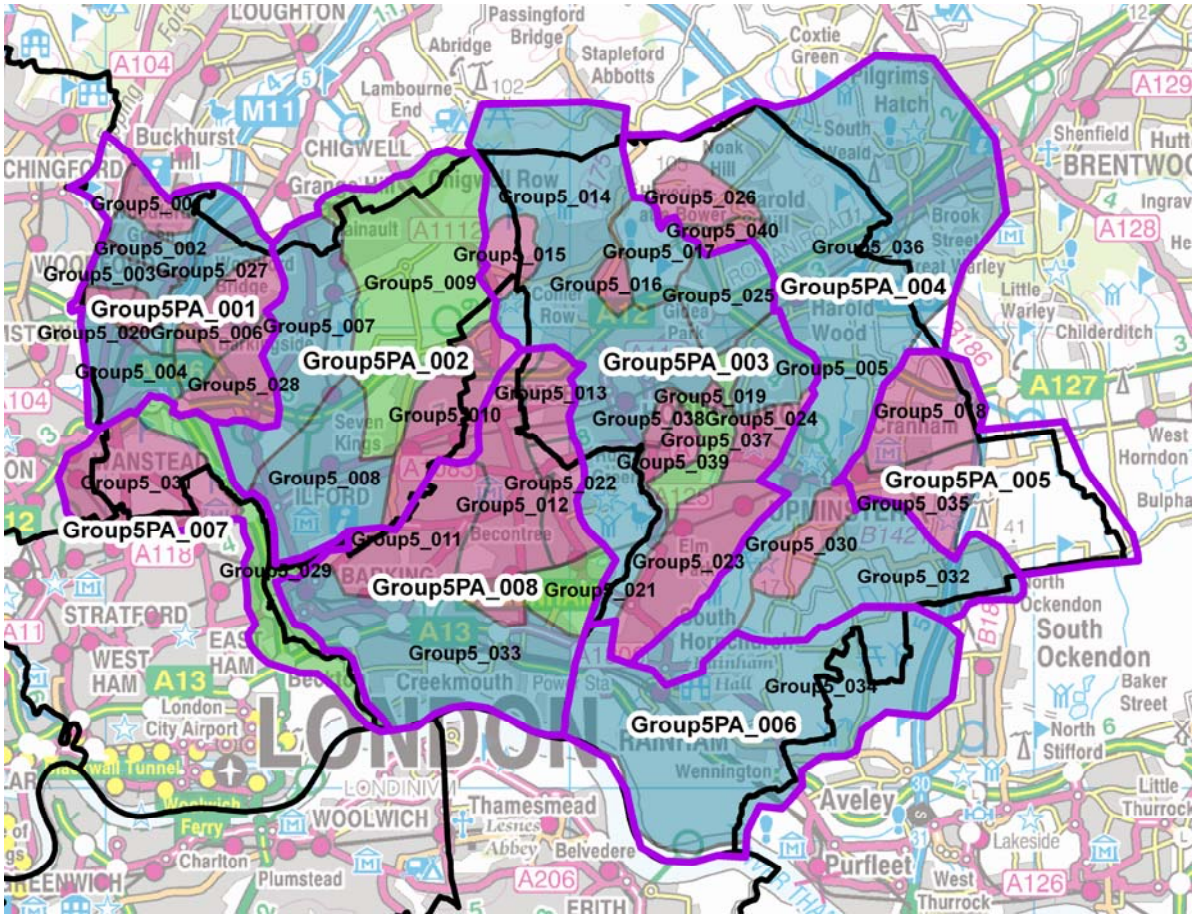


Figure 2.2 Responsibilities for SWMP Action Plan delivery across Barking & Dagenham, Havering and Redbridge

2.1.5 Setting objectives

Our communications and engagement process was instrumental in contributing to the delivery of the SWMP objectives set out in section 1.3.

The aim of the Objectives and Outcomes workshop was to initiate the thought-process for identifying local, Borough specific objectives that supplement the wider objectives of the SWMP, prompting questions such as:

- What are the priorities within the context of the Drain London programme?

- What will help meet the requirements of the new LLFA role?
- What needs to be achieved locally? What are the challenges and opportunities for this?
- Who needs to be involved? Who can help?
- What are the 'do-ability' levels in terms of resources, information, data, political will, and public acceptability?

The Options workshop held later in the SWMP development process was designed to align (from the earlier Objectives and Outcomes workshop) and agree the 'top three' Borough specific objectives and priorities for the SWMP and its implementation. These are set out in section 1.3.

2.2 Data Collection

The collection and collation of strategic level data was undertaken as part of the Tier 1 work and disseminated to Tier 2 consultants by the GLA. Data was collected from each of the following organisations:

- London Borough of Redbridge
- British Airports Authority
- British Geological Survey
- British Waterways
- Environment Agency
- Greater London Authority
- Highways Agency
- London Underground
- Network Rail
- Thames Water
- Transport for London

A comprehensive data set was passed onto Tier 2 consultants and in some cases additional supplemental data was provided by individual organisations. Full information regarding the data provided is detailed in Appendix A.

Table 2.3, below, provides a summary of data provided for this SWMP.

Data provider	Asset data	Flooding records	Planning / strategy documents	Geology	Flood risk mapping / models	LiDAR	Receptors	OS Mapping
London Borough of Redbridge	✓	✓	✓				✓	
British Airports Authority	✓							
British Geological Survey				✓	✓			
British Waterways	✓	✓						

Data provider	Asset data	Flooding records	Planning / strategy documents	Geology	Flood risk mapping / models	LiDAR	Receptors	OS Mapping
Environment Agency	✓	✓	✓		✓	✓	✓	
Greater London Authority			✓			✓		✓
Highways Agency	✓	✓						
London Underground	✓	✓						
Network Rail	✓	✓						
Thames Water	✓	✓	✓				✓	
Transport for London	✓							
Natural England							✓	

Table 2.3 Summary of key datasets used for the SWMP, by provider

2.3 Data Review

The key data sets used are summarised below, further details of the data sets used are provided in **Appendix A**.

OS Mastermap data was used in the modelling process to distinguish between land uses across the Borough. It was also used to better define the model grid so key flow paths along roads and watercourses would be better represented.

1m resolution **LIDAR** (with a stated vertical accuracy of +- 0.15m) was provided by the GLA. This dataset covered the area within the M25. LIDAR data was used to form terrain model within the Infoworks model.

Asset information provided from a variety of sources, predominately from the Borough, but including the Thames water sewer network, were used to define structures within the Infoworks model. They provide details of pipe/culvert dimensions which enable 1D elements to be modelled with greater accuracy.

Records of historic flooding were used to verify model results. However, two of the flooding history datasets provided were of limited use.

- The dataset provided by the London Fire Brigade outlining callouts to flooding incidents highlighted numerous locations, forming a random pattern across the borough which did not correspond to other historic sources. There was no detail within the dataset identifying the source of the flood, therefore it is likely to include incidents of burst water mains, fluvial floods, domestic plumbing failure as well as surface water flooding. This dataset was therefore not used.
- Access was provided by Thames Water to the DG5 Register of flood incident data but not on a property specific basis. As such this data was of limited use other than to indicate broadly where flooding incidents have occurred.

The **FEH CD-ROM** was used to obtain the rainfall parameters needed to define the hydrological inputs into the Infoworks model.

Receptor datasets were informative when defining critical drainage areas, and used within the prioritisation matrix.

The following four data sources have been utilised to produce the increased **Potential for Elevated Groundwater** map (iPEG):

- British Geological Survey (BGS) Groundwater Flood Susceptibility Map;
- Jacobs Groundwater Emergence Maps (GEMs);
- Jeremy Benn Associates (JBA) Groundwater Flood Map; and
- Environment Agency/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps.

2.4 Asset Register

Section 21 of the FWMA 2010 sets a duty on each London Borough (LLFA) to maintain a register of structures or features, and a record of information about each of those structures or features, which, in the opinion of the authority, are likely to have a significant effect on flood risk in its area. From the 6th of April 2011 all LLFAs have a duty to maintain a register. The legal characteristics of the register and record are outlined below in **Table 2.4**:

	Register	Record
a.	Must be made available for inspection at all reasonable times.	Up to the LLFA to decide if they wish to make it available for inspection.
b.	Must contain a list of structures or features which in the opinion of the authority, are likely to have a significant effect on a local flood risk.	For each structure or feature listed on the register, the record must contain information about its ownership and state of repair.
c.	s.21 (2) of the Act allows for further regulations to be made about the content of the register and record. There is currently no plan to provide such regulations therefore their content should be decided on by the LLFA depending on what information will be useful to them.	
d.	There is no legal requirement to have a separate register and record although as indicated above, only the register needs to be made available for public inspection.	

Table 2.4 Asset Register requirements

Defra have provided each LLFA with templates to demonstrate what information should be contained in the asset register. Although these templates are not intended as a working tool, they provide a good example of how an asset register might be structured.

Populating the asset register is outside the scope of the Drain London project and is the responsibility of each London Borough. The expectation from Defra is that LLFAs (London Boroughs) will utilise a risk-based approach to populate the register and record with those structures or features considered the most significant first.

2.4.1 Initial Review of Redbridge Asset Management Arrangements

A review of existing asset arrangements has been undertaken, the full report is included in **Appendix B**. The review scored the existing asset register arrangements against the following criteria:

- Level 1 – The Borough knows where their assets are, what they look like and what condition they are in. Register system may take the form of a spreadsheet or hard copy records.

- Level 2 – The Borough is aware of the 'Local Authority Flood Risk Asset Tool' currently being produced by the EA / Defra. Their register is GIS based (basic proprietary system only) or uses a highways based asset management system database. Their register captures information generally aligned with guidance provide by the Tool and the EA NFCDD system where practical. They know where their assets are and carry out reactive maintenance of significant structures as required.

- Level 3 – The Borough has a detailed understanding of Asset Registers as required by the Flood and Water Management Act. Their register system accurately replicates the 'Local Authority Flood Risk Asset Tool' data standards and related NFCDD structures to an attribute level. Their register is GIS based (advanced proprietary or bespoke system) or is completely integrated with an existing asset management system. They know where their assets are and carry out periodic maintenance on the structures using a risk based priority system.

Redbridge Borough Council supplied a large amount of asset information as part of the Drain London Tier 1 'data collection' exercise. This data had been reviewed and scored. The current status of the asset register appears to be Level 1.

Table 2.5 provides a summary of the actions required meet the full level 3 status as defined above.

Data Required	Preferred Format	Recommendations
Highway flooding and drainage records – including location and serviceability of road gulleys.	GIS	Complete – keep updating on a regular basis.
Drainage network information – sewers (surface, foul, combined), culverts, drains (surface water, highway), gullies, ditches, other open drainage channels	GIS	Compile GIS layers of: • Culverts • Ditches • Other open drainage channel
Local Authority led flood risk improvement schemes	Database	Keep a live document which records all such scheme details and contact details.
SUDS schemes information (Council adopted SUDS)	Database	Going forward keep a live document which records all such scheme details and contact details.
Balancing pond and lake information	Database and GIS	Complete – keep updating on a regular basis.
Critical local asset records (assets which are known to, or have the potential to flood)	GIS	Compile: • GIS layer of Critical local asset records
Historic sewer records (if any)	GIS	Inquire if any records are available from Thames Water etc. If available as drawings only compile GIS layer of historic sewer records available.
Historic construction records of drainage assets	GIS	Create GIS layer of the historic sewer plans provided
Capacity and condition of 'ordinary' watercourses essential to operation of the urban drainage systems, including culverted watercourses and flow models (where they exist).	GIS	Compile GIS layer of capacity and condition of 'ordinary' watercourses.
New development drainage studies and supporting information	Database	Bring together all information on an easily accessible database.
Road gulley cleaning/maintenance records	Database	Complete – keep updating on a regular basis.
Maintenance regimes and records of all assets	Database	Complete – keep updating on a regular basis.

Table 2.5 Action required to meet the requirements of the Flood and Water Management Act 2010

3 Phase 2: Risk Assessment

3.1 Intermediate Assessment

Aims

The aim of the Phase 2 Intermediate Risk Assessment is to *identify the sources and mechanisms of surface water flooding across the study area* which will be achieved through an intermediate assessment of pluvial flooding, sewer flooding, groundwater flooding and flooding from ordinary watercourses along with the interactions with main rivers and the sea. The modelling outputs will then be mapped using GIS software.

SWMPs can function at different geographical scales and therefore necessarily at differing scales of detail. Table 3.1 defines the potential levels of assessment within a SWMP. This SWMP has been prepared at the 'Borough' scale and fulfils the objectives of a second level 'Intermediate Assessment'.

Level of Assessment	Appropriate Scale	Outputs
1. Strategic Assessment	Greater London	Broad understanding of locations that are more vulnerable to surface water flooding. Prioritised list for further assessment. Outline maps to inform spatial and emergency planning.
2. Intermediate Assessment	Borough wide	Identify flood hotspots which might require further analysis through detailed assessment. Identify immediate mitigation measures which can be implemented. Inform spatial and emergency planning.
3. Detailed Assessment	Known flooding hotspots	Detailed assessment of cause and consequences of flooding. Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems.

Table 3.1 SWMP Study Levels of Assessment [Defra 2010]

As shown in **Table 3.1** above, the intermediate assessment is applicable across a large town, city or borough. In the light of extensive and severe historical flooding and the results from the over-arching national pluvial modelling suggesting that there are 32,100 properties at risk across the Borough, it is appropriate to adopt this level of assessment to further quantify the risks.

The purpose of this intermediate assessment will be to further identify those parts of the borough that are likely to be at greater risk of surface water flooding and require more detailed assessment. The methodology used for this SWMP is summarised below. Further detail of the methodology is provided in **Appendix C**.

- A Direct Rainfall approach using InfoWorks CS software has been selected whereby rainfall events of known probability are applied directly to the ground surface and is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond.
- 2-dimensional pluvial modelling has been supported by hydraulic field visits / surveys have been undertaken in conjunction with the London Borough of Redbridge staff and/or EA staff.
- The outputs from the pluvial modelling are verified (where possible) against historic surface water flood records.

3.2 Risk Overview

3.2.1 Overview of flood risk

The risk of surface water flooding and flooding from ordinary watercourses, for a 1 in 100 year rainfall event, has been mapped for the London Borough of Redbridge and is shown in **Figure 3.2**. Additionally **Table 3.2** indicates the number and types of properties affected across the Borough by flooding in the 1 in 100 year event.

Borough	Property Type	Flood Risk Vulnerability Classification	Total No. of units flooded (1 in 100)
Redbridge	Infrastructure	Essential Infrastructure	25
		Highly Vulnerable	26
		More Vulnerable	40
	Households	Non-deprived (all)	8869
		Non-deprived (basements)	200
		Deprived (all)	942
		Deprived (basements)	26
	Commercial	Units (all)	1452
		Units (basements)	63
	TOTAL		**11354**

Table 3.2 Properties flooded for a 1 in 100 year event within the London Borough of Redbridge

Figure 3.1 and **Figure 3.3** also provide an overview of risk within the Borough from Fluvial / Tidal flooding and groundwater flooding respectively.

3.2.2 Mapping accuracy and limitations

The mapping shown within this report is suitable to identify broad areas which are more likely to be vulnerable to surface water flooding. This allows the London Borough of Redbridge and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

In addition, the map can also be used as an evidence base to support the spatial planning to ensure that surface water flooding is appropriately considered when allocating land for housing development. The map can be used to assist emergency planners in preparing their Multi-Agency response plans.

Please note that these maps only show the predicted likelihood of surface water flooding (this includes flooding from sewers, drains, small watercourses and ditches that occurs in heavy rainfall in urban areas) for defined areas, and due to the coarse nature of the source data used, are not detailed enough to account for precise addresses. Individual properties therefore may not always face the same chance of flooding as the areas that surround them.

There may also be particular occasions when flooding occurs and the observed pattern of flooding does not in reality match the predicted patterns shown on these maps. We have done all we can to ensure that the maps reflect all the data we possess and have applied our expert knowledge to create conclusions that are as reliable as possible. It is essential that anyone using these maps fully understands the complexity of the data utilised in production of the maps, is aware of the limitations and does not use the maps in isolation.

We will not be liable if the maps by their nature are not as accurate as might be desired or are misused or misunderstood despite our warnings. For this reason we are not able to promise that the maps will always be completely accurate or up to date.

3.3 Surface Water Flooding

The methodology for assessing surface water flood risk is detailed in **Appendix C**. In brief the methodology used was to build a 2D model in InfoWorks CS using LIDAR to form the model DTM. InfoWorks uses an irregular mesh, therefore details from MasterMap were imported into the model to form breaklines forcing the mesh to follow features such as roads and watercourses. 1D model elements were included to represent culverts in more detail. To make the model run time more manageable a detailed mesh was applied to urban areas only. The more rural parts of the boroughs were represented using a much coarser mesh. The model was run for a range of rainfall events and depth, velocity and hazard grids were output.

Local Mechanism of flooding

The overland flow routes associated with surface water flooding across the borough generally follow naturally occurring drainage pathways, some of them containing watercourses, some following the course a watercourse would have taken before being culverted. Ponding associated with these generally occurs at the low spots, or where they come up against a man made obstruction to flow, such as a road or railway embankment.
There are some smaller local ponding incidents across the borough, as a result of water accumulating in natural dips in the topography.

LLFA responsibilities (in relation to surface water):

- Under the FWMA, LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area. This aspect of the FWMA is yet to be formally enacted.

- 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.
- The LLFA are charged with mapping the hazard associated with the source of flooding.
- 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.

3.4 Ordinary Watercourse Flooding

Flooding from Ordinary watercourses has been accounted for within the surface water flood modelling. Breaklines were place along the watercourses to ensure the InfoWorks irregular mesh followed the centreline. Elevation of the watercourse has been determined from the LIDAR. It has been assumed that the LIDAR is representative of the topography along these ordinary watercourses.

Any key structure along the length such as long culverts (not single road crossings) were modelled as 1D elements. The dimensions of such structures have been determined from asset information obtained in the data collection stage; where no specific information was available dimension have been inferred using local knowledge and LIDAR data.

Where areas of ordinary watercourse are covered by the EA flood zones these have been compared with the surface water modelling outputs to check for consistency. **Figure 3.5** below shows that where ordinary watercourses have been included in the EA flood map the flood extent is very similar to that modelled as part of the surface water modelling. The examples shown are taken from across the Group 5 area and provide confidence in the use of surface water modelling techniques to model the flood extent from ordinary watercourses.

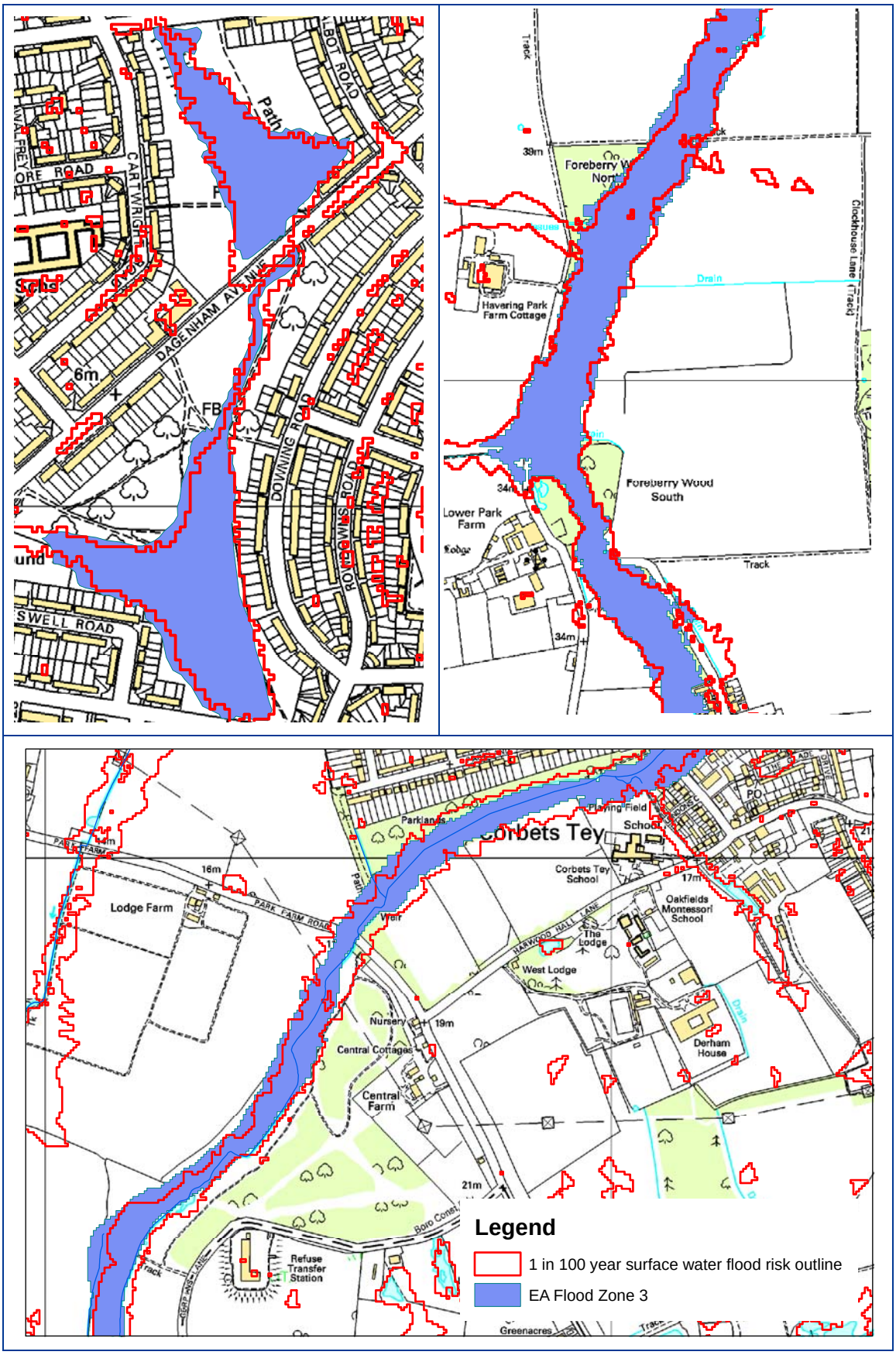


Figure 3.5 Comparison of modelled flood outputs (Q100) and the EA flood zone 3 for three sections of Ordinary Watercourse

LLFA responsibility (in relation to surface water)
Any watercourse that is not designated Main River is an Ordinary Watercourse, and is the responsibility of the London Borough in their role as Lead Local Flood Authority. As part of their new responsibilities, each London Borough is required to monitor flooding within its area and investigate the causes, and map the hazard associated with the source of flooding. The modelling undertaken for this SWMP provides a map of hazard associated with Ordinary Watercourses.

3.5 Groundwater Flooding

There have been no observed interactions specifically between surface water and groundwater in Redbridge. However, large areas within the borough 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 in **Appendix C** has been used to identify 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.

An increased Potential for Elevated Groundwater map (iPEG) has been developed for use 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. This has been compared with historic data on groundwater flooding in the assessment. Refer to **Appendix C** for further technical details about the iPEG map.

A record of groundwater events has been compiled as part of the PFRA for Redbridge; this has been used in combination with the iPEG map to better understand groundwater flood risk.

LLFA responsibility (in relation to groundwater)
As with flooding from surface water and Ordinary Watercourses, flooding from Groundwater is the responsibility of the London Borough in their role as Lead Local Flood Authority. Flood risk from groundwater should be considered as part of the LLFA's Local Flood Risk Management strategy.

3.6 Sewers

The sewer system was assumed to have a capacity of 6.5mm per hour. This was represented by removing 6.5mm/hr of rainfall from the inflow hyetograph for urban areas.

No connectivity between the sewer system and the above ground was modelled in detail. This would have been beyond the scope of this plan. Further detailed analysis of the affect of the sewer system could be undertaken in the future, if necessary, through the combination of a sewer model and the surface water model.

Flooding from the sewer system, caused by a blockage in or an overflow from (due to heavy rainfall) a sewer or urban drainage system, was not modelled in detail. Flooding from the sewer was considered during the later prioritisation through the use of Thames Water DG5 data. However, the data is not on a property specific

basis, and was of limited use other than to indicate broadly where flooding incidents have occurred.

Table 3.3 below shows the post codes where properties have suffered sewer flooding, and what severity that flooding was. 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. Caution should therefore be exercised when considering sewer flooding in postcode sectors which span two or more boroughs.

Post Code Sector	Count of properties on Thames Water DG5 register							
	2 in 10 external	2 in 10 internal	1 in 10 external	1 in 10 internal	1 in 20 external	1 in 20 internal	Severe	Total
E11 1	0	0	3	1	1	13	1	19
E11 2	0	0	0	0	0	0	0	0
E11 3	0	3	1	4	0	4	0	12
E12 5	0	0	0	0	0	2	0	2
E18 1	0	0	0	0	0	4	0	4
E18 2	0	0	2	0	0	0	0	2
E7 0	0	1	0	3	0	12	0	16
IG1 1	0	0	0	0	0	1	1	2
IG1 2	0	0	2	0	0	0	2	4
IG1 3	65	16	0	0	0	5	0	86
IG1 4	0	0	1	1	0	4	2	8
IG11 8	0	0	0	0	0	0	0	0
IG11 9	1	0	4	0	0	0	0	5
IG2 6	1	0	0	0	3	1	0	5
IG2 7	0	0	0	0	1	0	1	2
IG3 8	0	0	1	2	0	25	3	31
IG3 9	0	0	2	0	0	0	0	2
IG4 5	0	0	7	0	0	0	0	7
IG5 0	2	0	2	0	2	0	1	7
IG6 1	0	0	0	0	1	0	0	1
IG6 2	0	0	1	0	0	0	1	2
IG6 3	1	0	1	0	0	0	2	4
IG7 4	0	0	4	0	0	0	1	5
IG7 5	0	0	0	0	0	0	0	0
IG7 6	0	0	0	0	0	0	0	0
IG8 0	0	0	1	0	0	0	2	3
IG8 7	31	14	8	0	0	0	1	54
IG8 8	0	0	2	0	2	0	1	5
IG8 9	0	0	0	0	2	2	4	8
IG9 5	0	0	0	0	0	0	0	0
IG9 6	0	0	0	0	0	0	0	0
RM5 2	0	0	2	0	40	11	0	53
RM6 4	0	0	1	0	0	8	0	9
RM6 5	0	0	1	0	1	10	0	12
RM8 1	0	0	1	0	0	0	0	1
RM8 2	0	0	0	0	0	0	0	0
Total	**101**	**34**	**47**	**11**	**53**	**102**	**23**	**371**

Table 3.3 Thames Water DG5 properties at risk of sewer flooding in Postcode Sectors wholly or partially within the London Borough of Redbridge

Notes:
2 in 10, 1 in 10 and 1 in 20: refers to the frequency of sewer flooding at the property.
Internal or external: defines whether flooding has occurred internally within the property or externally (to gardens, driveways etc).
Severe: Indicates that sever external flooding has been experienced at this property.

LLFA Responsibility (in relation to surface water)

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. Co-operation between LLFA and the sewage undertakers will be a necessary part of this process.

3.7 Other Influences

Tidal and Fluvial interactions in the London area are often the result of increased water levels in the associated watercourses resulting in diminished capacity to accept and store surface water runoff. In defended situations, such as along the Thames and tidal reaches of main rivers, surface water can pond behind defences, and high water levels in the watercourse can cause flap valves present in defence walls to close and not discharge water, resulting in further ponding.

These interactions were represented crudely in the modelling by simply assuming the fluvial watercourses were bankfull. The outfalls to the Tidal River Thames were assumed to be free flowing.

Interactions between surface water and fluvial sources have been observed within the LB Redbridge along River Roding and Seven Kings Water. The Roding is also known to be tidally influenced at least within the southern half of the Borough, and is believed to have exacerbated the “locking” of surface water sewer outfalls in previous events.

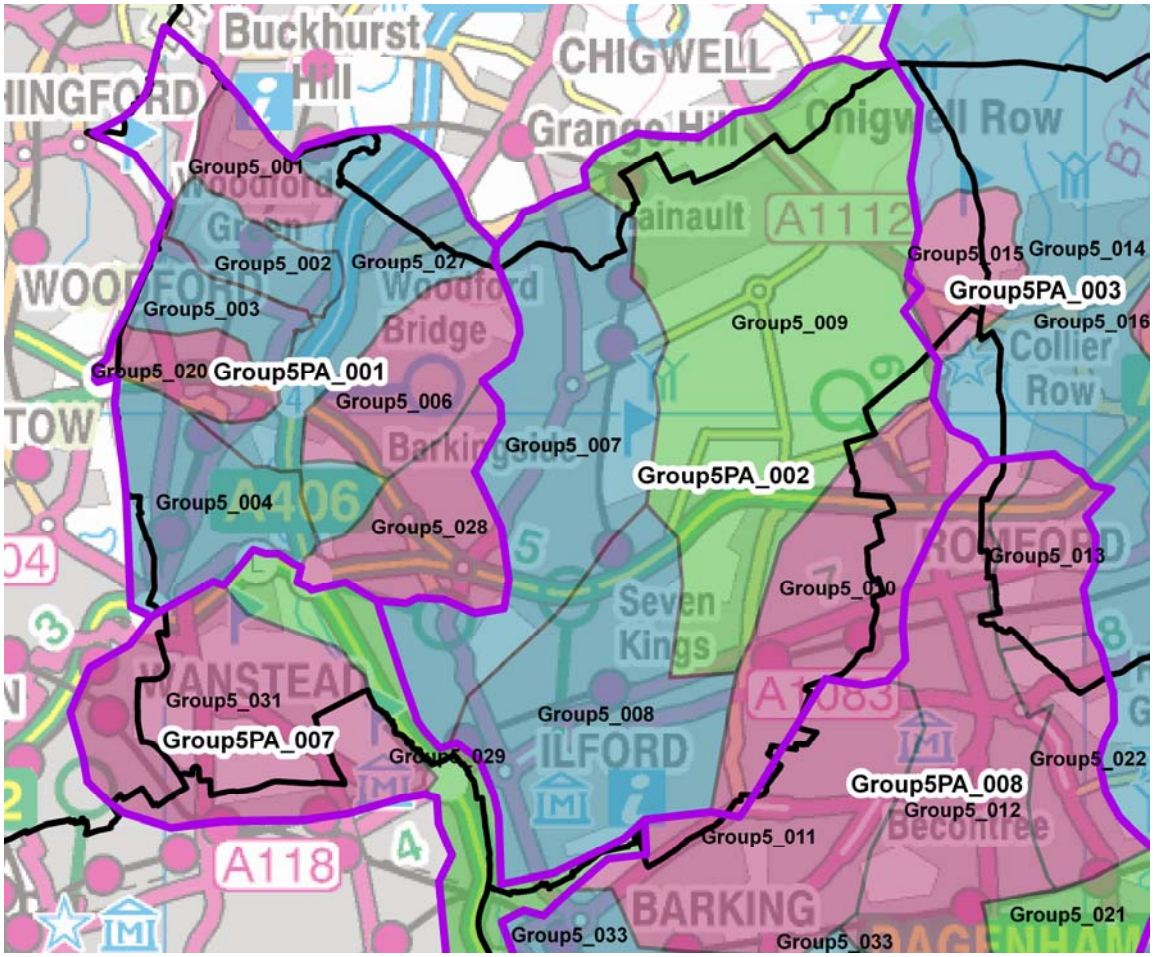
3.7.1 Local Operational Agreements

There are no standing local operational agreements between the Environment Agency and the London Borough of Redbridge. All Main Rivers in the Borough are maintained by the Environment Agency under their permitted powers. The London Borough of Redbridge maintains a record of flapped outfalls to the River Roding, attributed by maintainer.

3.8 Critical Drainage Areas

Critical Drainage Areas (CDAs) – areas of significant flood risk – have been defined across the study area for the three Group 5 Boroughs. **Figure 3.6** illustrates and lists the 14 CDAs within Redbridge, and highlights the level of responsibility for surface water management based on flooding source (as per **Figure 2.2**). To reflect the need for local flood risk to be managed strategically across the Borough, we have grouped CDAs to create ‘Policy Areas’, as depicted by the purple boundary lines in figures 2.2 and 3.6. These act as a focus for the setting of broader policy issues (such as SuDS) or generic measures (such as rainwater harvesting). When generic measures are applied across a wider policy area, greater benefit can be obtained. Figures 2.2 and 3.6 show how Policy Areas have been suggested for Redbridge, being divided into three Policy Areas (Group 5PA_001, _002 and _007). These policy areas do not follow political boundaries, but rather follow the

boundaries of CDAs to reflect the need for local flood management to be co-ordinated on a drainage area basis.



CDA 001	Woodford Wells	
CDA 002	Woodford Green	
CDA 003	Woodford Green South	
CDA 004	Snaresbrook	
CDA 006	Clayhall	
CDA 007	Barkingside, Newbury Park West and Cranbrook	
CDA 008	Ilford	
CDA 009	Seven Kings	
CDA 010	Goodmayes	
CDA 020	South Woodford	
CDA 027	River Roding north	
CDA 028	Gants Hill	
CDA 029	River Roding south	
CDA 031	Aldersbrook	

Surface Water only: LLFA direct responsibility as Surface Water derived risk

Surface Water with Main River interaction: Combined Surface Water risk areas of mutual responsibility between LLFA and a partner, where overarching lead sits with a partner

Main River with Surface Water interaction: LLFA acts as secondary partner where the lead responsibility lies with another organisation as main risk is not Surface Water derived

Figure 3.6 Critical Drainage Areas (CDAs) in Redbridge

Maps showing Surface Water Depth and Hazard Rating (for 1 in 100 chance of rainfall event occurring in any given year) for each CDA are included in **Appendix D**.

A validation exercise has bee carried out for each CDA. Surface water flooding within the CDA was considered to be validated where the CDA met one or more of the following criteria:

- One or more historic records confirm predicted surface water flooding
- Good correlation with EA Flood Map for Surface Water
- Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed

Modelled surface water flood risk in the CDA was considered to be "Non-Validated" where none of these validation criteria were met. This is not to say that the predicted surface water risk in these areas is necessarily incorrect; the lack of correlation may be explained by:

- Historic records and local knowledge of flood risk are acknowledged to be incomplete.
- The modelling undertaken for Drain London was to a higher level of local; detail than the EA's Flood Map for Surface Water (which was produced at a national scale) and therefore it is to be expected that the outputs from these two modelling exercises may differ in some areas.

However, where the modelled flood risk has not been validated against these criteria, there would need to be a greater emphasis on local investigations to increase confidence in the risk assessment, prior to making any significant capital or operational investments.

The results of the validation are provided in the CDA text below, and are also summarised in table 3.4. When reading the following sections describing individual CDAs, it is recommended that the maps are referred to, in particular:

- CDA map 1 - predicted surface water flood depth for the 1% AEP event.
- CDA map 2 – predicted flood hazard and flow direction for the 1% AEP event.
- CDA map 3 – as per map 1 but with the addition of historic flooding, key receptors and labels showing the locations of the Local Flood Risk Zones (LFRZs).
- Figure 3.3 showing Potential for Elevated Groundwater for the borough.

3.8.1 CDA 001 Woodford Wells

Surface water flood risk is predominantly confined to one flood risk zone in this CDA. Surface water flow paths are limited to the west by the drainage catchment boundary in the vicinity of A104 High Road Woodford Green and flow south east to the River Roding. One local flood risk zone (LFRZ) is concentrated in the area west of the railway line as shown in **Figure Group5_001.1** and **Figure Group5_001.2**.

LFRZ a: West of the railway

The flow pathway intersects the railway embankment adjacent to King's Avenue. Modelling suggests that pooling surface water could be particularly deep in this vicinity with depths exceeding 1.5m. The potential ponding appears to have a direct relationship to the railway embankment.

No critical receptors are identified at risk in this CDA.

There are 3 properties with basements close to ponding areas in this LFRZ; these are not shown as predicted to flood, but since predicted depths of ponding water are high, these properties could be at risk of flooding if the predicted flowpath were to alter slightly (for example, due to debris causing an obstruction).

Key Assumptions and Observations

- Modelling has assumed the railway embankment forms a barrier to surface water flow.
- Historic flood risk: There are four recorded incidents of groundwater flooding according to the EA: at Knighton Drive / Forest Way, two incidents on Princes Avenue, and an incident on Worcester Crescent.
- Groundwater flood risk: Map 3.3 indicates that there is an increased potential for elevated groundwater in permeable superficial deposits in the southeast of this CDA (Oxford Road and Ray Park sports ground).
- Basements: There are several areas of households with basements identified in this CDA: on King's Avenue near the edge of LFRZ a, on Forest Way near the ordinary watercourse, on Princes Avenue opposite the sports ground, and a small cluster in the far north of this CDA around the A124. None of these properties are predicted to be affected by surface water flooding according to the modelling undertaken. However, the properties in Kings Avenue and Forest Way lie close to surface water flow paths and may be at risk from, for example, a blocked culvert causing backing-up of water in a major storm event.

Validation

- No significant correlation with historical flood records.
- Good correlation with EA Flood Map for Surface Water.
- Culvert beneath railway not accessible by site visit, but modelling did include 1D representation of the culvert running from Knighton Wood to the River Roding, using limited asset information provided by the Borough.

3.8.2 CDA 002 Woodford Green

Surface water flood risk is predominantly confined to two local flood risk zones in this CDA. Surface water flow paths flow generally south east to the River Roding. The two local flood risk zones are concentrated in the areas of west of the railway line and west of Chigwell Road as shown in **Figure Group5_002.1** and **Figure Group5_002.2**.

LFRZ a: West of the railway

A surface water pathway runs towards the railway from the northwest. There are houses with basements in this LFRZ. Modelling suggests that ponding surface water could collect at the intersection of Snakes Lane West and Kings Avenue, near Woodford Station, and be particularly deep in this vicinity with depths exceeding 1.5m.

Critical receptors identified at risk in this LFRZ include 15 households and 20 commercial properties with basements, including one surgery / health centre; the school / college off Monkham's Avenue; and the Central Line (critical infrastructure).

LFRZ b: West of Chigwell Road

There is a single surface water pathway running between Rayleigh Road and St Anthony's Avenue that runs southeast towards the main river, the River Roding. Surface water risk in this LFRZ is also directly linked to water levels in the River Roding. Water that is unable to enter the Roding will back-up and cause localised flooding, particularly in the known flooding location of the Chigwell Road / Brackley Square area. Assets directly impacted include houses, and garages at the rear.

Critical receptors identified at risk in this LFRZ include a church and community centre / hall off the A113 Chigwell Road, a community centre/hall off Finchingfield Avenue, and the A113 Chigwell Road (critical infrastructure).

Key Assumptions and Observations

- Surface water management in LFRZ b is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding.
- Historic flood risk: There is an area of known historical surface water flooding in the area bounded by Snakes Lane East, the A113, and rear gardens of Brackley Square. The EA have recorded who incidents of groundwater flooding: in Harts Grove and Monkham's Avenue.
- Groundwater flood risk: Map 3.3 indicates that there are three main areas with increased potential for elevated groundwater in permeable superficial deposits: around the junction of Snakes Lane West and King's Avenue; in a band lying southwest to northeast covering St Anthony's Avenue, Rayleigh Road, Danbury Way, Maldon Walk, Greenstead Gardens and Greenstead Avenue; and in the area southeast of Finchingfield Avenue.
- Basements: There are several areas of identified households and commercial properties with basements: a large number around the A104/A1009 in the far northwest of the CDA; in LFRZ a as above; off Snakes Lane East near the junction with Prospect Drive; on Glastonbury Avenue and on St Anthony's Avenue. Apart from the properties in LFRZ a, these receptors are not predicted to experience surface water flooding according to the modelling undertaken. However, the properties on Glastonbury Avenue are predicted to be flooded to a depth of up to 1.5m in their rear gardens, so may still be considered at risk.

Validation

- One or more historic records confirm predicted surface water flooding – Brackley Square area.
- Good correlation with EA Flood Map for Surface Water.
- Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed.

3.8.3 CDA 003 South Woodford

Surface water flood risk is predominantly confined to two local flood risk zones in this CDA. Surface water flow paths are limited to the west by Epping Forest and flow generally east to the River Roding. The two local flood risk zones are concentrated in the areas west of the railway (central line - Epping Branch) and west of Chigwell Road as shown in **Figure Group5_003.1** and **Figure Group5_003.2**.

LFRZ a: West of the railway (central line – Epping Branch)

There are two known flooding areas in this LFRZ. These are focussed in Empress Avenue and St Ronan's Crescent. There are two pathways converging at the

junction of Beverley Close and Arundel Drive. There are three houses with basements in this LFRZ. Modelling suggests that pooling surface water could be particularly deep in this vicinity with depths exceeding 1.5m. The potential ponding appears to have a direct relationship to the railway embankment.

Critical receptors at risk in this LFRZ include three households with basements in Beverley Crescent; six households with basements on Warley Road are predicted to experience deep (greater than 1.5m depth) flooding of back gardens.

LFRZ b: West of Chigwell Road

Surface water risk in this LFRZ is directly linked to water levels in the River Roding. Water that is unable to enter the Roding will back-up and cause localised flooding, which is chiefly restricted to playing fields and allotments along Chigwell Road. Assets directly impacted include property adjacent to Wansford Road and Chigwell Road and localised flooding of assets in the Orchard Estate. There is a flood storage area between Orchard Estate and Chigwell Road, and a discrete pathway along Wansford Road and Grenville Gardens is also noted.

Critical receptors at risk in this LFRZ include the A113 (critical infrastructure) and a school / college on Raven Road.

Key Assumptions and Observations

- Modelling has assumed the railway embankment forms a barrier to surface water flow.
- Surface water management in LFRZ b is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding.
- Historic flood risk: There are two areas of recorded historical surface water flooding: at the western end of St Alban's Road / Salway Close and around the junction of Arundel Drive and The Vale, both in LFRZ a. There was one incident of groundwater flooding recorded by the EA in St Alban's Road.
- Groundwater flood risk: Map 3.3 indicates that the area surrounding the school off Wynndale Road, the area in the southern corner of this CDA bounded by Crescent Road and Waverley Road, and the area encompassing the playing field by Chigwell Road / Broadmead Road have an increased potential for elevated groundwater in permeable superficial deposits.
- Basements: There are many areas with basements in this CDA: Empress Avenue, Fuller's Road, Derby Road, the A1199 High Road Woodford Green, St Alban's Road, St Alban's Crescent, St Ronan's Crescent, Glebe Avenue, Parkland Road, Horn Lane, Fairfield Road, Warley Road, Beverley Crescent, Gordon Road, Maybank Road, Navestock Terrace and Bramley Road all contain properties with basements. These are mostly households but some are commercial properties.

Validation

- One or more historic records confirm predicted surface water flooding in St Alban's Road and The Vale/Arundel Drive.
- Good correlation with EA Flood Map for Surface Water.
- Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed. Primary flooding mechanism is where runoff down steep roads bypasses highway drainage and continues into properties built across the flow pathway.

3.8.4 CDA 004 Snaresbrook

This CDA extends from the remnant of Epping Forest on the western boundary of the borough, into the London Borough of Waltham Forest, to the River Roding main river in the east. Surface water flood risk is predominantly confined to three local flood risk zones. Surface water flow paths are limited to the west by the high ground with a remnant of Epping Forest and flow generally east to the River Roding. The three local flood risk zones are concentrated in the areas west of the railway line and west of the A406 as shown in **Figure Group5_004.1** and **Figure Group5_004.2**.

LFRZ a and b: West of the railway (Malcolm Way and Tavistock Road/Avon Way)

There are two pathways which intersect the railway and converge downstream in this area. There are houses with basements in these LFRZs. Modelling suggests that ponding surface water could be more than 1.5m deep in these areas. The potential ponding appears to have a direct relationship to the railway embankment.

Critical receptors at risk in these LFRZs include the A113 (critical infrastructure), the A1199 Holly Bush Hill (critical infrastructure), a community centre / hall on Holly Bush Hill in LFRZ a, five households with basements in LFRZ a in the Hermon Hill / Sylvan Road area, and five households with basements in LFRZ b in Tavistock Road.

LFRZ c: West of the A406

Surface water risk in this LFRZ is directly linked to water levels in the River Roding. Water that is unable to enter the Roding will back-up and cause localised flooding, which is chiefly restricted to open ground and allotments. Critical receptors at risk in this area include a community centre / hall off Merino Close.

Key Assumptions and Observations

- Modelling has assumed the railway embankment forms a barrier to surface water flow.Surface water management in LFRZ c is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding.
- Historic flood risk: Map 3.3 indicates that there is an area of recorded historical surface water flooding on Herman Hill. There is one incident of groundwater flooding recorded by the EA on Cheyne Avenue.
- Basements: There are a high number of properties with basements in this CDA. Most of the roads in the south of this CDA (south of LFRZ a) include some households or commercial properties with basements, including Snaresbrook Crown Court. The area lying between the A1199 The Drive and Chigwell Road also has a high number of properties with basements, including both households and commercial properties. Apart from those in LFRZ a and b as outlined above, most of these are not predicted to experience surface water flooding according to modelling.

Validation

- One or more historic records confirm predicted surface water flooding – recorded flooding in the low point along Hermon Hill on the predicted flow pathway although flooding is not predicted at the actual properties impacted.
- Correlation with EA Flood Map for Surface Water is not particularly close.
- Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed.

3.8.5 CDA 006 Clayhall

This CDA extends from Claybury Park in the northwest to the River Roding main river watercourse in the southeast. A surface water flow path runs southwest from the Claybury Park area southwest to the River Roding. Surface water flood risk is predominantly confined to one local flood risk zone in this CDA, concentrated upstream and downstream of Southend Road (A1400) as shown in **Figure Group5_006.1** and **Figure Group5_006.2**.

LFRZ a: Southend Road

The flow pathway intersects Southend Road and flows through Woodford Trading Estate. Surface water risk at the downstream end in this LFRZ may be directly linked to water levels in the River Roding, where there is an Electricity Sub Station. Water that is unable to enter the Roding may back-up and cause localised flooding. Modelling suggests that ponding surface water could be deep (greater than 1.5m deep) in parts of this LFRZ, particularly affecting properties in Coburg Gardens, Peel Place and Vienna Close upstream of the A1400. Critical receptors at risk in this LFRZ include the A1400 Southend Road (critical infrastructure).

Key Assumptions and Observations

- Surface water management in LFRZ a is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding.
- Historic flood risk: Map 3.3 indicates that there are three areas of recorded historical surface water flooding: off Atherton Road by Cocked Hat Plantation, around the junction of Kensington Drive and Roding Lane North, and the A1400 between the junction with Stradbroke Grove and Woodford Trading Estate. The EA recording one groundwater flooding incident near the junction of Lodge Hill and the A1400.
- Groundwater flood risk: The western half of LFRZ a has an increased potential for elevated groundwater in permeable superficial deposits.

Validation

- One or more historic records confirm predicted surface water flooding – Kensington Drive / Roding Lane North, The Glade and Southend Road (A1400).
- Good correlation with EA Flood Map for Surface Water.
- Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed.

3.8.6 CDA 007 Barkingside, Newbury Park West and Cranbrook

This CDA extends from the northern boundary of the borough south to the River Roding main river on the southern borough boundary. Surface water flood risk is predominantly confined to the single flow path that flows from north to south over a considerable distance, eventually joining the River Roding. From the LUL railway between Barkingside and Newbury Park stations this flowpath follows the Cran Brook, main river, through Valentines Park to its confluence with the River Roding. Three local flood risk zones are evident in this CDA, in the Barkingside area, west of Newbury Park and the Cranbrook area as shown in **Figure Group5_007.1** and **Figure Group5_007.2**.

LFRZ a: Barkingside

The flow pathway runs south either side of the LUL railway as surface water runoff collects from the upper catchment. Water that is unable to cross Station Road, will back-up and cause localised flooding in the vicinity of the school. Modelling suggests that ponding surface water could be particularly deep in this vicinity at 1m deep. Downstream there is a larger but undeveloped area at risk to the east of the railway where the potential ponding appears to have a direct relationship to the railway embankment.

Critical receptors at risk in this LFRZ include King Solomon High School and the school off Station Road, a community centre / hall off Station Road, ten commercial properties and four households with basements around Fulwell Cross roundabout, two churches at the junction of the A123 and Tomswood Hill, and the A123 Fencepiece Road (critical infrastructure).

LFRZ b: Newbury Park West

The main flow pathway (which follows the culverted Cran Brook) is joined by a second pathway here, upstream of Eastern Avenue (the A12). Modelling suggests that ponding surface water could be particularly deep along Cantley Gardens, Yoxley Drive and parts of Springfield Drive and Ardwell Avenue at over 1.5m deep. Critical receptors at risk in this LFRZ include the A123 High Street and the A12 (critical infrastructure).

LFRZ c: Cranbrook

There are known flooding locations in Valentines Park (from the Cran Brook) and Wanstead Park Road (from the River Roding). The surface water flow path continues south from the park along Northbrook Road to join the River Roding. The culverted Cran Brook follows this course. Modelling suggests that ponding surface water could be particularly deep in these areas at up to 1m deep.

Critical receptors at risk in this LFRZ include the A123 Cranbrook Road (critical infrastructure), a school / college at the north end of Northbrook Road, around 49 households and four commercial properties with basements in the area around Northbrook Road, Belgrave Road and Westbury Road, a few households with basements on Wanstead Park Road, and a few households with basements on Empress Avenue.

Key Assumptions and Observations

- Surface water management in LFRZ c is directly linked to fluvial management in the River Roding and the Cran Brook Main River tributary. Flood risk solutions here must be considered in the context of Environment Agency strategy for the River Roding and the Cran Brook.
- In LFRZ a there is a large, but undeveloped, area at risk to the east of the railway where the potential ponding appears to have a direct relationship to the railway embankment.
- Historic flood risk: There are two recorded areas of historical surface water flooding: Wanstead park Road and the area surrounding the lake on Cran Brook in the park. The EA have recorded four incidents of groundwater flooding in this CDA: near the south end of Northbrook Road, on Vaughan Gardens, on Cranbrook Road and on Mornington Avenue.
- Groundwater flood risk: Map 3.3 indicates an increased potential for elevated groundwater in permeable superficial deposits in the north (Fairlop and parts of Hainult and Barkingside) and south (parts of Ilford and Valentine's Park) of this CDA.
- Basements: There are a large number of properties with basements to the south west of Cranbrook Road.

Validation

Following the Drain London validation criteria, predicted flood risk in this CDA has not been validated:

- There are no confirmed historic incidents of flooding.
- The predicted flood extents do not correlate closely with the EA's Flood Map for Surface Water.
- A site visit was not undertaken.

3.8.7 CDA 008 Ilford

There are two surface water flow paths which flow south and converge in the vicinity of Ilford Deport between Ilford and Seven Kings Stations. From here the flow path runs south and accumulates in South Park. Two local flood risk zones are evident in this CDA, in the Vicarage Lane and South Park areas. There is a known flooding location in South Park. The main river watercourses Seven Kings Water and Loxford Water also flow through the southeast corner of this CDA. These can be seen in **Figure Group5_008.1** and **Figure Group5_008.2**.

LFRZ a: Vicarage Lane area

Flow pathways converge here. Modelling suggests that ponding surface water could be up to 1m deep in Vicarage Lane and the allotment ground to the south. There is one critical receptor in this LFRZ at risk.

LFRZ b: South Park area

The main flowpath flows around Cricklefield Stadium, also enters South Park here, having been diverted into culvert(s) beneath Green Lane, and continues south of the park. This watercourse also contributes to the flood risk in this area. The area north of Loxford Lane and west of South Park Drive is also indicated as an area at risk with modelling suggesting ponding depths of up to 1.5m. There is a recent housing development at Loxford Chase. A further area at risk is in the Green Lane / Connaught Road / Stanley Road / Melford Road area where modelling indicates water depths of up to 1.5m could occur. There are also basements in this area. Critical receptors at risk in this LFRZ include the A118 High Road (critical infrastructure), A1083 (critical infrastructure) and a community centre / hall on South Park Drive.

Key Assumptions and Observations

- Although not identified as a specific surface water LFRZ, flood risk to the east and south of this CDA is directly linked to fluvial management in the Loxford Water – Severn Kings Water Main River tributary of the River Roding. Flood risk solutions here must be considered in the context of Environment Agency strategy for the watercourse.
- Historic flood risk: South Park is identified as a site of historical surface water flooding. The EA have recorded two groundwater flooding incidents in Airlie gardens, one in Balfour Road and one in Mortlake Road.
- Groundwater flood risk: Map 3.3 indicates that most of this CDA east of LFRZs a and b has increased potential for elevated groundwater in permeable superficial deposits. A second band with increased potential for elevated groundwater in permeable superficial deposits exists to the north of LFRZ a.
- Basements: The extreme west of this CDA (Ilford area west of Cranbrook Road) contains a high number of households and other receptors with

basements. There are two other households with basements in Britannia Road.

Validation

- One or more historic records confirm predicted surface water flooding – Valentine's Park.
- There is not a particularly good correlation with the EA Flood Map for Surface Water.
- Flood mechanisms were not identified on site.

3.8.8 CDA 009 Seven Kings

Surface water flood risk is predominantly confined to the single flow path that flows from north to south over a considerable distance, from Hainault Forest Country Park to the north through Seven Kings Park to the main railway line at the southern boundary. The flowpath follows the Seven Kings Water, main river watercourse south from the A1112. Two local flood risk zones are evident in this CDA, in the upstream area of Peregrine Road and upstream of Seven Kings Recreation Ground, both of which are known flooding locations. These can be seen in **Figure Group5_009.1** and **Figure Group5_009.2**. The A12, while not included in a LFRZ, is also critical infrastructure predicted to experience surface water flooding according to modelling.

LFRZ a: Peregrine Road

The flow pathway runs south from Hainault Forest Country Park as Seven Kings Water watercourse. Modelling suggests that ponding surface water could be up to 1m deep upstream of Romford Road (the A1112). Properties in Peregrine Road to the south of here are at risk of flooding. Critical receptors at risk in this LFRZ include a church on Peregrine Road and the A1112 Romford Road (critical infrastructure).

LFRZ b: Seven Kings Park

Properties are at risk of flooding adjacent to the Seven Kings Water watercourse between Seven Kings Park and the Recreation Ground. Modelling suggests that ponding surface water could be up to 1m deep along Farnham Road, and up to 1.5m deep along Royal Close. Critical receptors at risk in this LFRZ include two schools on Arnham Road, the A118 High Road (critical infrastructure) and the Liverpool Street to Shenfield Main Line (critical infrastructure).

Key Assumptions and Observations

- No notable assumptions or specific observations made.
- Historic flood risk: There are identified historical areas of surface water flooding on Peregrine Road and covering the recreation ground off Westwood Road. There are incidents of groundwater flooding recorded by the EA on Newton Road and on Chestnut Grove.
- Groundwater flood risk: Map 3.3 indicates that the area of this CDA with increased potential for elevated groundwater in permeable superficial deposits mainly encompasses the central, rural part of the CDA but also includes parts of south Hainault and Seven Kings.
- Basements: There is a high number of both commercial properties and households with basements along Manford Way in Hainault, many of which are predicted to experience surface water flooding. There are a few other properties with basements in Fairview Road, Burrow Road, Inverness Drive, Roebuck Road in Hainault; these are mostly households with a few

commercial properties. With the exception of the households in Inverness Drive (which could experience flooding to depths of up to 0.5m) these properties are not predicted to experience surface water flooding according to modelling.

Validation

Following the Drain London validation criteria, predicted flood risk in this CDA has not been validated:

- There are no confirmed historic incidents of flooding.
- The predicted flood extents do not correlate closely with the EA's Flood Map for Surface Water.
- A site visit was not undertaken.

3.8.9 CDA 010 Goodmayes

Surface water flood risk is predominantly confined to the single flow path that flows from Marks Gate in the north to Goodmayes Park Recreation Ground in the south. Three local flood risk zones are evident in this CDA: in the Eastern Avenue (the A12); Chadwell Heath High Road; and Goodmayes Park areas. These can be seen in **Figure Group5_010.1** and **Figure Group5_010.2**.

While not included within a LFRZ, the Liverpool Street to Shenfield main line and A124 (both critical infrastructure) are also predicted to experience surface water flooding according to modelling.

LFRZ a: Eastern Avenue (the A12)

The flow pathway runs southeast from the lake on the north side of the A12 across low spots in Havering Gardens, Tolworth Gardens, Portland Gardens and Chadville Gardens, where there are properties at risk. Modelling suggests that ponding surface water could be up to 0.25m deep in these areas. Critical receptors at risk in this LFRZ include the A12 (critical infrastructure).

LFRZ b: Chadwell Heath High Road

The main flow pathway is joined by a second pathway here, at Grove Road, upstream of Chadwell Heath High Road. Modelling suggests that ponding surface water could be up to 1m deep along Grove Road. Critical receptors at risk in this LFRZ include the A118 High Road (critical infrastructure).

LFRZ c: Goodmayes Park area

The surface water flow path continues south through Goodmayes Park. The Mayes Brook follows this course. Modelling suggests that ponding surface water could be up to 1m deep upstream of Mayesbrook Road. Critical receptors at risk in this LFRZ include the church on Mayesbrook Road.

Key Assumptions and Observations

- No notable assumptions or specific observations made.
- Historic flood risk: The EA has recorded groundwater flooding incidents on Mayfair Avenue and Conway Crescent.
- Groundwater flood risk: Map 3.3 indicates that several areas of this CDA have increased potential for elevated groundwater in permeable superficial deposits: northwest of the A12; the north part of LFRZ a; and most of the southern half of the CDA including the A124.
- Basements: There are no identified households or other receptors with basements in this CDA.

Validation

Following the Drain London validation criteria, predicted flood risk in this CDA has not been validated:

- There are no confirmed historic incidents of flooding.
- The predicted flood extents do not correlate closely with the EA's Flood Map for Surface Water.
- A site visit was not undertaken.

3.8.10 CDA 020 South Woodford

Surface water flood risk is predominantly confined to a single local flood risk zone adjacent to the River Roding main river in the east, and modelling shows the potential for flooding in three areas along the North Circular Road (the A406). This is shown in **Figure Group5_020.1** and **Figure Group5_020.2**.

LFRZ a: adjacent to the River Roding (Charlie Brown's Roundabout)

A surface water pathway runs towards the River Roding from the west. Modelling suggests that ponding surface water could collect in the Charlie Brown's Roundabout area near Oakdale Junior School and be up to 1m in this vicinity. The potential ponding appears to be linked to water levels in the River Roding. Water that is unable to enter the Roding will back-up and cause localised flooding, which is chiefly restricted to open space near the roundabout. Critical receptors at risk in this area include the A113 Chigwell Road and A406 North Circular (both critical infrastructure).

Key Assumptions and Observations

- The three areas along the North Circular Road (the A406) where modelling indicates the potential for flooding, may be served by highway drainage, however this is not taken account of in the modelling.
- The potential ponding appears to be linked to water levels in the River Roding.
- Historic flood risk: There are no recorded incidents of historical surface water flooding. The EA record incidents of groundwater flooding on Buckingham Road and Essex Road.
- Groundwater flood risk: Map 3.3 indicates that the far eastern part of this CDA has an increased potential for elevated groundwater in permeable superficial deposits.
- Basements: There are a high number of households and residential properties with basements in this CDA, and most roads contain properties with basements, except for in the extreme southeast of the CDA near the River Roding and A113.

Validation

- No identified historical surface water flood incidents.
- Good correlation with EA Flood Map for Surface Water.
- Site visit was not able to confirm the flood mechanism in areas of predicted risk.

3.8.11 CDA 027 River Roding north

This CDA covers an area adjacent to the River Roding main river watercourse, in the north of the borough. Surface water flood risk is predominantly confined to three

local flood risk zones adjacent to the River Roding main river watercourse where property is at risk. Surface water risk is apparent in the Uplands Road area, north of Southend Road in the Westview Drive area, and southwest of Charlie Brown's Roundabout at Onslow Gardens. These can be seen in **Figure Group5_027.1** and **Figure Group5_027.2**. There are four households with basements within these flood risk zones.

LFRZ a: Uplands Road

A potential flood risk area is indicated in the Uplands Road area where water that is unable to enter the Roding will back-up and cause localised flooding to properties in Uplands Road. Modelling suggests that ponding surface water could be up to 1m deep in this area. Critical receptors at risk in this area include one "critical" element at risk ((A406 North Circular), one household with basement and two commercial properties with basements.

LFRZ b: Westview Drive / Lechmere Approach / Lechmere Avenue

A potential flood risk area is indicated in the Westview Drive / Lechmere Avenue area where water that is unable to enter the Roding will back-up and cause localised flooding to properties in Westview Drive / Lechmere Avenue. Modelling suggests that ponding surface water could be over 1.5m deep in this area. Critical receptors at risk in this area include include one "critical" element at risk (A113 Chigwell Road), two households with basements.

LFRZ c: Onslow Gardens

A potential flood risk area is indicated in the Onslow Gardens area where water that is unable to enter the Roding will back-up and cause localised flooding to properties in Onslow Gardens. Modelling suggests that ponding surface water could be up to 1.5m deep in this area. There are no critical receptors identified in this LFRZ.

Key Assumptions and Observations

- Surface water management in this CDA is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding.
- There are four households with basements within local flood risk zones in this CDA.
- Historic flood risk: There is an area of historical surface water flooding at the junction of the A113 Chigwell Road and B173 Manor Road. There are no groundwater flooding incidents recorded by the EA,
- Groundwater flood risk: Map 3.3 indicates that mainly the east and south of this CDA have an increased potential for elevated groundwater in permeable superficial deposits.
- Basements: There are a number of locations with identified households and commercial properties with basements: northeast of the A113 Chigwell Road most streets contain households or other receptors with basements; there are also households with basements on Southview Drive near LFRZ c, on Westview Drive in LFRZ b, Uplands Road in Woodford Bridge, the A113 Chigwell Road in and around LFRZ a, and Cross Road to the east of LFRZ a.

Validation

- Recorded flooding at Chigwell Rd is not predicted by the modelling, although this incident is believed to be due to localised sewer capacity and/or maintenance.
- Surface water flooding predicted by modelling and the EA's Flood Map for Surface Water do not correlate particularly well.

- Site visit with Borough engineer confirmed flood mechanism at Chigwell Road.

3.8.12 CDA 028 Gants Hill

This CDA comprises residential housing with Clayhall Park in the north and the River Roding, main river watercourse, in the southwest. Surface water flood risk is predominantly confined to a single local flood risk zone in the Gants Hill area. However there are also surface water flowpaths running westwards from here towards the River Roding. These can be seen in **Figure Group5_028.1** and **Figure Group5_028.2**. The A12 (critical infrastructure), while not included in an LFRZ, is also predicted to experience surface water flooding according to the modelling undertaken.

LFRZ a: Gants Hill

Modelling suggests that ponding surface water could collect in the area to the south of Gants Hill Underground Station where it could be up to 1m deep. Residential property is at risk in Cranbrook Road, Blenheim Avenue, Clarence Avenue and The Crescent. There are a number of properties with basements in these areas. Other surface water flowpaths run from the northeast and westwards parallel to Eastern Avenue (the A12).

Critical receptors at risk in this LFRZ include the A123 Cranbrook Road (critical infrastructure), a church on Clarence Avenue and four households with basements on the A123 Cranbrook Road.

Key Assumptions and Observations

- Historic flood risk: The southern parts of Ellesmere Gardens, Windermere Gardens and Danehurst Gardens and the A12 Eastern Avenue nearby have recorded historical surface water flooding. There are no incidents of groundwater flooding recorded by the EA in this CDA.
- Groundwater flood risk: According to Map 3.3 there is an increased potential for elevated groundwater in permeable superficial deposits in some parts of this CDA, mainly encompassing the area to the west of the A406 North Circular and an area surrounding and to the north of LFRZ a.
- There are a number of properties with basements in LFRZ a as detailed above, and also there are a high number of households and commercial properties with basements around the A12 / A1400 roundabout, to the north of the A12 nearby, near the A123 / B192 junction, on Wychwood Gardens, and on the A12 opposite Evanston Gardens, some of which are predicted to experience surface water flooding up to 0.5m deep according to modelling.

Validation

- One or more historic records confirm predicted surface water flooding – Ellesmere Gardens and Windemere Gardens.
- Surface water flooding predicted by modelling and the EA's Flood Map for Surface Water do not correlate particularly well.
- No site visit was undertaken.

3.8.13 CDA 029 River Roding south

This CDA runs south from the A12 along the River Roding and crosses into Newham Borough boundary to the south west and into Barking and Dagenham

Borough boundary to the south. It includes the Main River tributary of the Loxford Water. Surface water flood risk is predominantly confined to a single local flood risk zone adjacent to the River Roding as shown in **Figure Group5_029.1** and **Figure Group5_029.2**.

LFRZ a: adjacent to the River Roding

Potential flood risk areas are indicated beside the River Roding. Water that is unable to enter the Roding will back-up and cause localised flooding, which is chiefly restricted to open spaces. Critical receptors at risk in this LFRZ include the A406 North Circular (critical infrastructure) and two "more vulnerable" elements of infrastructure.

Key Assumptions and Observations

- Surface water management in LFRZ a is directly linked to fluvial management in the River Roding and solutions must be considered in the context of Environment Agency strategy for the River Roding
- Historic flood risk: There are no reported incidents of historic flooding or groundwater flooding reported in this CDA.
- Groundwater flood risk: Map 3.3 indicates that most of this CDA has an increased potential for elevated groundwater in permeable superficial deposits.
- Basements: There are households with basements in the north of the CDA but these are not predicted to experience surface water flooding. There are also a small number of households with basements along Wanstead Park Road; again, these are not predicted to flood in the modelled surface water event.

Validation

Following the Drain London validation criteria, predicted flood risk in this CDA has not been validated:

- There are no confirmed historic incidents of flooding.
- The predicted flood extents do not correlate closely with the EA's Flood Map for Surface Water.
- A site visit was not undertaken as the predicted flood risk in this CDA is primarily from the Main River Roding.

3.8.14 CDA 031 Aldersbrook

This CDA comprises the residential area of Aldersbrook and the surrounding open spaces of Wanstead Flats to the south and Wanstead Golf Course and Wanstead Park to the north. Surface water flood risk is predominantly confined to the single flow path that flows east through the series of ponds before joining the course of the River Roding. A single local flood risk zone is evident, at the western side of Aldersbrook, although streets in other parts of this residential area are subject to potential flood risk. This can be seen in **Figure Group5_031.1** and **Figure Group5_031.2**.

Although not included in a LFRZ, the A116 (critical infrastructure) is predicted to experience surface water flooding at the junction with Wanstead Park Road according to the modelling undertaken.

LFRZ a: Aldersbrook

Modelling suggests that ponding surface water could be up to 1m deep and affect houses. There are numerous households with basements in the Aldersbrook area.

There are many households with basements in this LFRZ. Most of these are not predicted to flood internally according to modelling, but they may still be at risk.

Key Assumptions and Observations

- No notable assumptions or specific observations made.
- Historic flood risk: There are no recorded incidents of surface water flooding in this CDA. The EA have recorded an incident of groundwater flooding on Belgrave Road.
- Groundwater flood risk: A large proportion of this CDA has an increased potential for elevated groundwater in permeable superficial deposits. The rural part of this CDA, LFRZ a, the area immediately surrounding the ponds in Wanstead Park, and residential areas to the south and west are all affected.
- Basements: Aldersbrook and Wanstead have a high proportion of households and commercial properties with basements. Most roads contain households and/or commercial properties with basements. However, only a small number are predicted to experience surface water flooding according to the modelling undertaken.

Validation

Following the Drain London validation criteria, predicted flood risk in this CDA has not been validated:

- There are no confirmed historic incidents of flooding.
- The predicted flood extents do not correlate closely with the EA's Flood Map for Surface Water.
- A site visit was not undertaken.

3.9 Summary of Risk

A summary table of surface water flood risk to: 1) Infrastructure, 2) Households and 3) Commercial/Industrial receptors is outlined, by CDA, in **Table 3.4** below. The moderation applied to the prioritisation matrix is also indicated on a primary and secondary basis.

CDA ID	Scheme Location	Moderation		Infrastructure					Households								Commercial / Industrial				Validation *
		Primary	Secondary	Essential		Highly Vulnerable		More Vulnerable	Non-Deprived (All)		Non-Deprived (Basements)		Deprived (All)		Deprived (Basements)		All		Basements Only		
				All	>0.5m Deep	All	>0.5m Deep	All	>0.5m Deep		>0.5m Deep		>0.5m Deep		>0.5m Deep		All	>0.5m Deep	All	>0.5m Deep	
Group5_001	Woodford Wells	Health and Safety	None	0	0	0	0	0	0	71	13	2	0	0	0	0	0	3	0	0	0	Validated (2)
Group5_002	Woodford Green	Regionally Important Infrastructure	Health and Safety	2	0	1	0	2	1	199	4	15	4	0	0	0	0	57	30	19	9	Validated (1, 2, 3)
Group5_003	South Woodford	Regionally Important Infrastructure	Health and Safety	1	0	0	0	0	0	198	22	3	2	30	6	0	0	35	3	0	0	Validated (1, 2, 3)
Group5_004	Snaresbrook	Regionally Important Infrastructure	None	2	1	2	1	3	0	493	78	21	7	0	0	0	0	29	2	0	0	Validated (1, 3)
Group5_006	Clayhall	Regionally Important Infrastructure	Health and Safety	1	1	0	0	1	0	447	53	2	0	0	0	0	0	68	3	0	0	Validated (1, 2, 3)
Group5_007	Barkingside, Newbury Park West and Cranbrook	Regionally Important Infrastructure	Health and Safety	2	2	2	1	10	1	1810	258	97	0	86	8	23	0	251	23	16	0	Non-Validated
Group5_008	Ilford	Regionally Important Infrastructure	Health and Safety	2	1	13	0	5	0	2256	75	0	0	546	7	3	0	422	9	5	0	Non-Validated
Group5_009	Seven Kings Water	Regionally Important Infrastructure	None	4	4	1	0	10	1	1122	31	15	2	170	0	0	0	223	12	12	2	Non-Validated
Group5_010	Goodmayes	Regionally Important Infrastructure	Health and Safety	4	4	1	0	6	0	1356	22	0	0	287	0	0	0	193	12	0	0	Non-Validated
Group5_020	South Woodford	Regionally Important Infrastructure	Health and Safety	2	2	1	0	2	0	169	5	20	1	0	0	0	0	34	0	9	0	Validated (2)
Group5_027	River Roding North	Health and Safety	None	0	0	0	0	1	0	236	4	4	0	0	0	0	0	51	11	2	0	Validated (3)
Group5_028	Gants Hill	Regionally Important Infrastructure	Health and Safety	2	0	5	0	2	0	573	6	17	1	80	0	0	0	75	0	0	0	Validated (1,3)
Group5_029	River Roding South	Regionally Important Infrastructure	None	1	1	1	0	3	0	107	1	0	0	272	50	0	0	95	24	0	0	Non-Validated
Group5_031	Aldersbrook	Regionally Important Infrastructure		1	0	0	0	0	0	86	0	3	0	0	0	0	0	32	3	0	0	Non-Validated

*** Validation criteria:**

Validated - The CDA meets one or more of the following criteria:

(1) One or more historic records confirm predicted surface water flooding

(2) Good correlation with EA Flood Map for Surface Water

(3) Site visit by consultant undertaken with LB representative and probable flood mechanism confirmed

Non-Validated - The CDA does not fulfil any of the 'validated' criteria

Table 3.4 Summary of Risk table by Prioritisation Matrix Category and CDA

4 Phase 3: Options

4.1 Objectives

The purpose of Phase 3 is to identify a range of structural and non-structural measures for alleviating flood risk and assess them to eliminate those that are not feasible or cost beneficial. The remaining options are then developed and tested against their relative effectiveness, benefits and costs. The target level of flood protection has been set at 1 in 75 years to align solutions with the likely level of insurance cover available to the general public.

To maintain continuity within the report and to reflect the flooding mechanisms within the Borough the option identification has taken place on an area-by-area (site-by-site) basis following the process established in Phase 2. Therefore, the options assessment undertaken as part of the SWMP assesses and short-lists the measures for each CDA and identifies any non-standard measures available.

Phase 3 delivers a high level option assessment for each of the local flood risk zones (LFRZs) identified in Phase 2. No monetised damages have been calculated and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. Costs should be treated at an order of magnitude level of accuracy. The options assessment presented here follows that described in the Defra SWMP Guidance but is focussed on highlighting areas for further detailed analysis and immediate 'quick win' actions. Further detailed analysis may occur for high priority LFRZs as defined by the Prioritisation Matrix the next Tier (Tier 3) of the Drain London project.

The objective of the options assessment process was to identify, shortlist and assess a suite of **measures** (individual actions or procedures to minimise current and future surface water flood risk, or to meet other SWMP objectives) for mitigating surface water flooding and agree preferred **options** (a single measure or combinations of measures) across each of the CDAs in Redbridge.

Structural and non-structural measures were identified, regardless of potential delivery mechanism or funding, and a preliminary options appraisal was undertaken to shortlist the range of feasible options to be taken forward to stakeholder consultation and detailed assessment.

The **Options Workshop** presented the outputs of the preliminary options appraisal to stakeholders and gave them the opportunity to confirm the shortlisted measures were acceptable for the area, and eliminate measures they deemed inappropriate. Site visits also took place to verify the technical feasibility of options and to assist with the option assessment process.

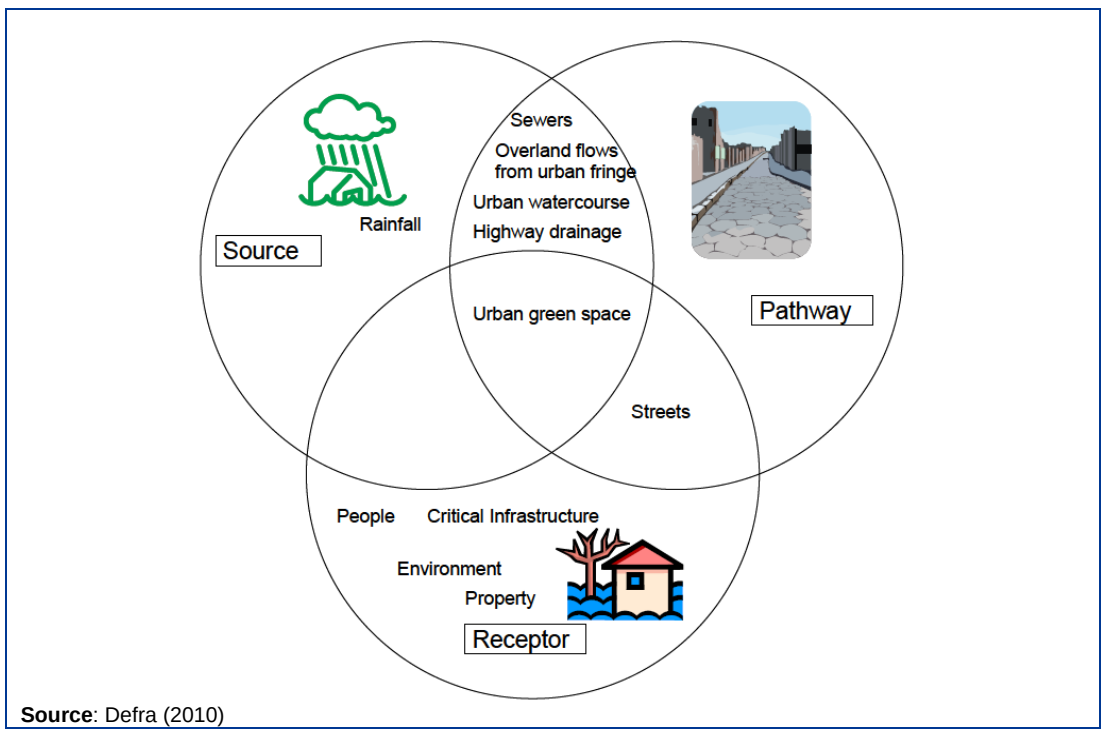
After collating stakeholder feedback and completing the preliminary options appraisal, a number of options were put forward for further assessment which determined the preferred option for each CDA, and estimated the benefits and approximate implementation costs. This options assessment process was subject to the Peer Review process detailed in section 1.8.

4.2 Measures

21 generic and site specific measures to mitigate surface water flooding (plus ‘Do Nothing’ and ‘Do Minimum’ scenarios) were identified (see **Table 4.1**) under the Defra classifications of source control measures, pathway measures and receptor measures (see **Figure 4.1**).

	Generic measures	Site specific measures
	• Do Nothing • Do Minimum (continue maintenance)	
Source control	• Green roofs • Soakaways, water butts & rainwater harvesting • Permeable paving • Road side rain garden (to help divert and temporarily store water along flow path routes and in potential ponding areas) • Other 'source' measures	• Swales • Detention basins • Ponds and wetlands
Pathway	• Improved maintenance regimes	• Increase capacity in drainage system • Separation of foul & surface water sewers • Managing overland flows • Land Management practices • Other 'pathway' measures
Receptor	• Improved weather warning • Planning policies to influence development • Social change, education and awareness • Improved resilience and resistance measures • Raising Doorway/Access Thresholds’ • Other 'receptor' measures	• Temporary or demountable flood defences - collective measure

Table 4.1 Generic and site specific measures



Source: Defra (2010)

Figure 4.1 Defra's 'Source-Pathway-Receptor' (SPR) model

In order to determine which measures should be considered in more detail a two-stage preliminary options appraisal was carried out.

Step 1 'technical feasibility':
The first stage of the preliminary options appraisal assessed the technical feasibility of the measures in the context of the benefits it would deliver. A feasibility score between 0 and 3 was assigned; any measures with a score of 2 or 3 were carried forward to step 2 of the appraisal.

3 Feasible with significant benefits
2 Feasible with some benefits
1 Feasible but marginal benefit
0 Not feasible or not relevant

Step 2 'overall assessment':
The second stage of the preliminary options appraisal applied the following criteria as defined in the Defra guidance:

- Technical
- Economic
- Social
- Environmental.

U Unacceptable
-2 Severe negative outcome
-1 Moderate negative outcome
0 Neutral
1 Moderate positive outcome
2 High positive outcome

In addition to these a further criterion of 'Sustainability (carbon footprint)' was added to distinguish between environmentally beneficial options and sustainable options. Measures were scored against each of these criteria on a scale of -2 to +2; any measures achieving an overall score (from Steps 1 and 2) of six or more were carried forward to detailed appraisal.

4.3 Potential Solutions or Measures

4.3.1 Do Nothing

Taking a ‘Do Nothing’ approach to the management of local flood risk would literally mean walking away and undertaking no further operational, maintenance activity or future capital investment.

This policy will render surface water drainage systems ineffective and reduce permeability in the surrounding area over time. The effect would be a rapid loss of performance in the existing assets with a subsequent increased frequency of flooding. This would, in turn, lead to greater impacts on receptors across the Borough. Climate change, in the medium and long term, will further exacerbate the problem.

This option is not considered viable as it would increase the impacts associated with surface water and ground water flooding and go against the principals of the Flood Risk Regulations 2009 and the Flood and Water Management Act 2010.

4.3.2 Do Minimum

The ‘Do Minimum’ option means a continuation of the minimal level of intervention to keep the surface/ground water drainage system operational by either;

1) Maintaining Current Standard, keeping existing assets operational at current levels without increasing any asset capacity or the intensity of maintenance regimes. Performance will reduce over time due to climate change.

2) Sustaining Current Standard, keeping existing assets operational, but also increasing the level of asset capacity or the maintenance intensity to address the impacts of climate change. Performance will not decrease over time in the context of climate change, but no further improvement to raise standards or address new problems, would be made.

For the purposes of this SWMP ‘Maintaining Current Standard’ is considered inappropriate in the context of the Boroughs roles and responsibilities as LLFA and has therefore not been considered further.

‘Sustaining Current Standard’ is considered the default position for the Borough in taking forward its role as LLFA. This option has not been considered in detail as a long-term measure for the management of local flood risk, but should be considered as the standard ‘default’ policy position on the management of local flood risk while investigations or alternative management solutions are being implemented.

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4.3.3 Generic Measures – Borough wide opportunities

Planning Policies to Influence Development

As LLFA, the Borough has a responsibility to ensure that development takes place in the most appropriate location, in the context of flood risk and in line with PPS25. This requires a pro-active stance on planning and building regulations policy across the Borough. The LLFA role as SuDS approval body, yet to be fully enacted by the FMWA 2010, requires all development to consider sustainable drainage in its design and for the LLFA to approve or adopt SuDS in a Borough wide, holistic manner.

It is recommended that a policy on SuDS and existing policies of local flood risk are reviewed in light of the findings of this SWMP.

Social Change, Education and Awareness

Increasing public understanding of local flood risk is a primary role of the LLFA. A programme of education and awareness raising on local flood risk issues is required to enable effective management of surface and ground water flooding.

Not all surface and ground water risk can be mitigated by physical measures. The Borough has a primary role in empowering communities to adapt to the impact of future flood risk by helping them to become more resistant and resilient to the consequences of flooding.

It is recommended that a programme of education and awareness raising is developed to enable social change.

Policy Driven Local Receptor Measures

A number of 'Generic Measures' across the Borough require a policy position to be formulated. These measures need to be considered in the context of the Policy Areas defined in **Figure 3.6**.

Policies on the application of; 1) **Raising Doorway/Access Thresholds**, 2) **Soak-aways, Water Butts & Rainwater Harvesting**, 3) **Permeable paving** and 4) **Green Roofs** should be linked to Planning and Building Regulations such that these measures are applied pro-actively to new build and retro fitted to established property where the opportunity is available.

On their own, these measures offer limited benefit when applied to one receptor, but collectively can offer significant local flood risk benefit. Where possible these measures have been recommended on a site specific basis by CDA to address immediate issues in LFRZ, however the Borough should look for strategic opportunities to apply these measures as part of its future Local Flood Risk Plan across the collection of CDAs and LFRZs in each Policy Area to secure larger strategic benefit. It was decided that the blanket application of generic measures, as part of the potential solutions presented in section 4.4, would be unrealistic in dealing with the identified risk. The use of generic measures, where possible, have been targeted to specific LFRZ to both contribute to the management of risk locally and to assist in awareness raising.

4.3.4 Maintenance

The maintenance of existing local flood risk structures/assets is critical in ensuring they are able to operate at optimum level when required. This will require both the Borough and its partners to co-ordinate a programme of maintenance. This is particularly relevant where Thames Water culverts have a limited flow capacity and present the potential for surface water flooding to occur upstream of a major element of infrastructure.

The maintenance of existing local flood risk structures/assets is critical in ensuring they are able to operate at optimum level when required. This will require both the Borough and its partners to co-ordinate a programme of maintenance. This is particularly relevant where third party assets have a limited flow capacity and present the potential for surface water flooding to occur upstream of a major element of infrastructure.

Specific investigations have been suggested for key assets, this must include existing maintenance practices to ensure that the operational optimum is understood against the likely worst case where regular maintenance is not undertaken (eg where a surface water pathway passes beneath the railway, the culvert should be maintained free of debris).

4.4 Potential Solutions or Measures by CDA

The following section identifies the potential measures for each CDA, providing an indication of the costs and property/assets benefiting.

Determining the Potential Solutions

An element of professional judgement has been applied in determining which options are appropriate to be taken forward as potential measures in each LFRZ. This has been informed by the full options assessment as provided in **Appendix E**, a number of site visits and the modelling undertaken in Phase 2. However, a full commentary on all options has not been made in the text of the report.

Site Specific Investigations

An indicative costs allowance has been made for site specific investigation where recommended. It is assumed that these will be led by the LLFA and enable an initial site visit and summary response.

4.4.1 CDA 001 Woodford Wells

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Road side gardens: These will help alleviate water from the flow path route and ponding areas	Where space is available in Monkhams Lane, Princes Avenue, Worcester Crescent, Malvern Drive and King's Avenue.	£17,000
Improved resilience and resistance measures	To 26 residential and 1 commercial properties at risk in Monkhams Lane, Princes Avenue, Worcester Crescent, Malvern Drive and King's Avenue.	£594,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Ponds and wetlands	The potential flow path runs within the fringes of Knighton Wood. The creation of ponds here would help divert and store runoff. Estimated pond size of 200 cubic metres.	£7,000
Investigations		
Three properties with basements	Investigate the resilience of properties close to modelled flooding in LFRZa	**£1000**
Other pathway measures	Investigate culvert works to improve flow capacity through the railway embankment.	**£1000**
	Total Costs CDA 001	**£620,000**

Recommended Investigations

Other pathway measures in CDA 001 include culvert works to improve flow capacity through the railway embankment. This requires detailed assessment and consideration of impacts east of the embankment.

Assets Benefiting from Potential Solutions or Measures

There are a total of 26 households at risk of flooding; of these 13 may experience flood depths in excess of 0.5m. There is also 1 commercial property at risk.

There are no critical receptors at risk in this CDA. However, three properties with basement are close to deep ponding areas in LFRZa and their resilience to flooding should be investigated.

4.4.2 CDA 002 Woodford Green

Potential Solutions or Measures Summary

Generic Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Road side gardens: These will help alleviate water from flow path routes and ponding areas.	***LFRZ b*** –Where space is available in Fyfield Road and Finchingfield Avenue.	£22,000
Improved resilience and resistance measures	To 46 residential and commercial properties at risk in LFRZa - Snakes Lane West and King Avenue / Opposite Woodford Station.	£1,012,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Temporary demountable defences	Up to126 residential and 28 commercial properties shown to be at risk in LFRZb would benefit from demountable barriers. This would need to be linked to generic measures such as flood warning etc.	£3,850,000
Investigations		
Essential Infrastructure	LFRZ a - Investigate the vulnerability of the Circle Line Tube Station. LFRZ b – Investigate the vulnerability of the A113 Chigwell Road.	**£2,000**
'Other' vulnerable Infrastructure	LFRZ a - Investigate the vulnerability of the surgery/health centre and school/college in Monkham's Lane. LFRZ b – Investigate the vulnerability of Church and community centre off Chigwell Road	**£2,000**
Other Investigations	Investigate potential for increased flow capacity through the railway station underpass	**£1,000**
	Total Costs CDA 002	**£4,889,000**

Recommended Investigations

Other pathway measures in **LFRZ a** include underpass improvements to increase flow capacity through the railway station underpass. This requires detailed assessment and consideration of impacts downstream.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 24 household at risk of flooding. Sixteen of these households have basements of which four may experience flood depth in excess of 0.5m. Infrastructure is also at risk; including one “essential” infrastructure element (Circle Line station) and two “more vulnerable” elements (a surgery/health centre and a school/college in Monkham’s Avenue). All but three of the 22 commercial/ industrial units has a basement at risk. Nine of these basements may experience flooding in excess of 0.5m.

In **LFRZ b** there are 126 residential properties at risk. There are 28 commercial properties at risk of which 21 may be subject to flooding in excess of 0.5m. There is one essential infrastructure element (A113 Chigwell Road) at risk and three “highly vulnerable” (A church and a community centre, both off Chigwell Road, and a community centre/hall off Finchingfield Avenue).

4.4.3 CDA 003 Woodford Green South

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Road side gardens: These will help alleviate water from flow path routes and ponding areas	**LFRZ a** - Where space is available in the vicinity of A1199 High Road Woodford Green, St Albans Road and Arundel Drive.	£33,000
	LFRZ b –Where space is available in Wansford Road and Grenville Gardens.	£33,000
Improved resilience and resistance measures	**LFRZ b -** To 90 residential and 20 commercial properties in the Wansford Road and Grenville Gardens areas.	£2,420,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Temporary demountable defences	LFRZa - Up to 55 properties shown to be at risk in the eastern end of Arundel Drive would benefit from demountable barriers. This would need to be linked to generic measures such as flood warning etc.	£1,425,000
Investigations		
Essential Infrastructure	LFRZ b – Investigate the vulnerability of the A113 Chigwell Road.	**£1,000**
‘Other’ vulnerable Infrastructure	LFRZ b – Investigate the vulnerability of the school/college on Raven Road	**£1,000**
Other Investigations	Investigate potential for increased flow capacity through the railway station underpass	**£1,000**
	Total Costs CDA 003	£3,914,000

Recommended Investigations

Other pathway measures in **LFRZ a** include culvert improvements to increase capacity through the railway embankment. This requires detailed assessment and consideration of impacts east of the embankment. Improved maintenance regimes

will be required to ensure the surface water pathways beneath the railway are maintained free of debris.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 55 households at risk of flooding including three with basements. Of these 22, including 2 with basements, may experience flood depths in excess of 0.5m. There are 2 commercial assets at risk which may experience flooding in excess of 0.5m.

In **LFRZ b** there are 90 households at risk. This includes 30 deprived households of which six may experience flooding in excess of 0.5m. Infrastructure is also at risk; including one “essential” infrastructure element (A113) and one “more vulnerable” element (school/college on Raven Road). There are twenty “commercial/ industrial” units at risk, of which one may experience flood depths in excess of 0.5m.

4.4.4 CDA 004 Snaresbrook

Potential Solutions or Measures Summary

Generic Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Soakaways, water butts & rainwater harvesting	Applied to the 272 residential and 8 commercial properties identified as at risk in the three LFRZ	£31,000
Road side gardens: These will help alleviate water from flow path routes and ponding areas	Where space is available in the vicinity of Charnwood Drive.	£66,000
Improved resilience and resistance measures	To 69 residential and 2 commercial properties in LFRZ c.	£1,562,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Ponds and wetlands	The modification of Eagle Pond could help store runoff. Estimated at £30k	£30,000
Temporary demountable defences	LFRZ a and b - Up to 203 residential and 6 commercial properties shown to be at risk in Malcolm Way and Tavistock Road would benefit from demountable barriers. This would need to be linked to generic measures such as flood warning etc.	£5,225,000
Investigations		
Essential Infrastructure	LFRZ a and b– Investigate the vulnerability of the A113 and A1199.	**£2,000**
‘Other’ vulnerable Infrastructure	LFRZ b – Investigate the vulnerability of the Merino Close community centre.	**£1,000**
	Total Costs CDA 004	£6,917,000

Recommended Investigations

Improved maintenance regimes will be required to ensure the surface water pathways beneath the railway are maintained free of debris.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 155 households at risk, this includes five household with basements. Of which 51 may experience flood depths in excess of 0.5m including 4 with basements.. One element of 'essential Infrastructure' (A113) and one "highly vulnerable" infrastructure elements (a community centre on Holly Bush Hill are at risk. There are six "commercial /industrial elements at risk.

In **LFRZ b** there are 48 households at risk, including five with basement s. Of these 22 households may experience flood depths in excess of 0.5m, including 3 with basements. One "essential" infrastructure element is at risk (A1199 Holly Bush Hill).

In **LFRZ c** there are 69 households at risk and a highly vulnerable receptor off Merino Close (community centre). Two commercial properties are also at risk.

4.4.5 CDA 006 Clayhall

Potential Solutions or Measures Summary

Generic Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Soakaways, water butts & rainwater harvesting	Applied to the 70% of the 319 residential properties and 60 commercial assets identified as at risk in the LFRZ a, b and c	£31,000
Road side gardens: These will help allieviate water from the flow path route and ponding areas	Where space is available in Chalgrove Crescent, Wensleydale Avenue and Roding Lane South.	£33,000
Improved resilience and resistance measures	To 30% of the residential properties (96) in the LFRZ a.	£2,112,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Temporary demountable defences	To 70% of the properties (253) shown to be at risk in Coberg Gardens would benefit from demountable barriers. This would need to be linked to generic measures such as flood warning etc.	£7,075,000
Investigations		
Other Investigations	Investigate the scope of local threshold raising of properties in LFRZ a,b and c. Linked to the application of resistance and resilience measures above. (319 residential and 60 commercial properties)	**£10,000**
Ponds and wetlands	The creation of ponds in Claybury Park, in the upper drainage catchment, would help store runoff.	**£1,000**
Land management practices	The modification of land management practices in Claybury Park would help reduce runoff.	**£1,000**
	Total Costs CDA 006	**£9,263,000**

Recommended Investigations

Improved maintenance regimes will be required to ensure the surface water pathways beneath the railway are maintained free of debris. There is scope to raise doorway/ access thresholds.

The creation of ponds in Claybury Park, in the upper drainage catchment, would help store runoff.

The modification of land management practices in Claybury Park would help reduce runoff.

Assets Benefiting from Potential Solutions or Measures

There are 319 households at risk, of which 53 may experience flood depths in excess of 0.5m. There is one “essential” infrastructure element at risk of flooding to a depth in excess of 0.5m (A1400 Southend Road). There are also 60 “commercial / industrial units” at risk of which three may experience flooding of greater than 0.5m.

4.4.6 CDA 007 Barkingside, Newbury Park west and Cranbrook

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Soakaways, water butts & rainwater harvesting	Applied to the 1017 residential properties and the 144 commercial properties identified as at risk in LFRZ a, b & c	£127,000
Road side gardens: These will help alleviate water from the flow path route and ponding areas	LFRZ a - Where space is available in Forest Road and Starch House Lane.	£33,000
	LFRZ b – Where space is available in Cantley Gardens and Springfield Drive	£33,000
	LFRZ c - Where space is available in Empress Avenue	£33,000
Improved resilience and resistance measures	To 50% of the properties (581) in LFRZ a, b & c.	£12,771,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Swales: These will help alleviate water from the flow path route and ponding areas	LFRZ a - Where space is available alongside Starch House Lane and Feybridge Drive.	£2,000
	LFRZ b – Where space is available alongside Duke Road	£2,000
Temporary demountable defences	To 50% of the properties (581) in LFRZ a, b & c. Specifically those shown to be at risk in Cantley Gardens and Springfield Drive. This would need to be linked to generic measures such as flood warning etc.	£14,513,000
Investigations		
Essential Infrastructure	LFRZ a, b and c – Investigate the vulnerability of the A123 and A12.	**£2,000**

'Other' vulnerable Infrastructure	LFRZ a – Investigate the vulnerability of King Solomon School and the school and community centre of Station Road LFRZ c – Investigate the vulnerability of the school/college at the north end of Northbrook Road	**£2,000**
	Total Costs CDA 007	**£27,518,000**

Recommended Investigations

There is scope to raise doorway/ access thresholds within the LFRZ in this CDA.

The creation of ponds on the Cran Brook south of Barkingside FC grounds and within Valentines Park would help store runoff.

Other pathway measures include localised kerb raising in the vicinity of Cantley Gardens, Springfield Drive, Empress Avenue and Wanstead Park Road.

Assets Benefiting from Potential Solutions or Measures

In LFRZ a there are 189 households at risk of which 4 households have basements Of these11 may experience flooding depths in excess of 0.5m and 4 households with basements. There is one "essential" and one "highly vulnerable" infrastructure element at risk of flooding in excess of 0.5m (A123 Fencepiece Road). There are four "more vulnerable" infrastructure elements at risk, with one of these at risk of flooding in excess of 0.5m (King Solomon High School, a school and a community centre adjacent to Station Road There are 76 "commercial /industrial" units at risk, of which 10 of these may experience flooding in excess of 0.5m. Six of the assets at flood risk also have basements.

In **LFRZ b** there are 601households at risk of flooding and 247 of these may experience flooding in excess of 0.5m. Two "essential" infrastructure elements are at risk of flooding in excess of 0.5m (A123 High Street and A12). There are 45 "commercial/ Industrial" units at risk. Eight of these may experience flooding in excess of 0.5m.

In **LFRZ c** there are 227 households at risk. There are 151 "non-deprived" households which include 26 with basements. There are 76 "deprived "households which include 23 with basements. Of the "deprived" properties there are 8 of which that may experience flooding in excess of 0.5m (none with basements). Two "essential" infrastructure elements are at risk of flooding one in excess of 0.5m (A123 Cranbrook Road), whilst there is one 'more vulnerable' infrastructure elements at risk (school/college at the north end of Northbrook Road). There are 23 "commercial/ industrial" units at risk. Five of these may experience flooding in excess of 0.5m and a further four have basements.

4.4.7 CDA 008 Ilford

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Soakaways, water butts & rainwater harvesting	Applied to the 471 residential properties and 61 commercial identified as at risk in LFRZ a & b	£58,000

Road side gardens: These will help alleviate water from the flow path route and ponding areas	LFRZ a - Where space is available in Aldborough Road South and Ley Street	£33,000
	LFRZ b – Where space is available in Pelham Road	£33,000
Improved resilience and resistance measures	To 80% of the residential and commercial properties (426) in LFRZ a & b.	£9,372,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Detention Basins	The creation of detention basins adjacent to the allotments in Vicarage Lane, alongside the railway, and within South Park would help store runoff.	£110,000
Temporary demountable defences	To 40% of the properties (213) in LFRZ a & b. Specifically those shown to be at risk in the Green Lane area would benefit from demountable barriers. This would need to be linked to generic measures such as flood warning etc.	£5,325,000
Investigations		
Essential Infrastructure	LFRZ b– Investigate the vulnerability of the A118 and A1083	**£2,000**
'Other' vulnerable Infrastructure	LFRZ b – Investigate the vulnerability of the community centre on South Park Drive).	**£1,000**
Other Pathway Measures	Investigate localised kerb raising in the vicinity of Cantley Gardens, Springfield Drive, Empress Avenue and Wanstead Park Road.	**£1,000**
	Total Costs CDA 008	**£14,935,000**

Recommended Investigations

Improved maintenance regimes will be required to ensure the surface water pathways beneath the railway are maintained free of debris. Similarly there is scope to raise doorway/ access thresholds.

Other Pathway Measures include localised kerb raising in the vicinity of Cantley Gardens, Springfield Drive, Empress Avenue and Wanstead Park Road.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 181 household at risk. This includes 71 "deprived" households of which four may experience flooding in excess of 0.5m. There is one element of "essential" infrastructure at risk. There are 15 "commercial/ industrial" units at risk.

In **LFRZ b** there are 290 households at risk which includes 62 "deprived" households Of the "non-deprived" households 62 may experience flooding in excess of 0.5m., . There are two "essential" infrastructure elements of which one may experience flooding up to 0.5m (A118 High Road and A1083). There is one "highly vulnerable" infrastructure element at risk (a community centre on South Park Drive).

There are 46 “commercial/ industrial” units at risk of which 4 may experience flooding up to 0.5m.

4.4.8 CDA009 Seven Kings

Potential Solutions or Measures Summary

Generic Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Soakaways, water butts & rainwater harvesting	Applied to the 153 residential and 28 commercial properties identified as at risk in LFRZ a & b	£20,000
Road side gardens: These will help alleviate water from the flow path route and ponding areas	**LFRZ a** - Where space is available in Peregrine Road.	£33,000
	LFRZ b - Where space is available in Farnham Road and Regent Gardens.	£33,000
Improved resilience and resistance measures	To 80% of the residential properties and commercial properties (145) in LFRZ a & b.	£3,190,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Ponds and wetlands	The creation of ponds at Hainault Forest Country Park, and Seven Kings Park would help store runoff. Assume 1000 cubic metres.	£33,000
Investigations		
Essential Infrastructure	Broader CDA issues -– Investigate the vulnerability of the A12, which is outside of the LFRZs but modelling suggests it is potentially at risk. LFRZ a - Investigate the vulnerability of the A1112 Romford Road. LFRZ b - Investigate the vulnerability of the A118 High Road and the Liverpool Street to Shenfield Main Line.	**£4,000**
‘Other’ vulnerable Infrastructure	LFRZ b – Investigate the vulnerability of the two schools in Amham Road	**£2,000**
Other Investigations	Investigate the scope of local threshold raising of properties in the LFRZs. Linked to the application of resistance and resilience measures above.	**£10,000**
	Total Costs CDA 009	**£3,325,000**

Recommended Investigations

There is scope to raise doorway/ access thresholds within the LFRZ in this CDA.

Modification of the watercourse to enable Fairlop Water to accept excess flood flows from Seven Kings Water should be investigated.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 9 “deprived” households at risk. There is one “essential” (A1112 Romford Road) and one “more vulnerable” infrastructure elements at risk which may experience flooding in excess of 0.5m. There are 13 “commercial/industrial” units at risk.

In **LFRZ b** there are 149 households at risk. This includes 37 “deprived” households 29 “non-deprived” households may experience flooding in excess of 0.5m.. There are two “essential” infrastructure elements at risk which may experience flooding in excess of 0.5m (A118 High Road and Liverpool Street to Shenfield Main Line). There are two “more vulnerable” infrastructure elements at risk of which one may experience flooding in excess of 0.5m (Two schools in Amham Road). There are fifteen “commercial/industrial” units at risk of which six may experience flooding in excess of 0.5m.

4.4.9 CDA 010 Goodmayes

Joint delivery with Barking and Dagenham is required for CDA 10.

Potential Solutions or Measures Summary

Generic Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Soakaways, water butts & rainwater harvesting	Applied to the 401 residential properties and 54 commercial properties identified as at risk in LFRZ a, b & c	£50,000
Road side gardens: These will help alleviate water from the flow path route and ponding areas	LFRZ a - Where space is available in Havering Gardens, Tolworth Gardens, Portland Gardens and Chadville Gardens.	£66,000
	LFRZ b – Where space is available in Grove Road	£33,000
Improved Resistance and resilience	To 100% of the residential and commercial properties (301) in LFRZ a & c.	£6,622,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Demountable defences	To all of the properties in LFRZb. This would need to be linked to generic measures such as flood warning etc.	£3,850,000
Investigations		
Detention basins	Investigate the modification of existing ponds on the north side of the A12 and in Good Mayes park .Also consider the potential for detention basins within Goodmayes Park	£3,000
Essential Infrastructure	Broader CDA issues -– Investigate the vulnerability of the Liverpool Street to Shenfield	**£4,000**

	Main Line and A124, which is outside of the LFRZs but modelling suggests it is potentially at risk. LFRZ a - Investigate the vulnerability of the A12. LFRZ b - Investigate the vulnerability of the A118 High Road.	
'Other' vulnerable Infrastructure	LFRZ c – Investigate the vulnerability of the church on Mayesbrook Road.	**£1,000**
Other Investigations	Investigate the scope of local threshold raising of properties in Grove Road.	**£2,000**
	Total Costs CDA 010	**£10,631,000**

Recommended Investigations

Where the surface water pathway passes beneath the railway any culvert should be maintained free of debris.

Other Pathway Measures include localised kerb raising in the vicinity of Grove Road

The creation or modification of existing ponds on north side of Eastern Avenue (the A12) and in Goodmayes Park would help store runoff.

Assets Benefiting from Potential Solutions or Measures

In **LFRZ a** there are 268 households at risk of which six may experience flooding in excess of 0.5m. There is one "essential" infrastructure element at risk which may experience flooding in excess of 0.5m (A12). There are twelve "commercial/industrial" units at risk of which four may experience flooding in excess of 0.5m.

In **LFRZ b** there are 112households at risk of which 15 may experience flooding in excess of 0.5m. There are 42 "commercial/industrial" units at risk of which seven may experience flooding in excess of 0.5m. There is one "essential" infrastructure element at risk which may experience flooding in excess of 0.5m (A118 High Road)

In **LFRZ c** there are 21 households at risk. There is one "more vulnerable" infrastructure element at risk which may experience flooding in excess of 0.5m. (A Church in Mayesbrook Road).

4.4.10 CDA 020 South Woodford

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Road side gardens: These will help alleviate water from flow path routes and ponding areas	Where space is available in Maybank Avenue, Essex Road and Thorn Close	£66,000
Improved resilience and resistance measures	To 100% of the residential and commercial properties (25) in the	£550,000

	LFRZ	
Investigations		
Essential Infrastructure	LFRZ a - Investigate the vulnerability of the A113 Chigwell Road and A406 North Circular.	**£2,000**
	Total Costs CDA 020	**£618,000**

Recommended Investigations
None identified.

Assets Benefiting from Potential Solutions or Measures
There are 21households at risk and four “commercial/industrial” units at risk. There are two “essential” infrastructure elements at risk which may experience flooding in excess of 0.5m (A113 Chigwell Road and the A406 North Circular).

4.4.11 CDA 027 River Roding North

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Improved resilience and resistance measures	To 100% of the residential and commercial properties (154) in all three the LFRZs	£3,388,000
Essential Infrastructure	LFRZ a - Investigate the vulnerability of the A113 Chigwell Road and A406 North Circular.	£2,000
	Total Costs CDA 027	**£3,390,000**

Recommended Investigations
Investigate the vulnerability of the A113 Chigwell Road and A406 North Circular. There are two “essential” infrastructure elements at risk which may experience flooding in excess of 0.5m (A113 Chigwell Road and the A406 North Circular) in LFRZ a and b.

Assets Benefiting from Potential Solutions or Measures
In **LFRZ a** there are 31 households at risk of which three may experience flooding in excess of 0.5m. One of the residential properties has a basement. There are 19 “commercial/industrial” units at risk of which two have basements at risk. 5 of which may experience flooding to greater than 0.5m. There is one “critical” element at risk (A406 North Circular).

In **LFRZ b** there are 89 households at risk of which one may experience flooding in excess of 0.5m. Two of the residential properties have basements. There are three “commercial/industrial” units at risk one of which may experience flooding to greater than 0.5m. There is one “critical” element at risk (A113 Chigwell Road).

In **LFRZ c** there are 12 households at risk.
There are no critical identified receptors in this LFRZ.

4.4.12 CDA 028 Gants Hill

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Road side gardens: These will help alleviate water from flow path routes and ponding areas	Where space is available in Clarence Avenue, The Crescent, Beehive Lane, Redbridge Lane East and Longwood Gardens.	£33,000
Improved resilience and resistance measures	To 100% of the 61 residential and 6 commercial properties in the LFRZ	£1,474,000
Other Investigations	Investigation into the creation or modification of the existing lake in Valentines Park would help store runoff.	£1,000
	Total Costs CDA 028	**£1,508,000**

Recommended Investigations

The creation or modification of the existing lake in Valentines Park would help store runoff.

Assets Benefiting from Potential Solutions or Measures

There are 61households at risk of which six may experience flooding in excess of 0.5m. Four of these households have basements of which one may experience flooding in excess of 0.5m. There is one “critical” (A123 Cranbrook Road) and one “more vulnerable” (a church on Clarence Avenue) infrastructure elements at risk. There are six “commercial/industrial” units at risk.

4.4.13 CDA 029 River Roding South

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Improved resilience and resistance measures	To 100% of the 79 residential and 53 commercial properties in the LFRZ	£2,904,000
	Total Costs CDA029	**£2,904,000**

Recommended Investigations

None identified.

Assets Benefiting from Potential Solutions or Measures

There are 79 households at risk which includes 34 “deprived” households. There is one “essential” infrastructure element at risk which may experience flooding in excess of 0.5m (the A406 North Circular) and two “more vulnerable”. There are 53 “commercial/industrial” units at risk 4 of which may experience flooding in excess of 0.5m.

4.4.14 CDA 031 Aldersbrook

Potential Solutions or Measures Summary

Generic Measures	Source/Pathway/Receptor	Indicative Cost
Soakaways, water butts & rainwater harvesting	Applied to the 66 residential and 18 commercial properties identified as at risk in the LFRZ	£9,000
Road side gardens: These will help alleviate water from the flow path route and ponding areas	Where space is available in Belgrave Road, Brading Crescent, Dover Road, Herongate Road, St Margarets Road and Merlin Road.	£33,000
Improved resilience and resistance measures	Applied to the 66 residential and 18 commercial properties identified as at risk in the LFRZ	£1,848,000
Specific Measures	**Source/Pathway/Receptor**	**Indicative Cost**
Swales	A swale alongside Belgrave Road will help intersect surface water from Wanstead Flats, subject to available space.	£2,000
Ponds and wetlands	Investigate the modification of the ponds here would help divert and store runoff that continues east to collect in the City of London Cemetery.	1,000
	Total Costs CDA 031	**£1,893,000**

Recommended Investigations

A surface water flow path runs through Wanstead Flats. The modification of the ponds here would help divert and store runoff that continues east to collect in the City of London Cemetery.

Assets Benefiting from Potential Solutions or Measures

There are 66 households at risk of which one has a basement at risk. There are 18 “commercial/industrial” units at risk, of which 3 may experience flooding in excess of 0.5m.

4.5 Potential Solutions or Measures Summary

A summary table of the percentage of surface water flood risk, eliminated or mitigated by the preferred option, is provided in **Table 4.2** below.

A capital cost banding, derived from the Prioritisation Matrix, is also provided to indicate the investment required to achieve the eliminated/mitigated benefits.

The full prioritisation matrix and summary benefits sheets are included in **Appendix E** – Options Assessment.

CDA ID	Scheme Location	Scheme Category	Infrastructure						Households				Commercial / Industrial		Capital Cost Band
			Essential		Highly Vulnerable		More Vulnerable		Non-Deprived (All)		Deprived (All)		All		
			Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	
Group5_001	Woodford Wells	Other or combination of above	0%	0%	0%	0%	0%	0%	20%	20%	0%	0%	0%	0%	501k - 1m
Group5_002	Woodford Green	Other or combination of above	100%	0%	0%	0%	0%	0%	70%	0%	0%	0%	0%	0%	1m - 10m
Group5_003	Woodford Green South	Other or combination of above	100%	0%	0%	0%	0%	0%	50%	10%	80%	20%	0%	0%	1m - 10m
Group5_004	Snaresbrook	Other or combination of above	50%	50%	0%	0%	0%	0%	40%	10%	0%	0%	40%	0%	1m - 10m
Group5_006	Clayhall	Other or combination of above	0%	100%	0%	0%	0%	0%	60%	10%	0%	0%	90%	0%	1m - 10m
Group5_007	Barkingside, Newbury Park West and Cranbrook	Other or combination of above	50%	50%	30%	0%	40%	10%	40%	20%	70%	10%	60%	10%	> 10m
Group5_008	Ilford	Other or combination of above	0%	100%	10%	0%	0%	0%	10%	0%	20%	0%	10%	0%	> 10m
Group5_009	Seven Kings Water	Other or combination of above	0%	30%	0%	0%	20%	10%	10%	0%	30%	0%	10%	10%	1m - 10m
Group5_010	Goodmayes	Other or combination of above	30%	30%	0%	0%	0%	0%	30%	0%	0%	0%	30%	0%	> 10m
Group5_020	South Woodford	Other or combination of above	0%	50%	0%	0%	0%	0%	10%	0%	0%	0%	10%	0%	1m - 10m
Group5_027	River Roding North	Other or combination of above	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%	60%	0%	501k - 1m
Group5_028	Gants Hill	Other or combination of above	0%	0%	0%	0%	50%	0%	10%	0%	0%	0%	10%	0%	1m - 10m
Group5_029	River Roding South	Other or combination of above	0%	0%	50%	0%	70%	0%	40%	0%	10%	0%	70%	0%	1m - 10m
Group5_031	Aldersbrook	Other or combination of above	0%	0%	0%	0%	0%	0%	80%	0%	0%	0%	10%	0%	1m - 10m
Group5_041	Chingford Hatch	Other or combination of above	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	< 25k

Table 4.2 Preferred Options Summary table- Eliminated and Mitigated Risk

4.6 Option Prioritisation

A Prioritisation Matrix was developed out of the need for a robust, simple and transparent methodology to prioritise the allocation of funding for surface water management schemes across the 33 London Boroughs by the Drain London Programme Board. As such, the prioritisation should be understood in the high-level decision-making context it was designed for. It is not intended to constitute a detailed cost-benefit analysis of individual surface water flood alleviation schemes.

The final prioritisation matrix will be circulated by the Drain London Board during 2011.

5 Phase 4: Implementation and Review

5.1 Action Plan

The Action Plan (included as a spreadsheet in **Appendix I**) collates all information undertaken in the first three phases of this SWMP study and:

- Outlines the actions required to implement the preferred options, where and how they should be undertaken;
- Sets out which partner or stakeholder is responsible for implementing the actions and who will support them;
- Estimates how much the options will cost and who will provide the funding;
- Prioritises actions and sets out a timeline for delivery;
- Links actions to other existing Action Plans within the Borough and neighbouring Boroughs as well as flagging up actions that are related to European legislation.

Table 5.1 outlines the Action Types used to categorise actions in the Action Plan:

Flood and Water Management Act / Flood Risk Regulations (FWMA / FRR)	Duties and actions as required by the FRR and FWMA - Refer to Appendix A of the LGG 'Preliminary Framework to assist the development of the Local Strategy for Flood Risk Management' (February 2011) for minimum requirements
Policy Action (Policy)	Spatial planning or development control actions
Communication / Partnerships (C+M)	Actions to communicate risk internally or externally to LLFA or create / improve flood risk related partnerships
Financial / Resourcing (F+R)	Actions to secure funding internally / externally to support works or additional resources to deliver actions
Investigation / Feasibility / Design (I/F/D)	Further investigation / feasibility study / Design of mitigation
Flooding Mitigation Action (FMA)	Maintenance or capital works undertaken to mitigate flood risk

Table 5.1 Action Types in the Action Plan

The action plan is generally split into two key themes, those actions that are CDA specific and those that are more generic and apply across the Borough or across multiple CDAs, these actions are then categorised by type as shown in Table 5.1.

CDA specific actions, once taken forward, will result in the mitigation/management or further investigation of local flood risk issues identified on a Local Flood Risk Zone basis.

Generic actions address aspects of the FWMA2010 or FRR2009 and the broader role of the Borough as LLFA in its widest sense.

5.1.1 Summary of Key Actions

Specific Actions

Adopting the 'Source, Pathway and Receptor' model, the CDA specific actions look to provide potential solutions to address the main risks in each LFRZ.

Source measures, on a 'property-by-property' basis, will provide limited benefit without collective application. In section 4.3 the use of Soakaways, Water Butts and Rain Harvesting has been recommended in a number of CDAs and LFRZs, however specific actions have not been identified in each CDA, as their application, maintenance and on-going monitoring will require a broader policy position to be taken before they can provide a meaningful local measure.

Pathway measures, including the use of Rain Gardens /Highway Management, Detention Ponds and Ponds and Wetlands are all considered to offer significant benefit. In some areas they offer 'quick win' solutions, particularly where land is owned by the Borough or where Highway Maintenance programmes facilitate opportunities. Investigations of culvert capacity particularly under railway embankments, is key in ensuring the risk identified in the modeling is truly representative. There are also opportunities to review existing storage capacity in some areas.

Receptor measures, such as the use of Resistance and Resilience and De-Mountable Barriers offer significant opportunity to limit the impact of flooding on built assets. In both cases the appropriateness of each measure to individual property requires investigation. Where it is believed these measures offer the best solution specific actions have been identified.

Generic Actions

Generic actions have been devised to address the longer-term institutional arrangements required to manage local flood risk in the Borough. These actions tackle aspects such as Policy on the use of SuDS, Coordinated Engagement and Communication of Risk with the public, professional partners and internal Borough functions. Other actions specifically include aspects of the formal responsibilities given to LLFAs under the FWMA2010, such as the development of asset registers and establishing a common baseline for recording and storing flood data.

5.2 Implementation Programme

An implementation programme based on the action plan is provided as **Appendix K**

5.3 Review Timeframe and Responsibilities

The FRR 2009 requires the review of the PFRA, Risk and Hazard Maps and Local Flood Risk Management Strategy/Plan on a 6 year cycle, or more frequently as outlined in section 5.4. This SWMP forms an important baseline for these

documents and should be updated to inform the review requirements of the FRR 2009 as a minimum.

High priority actions identified in the 'Action Plan' are likely to be those addressed first. This will result in the need for detailed local study, applications for funding and the implementation of solutions on the ground, all of which have the potential to change the findings and recommendations of this report.

It is recommended that an annual review of the High and Medium Priority actions is undertaken. This will allow for forward financial planning inline with external partners and internal budget allocations. Low priority actions should be reviewed on a three year cycle.

5.4 Ongoing Monitoring

The partnership arrangements established as part of the SWMP process (e.g., LB of Redbridge, EA and TWUL working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

The SWMP Action Plan should be reviewed and updated once every six years as a minimum, but there may be circumstances which might trigger a review and/or an update of the action plan in the interim, for example:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, **which may alter the understanding of risk within the study area**;
- Outcome of investment decisions by partners is different to the preferred option, which may require a revision to the action plan, and;
- Additional (**major**) development or other changes in the catchment which may affect the surface water flood risk.

The action plan should act as a live document that is updated and amended on a regular basis, such that it can form the basis of the FRR2009 'Local Flood Risk Management Strategy/Plan', required by December 2015.

Local Flood Risk management Strategy/Plan

It is anticipated that Drain London will circulate an addendum to this report that will provide guidance on converting the Action Plan from this SWMP into the Local Flood Risk management Strategy/Plan required, by the FRR 2009, by December 2015.

References

Cabinet Office, 2008. *The Pitt Review: Learning lessons from the 2007 floods*,

Defra, 2005. *Making Space for Water: Taking forward a new Government strategy for flood and coastal erosion risk management in England*, London: Defra.

Defra, 2010. *Surface Water Management Plan Technical Guidance*, London: Defra.

Appendix A: Data Review

Appendix B: Asset Register Recommendation

Appendix C: Risk Assessment – Technical Details

Appendix C consists of the following subsections:

- **C1 – Surface Water Modelling**
- **C2 – Groundwater**

C1 Surface Water Modelling

See PDF file Appendix C1

C2 Groundwater

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 C2.1** have been utilised to produce the increased Potential for Elevated Groundwater map. 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 were used as this was judged to best represent the hazard.

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 C2.1 National groundwater datasets

The techniques used to generate the iPEG map produced some small areas of increased potential and some dry islands within increased potential areas. These have not been cleaned in order to best represent the original data.

How to Use and Interpret the Map

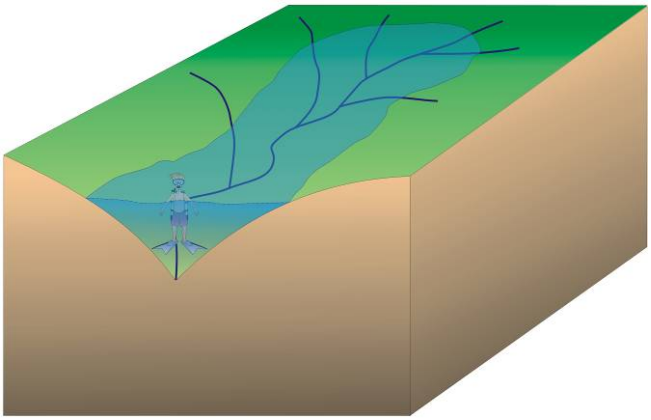
The increased Potential for Elevated Groundwater map shows those areas within the Borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface.

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 C2.2**.



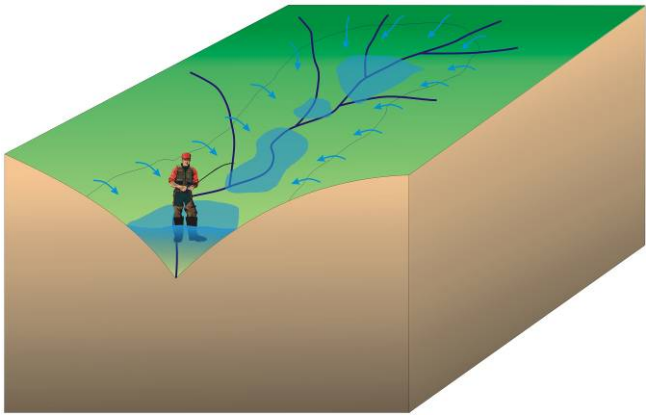


Figure C2.2 Cartoon illustrating the difference between fluvial (top image) and groundwater (bottom image) flood mapping

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.

Appendix D: Maps

The following maps are referenced as Figures in the text of this SWMP report	
Figure 1.0	Critical Drainage Area Index Map (in Executive Summary)
Figure 1.5	LIDAR Topographic Survey
Figure 1.6	Land Use Areas
Figure 1.7	Environmental Areas
Figure 3.1	Environment Agency Flood Map
Figure 3.2	Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure 3.3	Increased Potential for Elevated Groundwater map
Figure 3.4	Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_001.1	**Woodford Wells** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_001.2	**Woodford Wells** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_001.3	**Woodford Wells** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_002.1	**Woodford Green** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_002.2	**Woodford Green** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_002.3	**Woodford Green** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_003.1	**Woodford Green South** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_003.2	**Woodford Green South** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_003.3	**Woodford Green South** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_004.1	**Snaresbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_004.2	**Snaresbrook** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_004.3	**Snaresbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_006.1	**Clayhill** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_006.2	**Clayhill** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_006.3	**Clayhill** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_007.1	Barkingside, Newbury Park West and **Cranbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_007.2	Barkingside, Newbury Park West and **Cranbrook** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

Figure Group5_007.3	Barkingside, Newbury Park West and **Cranbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_008.1	**Ilford** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_008.2	**Ilford** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_008.3	**Ilford** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_009.1	**Seven Kings** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_009.2	**Seven Kings** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_009.3	**Seven Kings** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_010.1	**Goodmayes** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) **– also in Barking & Dagenham SWMP**
Figure Group5_010.2	**Goodmayes** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP) **– also in Barking & Dagenham SWMP**
Figure Group5_010.3	**Goodmayes** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations **– also in Barking & Dagenham SWMP**
Figure Group5_020.1	**South Woodford** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_020.2	**South Woodford** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_020.3	**South Woodford** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_027.1	River Roding North Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_027.2	River Roding North Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_027.3	River Roding North Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_028.1	**Gants Hill** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_028.2	**Gants Hill** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_028.3	**Gants Hill** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_029.1	River Roding South Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_029.2	River Roding South Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_029.3	River Roding South Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations
Figure Group5_031.1	**Aldersbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_031.2	**Aldersbrook** Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
Figure Group5_031.3	**Aldersbrook** Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) showing historic flooding, key receptors and LFRZ locations

The following additional maps have been produced to supplement the Figures listed above	
D.1	Environment Agency Flood Map for Surface Water 1 in 30 Chance of rainfall event occurring in any given year (3.33% AEP)
D.2	Environment Agency Flood Map for Surface Water 1 in 200 Chance of rainfall event occurring in any given year (0.5% AEP)
D.3	1 in 100 year rainfall event depth grid + Recorded Surface Water Flood Incidents 1 in 100 Chance of rainfall event occurring in any given year (1% AEP)
D.4	Thames Water Sewer Network
D.5	Recorded Incidents of Sewer Flooding
D.6	Infiltration SUDS Suitability Map
D.7	Geological Map - Bedrock
D.8	Geological Map - Superficial
D.9	Surface Water Depth (m) 1 in 30 Chance of rainfall event occurring in any given year (3.33% AEP)
D.10	Surface Water Depth (m) 1 in 75 Chance of rainfall event occurring in any given year (1.33% AEP)
D.11	Surface Water Depth (m) 1 in 100 Chance of rainfall event occurring in any given year plus an allowance for climate change
D.12	Surface Water Depth (m) 1 in 200 Chance of rainfall event occurring in any given year (0.5% AEP)
D.13	Surface Water Flood Hazard Rating 1 in 30 Chance of rainfall event occurring in any given year (3.33% AEP)
D.14	Surface Water Flood Hazard Rating 1 in 75 Chance of rainfall event occurring in any given year (1.33% AEP)
D.15	Surface Water Flood Hazard Rating 1 in 100 Chance of rainfall event occurring in any given year plus an allowance for climate change
D.16	Surface Water Flood Hazard Rating 1 in 200 Chance of rainfall event occurring in any given year (0.5% AEP)
D.17	Environment Agency Flood Map and Fluvial Flooding Incidents
D.18	Time to Peak for 3 hour rainfall event (1 in 100 chance of rainfall event occurring in any given year) – In Support of **Appendix H**

Appendix E: Option Assessment Details

Appendix E is included on the accompanying DVD

Appendix F: Peer Review

Appendix F is included on the accompanying DVD

Appendix G: Spatial Planner Information Pack

Background

PPS 25 sets out national planning guidance for development in relation to flood risk. It takes a risk based approach and categorises land uses into different vulnerabilities, which are appropriate to different flood zones.

PPS 25 applies to all forms of flood risk, however, surface water, groundwater and ordinary watercourse flood risks are generally less well understood than fluvial or coastal flood risk. In part this is due to the much faster response times of surface water flooding, a perception that the impacts are relatively minor and the highly variable nature of influences, e.g. storm patterns, local drainage blockages, interactions with the sewer system.

However climate change models are predicting more frequent heavy storms and there is emerging evidence that this is already happening. It is also clear from the flooding that occurred in several parts of England in summer 2007 that surface water flooding can have major impacts. In the heavily urbanised area of London, the risks are significant and it is important that appropriate consideration is given to these risks when new development is proposed.

The planning system is a key tool in reducing flood risk, and with this additional information, this can apply to the surface water risk as well as fluvial and tidal risk.

Since April 2011, London Boroughs have been given the roles of Lead Local Flood Authorities (LLFAs) by the Flood and Water Management Act 2010. This means that each borough has new duties. The Planning Department has an important role to play in delivering these new duties and must ensure that it forms part of authority wide co-ordination of the LLFA role.

Whilst this document is titled a SWMP, it also identifies flood risk at ordinary watercourses and has been adapted to include consideration of groundwater flood risk through the identification of a map showing “Increased Potential for Elevated Groundwater (IPEG).

The Greater London Authority will examine the 33 SWMPs across London to update the Regional Flood Risk Appraisal during 2012.

Using the SWMP to update the borough SFRA

Most borough SFRAs have little or no historic analysis of surface water, groundwater and ordinary watercourse flood risk.

The mapping within this SWMP, as referenced in appendix D, shows some areas that are vulnerable to extensive deep accumulations of water (>0.5m), these area have a high certainty of flooding during extreme storms and the damage occurring is likely to be significant. The mapping also shows some small areas of potentially deep (>0.5m), these area may have particular risks associated with them, but may also occur due to irregularities in mapping and modelling. The mapping also shows areas shallower flooding (<0.5m), some isolated and some more extensive flooding. Maps show general flow directions and approximate velocities (in the form of

'hazard' maps) as even relatively shallow water flowing a high velocities can be a threat to life and can cause damage.

For most boroughs the production of this SWMP will be a significant addition of new/updated data. Therefore, in due course, this should trigger a review of the SFRA. The SFRA should consider these risks in the following ways:

- Large areas of deep (>0.5m) flooding should be shown as Local Flood Risk Zones, unless there is evidence to suggest that these risk have been mitigated, for example by high capacity drainage or pumping infrastructure.
- Small, isolated areas of deep (>0.5m) flooding should be investigated to determine how likely they are to be at flood risk but do not need to be shown if there is no significant risk.
- Large areas of shallower flooding should be identified as Local Flood Risk Zones if they pose a significant risk, but do not need to be shown if the risks are relatively minor.
- Smaller isolated areas of shallower flooding should generally not be identified as Local Flood Risk Zones, unless there is a particular significant risk associated with that area, as it must be expected that most areas will be affected to some extent by rainwater.
- Routes of fast flowing water may be considered as Local Flood Risk Zones if they pose a significant risk.
- Areas of Increased Potential for Elevated Groundwater, should be shown where they are likely to pose a significant risk of flooding or where they are likely to affect the nature of future development, especially for the design and use of sub-surface spaces.

Identifying an area as a Local Flood Risk Zone, should mean that it is then be treated in a similar way to Environment Agency Flood Zone 3, namely that a Flood Risk Assessment is required and measures should be taken to reduce the likelihood and impact of any flooding.

Where a Critical Drainage Area contributes significant amounts of surface water to a Local Flood Risk Zone, the SFRA should identify this and suggest strict application of sustainable drainage measures in line with the London Plan Sustainable Drainage Hierarchy.

Using the SWMP to update policies in Development Plan Documents

Ideally the review of the borough SFRA should be a pre-cursor to any significant change to the Core Strategy and development control policies. Therefore reference to the SFRA should automatically update the approach to local flood risks. Where the SFRA has not been updated, the review of Development Plan Documents should consider the same steps outlined above for the SFRA review.

Using the SWMP to influence major areas of redevelopment

Where major development areas are proposed, either in the London Plan or within the Core Strategy DPD, these should be examined for:

- Local Flood Risk Zones that affects the area
- Increased Potential for Elevated Groundwater
- Contribution of run-off to Local Flood Risk Zones beyond the actual redevelopment area.

Given the large scale of major developments, it is unlikely that the Local Flood Risk would prevent redevelopment taking place, but it may affect the location, uses, design and resilience of the proposals. Therefore, a Flood Risk Assessment needs to be undertaken and it should consider:

- the location of different types of land use within the site(s)
- the layout and design of buildings and spaces to take account of flood risk, for example by dedicating particular flow routes or flood storage areas
- measures to reduce the impact of any flood, through flood resistance/resilience measures/materials
- incorporating sustainable drainage and rainwater storage to reduce run-off to adjacent areas
- linkages or joint approaches for groups of sites, possibly including those in surrounding areas

Using the SWMP to influence specific development proposals

Where development is proposed in an area covered wholly or partially by a Local Flood Risk Zone, this should trigger a Flood Risk Assessment, as already required under PPS25.

Whilst some small scale developments may not be appropriate in high risk areas, in most cases it will be a matter of ensuring that the Flood Risk Assessment consider those items listed under major developments above and also considers some or all of the following site specific issues:

- Are the flow paths and areas of ponding correct, and will these be altered by the proposed development?
- Has the site been planned sequentially to keep major surface water flow paths clear?
- Has exceedance of the site's drainage capacity been adequately dealt with? Where will exceedance flows run off the site?
- Could there be benefits to existing properties at risk downstream of the site if additional storage could be provided on the site?
- In the event of surface water flooding to the site, have safe access to / egress from the site been adequately considered.
- Have the site levels been altered, or will they be altered during development? Consider how this will impact surface water flood risk on the site and to adjacent areas.
- Have inter-dependencies between utilities and the development been considered? (for example, the electricity supply for building lifts or water pumps)

Specific Locational Considerations

Within the London Borough of Redbridge, the following major redevelopment areas have already been identified.

- **Ilford Opportunity Area:** affects the London Borough of Redbridge.

Mapping Checklist

The table below indicates the SWMP maps which are of potential use to spatial planning, and indicates which maps may be suitable for replacing existing SFRA maps:

Issue	SWMP maps	Consider replacing existing SFRA maps?
Surface water flood risk	Figures 3.1 – 3.4 Maps D.9 – D.16	Yes – more detailed methodology to that used for the SFRA.
Increased potential for elevated groundwater	Figure 3.3	Yes – more detailed methodology to that used for the SFRA.
Infiltration SUDs suitability map	Map D.6	Yes – provides a consistent initial infiltration SUDs screening process for all London Boroughs, but does not replace on-site assessments.
Recorded incidents of sewer flooding	Map D.5	Yes – similar method (based on postcode sector) but brings the records up-to-date to June 2010.

Table G1 SWMP maps of potential use to spatial planners

Appendix H: Resilience Forum and Emergency Planner Information Pack

Background

Presently, surface water flooding is less well understood than other sources of flooding, partly because surface water events tend to happen and disperse quickly meaning that there is a lack of accurate and consistent records and partly because they are not tied to readily identifiable features such as rivers or the sea. Therefore this SWMP offers an opportunity to communicate up to date information about locations at risk from surface water flooding to those with an interest. Responses in an emergency will be informed by known surface water flooding locations, especially near public buildings and major transport routes and important infrastructure.

The purpose of this information pack is to assist in communicating surface water flood risk to the London Local Resilience Forum, and Emergency Planners within the London Resilience Partnership to enable them to ensure that incident management plans are updated based on the improved understanding of surface water flooding. SWMP mapping outputs and knowledge will be used to:

- Update Community Risk Registers (CRR);
- Update Multi-Agency Flood Plans (MAFP).

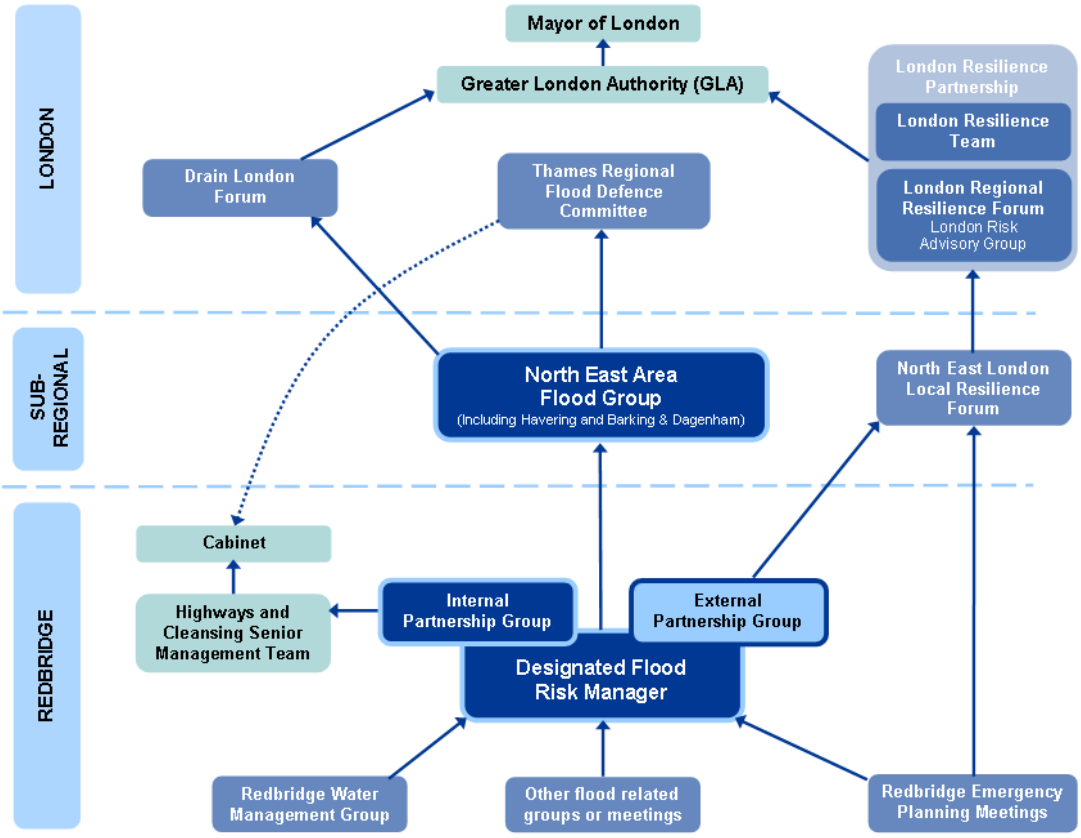
This pack is presented as a Frequently Asked Questions (FAQ) document and contains information that addresses the following points:

1. How can SWMP outputs improve Community Risk Registers?
2. How can SWMP outputs improve Multi-Agency Flood Planning?
3. How do SWMP outputs compliment the Flood Forecasting Centre's Extreme Rainfall Alert (ERA)?
4. Examples of Good Practice

In updating Multi-Agency Flood Plans, as well as the neighbouring boroughs of Havering and Barking and Dagenham, Redbridge 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. This should include appropriate aspects for Surface Water Flood Risk Management.

In order to assist with this, as part of the Preliminary Flood Risk Assessment (PFRA) process, Redbridge has identified a number of groups, committees and forums both internally within the Borough and across the different partner organisations, and set up a **Designated Flood Risk Manager role** (which oversees internal and external partnership groups) to be the overarching flood lead for Redbridge and to centralise current work.

The overall partnership structure (which is shown below), and how the Designated Flood Risk Manager role fits within the context of existing regional and London-wide flood-related groups, is detailed in **Appendix J** of the SWMP.



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 the PFRA and SWMP 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.

1. How can SWMP outputs improve Community Risk Registers?

Community Risk Registers (CRR) are prepared by Category 1 responders and are required as part of the Civil Contingencies Act (CCA) 2004. The CCA requires that Category 1 responders undertake risk assessments and maintain these risks in a CCR. In this context risks are defined as events which could result in major consequences, and they include risks from flooding.

Outputs from SWMP can be used to reduce the uncertainties associated with assessing the likelihood and impact of surface water flooding (see Community Risk Register HL18 for more information on current risk assessment). SWMP presents an opportunity for the identification of vulnerable sites and populations which may be at increased risk, and allows for risk-based prevention or mitigation actions to be taken.

2. How can SWMP outputs improve Multi-Agency Flood Plans?

Multi-Agency Flood Plans (MAFP) are specific emergency plans which should be developed by LRFs, to deliver a coordinated plan to respond to flood incidents. MAFPs recognise the need for specific flooding emergency plans, due to the complex nature of flooding and the consequences that arise. Guidance on producing a MAFP is available at http://www.ukresilience.gov.uk/media/ukresilience/assets/flooding_ma_planning_guidance_0208.pdf.

Outputs from SWMPs should inform the development of, or update, the MAFP.

The SWMP surface water mapping should be used as an initial indicator of a possible risk. A Flood Risk Assessment at a site shown as being at risk of surface water flooding should consider:

- Impacts on flood receptor sites
- The degree of receptor vulnerability
- In the event of surface water flooding to the site, has safe access to / egress from the site been adequately considered?

The table below indicates the SWMP maps which are of potential use to emergency planning, and indicates which maps may be suitable for updating existing MAFP maps:

Issue	SWMP maps	Consider updating existing MAFP maps?
Surface water flood risk	Figures 3.1 – 3.4 Maps D.9 – D.16	Yes – more detailed methodology to that used for the MAFP.
Increased potential for elevated groundwater	Figure 3.3	Yes – more detailed methodology to that used for the MAFP.

Table H1 SWMP maps of potential use to emergency planners

3. How do SWMP outputs compliment the Flood Forecasting Centre's Extreme Rainfall Alert (ERA)?

In 2008 the Met Office and the Environment Agency set up the Flood Forecasting Centre to provide services to emergency and professional partners. The Flood Forecasting Centre provides an Extreme Rainfall Alert (ERA) service to Category 1 and Category 2 responders. The ERA is issued at county level and is used to forecast and warn for extreme rainfall that could lead to surface water flooding, particularly in urban areas. It is designed to help local response organisations manage the impact of flooding via two products:

1. Guidance – issued when there is a 10% or greater chance or extreme rainfall;
2. Alert – issued when there is a greater than 20% chance of extreme rainfall.

The ERA cannot provide site-specific real-time surface water flood forecast, but does offer a county level alert of impending rainfall. The alert is based on the probability of rainfall occurring, rather than being a definitive forecast.

Surface water flooding has very short lead times and is hard to predict in real time because local topography and drainage infrastructure affect the direction of runoff and location of flooding. However, the assessment carried out as part of this SWMP study has taken an important step towards the likely flow pathways and locations of ponding of surface water. Used in parallel with the ERA, this can be used to improve emergency planning and responses for surface water flooding events.

4. Examples of Good Practice for Emergency Planners

- **Ensure that a programme of engagement on flood risk awareness is initiated within the Borough.** Meet with key corporate communications teams to agree an approach to social change, education and awareness raising inline with the needs of the Borough.

- **Build trust -** Public and stakeholder trust in authorities through **long term, transparent engagement.**

    - Ensure there are key messages that encourage attitude and behaviour change with the public. This will help to address misconceptions that flooding results from a failure on someone's part.

    - Educate the public to help them better understand where responsibilities lie, changes they can make to their own lifestyles, and actions they can take to physically reduce personal flood risk.

    - Encourage communities towards creating their own community action/response plans to support wider ownership of risk and responsibilities

    - Consider holding face to face interviews with at -risk families and groups to better inform your Community Risk Register. This will help both you and them to better understand risk and plan to manage it.

- Establish a **common baseline for flood data** and information in line with EA requirements. Set up a Borough '**One-Stop Shop'** to enable efficient information consolidation and data sharing. This will support efficient planning and updating of the MAFP.

- **Develop a surface water flooding response plan with vulnerable receptors as external partners**. Vulnerable receptors could include hospitals, schools and care homes. Identify these through Emergency Planning and other relevant forums and build into stakeholder engagement. This will assist with prioritisation decisions. For example 'early warning' processes, appropriate measures, funding and resourcing.

- Link the actions from the SWMP directly to the **Flood Risk Management Strategy** for the Borough such that a programme of work is visible.

- Link with the Planning Department's **Strategic Flood Risk Assessment** (SRFA) to ensure that Emergency Planners are involved in land use decisions for new development.

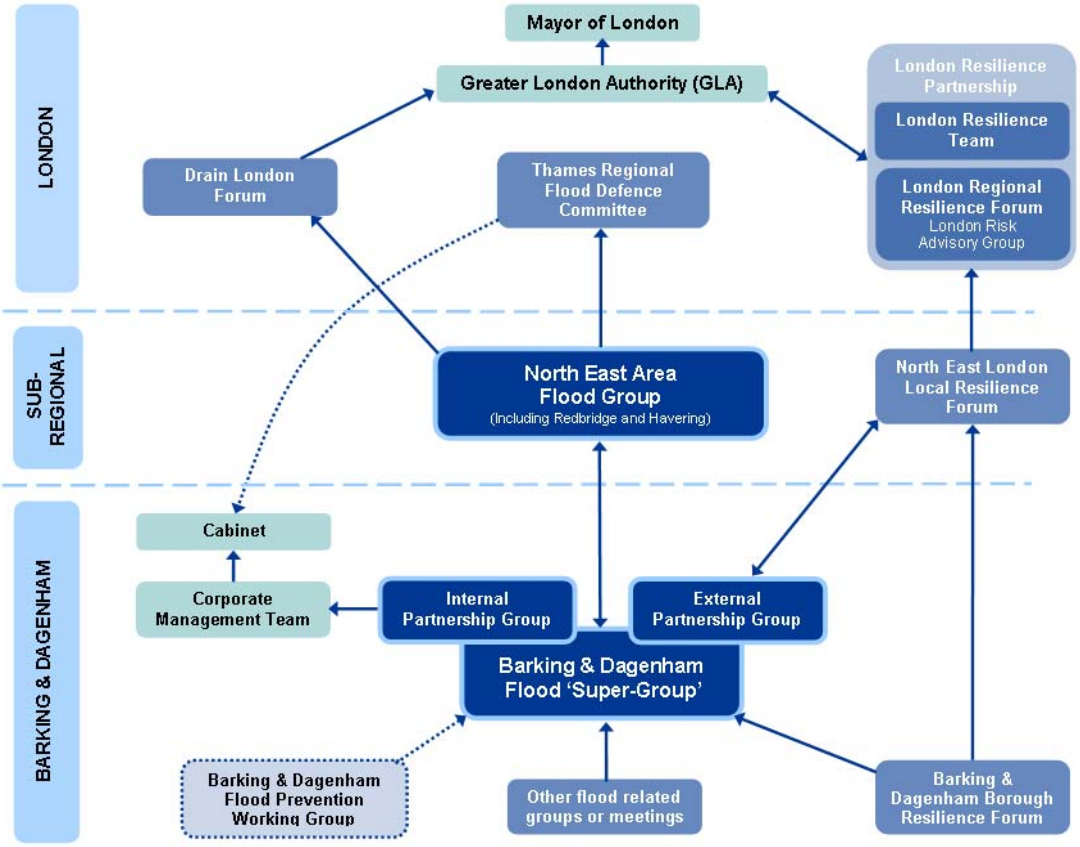
- Create a key facts and 'what to do' section for surface water flooding in **emergency handbooks**. Provide easy- to- reach contact points, and regularly update your website

- Work with other agencies, such as the **Environment Agency flood alert/warning schemes**, in the interests of cost effectiveness and good communication - but still own the responsibility for your borough. Use others' information to reinforce your own process.

Appendix I: Action Plan

The full Action Plan is included in Appendix I on the accompanying DVD.

Appendix J: 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 laws under GLA.

Barking & Dagenham Flood 'Super-Group'

Led by Barking & Dagenham, this Flood 'Super-Group' was set up to consolidate the existing flood related groups, meetings and committees across the Borough (e.g. the Barking & Dagenham Flood Prevention Working Group) and partner organisations, and to act as the central local level hub of the partnership structure. The 'Super-Group' consists of separate Internal and External Partnership Groups; Barking & Dagenham 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 'Super-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 'Super-Group' is responsible for driving the communication of risk to stakeholders and the public by producing and disseminating literature and undertaking communication and engagement events

and activities as appropriate (such as public information, community plans, flood exercises and planning advice). The Barking & Dagenham Borough Resilience Forum will feed outputs and knowledge into the Flood 'Super-Group'.

Internal Partnership Group – includes representatives from Streetcare (e.g. highways and drainage), Development and Building Control (e.g. emergency and spatial planning), Parks, Regeneration, Culture and Leisure, Insurance and Communications. The Internal Partnership Group meets as often as required in addition to the regular quarterly 'Super-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 'Super-Group' format as appropriate. The Internal Group reports to the Barking & Dagenham 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, London Transport, Highways Agency, London Fire Brigade and Transport for London. The External Partnership Group meet quarterly as part of the Flood 'Super-Group' and occasionally additionally attend Internal Group meetings, or separate individual meetings, as requested by Barking & Dagenham.

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 Barking & Dagenham's Flood 'Super-Group' and the equivalent local level groups within Redbridge and Havering. 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. 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.

Barking & Dagenham Borough Resilience Forum

Barking & Dagenham Borough Resilience Forum, which meets quarterly, 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 Regional 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 Regional Resilience Forum (of which the London Risk Advisory Group is a sub-group) and the London Resilience Team.

London Regional Resilience Forum - the London Regional 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 Regional 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 Regional 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 programme 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 programme 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.

Barking & Dagenham Flood Prevention Working Group (potentially to be subsumed into the Barking & Dagenham Flood 'Super-Group')

The Barking & Dagenham Flood Prevention Working Group works to assess and mitigate all known flood risk areas in the Borough. The group, which meets quarterly, consists of representatives from Planning, Parks, Asset Management, Civil Contingencies, Customer Services, Transport, Environmental and Enforcement departments. In light of recent LLFA responsibilities under FRR requirements, this group now operates as part of the Internal Partnership Group of the Redbridge Flood 'Super-Group'.

Appendix K: Implementation Programme