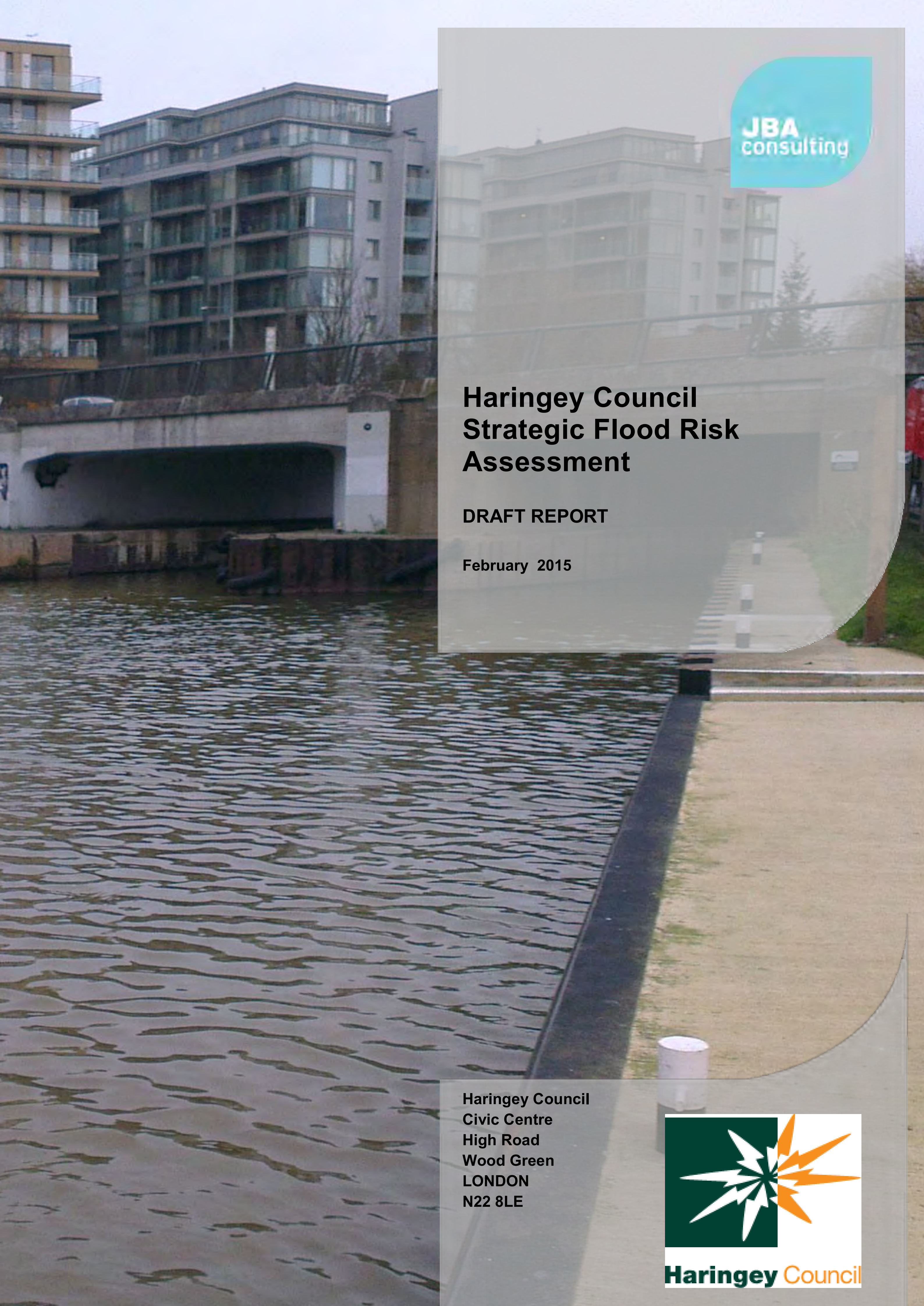

Haringey Council Strategic Flood Risk Assessment

DRAFT REPORT

February 2015

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1 Chapters 1 & 2		Jane Mulcahey, London Borough of Haringey
Draft v2 Chapters 1,2,3, 6& 7		Jane Mulcahey, London Borough of Haringey
V3 Draft	Full Report with initial comments	Jane Mulcahey, London Borough of Haringey
V4 Final	Full Report	Jane Mulcahey, London Borough of Haringey
V5 revised (Feb 2015) Draft	Additional site and new flood risk mapping	Gavin Ball, London Borough of Haringey

Contract

This Level 2 Strategic Flood Risk Assessment (SFRA) is commissioned by Haringey Council. This document has been prepared by JBA Consulting in response to the Level 2 SFRA commission awarded by Haringey Council, in August 2012. It was updated in 2015 to included additional development sites and updated flood risk information.

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Purpose

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Executive Summary

Context

This SFRA updates and enhances the previously commissioned North London Level 1 SFRA and replaces the SFRA issued by the London Borough of Harringey in March 2013. The assessment looks exclusively at flood risk within the London Borough of Haringey. The mapping in this SFRA replaces the mapping contained in the Level 1 SFRA. The Preliminary Flood Risk Assessment (PFRA) commissioned for Haringey by the Greater London Authority (GLA) identifies the borough (along with the other 32 London Boroughs) as an area of significant flood risk, in accordance with the Flood Risk Regulations, 2009. The outcome of a high level Surface Water Management Plan (SWMP), also commissioned by the GLA identified nine Critical Drainage Areas (CDAs) across the borough.

Flood Risk in Haringey

Surface water runoff is the source of flood risk that potentially has the greatest effect in Haringey and is the flooding most likely to be experienced. There is also significant residual risk as a result of reservoir breach effecting large areas of the borough which is much less likely to be experienced, but the consequences would be significant.

Climate change effects increase the severity and frequency of the flood risk. The extent and frequency of surface water flooding would be increased across the borough. The standard of protection from river flooding is also reduced by climate change effects in some parts of the borough adjacent to the River Lea.

Planned Development in Haringey

A total of 133 development sites have now been assessed as part of this SFRA (only 77 were assessed in the March 2013 version). The planned new development consists of approximately three and a half square kilometres of new infrastructure distributed across the borough covering nearly 12% of the total borough area.

Impact of Development in Haringey

Haringey is a densely developed area of London. The impact of development without accompanying mitigation measures is negative. However, with careful planning supported by effective local policy the planned development presents a significant opportunity to introduce measures that will contribute to betterment of the existing situation.

Mitigation Options

A range of mitigation options are outlined - chiefly focusing on surface water schemes including those highlighted in the recent high level Surface Water Management Plan as well as identifying other local solutions that can contribute to strategic benefits.

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Contents

List of Figures

List of Tables

Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability
AStSWF	Areas Susceptible to Surface Water Flooding
CC	Climate change- Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	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- 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.
CIRIA	Construction Industry Research and Information Association
CLG	Government Department for Communities and Local Government
Cumecs	The cumecs is a measure of flow rate. One cumec is shorthand for cubic metre per second; also m^3/s (m^3s^{-1}).
D/S	Downstream
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
F&WMA	Floods and Water Management Act
FEH	Flood Estimation Handbook
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.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a Main River
FMfSW	Flood Map for Surface Water
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRIS	Flood Reconnaissance Information System
HOST	A delineation of UK soil types according to their hydrological properties to produce the 29-class Hydrology of Soil Types (HOST) classification. It is available as a 1km grid.
IDB	Internal Drainage Board
JBA	Jeremy Benn Associates
LB	London Borough
LDDs	Local Development Documents
LDF	Local Development Framework
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers

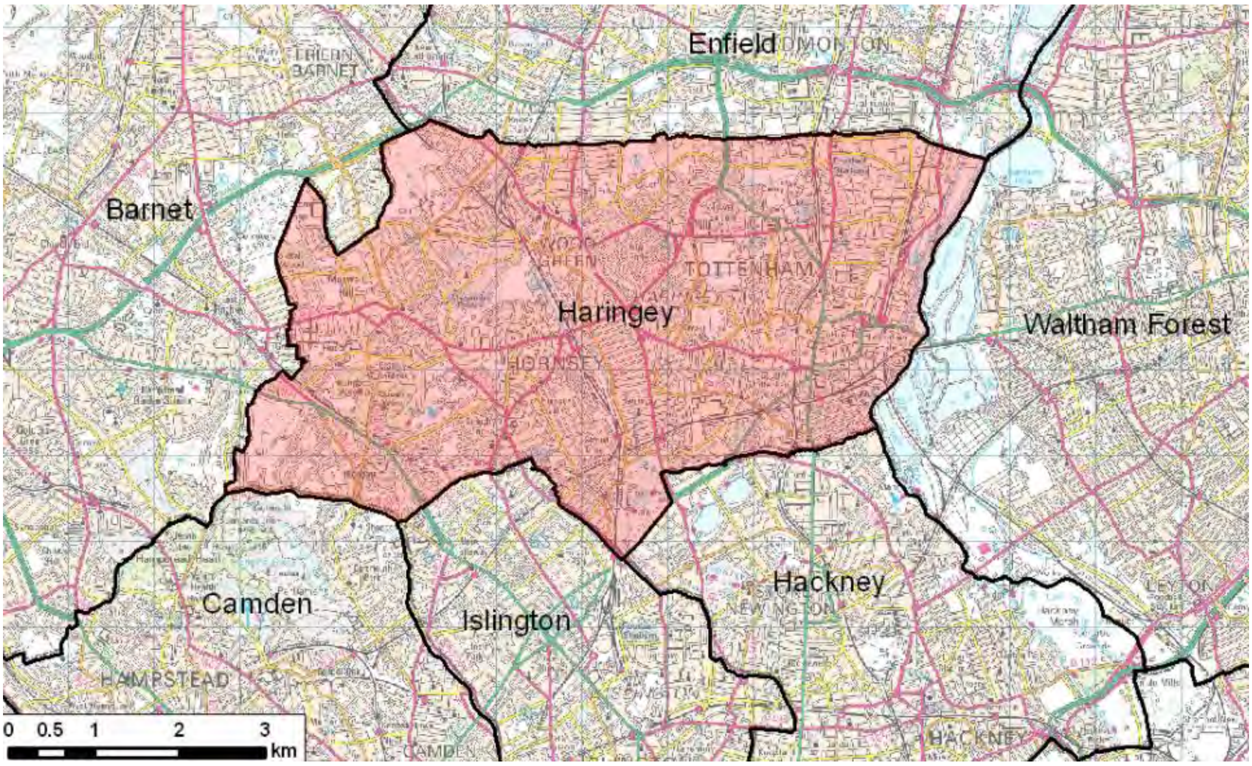
Term	Definition
mAOD	metres Above Ordnance Datum
MMO	Marine Management Organisation
NFCDD	National Flood and Coastal Defence Database
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
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.
ReFH	Revitalised Flood Hydrograph
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.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
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.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment - The Strategic Housing Land Availability Assessment (SHLAA) is a technical piece of evidence to support the Local Plan: Strategic Policies and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing land in the District which is suitable and deliverable.
SPRHOST	Standard Percentage Runoff (%) associated with each HOST soil class
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 - 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 flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
U/S	Upstream

1. Introduction

1.1 About Haringey

The London Borough of Haringey (referred to as LB of Haringey or the borough) is situated in North London. The borough is one of 33 Local authorities in Greater London and is ranked 23rd by area (at 29.6 km^2) and by population (at 225,000[1]). Like other London Boroughs, Haringey is a Lead Local Flood Authority (LLFA) and Local Planning Authority whose actions are influenced by Greater London Authority policies and plans. The LB of Haringey shares boundaries with 6 other London Boroughs, Enfield to the North, Waltham Forest to the East, Hackney, Islington and Camden to the south and Barnet to the West. The borough covers the areas of Tottenham, Muswell Hill, Hornsey and Wood Green and is home to Alexandra Palace and White Hart Lane. The borough is characterised by dense development with selected notable areas of public open space. The extent of the borough is shown in Figure 1-1 below.

Figure 1-1: Study Extent



1.2 About this Report

As a Lead Local Flood Authority and Local Planning Authority, the LB of Haringey requires a Level 2 SFRA to contribute to the evidence base for the LB of Haringey's Local Development Documents (LDDs) in accordance with the National Planning Policy Framework (NPPF)[2].

The National Planning Practice Guidance (NPPG) advises that Local Plans should be supported by an SFRA. Initially the SFRA should be used to refine information on the areas that may flood, taking into account other sources of flooding and the impacts of climate change. The SFRA includes results from analysis that enables the preparation of mapping showing flood outlines for different probabilities, impact, rate of onset, depth and velocity variance of flooding taking account of the presence and likely performance of flood risk management infrastructure, to meet the requirements of the NPPG[3]

---

[1] According 2010 population estimate.
[2] Department for Communities and Local Government (March 2012) National Planning Policy Framework available http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf
[3] Department for Communities and Local Government (March 2014) National Planning Practice Guidance available at

LB Haringey needs the SFRA to

- provide a robust evidence base for climate change adaptation policies;
- support the preparation of Development Management and Site Allocation policies, and the Sustainability Appraisal of LB of Haringey's flood risk policies;
- identify areas of flood risk and provide the basis from which to apply the Sequential and Exception Tests;
- identify opportunities and threats for development and infrastructure, including the potential impacts of subterranean development;
- provide advice on mitigation measures;
- provide specific recommendations for flood risk management and, where relevant, site specific recommendations; and
- have regard to the 19 recommendations within the GLA's London Regional Flood Risk Appraisal[4].

1.2.1 Relation to previous Level 1 SFRA

The Level 2 Strategic Flood Risk Assessment (SFRA) for the LB of Haringey includes information, analysis and figures that supersede some elements contained in the document "North London SFRA Level 1 Report". The Level 2 document does not however replace the Level 1 SFRA entirely. Some references are made back to the Level 1 North London SFRA.

1.3 SFRA Objectives

The SFRA is a key part of the evidence base to help inform the allocation of development in a local plan area, through the preparation of LDDs. The primary objective of the SFRA is to be part of the evidence base supporting the Local Plan along with the following:

- Haringey's Local Plan: Strategic Policies (formerly Core Strategy)
- Development Management and Site Allocations Local Development Documents (LDDs)
- Tottenham Hale and Northumberland Park Area Action Plans (AAPs)
- Sustainable Design and Construction Supplementary Planning Document (SPD)
- Basement Development Planning Guidance.

The NPPG states that SFRAs need to provide sufficient detail on all sources of flood risk, enabling the Local Planning Authority (LPA) to:

- determine the variations in risk from all sources of flooding across their areas, and also the risks to and from surrounding areas in the same flood catchment;
- inform the sustainability appraisal of the Local Plan, so that flood risk is fully taken into account when considering allocation options and in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased
- apply the Sequential and, where necessary, Exception Tests in determining land use allocations;
- identify the requirements for site-specific flood risk assessments in particular locations, including those at risk from sources other than river and sea flooding;
- determine the acceptability of flood risk in relation to emergency planning capability;
- consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for flood water.

To meet these objectives it will also be a requirement that those preparing information for assessment and testing of flood risk understand the assessment process and the specific characteristics of the flooding that affects the area. The SFRA should also:

- identify strategic measures (if required) to address the effects of proposed development; and

http://planningguidance.planningportal.gov.uk/.
[4] London Regional Flood Risk Appraisal (2009) available at http://www.london.gov.uk/sites/default/files/uploads/regional-flood-risk09.pdf

- influence and provide evidence that assists when making decisions on windfall planning applications.

Thus the report provides the reader with an understanding of flood risk and how this can be managed in the future.

1.4 How to Find What You Need in the SFRA

Use Table 1-1 to find the information that you need.

Table 1-1: SFRA Report layout

Section	Description of contents
Executive Summary	A short non-technical executive summary
1. Introduction	This section - defines objectives, describes the background of the study area, outlines the approach adopted and the consultation performed.
2. Understanding flood risk within Haringey	Gives a general introduction to the assessment of flood risk and describes the general characteristics of the flooding affecting the assessment area. It also summarises the responses that can be made to flood risk together with policy and institutional issues that should be considered.
3. Policy Context	This gives an outline of the relevant national, regional and local planning policy context for the study and how it affects Haringey including: the NPPF 2012; NPPG 2014; and the London Plan 2011.
4. Mapping and risk based approach	Provides details of the areas of flood risk in the LB of Haringey and the likely impacts upon development and infrastructure, to enable the Council to assess the flood risk of specific development proposals, including the Exception Test for any sites in Flood Zones 2 and 3.
5. Overview of future development	Summarises potential effects of new development that should feed into detailed policy on flood prevention and management.
6. Subterranean development	Identifies the potential impact of subterranean development on local drainage patterns, flooding, land instability and neighbouring properties, including implications for works that do not require planning permission.
7. Strategic Options	Examines strategic flood alleviation considerations necessary for growth and development, including flood mitigation opportunities. Drainage network issues are considered in the Surface Water Management Plan.
8. Review of development sites	Specific recommendations for flood risk management and, where relevant, site specific recommendations.
9. FRA Requirements	Identifies the scope of the technical assessment that must be submitted in FRA's supporting applications for new development.
10. Outcomes	Reviews the implications of the analysis undertaken for the Level 2 SFRA.

Figure 1-2: Key documents and strategic planning links - Flood Risk

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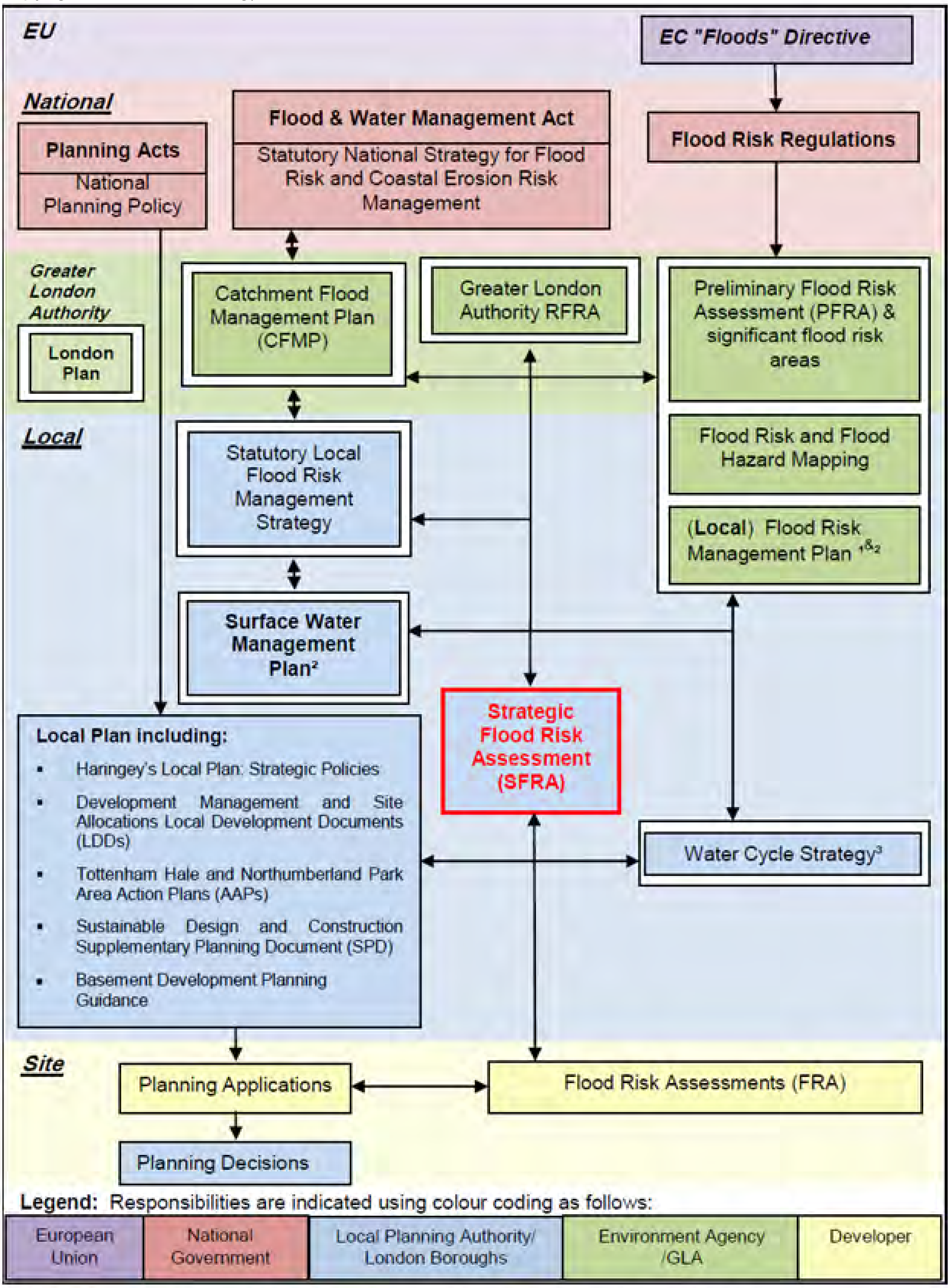


[1] By 2015 there is a requirement for Flood Risk Management Plans for River, Sea and Reservoir flooding.
[2] Can be harmonised with Flood & Water Management Act requirements
[3] The Water Cycle Strategy is also influenced by requirements of the River Basin Management Plan

1.4.1 Policy Hierarchy

Figure 1-2 shows the key strategic planning links for flood risk and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, in conjunction with the Localism Act's "duty to cooperate", introduce a wider requirement for the exchange of information and the preparation of strategies and management plans.

The over arching aim of planning policy on development and flood risk is to ensure that flood risk is taken into account at all stages of the planning process. The Greater London Authority (GLA) provides a Regional level of planning for the London Boroughs. The GLA has prepared a Regional Flood Risk Appraisal and the landscape for the assessment of flood risk is illustrated in Figure 1-2.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and management plans. SFRAs are also linked to the preparation of catchment flood management plans (CFMPs), shoreline management plans (SMPs) and surface water management plans (SWMPs) and water cycle strategies (which are also linked to River Basin Management Plans under the Water Framework Directive). It should be recognised that there is also a requirement for decisions to be based on sustainability appraisals and the information in the SFRA should be used to inform this process at the local level.

1.4.2 Responsibilities

The new and emerging responsibilities of the principal parties under the Flood and Water Management Act and the Flood Risk Regulations are summarised in Table 1-2.

Table 1-2: Roles and Responsibilities

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Statutory Strategy Reporting and general supervision (overview role)	Main rivers, reservoirs Preliminary Flood Risk Assessment (per River Basin District)* Identify Significant Flood Risk Area Flood Risk and Hazard Maps Flood Risk Management Plan **
Lead Local Flood Authority (LB of Haringey)	Input to national strategy - Formulate and implement local flood risk management strategy	Surface water, groundwater, other sources of flooding Prepare and publish a PFRA Identify Flood Risk Areas Prepare Flood Hazard and Flood Risk Maps Prepare Flood Risk Management Plans SuDS Approval Body Ordinary Watercourse
Greater London Authority (GLA)	Set housing targets and the Spatial Development Strategy for London. Sets guidelines for individual boroughs' local development plans to conform to.	Monitor the progress made against the 19 recommendations made in the London Regional Flood Risk Appraisal as part of the London Plan Annual Monitoring Report.
* With reference to the LB of Haringey the EA exercised an exception and did not deliver the PFRA (per River Basin District) ** EA commenced consultation on the preparation of Flood Risk Management Plans in October 2012 (this is in accordance with the Risk Regulations)		

Thus, those making use of flood risk information described in the LB of Haringey SFRA Level 2 documents should also make reference to, and be aware of the following:

- North London Strategic Level 1 SFRA [2008][5]
- Regional Flood Risk Appraisal (RFRA) [2009][6]
- Thames River Basin Management Plan [2009][7];

[5] North London Boroughs (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan available at http://www.nlwp.net/downloads/north_london_sfra_final_august_08.pdf
[6] http://www.london.gov.uk/priorities/planning/research-reports/technical-research-reports
[7] DEFRA & Environment Agency (2009) River Basin Management Plan Thames River Basin District available at http://publications.environment-agency.gov.uk/PDF/GETH0910BSWA-E-E.pdf

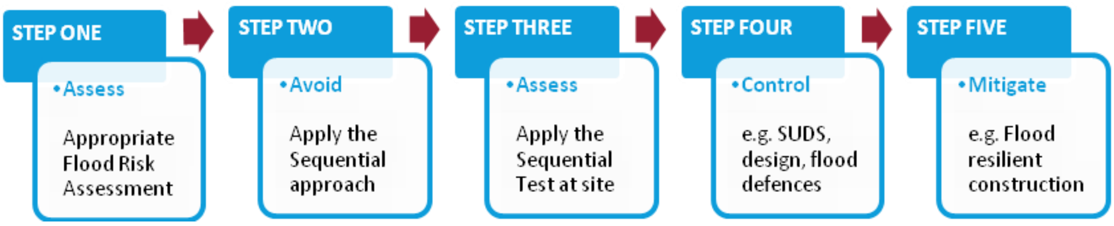
- Thames Catchment Flood Management Plan (CFMP)[2008][8],
- Surface Water Management Plan (SWMP) for the London Borough of Haringey, Drain London [FINAL DRAFT v 2.0 issued in August 2011][9];
- Preliminary Flood Risk Assessment for London Borough of Haringey, Drain London, [May 2011][10];
- Haringey Planning Regeneration and Economy, Draft Basement Development Guidance Note [June 2012][11]
- Haringey Adopted Local Plan: Strategic Policies [March 2013]
- Flood Risk Management Strategy and Plan (LB of Haringey)

1.5 Approach

1.5.1 General Assessment of Flood Risk

The SFRA adopts the flood risk management hierarchy advocated in the NPPG[12] as summarised in Figure 1-3.

Figure 1-3: Flood Risk Management Hierarchy



This hierarchy underpins the risk based approach and must be the basis for making all decisions involving development and flood risk. When using the hierarchy, account should be taken of the source pathway receptor model illustrated in Figure 1-4 and explained as follows.

- The nature of the flood risk (the ***source*** of the flooding);
- The spatial distribution of the flood risk (the ***pathways*** & areas affected by flooding);
- Climate change impacts; and
- The degree of vulnerability of different types of development (the ***receptors***).

Site allocations should reflect the application of the Sequential Test using the maps and guidance in this SFRA. The information in this SFRA should be used as evidence and where necessary reference should also be made to relevant evidence in the documents described in Section 1.4.2 of this chapter. The Flood Zone maps and flood risk information on other sources of flooding contained in this SFRA should be used where appropriate to apply the sequential test.

Where other sustainability criteria outweigh flood risk issues, the decision making process should be transparent. Information from this SFRA should be used to justify decisions to allocate land in areas at high risk of flooding. To that end, this report contains information on the level of flood hazard at the allocated sites proposed by the LB of Haringey within their Draft Site Allocations Document.

The basis for all decision making in flood risk is to first understand the risk and then identify responses to that risk so that it is effectively managed. The SFRA provides detailed information that must be supplemented, where necessary, with more detailed information contained in the other relevant documents described in this chapter.

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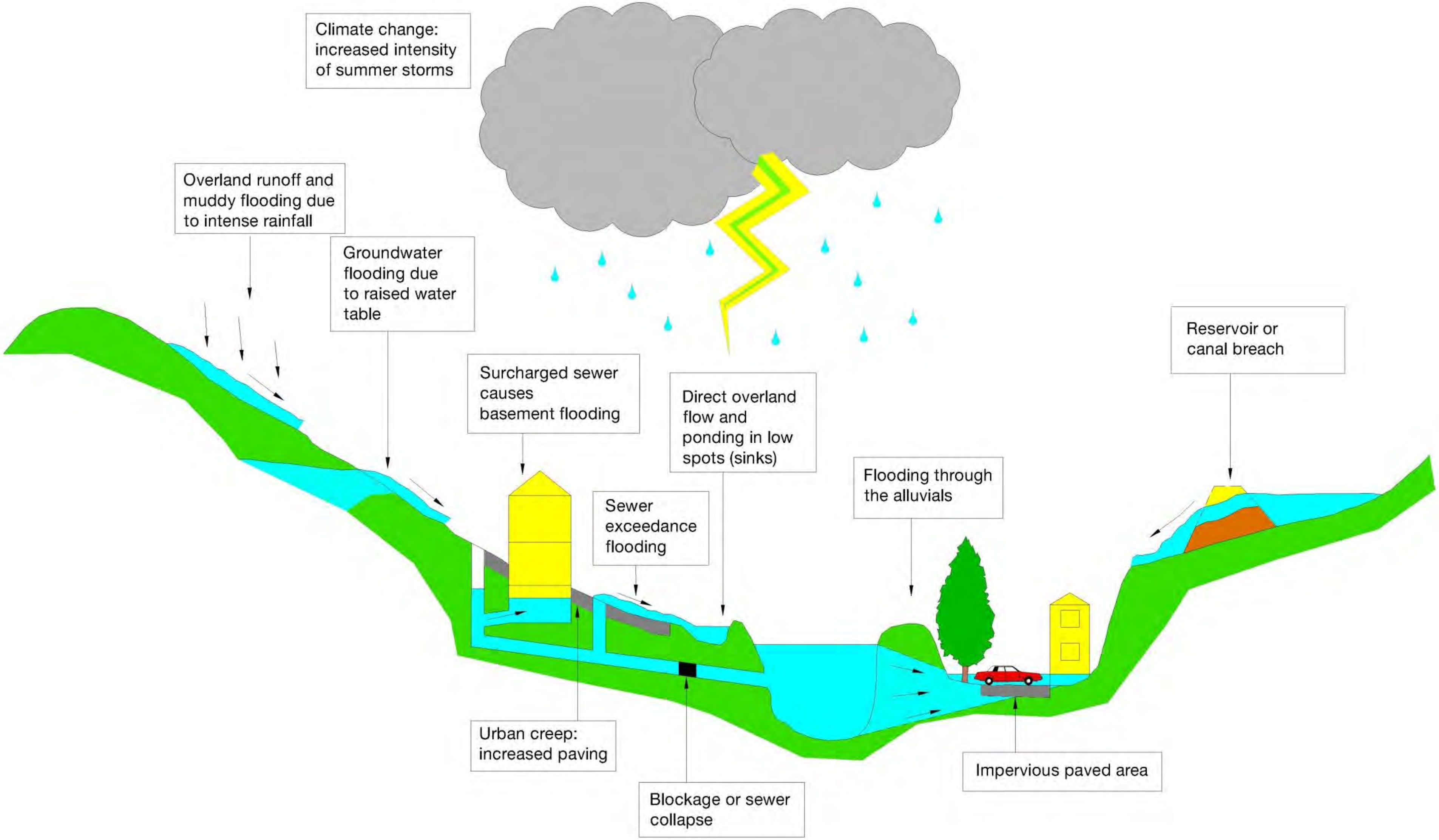
[8] Environment Agency (2009) Thames Catchment Flood Management Plan, summary report available at http://publications.environment-agency.gov.uk/PDF/GETH1209BQYL-E-E.pdf
[9] London Borough of Haringey (2011) Surface Water Management Plan for London Borough of Haringey
[10] London Borough of Haringey (2011), Preliminary Flood Risk Assessment for London Borough of Haringey
[11] At the time of writing the Level 2 SFRA, the Basement Development Guidance Note was in Draft form. Please be aware that the Final Basement Development Guidance Note will take precedence over the Draft Report.
[12] Department for Communities and Local Government (March 2014) National Planning Practice Guidance available at http://planningguidance.planningportal.gov.uk/

Figure 1-4 Source Pathway Receptor flooding from varying sources



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1.5.2 Technical Assessment of Flood Hazards

The technical assessment of river, sea and surface water risk has been performed by using computer models supplied by the Environment Agency and the LB of Haringey, combined with guidance obtained from the Environment Agency. In particular, to prepare this version of the SFRA the Lower Lee hydraulic models, supplied by the Environment Agency have been used to provide flood outlines for fluvial (river) events (these include assumptions on the tidal boundaries). The models enable the effect of climate change to be evaluated for the 1 in 100 Annual Exceedance Probability (AEP) event.

The results from National Reservoir Inundation Modelling have been obtained from the Environment Agency for consideration of Hazard from a reservoir breach.

Reference has been made to Appendix D of the SWMP for the London Borough of Haringey, to ascertain the level of risk from surface water. During the course of the SWMP, eight TUFLOW hydraulic models across the borough were run to estimate the mapping for the following rainfall events[13]:

- 1 in 30 AEP
- 1 in 75 AEP
- 1 in 100 AEP
- 1 in 100 AEP plus climate change (+30%)
- 1 in 200 AEP.

A number of the models produced for the SWMP and their results have been supplied for this assessment.

The Increased Probability of Emergence of Groundwater map (iPEG) has been used to assess flood risk from ground water. This was compiled as part of the Drain London programme and is published in the SWMP.

No modelling has been made available to assess the impact from the New River. However Thames Water and the Environment Agency perceive the risk from this channel to be low. A desk top review of the mapping data identified areas of raised embankment along its length in the LB of Haringey, the risk of breach is therefore assumed to be low. Risk from overtopping may present a potential hazard as a result of blockage or poor operation of the New River. However, as a result of the low gradient of the channel any overtopping is likely to affect a large length of the canal to a low depth. The resulting pooling of water in the vicinity of the New River would likely be similar to those areas identified in the surface water assessment.

1.5.3 Scope of Assessment

As outlined above in section 1.2 the scope of this report is defined in the NPPG[14]. The technical assessment for this SFRA should refine information on the areas that may flood, taking into account other sources of flooding and the impacts of climate change. The SFRA includes results from analysis that enables the preparation of mapping showing flood outlines for different probabilities, impact, rate of onset, depth and velocity variance of flooding taking account of the presence and likely performance of flood risk management infrastructure. The technical assessment also includes review of the potential impacts of development within the LB of Haringey, particularly in terms of increase in rainfall runoff.

[13] Haringey Council (2011) Surface Water Management Plan (SWMP) for the London Borough of Haringey, Drain London [FINAL DRAFT, Appendix C1 – Surface Water Modelling

[14] Department for Communities and Local Government (March 2014) National Planning Practice Guidance available at http://planningguidance.planningportal.gov.uk/..

1.6 Consultation

The following parties (external to the LB of Haringey) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Thames Water,
- DEFRA,
- Network Rail,
- Transport for London,
- Greater London Authority
- Drain London,
- Neighbouring boroughs (in particular Enfield)[15].

[15] It should be noted that Enfield Council has been doing modelling work with the Environment Agency in relation to the Meridian Water Development.

2. Understanding Flood Risk in Haringey Council

2.1 Historic Flooding

Section 5.3.1.5 of the North London Level 1 SFRA[16] describes records of flooding within LB of Haringey boundary up until 2008.

The Final DRAFT SWMP for the London Borough of Haringey[17] describes flooding from the following sources:

- Surface water - Section 3.37
- Ordinary Watercourses - there were no recorded events discussed within the SWMP
- Groundwater - Section 3.5.5
- Sewer Flooding - Section 3.6.2

Since the completion of the SFRA Level 1 (2008) and the SWMP (2012), incidents of flooding were reported in September 2011, due to heavy rainfall at Stanhope Road, Crouch End. Flooding also impacted Coolhurst Road, Priory Gardens and Park Road, all located in Crouch End, and Muswell Hill Road, in Muswell Hill.[18] In April 2012, flooding occurred on High Road Tottenham. Anecdotal evidence suggests that this was due to blocked drains in the area.[19]

2.2 Topography, Geology, Soils and Hydrology

For the purposes of this SFRA, LB of Haringey is covered by the Thames Catchment, in particular the Lower Lee.

The topography of the LB of Haringey results in the land generally sloping down in an easterly direction down towards the River Lee. The geology of the LB of Haringey is characterised by the London Basin, which has been infilled over time by London Clay deposits. Further details on the topography and geology of the LB of Haringey are can be found within Section 1.5.9 of the SWMP (2012).

A list of the rivers within the LB of Haringey boundary is included within Table 2-1. From a review of mapping, previous studies and histories of the area, the 'watercourses' shown in Figure 2-1 have been identified within the LB or Haringey. Of note the 'New River' is not strictly a watercourse, however, is included here. The New River is variously referred to as a water supply aqueduct, flowing reservoir or canal and occasionally (incorrectly) referred to as a waterway, which implies it is navigable (or rather intended for navigation).

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[16] North London Boroughs (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan available at http://www.nlwp.net/downloads/north_london_sfra_final_august_08.pdf
[17] London Borough of Haringey (2011) Surface Water Management Plan for London Borough of Haringey
[18] http://www.tottenhamjournal.co.uk/news/flooding_in_haringey_puts_people_at_risk_after_budget_cuts_1_1027197
Tottenham Journal (2011), "Flooding in Haringey ‘puts people at risk’ after budget cuts" September 19 2011.
[19] http://www.flickr.com/photos/alanstanton/7576550800/
Flickr (2012) " Blocked drains 400-442 High Road Tottenham" 14 July 2012

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Table 2-1: 'Watercourses' of Haringey

Watercourse	Type	Location	Responsible Party
Upper Mutton Brook	Ordinary Watercourse	Highgate Golf Club	LB of Haringey
Coppets Brook (or Coldfall Wood Brook)	Ordinary Watercourse	From Coldfall Wood to Strawberry Vale Brook	LB of Haringey
Strawberry Vale Brook	Main River	From St Pancras and Islington Cemetery along NW of borough boundary to under North Circular where it becomes Bounds Green Brook	EA
Bounds Green Brook	Main River	From North Circular along part of the NW boundary of the borough to its confluence with the Pymmes Brook at New Southgate	EA
Muswell Hill Golf Course Brook	Ordinary Watercourse	From Muswell Hill Golf Course, through Hollickwood Park under the North Circular to meet Bounds Green Brook.	LB of Haringey
Muswell Stream	Ordinary Watercourse	From Muswell Hill across Bound Green and the North Circular to meet Pymmes Brook under the bus garage in Palmers Green. Attenuated at Woodside Park.	LB of Haringey
New River	Water supply aqueduct	From Ware in Hertfordshire to Stoke Newington.	Thames Water
Upper Moselle Brook Tributaries*	Ordinary Watercourse	Various streams from the hills of Highgate and Archway that converge at Priory Park, Hornsey including Cholmeley Brook from just north of Waterlow Park, Priory Brook from near Highgate Station and Etheldene Stream from Queens Wood.	LB of Haringey
Moselle Brook (or River Moselle)	Main River	From Myddelton Road, Hornsey through Noel Park and Tottenham the distributaries with the Carbuncle Ditch at Scotland Green.	EA
Lower Moselle Brook*	Ordinary Watercourse	Downstream of distributaries with Carbuncle Ditch the Moselle Brook flows south through Tottenham Hale towards the retail park to meet the Pymmes Brook in South Tottenham, just upstream of the Stonebridge Brook.	LB of Haringey
Lower Moselle Brook New cut*	Ordinary Watercourse	1968 new cut of the Moselle Brook from Tamar Way east to Pymmes Brook just north of Ferry Lane.	LB of Haringey
Lesser Moselle	Ordinary Watercourse	Sourced in playing fields north of Lordship Lane emerging at Stockton Road running east to meet the Moselle Brook in Tottenham Cemetery. Also fed by overtopping of cemetery's ornamental lake.	LB of Haringey
Carbuncle Ditch (or Garbell Ditch)	Main River	From Scotland Green along southern boundary of Hartington Park and following Carbuncle Passage and foot path across Tottenham Marsh to meet Pymmes Brook	EA
Stonebrook Ditch	Main River	From South Tottenham to River Lee near Warwick Reservoir	EA
Pymmes Brook	Main River	From New Barnet south towards Haringey to meet the Bounds Green Brook at New Southgate. Continues east to Angel Road where it is meet by the Salmon's Brook. Turns south again to flow though Tottenham Marshes parallel to the Lee Navigation to join the Lee Navigation and Lee Diversion south of Tottenham Lock.	EA
River Lee Navigation	Main River	From Hertford Castle Weir the Navigation flows south to enter the LB of Haringey to the west of Banbury Reservoir. Continues to run south to Tottenham Hale where it meets the Pymmes Brook and River Lea Diversion south of Tottenham Locks.	EA
River Lea Diversion (or New Cut)	Main River	The diverted course of the River Lea around the Chingford Reservoirs and the Banbury reservoir. Merges with the River Lee Navigation below Ferry lane.	EA
River Lea (or Lee)	Main River	Sourced in the Chiltern hills it flows south via various channels to meet the River Thames at Bow Creek. In the LB of Haringey the reach below the confluence of the River Lee Navigation, Rive Lea Diversion and the Pymmes Brook is generally none as the River Lea until it reaches Lea Bridge where the channel bifurcates again.	EA
*Exact location and connectivity uncertain due to lack of or conflicting information. See description of 'lost rivers' below.			

A number of these watercourses are in parts considered 'lost'. A lost watercourse (most often referred to as a lost river) is one that has been culverted (now flows in a pipe or closed conduit) and the exact location is no longer clear at ground level. The watercourse may still be open over short lengths but little or no evidence is available to track the path of the watercourse above ground. Of particular note within the LB of Haringey are:

- Upper Moselle Brook Tributaries
- Lower Moselle Brook
- Lower Moselle Brook New Cut
- Muswell Stream

Figure 2-2 below shows the extent to which the watercourses in the LB of Haringey have been culverted. As can be seen from Table 2-1 there are a number of different parties responsible for the various watercourses in the LB of Haringey. Figure 2-3 shows the breakdown by Main River and Ordinary Watercourse. The Environment Agency has responsibility and powers over Main Rivers. The responsibility and powers for Ordinary Watercourse are split between the Lead Local Flood Authority (in this case the LB of Haringey) any Internal Drainage Boards and in some circumstances water companies (such as the case with the New River and Thames water). In addition some watercourses are covered by Navigation Authorities which have additional powers and responsibilities (such as the case with the Lee Navigation and the Canals and Rivers Trust).

Understanding the location and ownership of cuverted watercourses is particularly important for development and flood risk. Development sites that are located on top of or adjacent to the existing culverted watercourse must take into account the condition of the culvert to ensure the culvert is strong enough to withstand potential increased loads during the construction and implementation of the proposed development and there is no short or long term risk to the structural integrity. The culvert may provide local benefit to flood risk by conveying flows away from the site below ground. However it is important to understand the implications of culvert failure such as collapse or blockage as this may result in flooding of sites even if they are in Flood Zone 1. When developing site located on top of or adjacent culverted watercourse in the borough the aspiration to de-culvert lost watercourses and in particular the Main River Moselle Brook as part of any new development of these sites should be reviewed. If it is not possible to reinstate an open channel then the culvert should not be built on and if it is in poor condition it should be replaced or repaired.

There are a number of reservoirs in the LB of Haringey. These are discussed further in section 4.1.4

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Figure 2-1: LB of Haringey- 'watercourses'

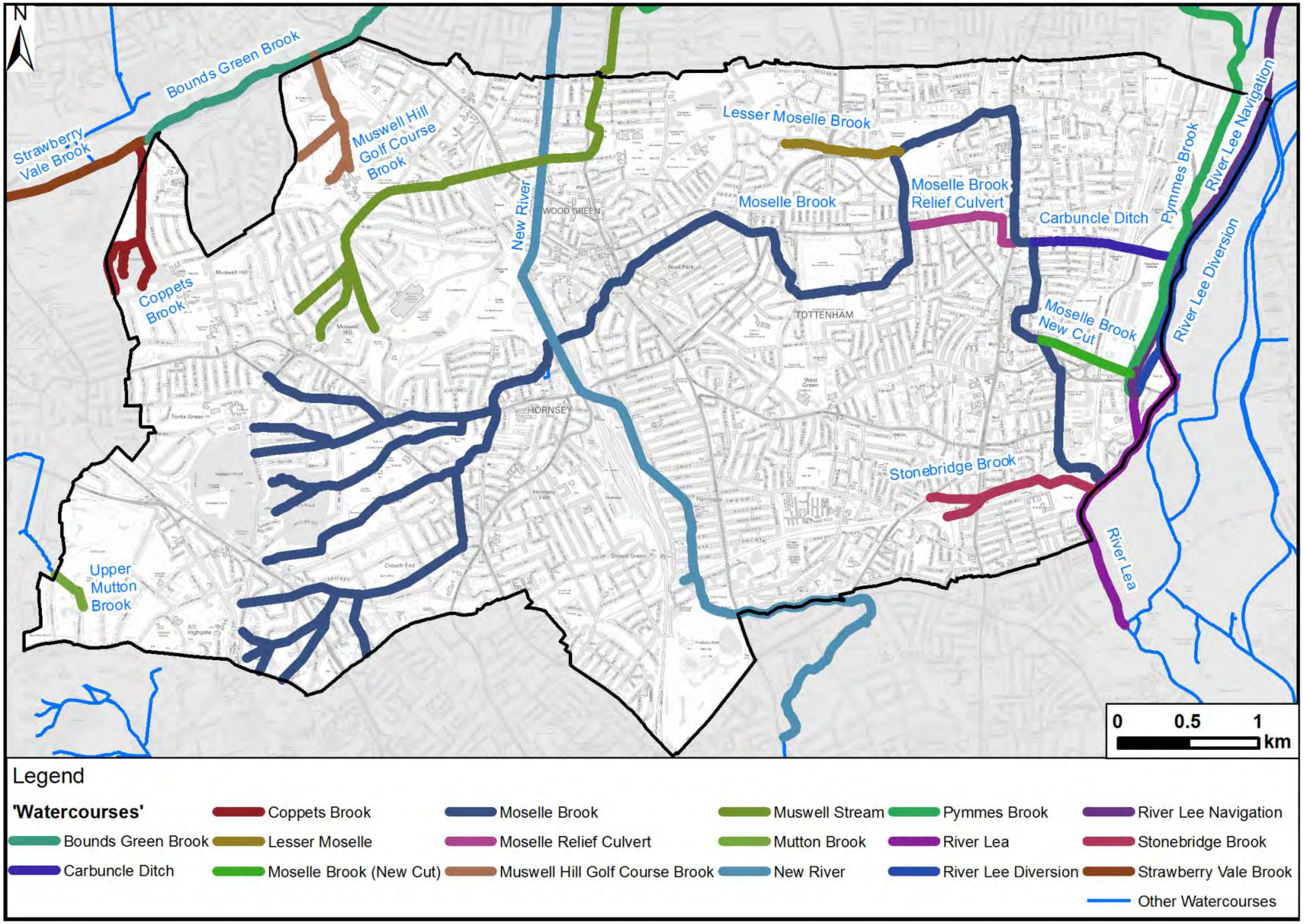
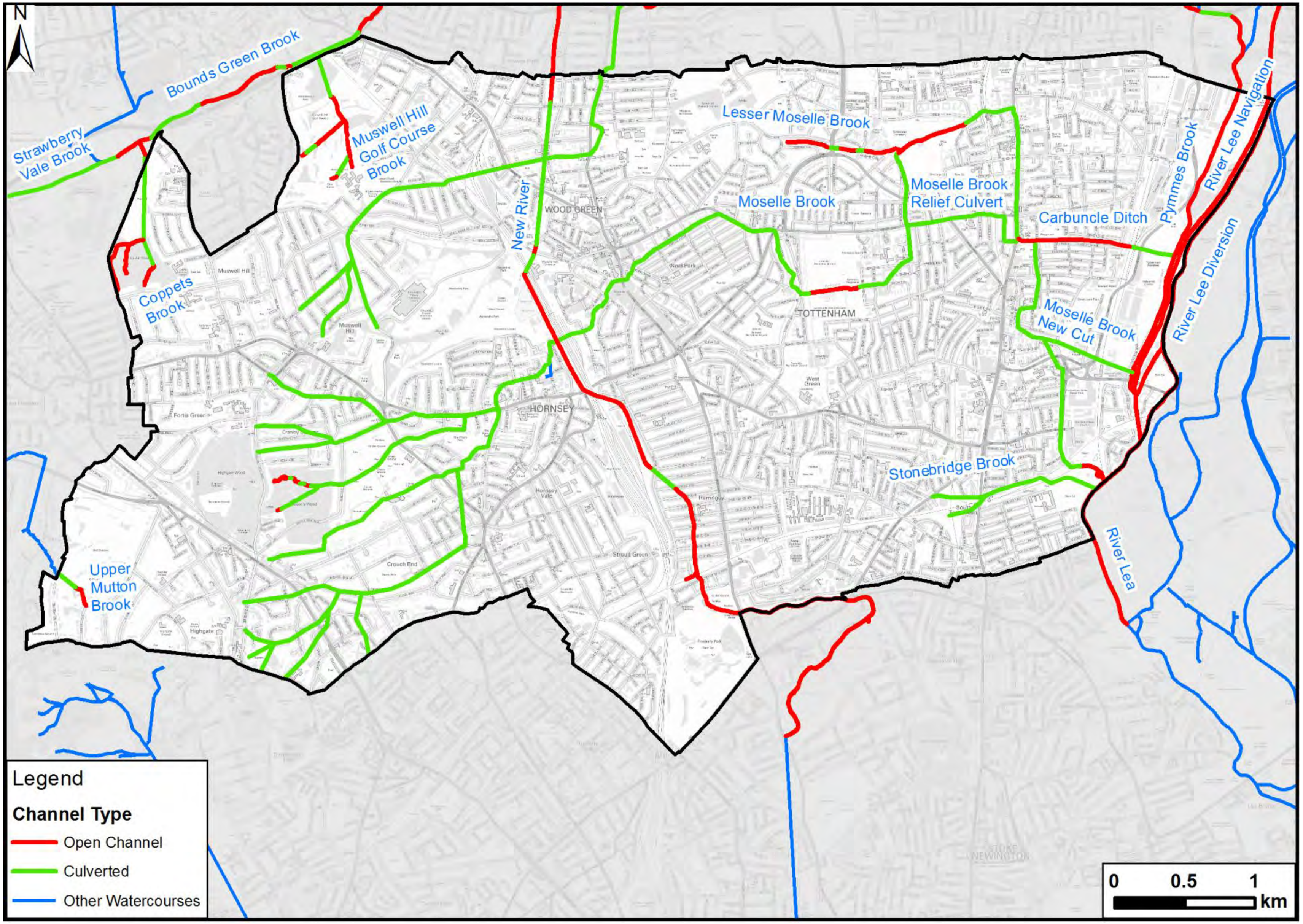
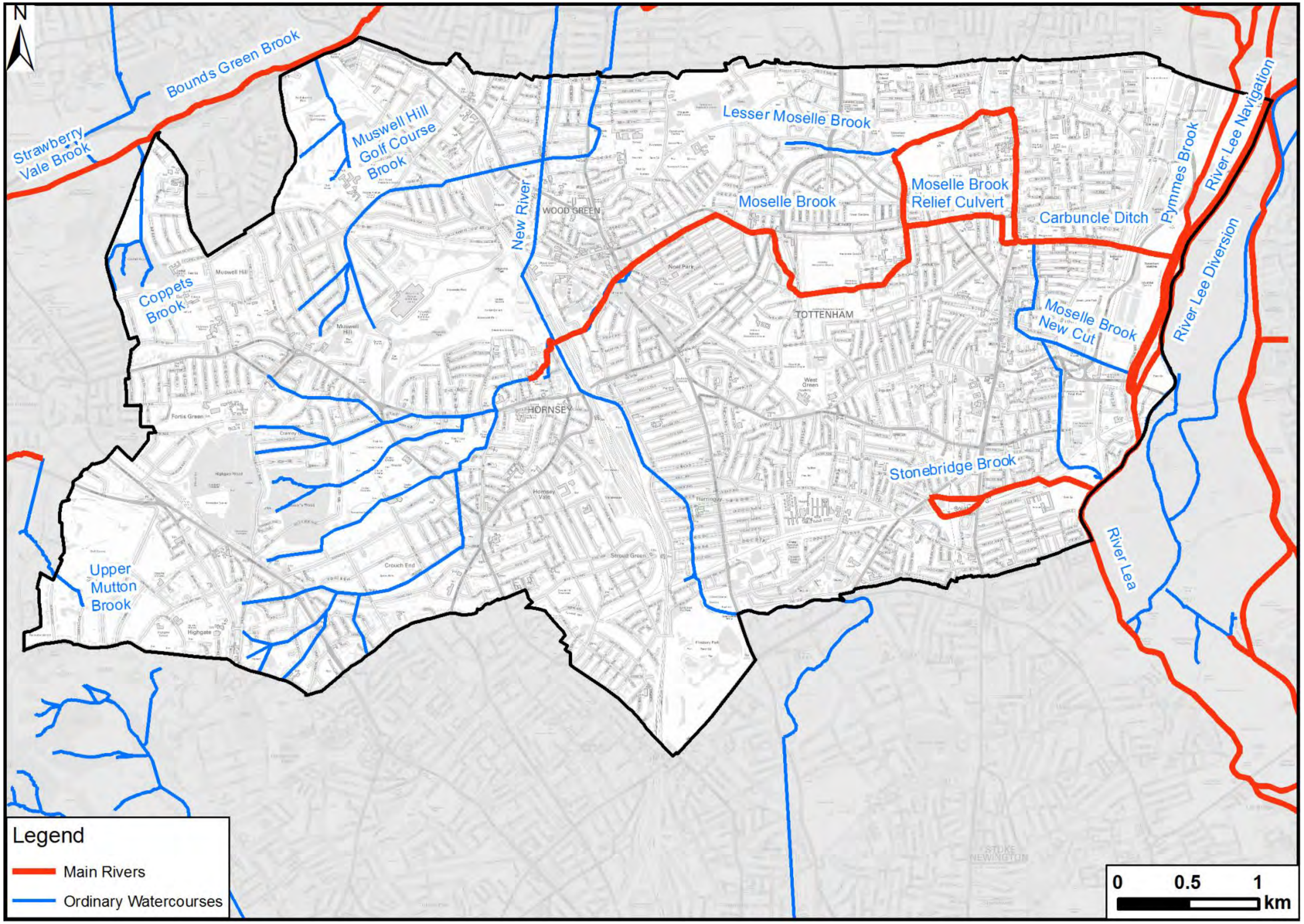


Figure 2-2: LB of Haringey- Channel Type



JBA consulting

Figure 2-3: LB of Haringey- Responsible party of 'watercourses'



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2.3 How Flood Risk is Assessed

2.3.1 Definitions

2.3.2 Flood

Section1 (subsection 1) of the Flood and Water Management Act (FWMA) (2010) defines a flood as:

'any case where land not normally covered by water becomes covered by water'.

Section1 (subsection 2) states 'it does not matter for the purposes of subsection (1) whether a flood is caused by:

Heavy rainfall

A river overflowing or its banks being breached

A dam overflowing or being breached

Tidal waters

Groundwater, or

Anything else (including any combination of factors).

Note: Source does not include the following – flood from any part of a sewerage system, unless caused by an increase in the volume of rainwater, entering or affecting the system, or a flood caused by a burst water main.

Flood Risk = (Probability of a flood) x (scale of the consequences)

2.3.3 Flood Risk

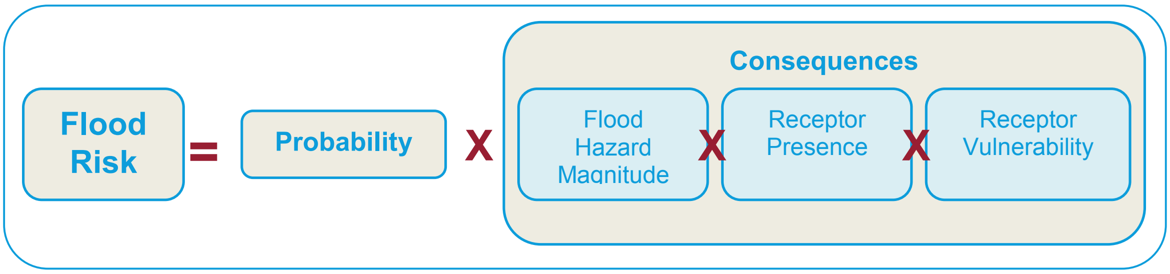
Section 3 (subsection 1) of the FWMA defined flood risk as:

'a risk in respect of an occurrence assessed and expressed (as for insurance and scientific purposes) as a combination of the probability of the occurrence with its potential consequences.'

Thus it is possible to define flood risk as:

Flood Risk = (Probability of a flood) x (Scale of the Consequences)

On that basis it is useful to express the definition as follows:



Using this definition it can be seen that

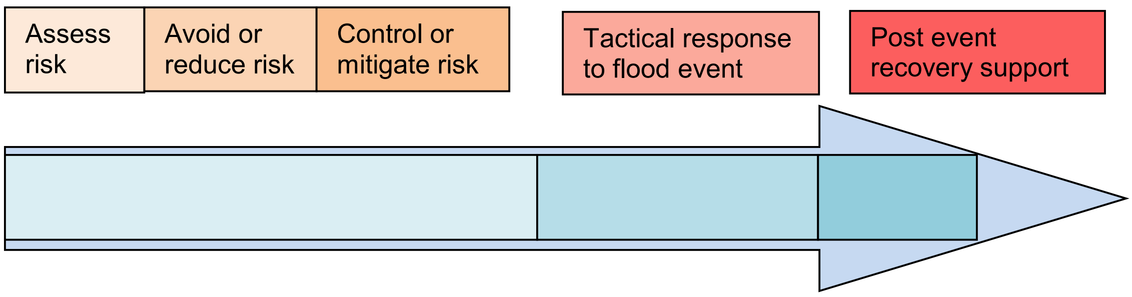
- **Increasing the probability or chance of a flood being experienced increases the flood risk.** In situations where the probability of a flood being experienced increases gradually over time, for example due to the effects of climate change, then the severity of the flood risk will increase (flooding becomes more frequent or has increased effect).
- **The scale of the consequences can increase the flood risk.**
  - Flood Hazard Magnitude: If the direct hazard posed by the depth of flooding, velocity of flow, the speed of onset, rate of risk in flood water or duration of inundation is increased, then the consequences of flooding, and therefore risk, is increased.

- Receptor presence: The consequences of a flood will be increased if there are more receptors affected, for example with an increase in extent or frequency of flooding. Additionally, if there is new development that increases the probability of flooding (for example, increase in volume of runoff due to increased impermeable surfaces) or increased density of infrastructure then consequences will also be increased.
- Receptor vulnerability: If the vulnerability of the people, property or infrastructure is increased then the consequences are increased. For example, old or young people are more vulnerable if there is a flood.

2.3.4 Using SFRA Risk Information

The SFRA contains information that can be used at strategic, operational and tactical levels, as shown in Figure 2-4.

Figure 2-4: Use of SFRA information



The SFRA will be an important source of information in the preparation of the Local Flood Risk Management Strategy.

The SFRA contains information that should be used for planning in advance of flooding. It also provides information on the effects of flood events (due to failure or overtopping of defences). The SFRA flood risk data should be updated following flood events. The assessment of flood risk in the SFRA is primarily based on the following three types of information:

2.3.4.1 Flood Zones

The SFRA includes maps that show the Flood Zones. These zones describe the land that would flood if there were no defences present (if there are no defences it shows the land that is flooded). The NPPF identifies the following Flood Zones and these are used in the LB of Haringey Level 2 SFRA to provide assessment of flood risk to site from rivers as sea flooding. A concept diagram showing the classification of Flood Zones graphically is included in Figure 2-5 below. A fuller discussion of Flood Zones and their relation to planning policy can be found in the NPPF and the NPPG.

.Figure 2-5: Definition of Flood Zones

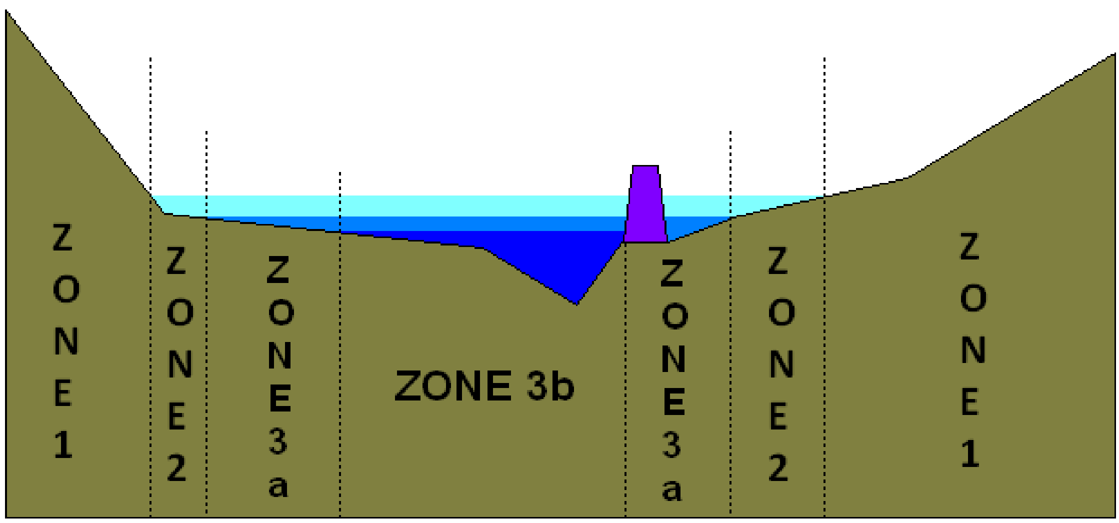


Table 2-2: Flood Zone descriptions

	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.1% – 0.5%) in any year.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year.
Zone 3b	Function Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of function floodplain should take account of local circumstances.

New development should, whenever possible, be placed in Flood Zone 1. The Flood Zones are indicative of the potential undefended floodplain. Allocating sites in Flood Zone 1 means that future development is not reliant on fluvial or coastal flood defences. This negates the requirement of committing future generations to costly long term expenditure, which becomes unsustainable in light of the effects of climate change. However, developers should be aware that the runoff from development on Flood Zone 1 land can potentially cause an increase in the probability of flooding. Information in the SFRA should be used to address this issue.

2.3.4.2 Actual Flood Risk

If it has not been possible for all future development to be situated in Flood Zone 1, then a more detailed assessment is needed to understand the implications of locating proposed development in Flood Zones 2 or 3 and the “actual risk” of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are as follows:

- Residential development should be protected for its lifetime against river flooding with an annual probability of 1% in any year; and
- Residential development should be protected for its lifetime against sea flooding with an annual probability of 0.5% in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated;
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed;
- The standard of safety must be maintained for the intended lifetime of the development (assumed to be 100 years for residential development). Over time the effects of climate change will erode the present day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained; and
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the

respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding, or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

Those using the LB of Haringey Level 2 SFRA should refer to the Environment Agency's Asset Information Management System (AIMS) for details on the standard of protection of defences.

2.3.4.3 Residual Risk

The residual risk refers to the risks that remain in circumstances where measures have been taken to alleviate flooding. It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate. This can result in over-topping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; or
- Failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner, failure of pumping stations or blockage or collapse of culverted watercourse

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance, attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events.

2.4 Understanding Flooding in Haringey Council

2.4.1 Introduction

Flood Risk has been assessed by performing a review of the following existing analyses, hydrological assessment and hydraulic modelling, see Table 2-3.

Table 2-3: Previous Flood Risk Studies

Studies	Parties
North London Level 1 Strategic Flood Risk Assessment, (2008).	Joint waste plan SFRA
Haringey Preliminary Flood Risk Assessment, 2011	LB of Haringey
Haringey Draft Surface Water Management Plan, 2011	LB of Haringey
River Thames Catchment Flood Management Plan (CFMP)	Environment Agency
Thames River Basin Management Plan (RBMP)	Environment Agency
Areas Susceptible Surface Flood Maps.	Environment Agency
Flood Map for Surface Water Flooding for 30 year period and for 200 year period.	Environment Agency
Maps showing the Areas Benefiting from Defences	Environment Agency
National Reservoir Inundation Mapping	Environment Agency
Environment Agency flood risk models and model output data.	Environment Agency
Current condition of flood defences (Environment Agency).	Environment Agency
Failure of flood defences linked to the National Flood Risk Assessment classifications	Environment Agency
DG5 Register	Thames Water

2.4.2 Description of Principal Flood Areas and Mechanisms

The following paragraphs discuss the flood areas and mechanisms evident within the LB of Haringey.

Fluvial

The River Lee forms the eastern Haringey boundary with Waltham Forest. The Environment Agency Flood Zones are mostly located along this eastern border. Flood Zone 3 is predominantly limited to the channels and Tottenham Marshes; however Flood Zone 2 extends further eastwards.

The River Moselle flows though Tottenham; this was once a direct tributary of the River Lee. Since the River Moselle was culverted the channel now artificially flows into Pymmes Brook before flows join the River Lee. There is a small area of the River Moselle designated as Flood Zone 2 & 3. This is located at the Lordship Recreation Grounds. The Lordship Recreational Grounds have recently been the site of significant restoration efforts including river restoration to re-align the channel and introduce additional temporary storage areas for times of high flow. These areas are still shown as within Flood Zone 3b, 3a and 2 as they are areas designed to be preferentially inundated in times of flooding.

Artificial watercourse

There are two artificial 'watercourses' within the LB of Haringey, the River Lee Navigation channel (part of the Main River network) and the New River (Thames Water). The New River was originally constructed as a water supply aqueduct. Over time, the course of the aqueduct has been altered and capacity increased in line with demand. The water level is regulated by a number of sluice gates and pumps. Stretches of the New River channel have been raised above the surrounding ground levels. The New River has a maintained water level managed by Thames Water. The risk of flooding from the New River is low. There are no sections identified in the LB of Haringey raised above ground level that may present breach risk. However there is risk of overtopping following a failure of the assets to maintain water level correctly. This could have consequences to properties in the vicinity, and an appropriate assessment of this residual risk should be included in a flood risk assessment with measures to provide safe access and egress from any proposed development.

Sewer

The LB of Haringey SWMP collated data from Thames Water with regard to the mechanisms of sewer flooding. The data provided was at a high level, where incidents of sewer related flooding were reported at a broad scale. Locations of sewer flooding were identified using a four digit post code e.g. N15 4. Data showed that the majority of the incidents of sewer flooding were located in the south of the borough, around southeast Tottenham and Crouch End extending through to Highgate and Muswell Hill.

Southeast Tottenham is located at the low point of the catchment, which drains into the River Lee. Restricted free flow, from surface water sewer outfalls, when the river level is higher than the soffit of the sewer outfalls would result in surcharging/ backing up of the sewer system. This could provide an explanation for the number of recorded incidents of sewer flooding incidents in this area. It should also be noted that the number of incidents were recorded at postcode level. Further details are provided within Table 3.5 of the LB of Haringey SWMP.

Any proposed development located within the postcodes described in the LB of Haringey SWMP should demonstrate how, through the use of SuDS the amount of surface water entering the sewer systems is managed. It is particularly important to show how any excess surface water resulting from an increase in hard surface areas as part of the development is to be managed.

Groundwater

It was concluded in the North London SFRA that Haringey was at risk from fluvial, sewer and pluvial flooding but not groundwater or tidal flooding. As part of the Drain London project, consultants were commissioned to produce a dataset referred to as the Increased Potential Elevated Groundwater (iPEG) maps[20]. The assessment was carried out at a Greater London scale. The iPEG mapping assists in identifying areas which have an increased potential to experience groundwater flooding. The iPEG map shows those areas within the borough where there is an increased potential for groundwater to rise to within 2m of the ground surface. When groundwater rises to this level water may be able to enter basements and continue to rise to cause surface water flooding. The iPEG map includes an assessment of the potential groundwater to rise in both consolidated aquifers and from superficial permeable deposits (unconsolidated aquifers). The map also includes those areas close to rivers which are underlain by permeable superficial deposits where groundwater may rise to elevated levels driven by high water levels in the river. See Figure 10 of the LB of Haringey SWMP entitled "Increased potential for Elevated Groundwater Map (iPEG)" provides the results of the full catchment analysis for ground water flood risk.

Surface Water

Considering the local geology of the LB of Haringey is predominantly London Clay, there is little opportunity for surface water to infiltrate the ground resulting in increased volumes of surface water runoff. The extent of surface water flooding is controlled by the topography as well as the impermeability of the land surface. Low-lying impermeable areas are more susceptible to surface water flooding in the form of ponding. Areas that are steeper help to produce surface runoff as there is less chance of local ponding.

According to the modelled results from the LB of Haringey SWMP, the estimates of the 30-year probability flood extent indicates that surface water flooding is sparsely distributed. There are some areas of ponding to the west of Hornsey and also around residential property to the north of Wood Green. For the 200-year probability flood event, the modelled results show more widespread surface water flooding with some ponding in the vicinity of Warkworth Road in the north of Tottenham as well as parts of central Tottenham. For further details please refer to the LB of Haringey SWMP, Appendix D.

Critical Drainage Areas (CDAs)

The LB of Haringey SWMP completed an analysis of the number of properties at risk of flooding for the 1 in 100 year rainfall event and reviewed the potential number of properties with surface water flooding of a depth greater than 0.03m. A review of the numbers of properties affected coupled with local knowledge of the study area identified 9 Critical Drainage Areas. Table 2-4**Error! Reference source not found.** lists the CDAs along with a description of their location.

[20] London Borough of Haringey (2011) Surface Water Management Plan for London Borough of Haringey - Figure 10 "Increased Potential Elevated Groundwater"

Table 2-4 Critical Drainage Areas (CDAs)

CDA Code	CDA name	Total area of CDA
Group4_010	Green Lanes and neighbouring road, Wood Green	1.08*
Group4_055	North of Hornsey High Street and west of mainline railway, Hornsey	4.23
Group4_056	Rathcoole Gardens, Hornsey Vale	0.62
Group4_057	Seven Sisters Road, South Tottenham	3.03*
Group4_061	Tottenham High Road and area surrounding Hatfield Road, Tottenham	1.15
Group4_062	Milton Park, Crouch End	0.42
Group4_063	The Roundway (A10) and Warkworth Road, Tottenham	1.74*
Group4_073	Alexandra Palace Railway Station and mainline railway, Wood Green	1.38
Group4_075	Lordship Lane and Ellenborough Road, Noel Park	0.15
* Includes area outside of LB of Haringey		

A critical drainage area (CDA) is defined by the Drain London Tier 2 Technical Specification as *"a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or river) often cause flooding in a Flood Risk Area during severe weather thereby affecting people, property or local infrastructure*." Nine CDAs have been defined within the borough (three of which cross over into neighbouring boroughs). Figure 2-6 below shows the location of these critical drainage areas within the LB of Haringey.

LB of Haringey should be aware of these CDAs when considering planning applications, where development is proposed, any planning application should be supported by an appropriate flood risk assessment.

The remainder for the borough was divided up, for the purposes of assessment, into local Haringey Drainage Areas (HDAs).

2.4.3 Haringey Drainage Areas (HDAs)

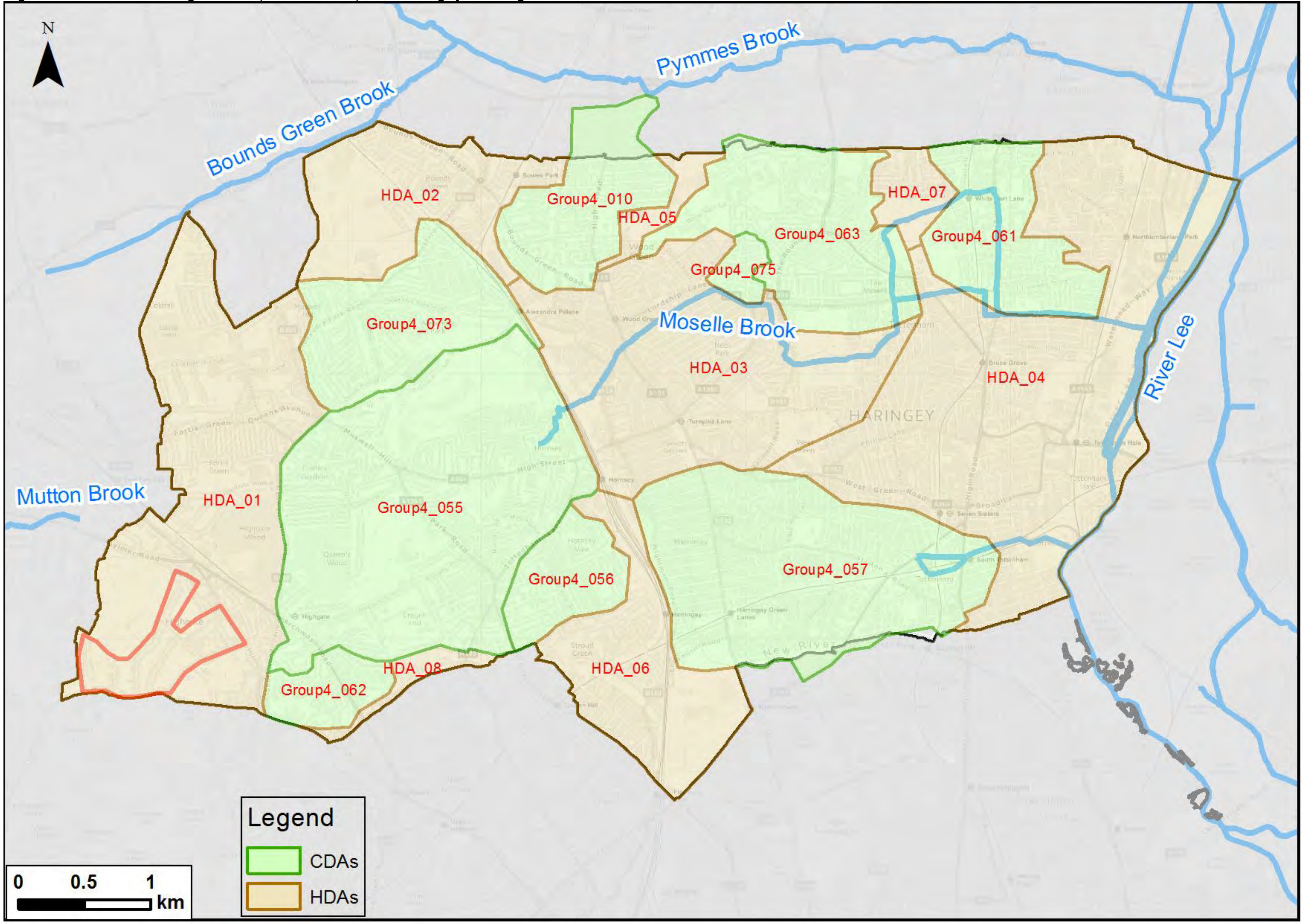
The remaining areas of the LB of Haringey, outside of the CDAs, have been divided based on SWMP results for the 1 in 200 AEP event modelled results, the Flood Zone, topography and historic flood outlines. Although these areas are outside of the Drain London "critical" definition above area, when considering mitigation of potential cumulative effects of development within the LB of Haringey. Eight additional areas, (Haringey Drainage Areas (HDAs) have been identified for the purposes of assessment at a local level. Table 2-5 below lists the CDAs along with a description of their location.

Table 2-5 Haringey Drainage Areas (HDAs)

CDA Code	CDA name	Total area of CDA
HDA_01	Fortis Green and Highgate	3.87
HDA_02	North Alexandra Park and Bounds Green	1.44
HDA_03	Noel Park, West Green and west Bruce Grove	3.31
HDA_04	East Bruce Grove, Tottenham Hale, and Northumberland park	5.25
HDA_05	Woodside	0.21
HDA_06	Stroud Green and Harringay	1.51
HDA_07	White Hart Lane	0.32
HDA_08	South Crouch End	0.19

CDAs and HDAs will be used to frame the overview of future development in Section 5 of this document.

Figure 2-6 Critical Drainage Areas (SWMP 2012) and Haringey Drainage areas



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2.5 Possible Responses to Flooding

2.5.1 Assess

The first response to flooding must be to understand the nature and frequency of the risk. The assessment of risk is not just performed as a "one off" during the process, but rather the assessment of risk should be performed during all subsequent stages of responding to flooding.

2.5.2 Avoid

If possible and appropriate the hazard should be avoided. If it is possible to place all new growth in areas at a low probability of flooding then the flood risk management considerations will relate solely to ensuring that proposed development does not increase the probability of flooding to others. This can be achieved by implementing SuDS systems and other measures to control and manage surface run-off. In some circumstances it might be possible to include measures within proposed growth areas that reduce the probability of flooding to others and assist existing communities to adapt to the effects of climate change. In such circumstances the growth proposals should include features that can deliver the necessary levels of mitigation so that the standards of protection and probability of flooding are not reduced by the effects of climate change. In Haringey Council, consideration should be given not only to the peak flows generated locally by new development but also to the volumes generated during longer duration storm events since these volumes have the potential to exacerbate flood levels in the river system.

2.5.3 Substitute, Control and Mitigate

These responses all involve management of the flood risk and thus require an understanding of the consequences (the magnitude of the flood hazard and the vulnerability of the receptor).

There are opportunities to reduce the flood risk by lowering the vulnerability of the proposed development. For instance changing existing residential land to commercial uses will reduce the risk provided that the residential land can then be located on land in a lower risk flood zone.

Flood risk management responses in circumstances where there is a need to consider growth or regeneration in areas that are affected by a medium or high probability will include:

- Strategic measures to maintain or improve the standard of flood protection so that the growth can be implemented safely for the lifetime of the development (must include provisions to invest in infrastructure that can adapt to the increased chance and severity of flooding presented by climate change);
- Design measures so that the proposed development includes features that enable the infrastructure to adapt to the increased probability and severity of flooding, whilst ensuring that new communities are safe and that the risk to others is not increased (preferably reduced);
- Flood resilient measures that reduce the consequences of flooding to infrastructure so that the magnitude of the consequences is reduced. Such measures would need to be considered alongside improved flood warning, evacuation and welfare procedures so that occupants affected by flooding could be safe for the duration of a flood event and rapidly return to properties after an event has been experienced.

It would be necessary to address the required commitment and provisions for the long term management and maintenance of all measures to control and mitigate flooding, where they have to be deployed.

It should be noted that the Flood and Coastal Risk Management Grant in Aid (FCRMGiA) funding arrangements introduced in 2011 do not make government funds available for any new development implemented after 2012. Accordingly, it is essential that appropriate funding arrangements are established for new development proposed in locations where a long term investment commitment is required to sustain Flood Risk Management (FRM) measures. The strategic investment commitment is required so that in future the FRM measures can be maintained and afforded for the lifetime of the development, since the available funds from FCRMGiA will potentially not reflect the scale of development that is benefitting.

The policy statement Flood and Coastal Resilience Partnership Funding (2013) sets out the arrangements that will apply for the allocation of capital Flood Defence Grant-in-Aid (FDGiA) to flood and coastal erosion risk management projects. Flood and Coastal Resilience Partnership Funding will form part of the Environment Agency's overall capital allocation projects until the end of the 2014/2015 financial year. Under this system, central government contributions will cover the full cost of a scheme if it has high benefits – such as if many houses are protected. However, where the benefits are not high enough for central government contributions to cover the costs, local contributions can top up the funding.

The National Flood and Coastal Erosion Management Strategy summarises the new system:

In essence, instead of meeting the full cost of a limited number of schemes, a new partnership approach to funding could make government money available to pay a share of any worthwhile scheme. The amount in each case will depend on the level of benefits the scheme provides. For example, the number of households protected, or the amount of damage that can be prevented. The level of government funding potentially available towards each scheme can be easily calculated. Local authorities and communities can then decide on priorities and what to do if full funding isn't available. Projects can still go ahead if costs can be reduced or other funding can be found locally.[21]

There are a number of potential impacts of this change in funding. The Government stated that its proposals will help to:

- Encourage total investment in Flood and Coastal Erosion Risk Management by operating authorities to increase beyond what is affordable to national budgets alone.
- Enable more local choice within the system and encourage innovative, cost-effective options to come forward in which civil society may play a greater role; and
- Maintain widespread uptake of flood insurance[22].

2.6 Thames Catchment Flood Management Plan (CFMP)

The Thames Catchment Flood Management Plan (CFMP) has been one of the principal influential documents in preparing this SFRA. The key objective of a CFMP is to develop complementary policies for long-term management of flood risk within the catchment that take into account the likely impacts of changes in climate, the effects of land use and land management, deliver multiple benefits and contribute towards sustainable development (CFMP: volume I – policy guidance, 2004).

As part of the CFMP process each CFMP area was divided up into broad areas (known as 'policy units'), which represent areas of similar characteristics, similar flood mechanisms and similar flood risks. Each policy unit was then assessed to decide which policy will provide the most appropriate level and direction of flood risk management both now and in the future.

One of six standard flood risk management policies has been applied to each policy unit:

- Policy 1 – No active intervention (including flood warning and maintenance). Continue to monitor and advise.
- Policy 2 – Reduce existing flood risk management actions (accepting that flood risk will increase over time).
- Policy 3 – Continue with existing or alternative actions to manage flood risk at the current level.
- Policy 4 – Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).
- Policy 5 – Take further action to reduce flood risk.
- Policy 6 – Take action to increase the frequency of flooding to deliver benefits locally or elsewhere (which may constitute an overall flood risk reduction, e.g. for habitat inundation).

The LB of Haringey is located in both the Lower Lee and the Lower Lee Tributaries policy units. Policy 5 applies to the Lower Lee and Policy 6 to the Lower Lee Tributaries.

[21] National Flood and Coastal Erosion Risk Management Strategy for England: Summary Strategy, Environment Agency, July 2011

[22] Future Funding for Flood and Coastal Erosion Risk Management, Impact Assessment, Defra, November 2010.

The **Lower Lee policy unit** is predominantly located within the floodplain of the Lower Lee. Therefore the CFMP, by applying policy 5, recommends measures to lower the probability of exposure to flooding and/or the magnitude of the consequences of a flood.

The **Lower Lee Tributaries policy unit** covers the remaining area of the LB of Haringey. The application of Policy 6 implies that measures should be sought within the LB of Haringey and potentially within its neighbouring boroughs to look for opportunities to make space for flood waters, i.e. create additional areas of flood storage or deculverting watercourses.

The policies in the CFMP have been prepared using evidence that assesses the current conditions and estimates the effects of future changes due to climate change.

3. Policy Context

3.1 National Planning Policy Framework (NPPF)

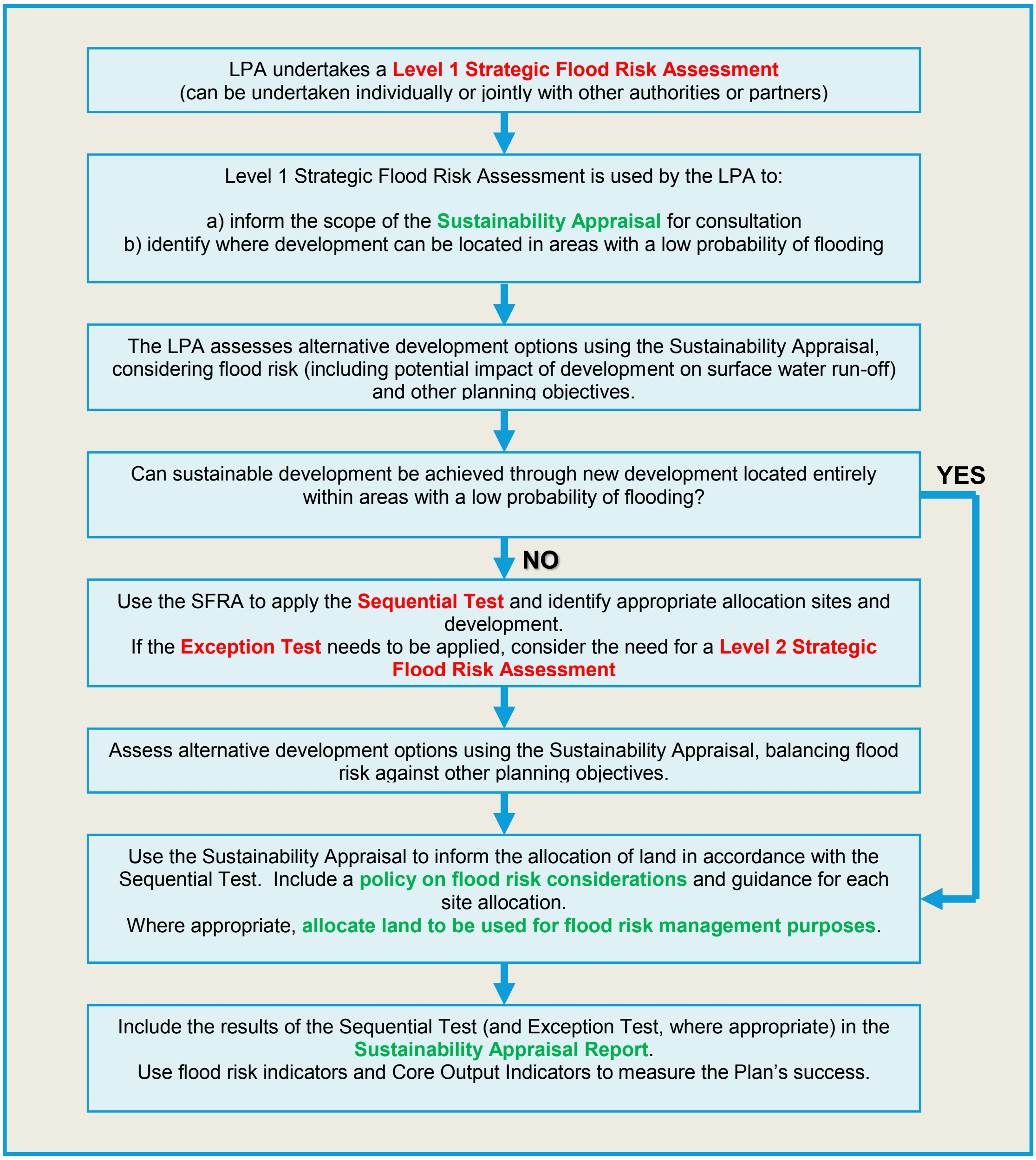
The National Planning Policy Framework (NPPF) was issued on 27 March 2012 to replace the previous documentation, as part of reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. It replaces the previous Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs).

The NPPF is a source of guidance for local planning authorities to help them prepare Local Plans and for applicants preparing planning submissions. Paragraph 100 of the NPPF states "Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change"[23].

In March 2014 National Planning Practice Guidance (NPPG) on flood risk was published alongside the NPPF[24] and sets out how the policy should be implemented. Diagram 1 in the National Planning Practice Guidance also sets out how flood risk should be taken into account in the preparation of Local Plans.

Figure 3-1: Flood risk and the preparation of Local Plans†

[23] Department for Communities and Local Government (March 2012) National Planning Policy Framework available http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf
[24] Planning Practice Guidance: Flood Risk and Coastal Change (2014)
http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/



† Based on Diagram 1 of National Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-021-20140306) March 2014.

3.1.1 Sequential Test

The Sequential, risk-based approach designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible. Details of the Sequential Test are described in NPPF and NPPG. This test must be performed when considering the placement of future development and for planning application proposals. The NPPG gives detailed instructions on how to perform the test. These instructions on how to perform the Test should be used with the following information from the SFRA:

- Identify the area to be assessed (including alternatives) on the Flood Zone Maps that are provided with this assessment;
- Establish the risk of flooding from other sources again using the Maps in this SFRA; and
- Follow the instructions given in the NPPG[25].

[25] Department for Communities and Local Government (March 2014) National Planning Practice Guidance - How should the Sequential Test be applied to planning applications? available at

The Environment Agency has published a technical note[26] which provides guidance on how to apply the Sequential Test as per the NPPF and in relation to the allocation of land, individual planning applications, windfall sites, renewable energy projects, redevelopment of an existing single property and change of use.

The Sequential Test is used to direct all new development (through the site allocation process) to locations at the least risk of flooding, giving highest priority to Flood Zone 1. It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic. A greater understanding of the scale and nature of the flood risks is required. The Level 2 SFRA provides further flood risk evidence which the Council can use to assess whether it is necessary to revisit/update the Sequential Test. When deciding on the ability to manage flood risk for new development located in Zones 2 and 3 consideration must be given to a wide range of issues. The issues to be addressed include how any evacuation of the occupants would be handled, how the new development fits in with the existing flood management provision and, in circumstances where flooding is experienced how quickly the wider area would recover and return to normal. At some of the locations it could be found that Flood Risk Management measures are more easily integrated alongside proposed new development to address the flood risk issues, usually as a consequence of the prevailing natural or artificial topography. In these circumstances the Flood Risk Management proposals could be deployed without causing a significant alteration to the design and its place setting. However, even in these circumstances it should be recognised that Flood Risk Management Measures at one location can have the potential to cause an alteration to the flood risk to adjacent property or in flood cells on the opposite bank.

3.1.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a local plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using Strategic Flood Risk Assessments to apply the Sequential and Exception Tests where necessary.

The Sequential Test should be applied to the whole local planning authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a local plan sustainability appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan (Figure 3-2).

The Exception Test should only be applied following the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Exception Test should be applied in the preparation of a Local Plan (Figure 3-3).

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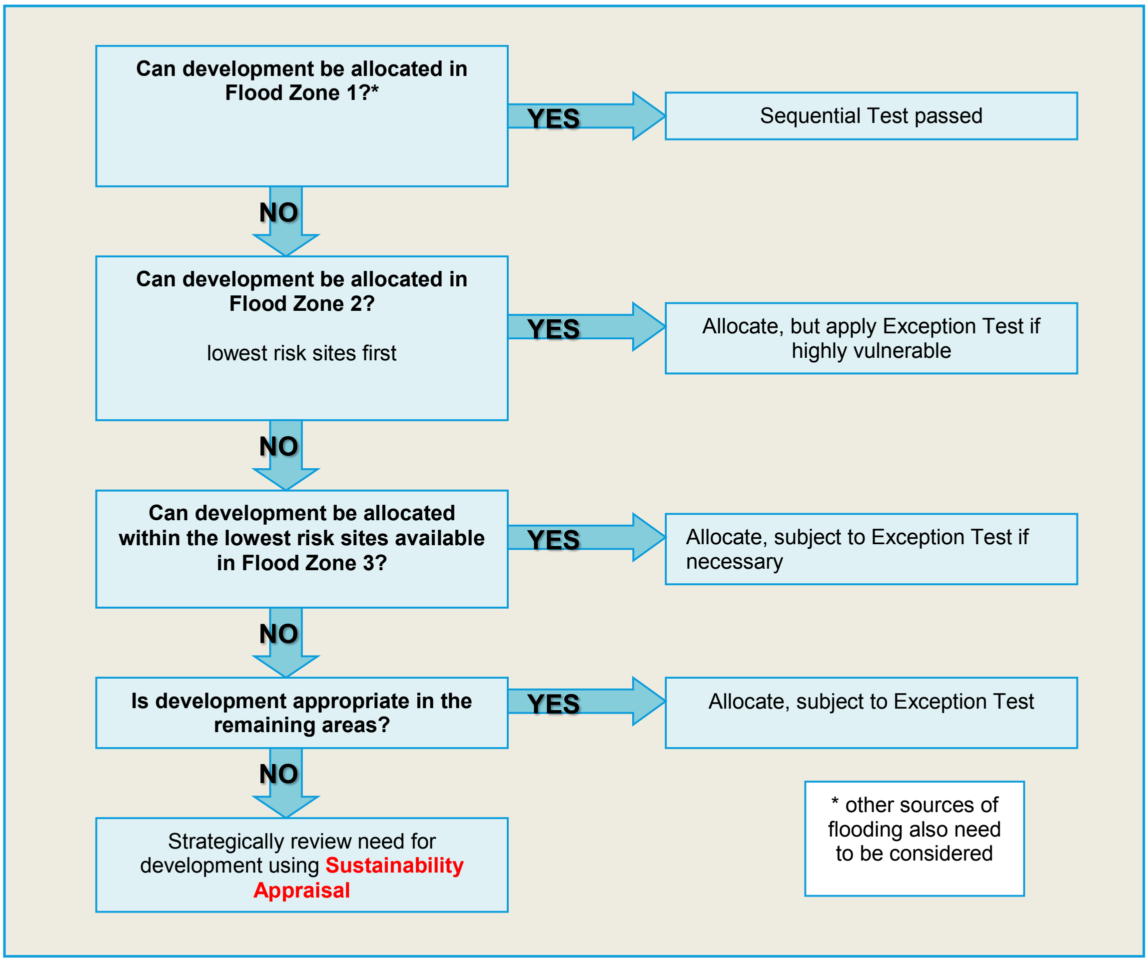
http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/applying-the-sequential-test-to-individual-planning-applications/

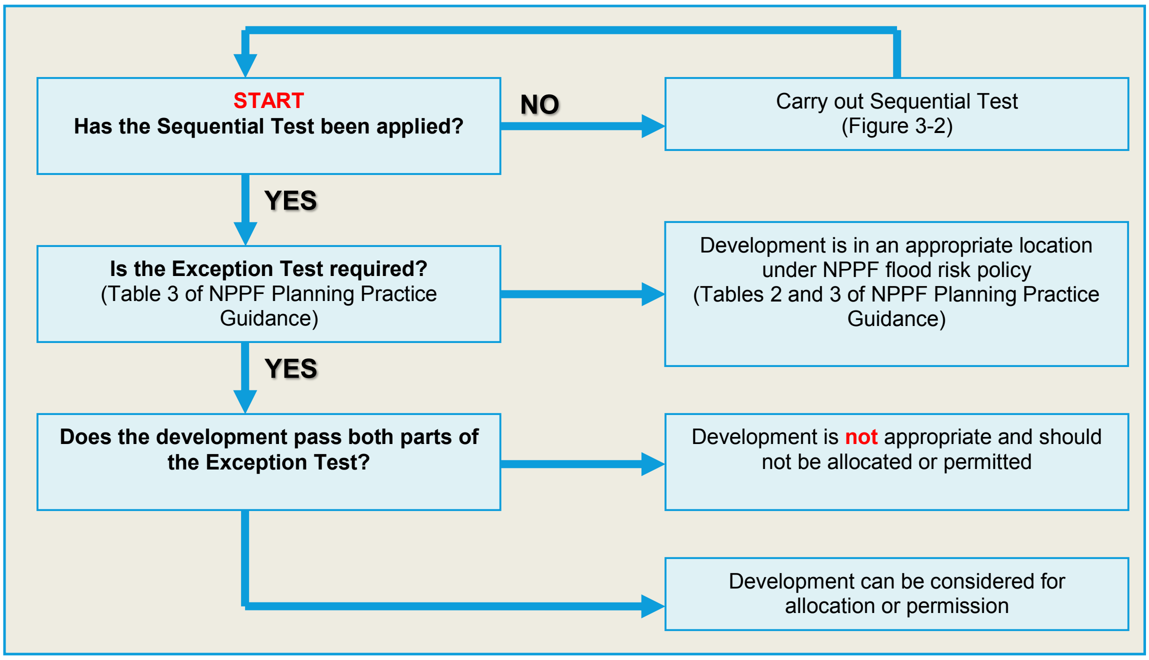
[26] Environment Agency (2012) Demonstrating the flood risk Sequential Test for Planning Applications version 4 http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/static/documents/Sequential_test_process_4.pdf

Figure 3-2: Applying the Sequential Test in the preparation of a Local Plan†



† Based on Diagram 2 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 020, Reference ID: 7-021-20140306) March 2014

Figure 3-3: Applying the Exception Test in the preparation of a Local Plan†



† Based on Diagram 3 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 028, Reference ID: 7-021-20140306) March 2014

3.2 Applying the Sequential Test and Exception Test to individual planning applications

The NPPF Planning Practice Guidance[27] sets out how developers and planners need to consider flood risk to, and from, the development site, following the broad approach of assessing, avoiding, managing and mitigating flood risk. A checklist for Site Specific Flood Risk Assessments is provided in Paragraph 68 of the Guidance.

A site-specific flood risk assessment should be carried out to assess flood risk to, and from a development. The assessment should demonstrate how flood risk will be managed over a development's lifetime, taking climate change and the user vulnerability into account.

The NPPF Planning Practice Guidance sets out the following objectives for a site specific Flood Risk Assessment (FRA). An FRA should establish:

- Whether a proposed development is likely to be affected by current or future flooding from any source
- Whether it will increase flood risk elsewhere
- Whether the measures proposed to deal with these effects and risks are appropriate
- The evidence for the local planning authority to apply (if required) the Sequential Test
- Whether the development will be safe and pass the Exception Test (where applicable)

3.2.1 Sequential Test

The Sequential Test must be performed when considering the placement of future development and for planning application proposals. The sequential approach to locating development should be followed for all sources of flooding. The Flooding and Coastal Change Planning Practice Guidance to the NPPF gives detailed instructions on how to perform the test.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site)

The Sequential Test does not normally need to be applied for individual developments under the following circumstances

- Development proposals in Flood Zone 1 (unless the SFRA for the area, or any other recent information, indicates there may be flooding issues now or in the future)

For developments that do not fall under the above categories, local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies27. A pragmatic approach should be taken when applying the Sequential Test.

Local planning authorities, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied, and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The information provided in this SFRA can be used to:

- Identify the area to be assessed (including alternatives) on the Flood Zone Maps that are provided with this assessment;
- Establish the risk of flooding from other sources
- Follow the instructions given in the Planning Practice Guidance.

27 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 033, Reference ID: 7-056-20140306) March 2014

3.2.2 Exception Text

If, following application of the Sequential Test, it is not possible for the development to be located in areas with a lower probability of flooding then the Exception Test must be applied, if appropriate. The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

1. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared

   Local planning authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and provide advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the local planning authority should consider whether the use of planning conditions and/or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[28].

2. A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

   The site specific flood risk assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered[29]

- The design of any flood defence infrastructure
- Access and egress
- Operation and maintenance
- Design of the development to manage and reduce flood risk wherever possible
- Resident awareness
- Flood warning and evacuation procedures
- Any funding arrangements required for implementing measures

The NPPF and Technical Guidance provide detailed information on how the Test can be applied.

3.3 Localism Act30

The purpose of this Act, which was given Royal Assent on 15 November 2011, is to shift power from central government back to the councils, communities and individuals. This Act allows councils to establish their own development plans to take account of local employment, housing and other land used in the plan making process.

In order for councils to achieve sustainable development practices, Provision 110 of the Act was introduced to encourage cooperation during the planning process. This duty to cooperate requires Local Authorities to "engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter".

Another requirement of this Act is for councils to provide technical advice and support on neighbourhood's development proposals. The Act enables local people to decide on the location of new housing and business developments through the use of neighbourhood plans. Following a request to the LB of Haringey the Council has approved the Highgate Neighbourhood Forum and Neighbourhood Area.

[28] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014
[29] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014
[30] Localism Act 2011: Section 110. http://www.legislation.gov.uk/ukpga/2011/20/section/110

3.4 The London Plan[31]

Policy 5.12 within the London Plan (2011) focuses on development in flood risk areas and describes how the Exception test is required in order to assess the flood resilient design of any proposal. The policy also states that development close to flood defences will be required to protect existing defences and not adversely impact flood defence in the area.

The Plan also states that fluvial flood risk in the London area is expected to increase over the next century due to a predicted 40% increase in peak flows. Therefore one of the main approaches of this plan is to steer development away from high flood risk areas so that new development can provide a means to reduce flood risk. This can be achieved by putting flood conveyance schemes into practice and setting development away from river banks.

The Plan states that the preparation of Local Development Frameworks (LDFs) is vital in the planning process as it requires SFRA to be prepared at a local level within the LB of Haringey in which a high level assessment of the flood risk is made for sites allocated within the local plan. Once the risk to these sites has been identified, the policies are adjusted in an attempt to reduce these risks, especially when redeveloping sites at risk of flooding.

3.5 London Regional Flood Risk Appraisal (RFRA)[32]

This RFRA, combined with the policies in the London Plan, aims to ensure that overall flood risk (probability x consequences) does not increase and that by addressing existing problems, overall risk is reduced.

The RFRA recognises that managing flood risk in London cuts across the responsibilities of many organisations. Whilst the Environment Agency and the LLFA have the lead responsibility, the RFRA recommends that co-ordinated actions/policies and collaborative working are required to manage and minimise the risks.

The RFRA highlights that the fluvial risk posed by the River Lee and its tributaries is an issue and recognises the River Thames CFMP's policy to take further action to reduce the risk of flooding.

In addition it recognises that the River Moselle presents a risk although there is limited floodplain identified. It suggests that redevelopment should seek to reduce surface water discharge.

The RFRA contains 19 recommendations, involving or led by a range of organisations. Progress against these recommendations is monitored annually in the London Plan Annual Monitoring Report. Of these 19 recommendations, three refer to specific locations outside of the LB of Haringey, the remaining 16 are of relevance will be taken into consideration by the LB of Haringey when considering planning applications.

3.6 River Basin Management Plan Thames River Basin District

The River Basin Management Plan (RBMP) was issued in 2009 and is about the pressures facing the water environment across the Thames river basin district and the actions that will address them. It has been prepared under the Water Framework Directive, and is the first of a series of six-year planning cycles. The programmed management cycles are 2009-2015, 2015-2021 and 2021-2027. It is anticipated that the plan will result in 60% of all water bodies achieving good ecological status by 2021 and as many as possible by 2027. The plan identifies all watercourses in Haringey lie in the 'London catchment' and as such are generally affected by issues caused by:

- Pollution pressures through increased runoff and operation of Combined sewer Overflows (CSOs).
- Misconnections.
- Point discharges of effluent from sewage treatment work effluent.

To deliver the outcomes the Environment Agency and Natural England will work together to develop and implement the 'London Rivers Action Plan'.

[31] Mayor of London (2011) The London Plan - Spatial development strategy for London available at http://www.london.gov.uk/sites/default/files/The%20London%20Plan%202011_0.pdf
[32] London Regional Flood Risk Appraisal (2009) available at http://www.london.gov.uk/sites/default/files/uploads/regional-flood-risk09.pdf

The SFRA identifies and influences the implementation of measures that not only address flood risk but also contribute to improved water quality. When using information in the SFRA consideration should be given to the multiple benefits that can potentially be obtained when delivering new infrastructure and the contribution that can be made to sustainable water management as defined in the Thames RBMP.

3.7 Association of British Insurers (ABI): Guidelines on Planning and Insurance in Flood Risk Areas for Local Authorities in England.33

The National Flood Forum and the ABI have published guidance which aims to help local authorities in England when producing local development plans and helps them deal with the planning application process in flood risk areas. The guidance compliments the NPPF and the main guidelines are:

- Ensure strong relationships with technical experts on flood risk
- Consider flooding from all sources, taking account of climate change impacts
- Take potential impacts on drainage infrastructure seriously
- Ensure that flood risk is mitigated to acceptable levels for proposed developments
- Make sure local plans take account of all relevant costs and are regularly reviewed

3.8 Climate Change and Adaptation and Mitigation

An important part of the SFRA analysis process is the consideration of future climate change and the increased impact that development may have as a result of that climate change. When reviewing development plans it is important to understand not only the current predicted flood risk to a site but also the flood risk for the life time of the development. For residential development the analysis is undertaken based on a development lifetime of 100 years. A number of adaptation and mitigation measure are considered within this document and should be a feature of planning applications and FRAs in support of development within the LB of Haringey on a site by site basis. The following section serves as an introduction to the assessment behind these measures and the reasoning for their importance to development. The focus has been on new development however the key features of this discussion apply equally to retro-fit of adaptation and mitigation measures to existing development.

3.8.1 Adaptation

The UK Climate Change Impacts Programme (UKCCIP) report Identification of Adaptation Options[34] presents a framework for identifying and appraising adaptation measures. It starts with identifying that there may be several viable options for effective adaptation. These options are then reviewed to assess the risks of implementation in the face of associated uncertainties. As a result of this review schemes that are the most cost effective and present multiple benefits come out of the analysis above those that are cost intensive and are reliant on a substantial increase on the current level of risk to provide significant benefit.

Following a review, adaptation options have been grouped into four categories:

- No-Regrets,
- Low Regrets,
- Win-Win
- Flexible/Adaptive Management.

The four categories are discussed below.

No-regrets options

[33] Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England (Association of British Insurers and National Flood Forum, April 2012)

[34] Identifying adaptation options -UK Climate Change Impacts Programme http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID_Adapt_options.pdf

No-regrets options are adaptive measures that deliver benefit whatever the extent of future climate change. No-regrets options include those justified (cost-effective) under current climate conditions and the benefits of the scheme are only further justified when consideration of projected climate change levels is taken into account. Focusing on no regrets options is particularly appropriate for the near term as they are more likely to be implemented due to their obvious and immediate benefits.

No-regrets adaptation options include actions or activities directed at building adaptive capacity as part of an overall adaptive strategy. Those relevant to the SFRA include the following examples:

- Avoiding building in high-risk areas (e.g. flood plains) when locating development (Sequential Test)
- Reducing water usage in new development
- Building/designing property and buildings to minimise over-heating in summer months though the use of green space and running water.
- Reducing the consequences of flooding (increasing resilience) through the use of water-resistant materials for floors, walls and fixtures, and the sitting of electrical controls, cables and appliances at a higher than normal level.

Such options will require investments but overall are at least cost neutral when the immediacy of the targeted risks and realised benefits are considered.

Low-regrets options

Low regrets options are adaptive measures for which the associated costs are relatively low and for which the primary benefits realised only under the projected future climate change scenario. Benefits under these scenarios may be relatively large and there may even be some current benefits from implementing the schemes, but the present day benefits alone would not be enough to pass cost-benefit analysis by its self.

Low-regret adaptation options include actions or activities that directly target the consequences of climate change but have a low relative cost. Those relevant to the SFRA include:

- Building extra climate headroom in new developments to allow for further modifications (e.g. increased drainage and increased finished floor level)
- Restricting the type and extent of development in flood-prone areas
- Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of additional temporary storage of runoff or flood water
- Sharing in developing and operating additional water storage facilities (e.g. Community groups, Local Flood Risk Management partnership working arrangements to identify and implement measures).
- Improving the flood resilience of critical infrastructure, when it is renewed. (such as electricity sub stations).

Both no- and low-regrets options have merit in that they are directed at maximising the return on investment when certainty of the associated risk is low.

Win-Win options

Win-win adaptation options are measures that have the desired result in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits. Within the climate change context, win-win options are often associated with those measures or activities that address climate impacts but which also contribute to mitigation or other social and environmental objectives. These types of measures include those that are introduced primarily for reasons other than addressing climate risks, but also deliver the desired adaptation benefits.

- Flood management that includes creating or re-establishing flood plains which increase flood management capacity and support biodiversity and habitat conservation objectives;
- Improving preparedness and contingency planning to deal with risks (including climate);
- Green roofs and green walls which have multiple benefits in terms of reducing building temperature and rainfall runoff from buildings, and increased green spaces within urban areas, but also reduces energy use for both heating and cooling.

- Flood mitigation measures that also contribute to improved water quality within the catchment (e.g. SUDs measures that improve the quality of discharges to the River Lee)

Flexible or adaptive management options

Flexible or adaptive management adaptation options involve putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. This approach reduces the risks associated with being wrong, since it allows for incremental adaptation. Measures are introduced through an assessment of what is appropriate today, but are designed to allow for incremental change, including changing tack, as knowledge, experience and technology evolve.

“Delaying” introducing a specific adaptation measure (or suite of measures) can be part of a flexible or adaptation management strategy as long as that decision is accompanied by a commitment to continue building the necessary adaptive capacity while continuing to monitor and evaluate the evolving risks. A decision to delay introducing a specific action is often taken when the climate risks are below defined thresholds or when the required adaptive capacity is insufficient to warrant immediate effective action.

Examples of Flexible or adaptive management adaptation options that are relevant to the SFRA include:

- Delay implementing specific adaptation measures while improving understanding of risk
- Introducing progressive withdrawal from areas at risk of flooding and creation or re-establishment of floodplains consistent with risks and development lifetimes
- Progressive development and investments in adaptation measures consistent with projected changes in climate (e.g. progressive investments in defence maintenance and level raising to maintain status quo).

Flexible or adaptive management options are perhaps the most important to plan ahead of time and should be a key feature of any local flood risk management plan. Flexible or adaptive management options are best suited to schemes that are not economically viable under the present circumstances, based on the whole life costing. However, as the local situation changes with time (e.g. change in land use and development rates) then the schemes become increasingly viable. By identifying this type of opportunity early on it is possible to invest in a flexible plan of action and avoid repetition of work each time the scheme or measure is reviewed. A solution can be as simple as over engineering the foundations of a flood defence so that additional courses of bricks can be added over time to raise the level of the defence, rather than having to demolish the defence and start anew each time its level is altered. Such measures also allow for careful financial management of the funding to spread the whole life cost across a number of different funding streams as they become available.

3.8.2 Mitigation measures

The scale of redevelopment being proposed in the next 5, 10 and 15 years presents an important opportunity to 'design-in' capacity for climate change mitigation into new development. The key opportunity for development or re-development of this scale is to build in additional capacity into systems to counter the predicted effects of climate change. This form of adaptation linked to new development is particularly important in densely developed urban areas, where it is possible to gradually introduce measures that contribute to a reduction in the overall effects of climate change in subsequent planning cycles and periods of redevelopment.

By requiring sites to mitigate today for the effects of 100 years of climate change it has the additional benefit of introducing local capacity in the present day systems. The mitigation schemes that include provision for the level of service, which will be required in 100 years, will provide an augmented level of service under present day conditions.

4. Mapping and Risk Based Approach

4.1 Summary of Mapping for All Sources of Flood Risk

The sections below summarise the assessment that has been undertaken of flood risk in the LB of Haringey for all sources of flooding.

4.1.1 Hydraulic River Modelling

Flood risk from the following 'watercourses' was considered as part of this SFRA

Watercourse	Type	Responsible Party	Representation
Coppets Brook (or Coldfall Wood Brook)	Ordinary Watercourse	LB of Haringey	Surface Water model
Strawberry Vale Brook	Main River	EA	Surface Water model
Bounds Green Brook	Main River	EA	ISIS-TUFLOW EA model
Muswell Hill Golf Course Brook	Ordinary Watercourse	LB of Haringey	Surface Water model
Muswell Stream	Ordinary Watercourse	LB of Haringey	Surface Water model
New River	Water supply aqueduct	Thames Water	Surface Water model
Upper Moselle Brook Tributaries	Ordinary Watercourse	LB of Haringey	Surface Water model
Moselle Brook (or River Moselle)	Main River	EA	ISIS-TUFLOW EA model
Lower Moselle Brook	Ordinary Watercourse	LB of Haringey	Surface Water model
Lesser Moselle	Ordinary Watercourse	LB of Haringey	Surface Water model
Carbuncle Ditch (or Garbell Ditch)	Main River	EA	ISIS-TUFLOW EA model
Stonebrook Ditch	Main River	EA	ISIS-TUFLOW EA model
Pymmes Brook	Main River	EA	ISIS-TUFLOW EA model
River Lee Navigation	Main River	EA	ISIS-TUFLOW EA model
River Lee Diversion (or River Lee New Cut)	Main River	EA	ISIS-TUFLOW EA model
River Lee	Main River	EA	ISIS-TUFLOW EA model

Where watercourses have been listed as being represented by an ISIS-TUFLOW EA model the watercourse is included in a 1D-2D hydraulic model with the channel represented in the 1D ISIS element and the floodplain is represented in the 2D TUFLOW element. These models are currently in the process of being updated by the EA but unfortunately are not available in time for this document.

Where watercourses have been listed as being represented by the surface water model, it has been assumed that the channel capacity has limited influence on flood potential and in the absence of other modelling it is assumed that the surface water flood risk modelling (outlined in this chapter) is suitable for representing flood risk in these areas. These areas mostly contain culverted ordinary watercourses and the nature and extent of the connectivity to the surface is unknown.

4.1.2 Surface Water

There are three sources of information that can be used in relation to the identification of potential surface water flood risk in the LB of Haringey. These are:

3. The updated Flood Map for Surface Water (uFMfSW) which predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. If the uFMfSW indicates a risk to a site allocation or settlement this has been discussed in further detail in Section 10 and Appendix A It should be noted that, because of its broad-scale nature, wherever possible these mapped outlines should be used in conjunction with other sources of local flooding information to confirm the presence of a surface water risk.
4. Results from the Haringey SWMP hydraulic models - As part of the SWMP process hydraulic modelling has been undertaken to model the risk from pluvial sources. Several 2-dimensional direct rainfall models were created, using the TUFLOW software, to determine the causes and consequences of surface water flooding within Haringey. The results of the models provide an indication of key flow paths, velocities and areas where water is likely to pond. This modelling was used to define Critical Drainage Areas. It should be noted that this modelling did not take full account of the hydraulic effect of underground pipe systems[35]. Underground pipe systems have potential to provide conveyance of flows away from areas of flooding to reduce the flood extent. Conversely the same underground pipe systems have the potential to increase flood extent to that currently shown as a result of blockage, under capacity or surcharge of pipes. This may be appropriate for a strategic assessment however should not be considered appropriate for a site specific FRA.
5. Results from Critical Drainage Area detailed hydraulic models - following the identification of Critical Drainage Areas within the Haringey SWMP a rolling programme of detailed modelling has been undertaken to improve the confidence in surface water flood risk mapping in these high-risk areas. At the time of preparation of this version of the SFRA results are available for CDAs 055 (Area North of Hornsey High Street, Hornsey), 057 (Seven Sisters / Culvert Road, South Tottenham) and 073 (Alexandra Palace Railway Station and mainline railway, Wood Green). Results for CDAs 063 (The Roundway (A10) and Warkworth Road, Tottenham), 061 (Tottenham High Road and Suburbs, Tottenham Hale) and 075 (Ellenborough Road, Noel Park) are subject to approval. Results for CDA 010 (Green Lanes and neighbouring roads, Wood Green) are being taken forward in partnership with LB of Enfield. Future work is expected on CDAs 56 (Rathcoole Gardens, Hornsey Vale) and 62 (Milton Park and Causton Road, Crouch End).

For the purposes of this report we will be referring to the CDA detailed model results where these are approved, and uFMfSW in areas where the detailed results are still pending approval or not available. The modelling results from the LB of Haringey SWMP (2012) have not been retained on the assumption that these are superseded by the uFMfSW modelling which should in-turn be superseded by the detailed CDA modelling results once approved to make use of the latest and best information available.

The events referred to and used to inform this study are the

- 1:30 AEP;
- 1:100 AEP;
- 1:1000 AEP.

4.1.3 Ground Water

Groundwater flood risk was considered through review and analysis of the following datasets

- Bedrock geology
- Superficial deposits
- Areas Susceptible to Groundwater Flooding (AStGWF), a strategic scale map showing groundwater flood areas on a 1km square grid
- Source Protection Zones (SPZs)[36]

[35] See Appendix C1 of the LB of Haringey SWMP for further information regarding the methods used to model surface water within Haringey.

[36] Groundwater maps are available at http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=groundwater

- Mapping of ground water emergence flood risk was also informed by the LB of Haringey SWMP. It should be noted that, as discussed in the SWMP, the iPEG map[37] is intended as an assessment of potential risk from groundwater flooding at surface level. The iPEG data does not cover flood risk to subterranean development or other below surface activities.

4.1.4 Reservoir Inundation Mapping

National Reservoir Inundation Maps (NRIMs) have been provided by the Environment Agency to inform this study. The following reservoirs are considered in this assessment.

Table 4-1: Reservoirs

Reservoir Name	Utility Company	Local Authority
High Maynard	Thames Water Ltd	Waltham Forest
Lockwood	Thames Water Ltd	Waltham Forest
Stoke Newington (East)	Thames Water Ltd	Hackney
Crouch Hill	Thames Water Ltd	Haringey
East Warwick	Thames Water Ltd	Waltham Forest
Bishops Wood Reservoir	Thames Water Ltd	Haringey
King George V	Thames Water Ltd	Enfield
West Warwick	Thames Water Ltd	Waltham Forest
Walthamstow No.5	Thames Water Ltd	Waltham Forest
Stoke Newington (West)	London Borough of Hackney	Hackney
Walthamstow No.4	Thames Water Ltd	Waltham Forest
Fortis Green	Thames Water Ltd	Haringey
Banbury	Thames Water Ltd	Waltham Forest
William Girling	Thames Water Ltd	Enfield
Hornsey	Thames Water Ltd	Haringey

4.2 Other Relevant Flood Risk Information

The mapping prepared for this version of the SFRA provides information on

- the extent of flooding;
- the depth of flooding;
- the velocity of flood water; and
- the hazard from floodwater.

It should be noted that users of this SFRA should also refer to other relevant information on flood risk, as this is published and becomes available, where this is appropriate. Other information that should be referred to includes:

- The LB of Haringey's Preliminary Flood Risk Assessment (PFRA)
- The LB of Haringey's Surface Water Management Plan (SWMP)
- Hazard and Risk Mapping prepared for the Flood Risk Regulations
- Flood Risk Management Plan in accordance with the Flood Risk Regulations
- Environment Agency's Asset Information Management System (AIMS)
- National Receptor Dataset (NRD) (available now)

Information produced by the Environment Agency on how to challenge Flood Maps and Flood Zones included within the SFRA is included in Appendix C.

[37] LB of Haringey (2011) Surface Water Management Plan for London Borough of Haringey Figure 10 Increased Potential for Elevated Groundwater Map

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5. Overview of Future Development

5.1 Introduction

Haringey Council Local Plan: Strategic Policies (formerly Core Strategy) was adopted in March 2013. The London Plan sets the London wide target of 322,100 additional homes from 2011/2012 to 2021/2022 with the target for the LB of Haringey being 8,200 additional dwellings. The LB of Haringey's annual housing trajectory, which shows sites that are expected to come forward within the next 15 years, shows the supply of additional homes is expected to be approximately 13,000. The Council are seeking to enable the development of 861 new dwellings per year or 5% above the target stipulated in the London Plan as required by NPPF.

This chapter of the report considered the effect of the proposed development on the surface water catchment.

A four step approach has been taken to prepare results as described below:

- Part 1 contains a description of the proposed development sites, their location, their size, their proposed use and the estimated timeframe for their development. This is presented in sections 5.2 to 5.4. The assessment also identifies whether the sites lie in a Critical Drainage Area (CDA), as defined in the Surface Water Management Plan. In addition surface water drainage catchments called Haringey Drainage Areas (HDAs) are defined to enable strategic management of runoff outside of CDAs.
- Part 2 describes the process for establishing a 'green field' baseline estimate of surface water runoff for each of the sites which is then used to assess the potential effects of proposed and existing development. This is presented in section 5.5.
- Part 3 describes the results of the assessment of proposed and existing development over a 5, 10 and 15 year period. This is presented in sections 5.6 to 5.7.
- Part 4 describes the results from assessment of the impact of climate change on surface water runoff for the 'green field' scenario, the existing situation and a scenario where by proposed development occurs as planned. This is presented in section 5.8.

5.2 Part 1A - Extent and type of development

133 sites for future development have been identified for review within this report. For the purposes of discussion within this report, the areas have been grouped by their respective CDA or HDA as relevant into 17 areas shown in Figure 5-1 (note 3 drainage areas do not feature development sites). Where site cross more than one CDA or HDA they are assigned to the drainage area where within which the centre point of the site is located. The sites are grouped as shown in Table 5-1

Table 5-1: Development sites by group

Group No.	Group Name	Sites
Group4_010	Green Lanes and neighbouring road, Wood Green	Myddleton Road (south), Wood Green N22 Civic Centre, High Road Wood Green, N22
Group4_055	North of Hornsey High Street and west of mainline railway, Hornsey	Highgate Rail & Gonnerman's Wightman Road Tunnel Gardens Texaco Garage, Tottenham Lane, N8 R/O 1-15 Park Avenue North, N8 R/O 1-31 Priory Avenue, N8 L/A 1 Shanklin Road, N8 Old Crouch End Motors, Coleridge Road, N8 Works on Summersby Road, N6 Playing Fields, Stanhope Road, Hornsey, London, N6 5AW Lynton Road

Group No.	Group Name	Sites
		Alexandra Palace Haringey Heartlands - Hornsey Depot, N8
Group4_056	Rathcoole Gardens, Hornsey Vale	Rear of 60-88 Cecile Park, N8 Hornsey Town Hall, The Broadway, N8 159 Tottenham Lane N8 9BT
Group4_057	Seven Sisters Road, South Tottenham	Summersby Road Overbury Road 500 White Hart Lane Helston Court Harringey Warehouse District Former Petrol Station, 308 West Green Road, N15 St Annâ€™s Hospital, N15 341-379 Seven Sisters Road, N15 Arena Business Centre, Ashfield Road, N15 Seven Sisters Road/Durnford Street/Gourley Place, N15 Omega Works, Hermitage Road, N15 British Distributing Co, Colina Mews, Green Lanes, N4 Ashfield Road, N4 1PG Finsbury Park Bowling Alley Seven Sisters and Westerfield Road, N15 5LF
Group4_061	Tottenham High Road and area surrounding Hatfield Road, Tottenham	Land Adjacent Railway Lines, White Hart Lane, N15 Castleford Close, Castleford Road, N17 Site next to 6th Form Centre, College Rd/Pretoria Rd, N17 686 & 700-702 High Road, N17 0AE Irish Centre White Hart Lane High Road West White Hart Lane Stadium, N15
Group4_062	Milton Park, Crouch End	Turnpike Lane Triangle Furnival House, 50 Chormley Park, N6 5EW Cholmeley Park N6 5ET Tottenham Delivery Office
Group4_063	The Roundway (A10) and Warkworth Road, Tottenham	Bury Road Car Park
Group4_073	Alexandra Palace Railway Station and mainline railway, Wood Green	100 Albert Road, N22 7AH Sunshine Garden Centre, Durnsford Road, Wood Green, London, N11 2EL
Group4_075	Lordship Lane and Ellenborough Road, Noel Park	No sites identified
HDA_01	Fortis Green and Highgate	460-470 Archway Road Highgate Bowl Apex House St Lukeâ€™s Woodside Hospital, Woodside Avenue, N10 Coppetts Road, N10 Highgate/Church Road Clinic, N6 Cranwood Home for the Elderly, Woodside Avenue N10 10A Annington Road, N2

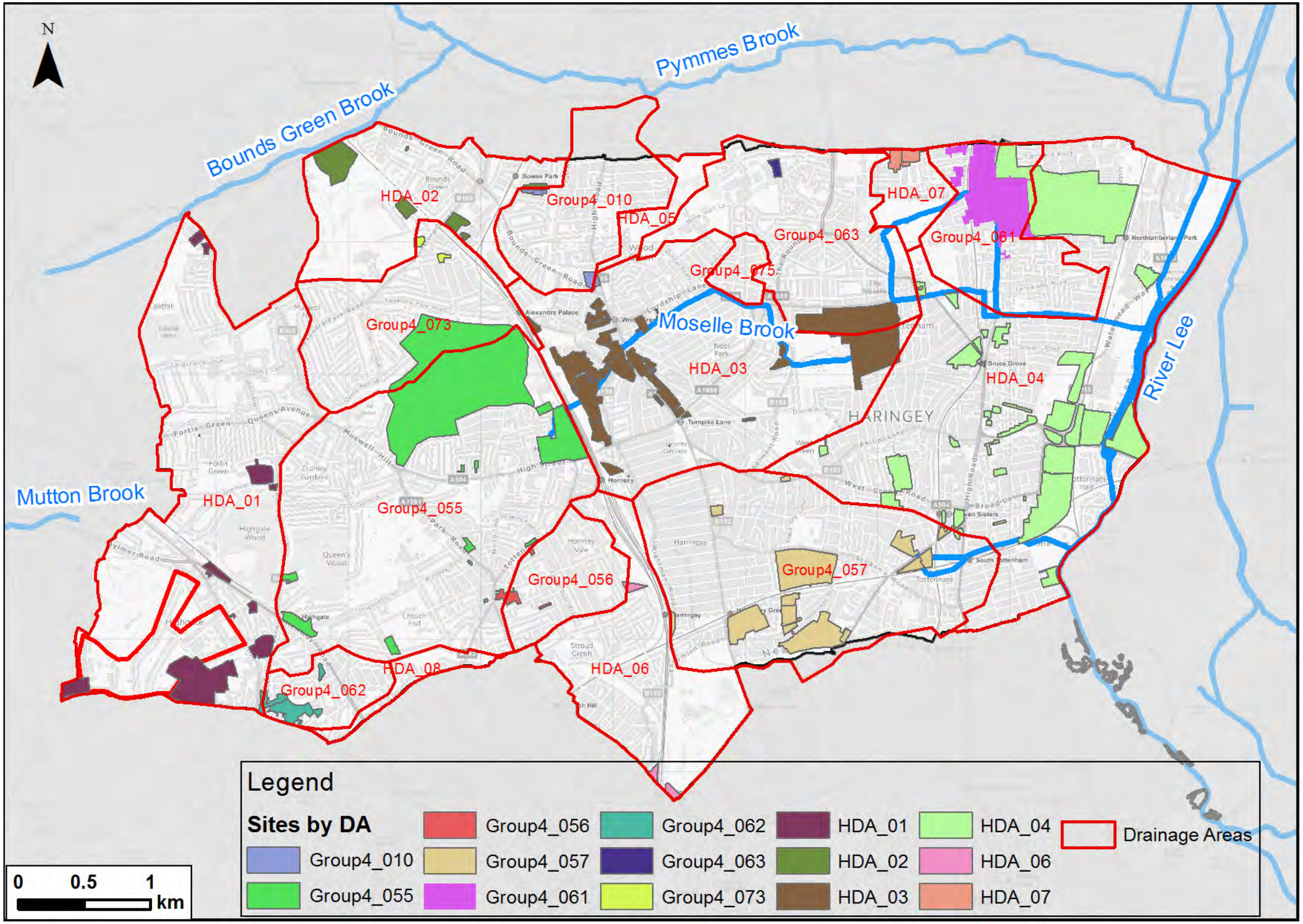
Group No.	Group Name	Sites
		Gilson Place, Copetts Road, N10 1JP 505-511 Archway Road, N6 4HX Highgate Magistrates Court Land Rear of 318-320 High Road 460-470 Archway Road Highgate Bowl Apex House St Lukeâ€™s Woodside Hospital, Woodside Avenue, N10 Coppetts Road, N10 Highgate/Church Road Clinic, N6 Cranwood Home for the Elderly, Woodside Avenue N10 10A Annington Road, N2 Gilson Place, Copetts Road, N10 1JP 505-511 Archway Road, N6 4HX Highgate Magistrates Court Land Rear of 318-320 High Road
HDA_02	North Alexandra Park and Bounds Green	Clarendon Road South Tottenham Magistrates Court Aneurin Bevan House, N11 Friern Barnet Former Sewage Works, Pinkham Way, N10 L/A 28 Torrington Gardens, N11 Myddleton Road (North), Wood Green N22
HDA_03	Noel Park, West Green and west Bruce Grove	Morrisons Wood Green Library Stroud Green Road Park Grove & Durnsford Road Land Between Westbury & Wymark Avenues Wood Green High Road Tottenham Hale Retail Park Gourley Triangle Clarendon Square Gateway Hornsey Water Treatment Works Brunel Walk & Turner Avenue Helston Court & Russell Road 353A Wightman Road, N8 105 Raleigh Road, N8 Haringey Heartlands - Phase 1, N22 Lymington Avenue, N22 Haringey Professional Development Centre, Downhills Park Road, N17 41-67 High Road Wood Green, N22 673 Lordship Lane, N22 5LA Barbour Wilson & Co Ltd. Crawley Road N22 6AN Leaside Buses Bus Depot, High Road N22 4TZ Green Ridings House High Road Bounds Green Road N22 8HE Broad Water Farm Haringey Heartlands - Phase 2, N22

Group No.	Group Name	Sites
HDA_04	East Bruce Grove, Tottenham Hale, and Northumberland park	Hale Village Land front of Tottenham Leisure Centre South Tottenham Indrustrial Park Land Behind Seven Sisters and Tewkesbury Road Reynardson Court Tamar way Lawerence Road Westerfield Road Car Park Reynardson Court and Tamar Reynardson Court and Tamar Bruce Grove/ Tottenham Delivery Office Tottenham Hale, Ashley Road Depot & Technopark , N15 Tottenham Hale: Ashley Road South , N15 Tottenham Hale: Welbourne Centre, Park View Road, N15 Tottenham Hale: Hale Wharf, N15 Tottenham Hale: Tottenham Hale Retail Park, N15 Tottenham Hale: Tottenham Hale Station & Forecourt, N15 Lawrence Road, N17 52-68 Stamford Road, N15 313-315 The Roundway, N17 Magistrates Court, Lordship Lane, N17 Marsh Lane, N15 Protheroe House Wards Corner, Tottenham N15 Somerset Road, N17 9EJ Stamford Road, N15 4PU Tynemouth House, N15 4AT Westerfield Road, N15 5JX 551a Morrisons Yard, High Road, Tottenham N17 6SB Land between Rangemoor Road and Herbert Road N15 4ND Saltram Close, N15 4DZ Bruce Grove Paddocks at Hale Wharf Monument Way Moorefield Road at Grove Station Northumberland Park Turner Avenue & Brunel Court Keston Road Day Centre Council buildings at Apex House 820 Seven Sisters Road Tottenham,N15 5PQ
HDA_05	Woodside	No sites identified
HDA_06	Stroud Green and Harringay	Hillcrest Mecca Bingo Chettle Grove
HDA_07	White Hart Lane	39 Queen St, N17 The Selby Centre, Selby Centre, Tottenham N17 8JL
HDA_08	South Crouch End	No sites identified

5.3 Part 1B - Review of Future Development

Each of the proposed sites put forward for review in relation to future development in this document are summarised by the grouped areas defined.

Figure 5-1: Development Areas in LB of Haringey



Group No.	Group Name	Drainage Area area (km^2)	Development Site area (km^2)	% of Drainage Area identified as development site
Group4_010	Green Lanes and neighbouring road, Wood Green	1.08	0.02	1.7
Group4_055	North of Hornsey High Street and west of mainline railway, Hornsey	4.23	0.89	21.1
Group4_056	Rathcoole Gardens, Hornsey Vale	0.62	0.02	2.6
Group4_057	Seven Sisters Road, South Tottenham	3.03	0.36	11.8
Group4_061	Tottenham High Road and area surrounding Hatfield Road, Tottenham	1.15	0.28	24.3
Group4_062	Milton Park, Crouch End	0.42	0.06	14.4
Group4_063	The Roundway (A10) and Warkworth Road, Tottenham	1.74	0.01	0.5
Group4_073	Alexandra Palace Railway Station and mainline railway, Wood Green	1.38	0.01	0.7
Group4_075	Lordship Lane and Ellenborough Road, Noel Park	0.15	0.00	0.0
HDA_01	Fortis Green and Highgate	3.87	0.22	5.8
HDA_02	North Alexandra Park and Bounds Green	1.44	0.10	6.8
HDA_03	Noel Park, West Green and west Bruce Grove	3.31	0.54	16.2
HDA_04	East Bruce Grove, Tottenham Hale, and Northumberland park	5.25	1.02	19.4
HDA_05	Woodside	0.21	0.00	0
DA_06	Stroud Green and Harringay	1.51	0.02	1.3
HDA_07	White Hart Lane	0.32	0.03	8.5
HDA_08	South Crouch End	0.19	0.00	0.0
Total		29.90	3.56	11.9

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5.4 Part 1C - Programme of Future development

To assess the impact of development over the next 5, and 15 years the following assumptions have been included:

- Baseline site runoff estimates are based on the runoff that would be generated by the 'green field' (undeveloped) scenario
- Post development sites are assumed to have an un-attenuated runoff rate of 70% (i.e. 70% of rain falling on a site becomes runoff)
- Where sites are listed in the Housing Trajectory the number of units complete is used as a proxy for the percentage of development of that site complete for the 5 year estimations.
- Where sites are not listed in the housing trajectory one of the following assumptions have been made:
    - Small non-major infill site. These sites not listed on the Housing Trajectory as they have arereass less than 0.25ha it is assumed that this wil be assumed to have a 50/100/100 split, that is to say they are assumed to be 50% complete in 5 years and 100% complete in 10 (therefore also 100% complete in 15 years).
    - Non Residential. Where sites are identified for non-residential development a 50/100/100 split is assumed. Non-residential sites would not feature in the Housing Trajectory.
    - Planning application received / approved. Where sites have submitted planning applications or received permission but not included on the Housing Trajectory, a 50/100/100 split is assumed.
    - Development Complete. Where sites are listed as complete they are assumed to be 100% complete from day 1 therefore a 100/100/100 split is assumed.
    - Community Gardens / Protected Open Space. Where sites are listed as existing or likely community gardens or protected open space it is assumed that no development will occur there for a 0/0/0 split is used.
    - Other. Where sites do not feature in the housing trajectory but do not fall into one of the above classes a 50/100/100 split is assumed.

5.5 Part 2 - Defining the Baseline

The sites proposed for development have a variety of existing uses with different methods of draining surface water. It is likely that the majority of sites are served by undefined existing surface water drainage measures. For the purposes of this SFRA and to establish a clear baseline for all sites, an estimation of green field runoff has been prepared and assumed to be the baseline condition. The rationale for using green field runoff to establish a baseline across all development sites is so that all development can be assessed on equal terms and against the 'natural' response of the catchments to rainfall events. This method is supported by the Haringey Sustainable Design and Construction draft Supplementary Planning Document[38] which states that surface water discharge from the developed site should mimic that of an undeveloped green field site, up to and including a 1 in 100 annual exceedance probability critical duration storm event. It should be noted that this method is also in line with DEFRA's draft National Standards for sustainable drainage systems[39] recommendations. All development sites should include sustainable drainage systems that seek to mimic the green field response of the site up to a minimum of the 1 in 100 year event for critical duration (see discussion of critical duration in section 5.5.1).

The baseline conditions are assessed by considering:

- The critical duration of the rainfall event (the length of time it is raining)
- The effect of the underlying soil and geological strata on the rate and volume of rainfall that runs off the land (the rate and volume of runoff)
- The depth of rainfall that falls and how this varies across the borough

5.5.1 Critical duration

For the purposes of the high level assessment described in this study a critical duration of 6 hours has been used. This is supported by the draft National Standards for Sustainable Drainage Systems. However it is acknowledged that this may not be reflective of the local critical duration for sites within the LB of Haringey. There are a number of considerations in establishing the critical duration rainfall event for a site, most notably the response from the receiving flow path. The LB of Haringey sits within the Thames Catchment which can have a response to extreme rainfall events that are measured in days and weeks, it also sits within the River Lee sub-catchment which can have a response lasting for days in the region of 50-75 hours. The sites may also drain to the Lee tributary sub-catchments such as the Moselle Brook or Stonebridge Brook which will have much quicker reactions than the Rivers Lee or Thames. The critical duration of the receiving infrastructure or watercourse is an important consideration when considering drainage system design. All of the sites' specific FRAs should include an assessment of the critical duration of the receiving watercourse. Storage retention time is an important consideration in managing the runoff volume and peak flow from a site. FRAs should include a site drainage strategy including an assessment of the local and cumulative impact of storing runoff with controlled release at green field rates to ensure no negative impact downstream.

5.5.2 Green field runoff

To establish green field runoff volumes it is necessary to define the rate of runoff from individual sites and the depth of rainfall predicted for the design event.

Rate of Runoff

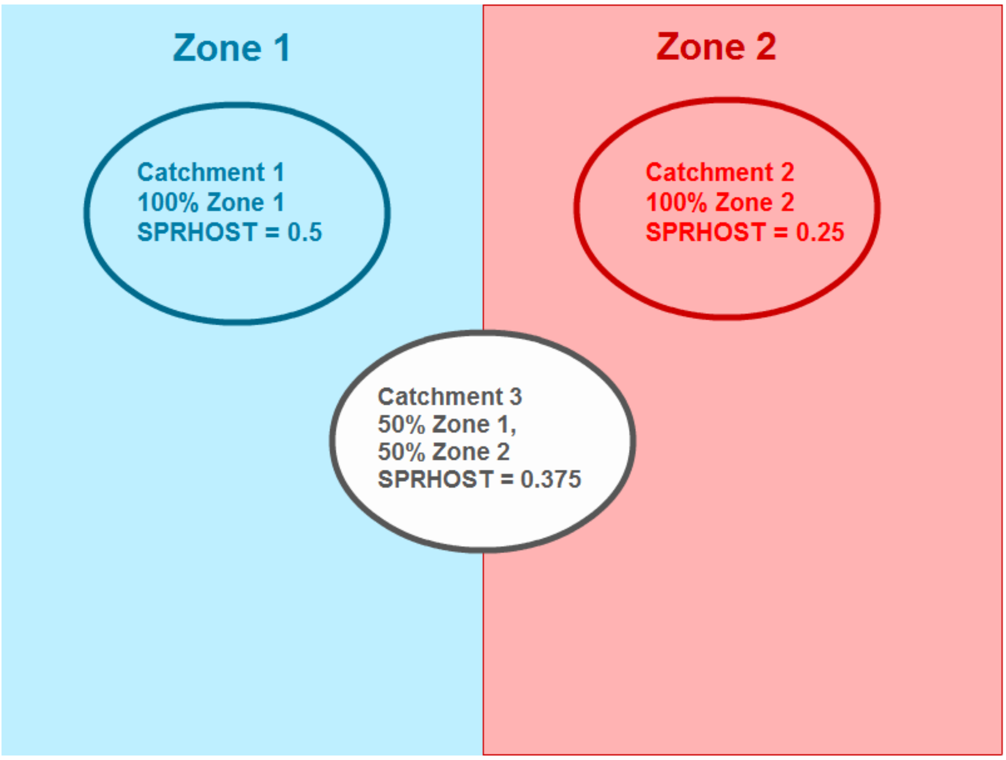
To define the rate of runoff for individual sites, data was extracted from the Flood Estimation Handbook (FEH) CD-ROM. The FEH CD-ROM contains a range of parameters that describe the makeup of all catchments within the UK over 0.5km^2 based on the Institute of Hydrology Digital Terrain Model (IHDTM). Catchments less than 0.5km^2 are aggregated with neighbouring catchments to form the minimum size. Data can only be extracted for catchments and not individual points or user defined areas such as development site outlines.

The various descriptive parameters are collectively termed 'catchment descriptors'. One of these catchment descriptors is termed SPRHOST. SPRHOST is the standard percentage runoff (SPR) derived using the hydrology of soil types (HOST) classification. SPRHOST can be used to estimate the rate of green field runoff from a catchment.

[38] Haringey (2010) Sustainable Design and Construction draft Supplementary Planning Document
[39] DEFRA (2011) National Standards for sustainable drainage systems, Designing, constructing, operating and main taining drainage for surface runoff

To provide an estimate of the rate of green field runoff for the whole of the LB of Haringey it was necessary to extract data from the FEH CD-ROM for a number of catchments within the model. Some catchment descriptors are linked to discrete local zones. Where a catchment crosses more than one zone a weighted average of the values from the respective zones is taken. To simplify matters as far as possible only small catchments were used to extract values. The smaller the catchment the less likely it is that the catchment will significantly split across multiple zones (or when they do cross multiple zones it is probable they will cross a smaller number of zones making backwards inference of the base values from each zone less difficult). Figure 5-2 shows pictorially the way some catchment descriptors are calculated when they fall across more than one zone. Catchment 1 in Figure 5-2 is entirely in Zone 2 and has a SPRHOST value of 0.5 (100% of 0.5 = 1 x 0.5 = 0.5). Catchment 2 in Figure 5-2 is entirely in Zone 1 and has a SPRHOST value of 0.25 (100% of 0.25 = 1 x 0.25 = 0.25). Catchment 3 in Figure 5-2 is half in Zone 1 and half in zone 2 and has a SPRHOST value of 0.375 (50% in 0.25 and 50% in 0.5= 0.5 x 0.25 + 0.5 x 0.5 = 0.375).

Figure 5-2 A diagrammatical representation of the calculation of weighted average catchment descriptors



For this assessment SPRHOST for each site was determined by which zone the centroid of the site was located within. An alternative approach using area weighted was considered however this was discounted due to the small area of the development sites, the strategic level of the assessment and the relative uncertainty in zone boundary location.

Figure 5-3 A diagrammatical representation of the inference representative local values based for sites

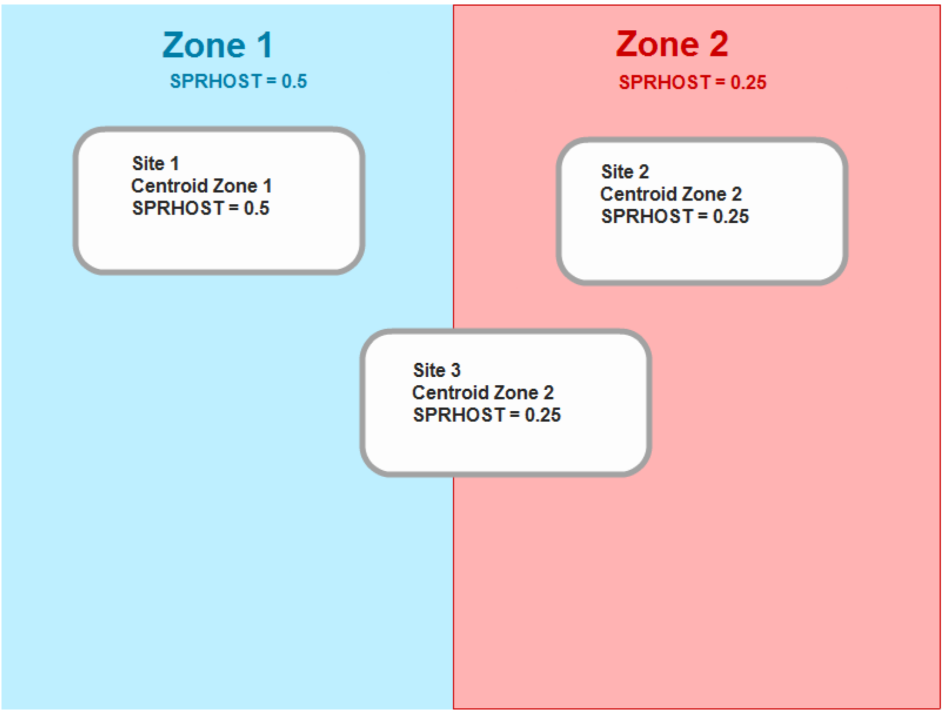


Figure 5-3 shows pictorially how, if the location and the SPRHOST values of each zone are known then the SPRHOST values for each site can be assigned. Figure 5-3 has its centroid (centre point) in zone 1, in this case site one is entirely in zone 1 therefore it can be assigned an SPRHOST value of 0.5. Similarly site 2 in Figure 5-3 has its centroid in zone 2, therefore it can be assigned an SPRHOST value of 0.25. Site 3 is partly in Zone 1 and Partly in Zone 2 (approximately 30% Zone 1 and 70% zone 2). Importantly its centroid is in Zone 2 therefore it is assigned an SPRHOST value of 0.25.

The SPRHOST classification for each small catchment was analysed and plotted geographically. This map was used to estimate SPRHOST values for the LB of Haringey, see Figure 5-4. SPRHOST values are estimated to be highest in the centre of the LB of Haringey around Wood Green and Hornsey. The lowest SPRHOST values are estimated to be in the south west of the borough (Highgate); to the north east (Tottenham Vale); and to the west of the borough in Fortis Green.

Figure 5-5 shows the small catchments overlaid onto the British Geological Society (BGS) superficial deposits data. From this figure it can be seen that:

- the lower SPRHOST values around Fortis Green correspond well with the area of well draining superficial deposits including 'Sand and Gravel' and 'Diamicton'.
- the lower SPRHOST values in the extreme east of the LB of Haringey correspond with locations where the 'Clay and Silt' superficial deposits shown

Within certain small catchments, the presence of the underlying well draining superficial deposits decreases the SPRHOST value, as the permeable nature of the deposits reduces the runoff that can be generated by these catchments.

The east of the LB of Haringey (i.e. Tottenham Marshes) is shown to be covered in a superficial deposit of 'Silty, Peaty, Sandy Clay' and 'Clay, Silt, Sand and Gravel'. These areas are not defined by a small catchment (~0.5km^2) due to the proximity to the River Lee channel. It can be inferred that these areas are likely to have low permeability due to their fine alluvial deposits.

Figure 5-6 shows the small catchments overlaid on the BGS bedrock deposits data. From this figure it can be seen that:

- The bedrock geology is shown to be London Clay Formation for the majority of the LB of Haringey. This bedrock deposit type correspond well with areas of higher SPRHOST values.

- The areas in the south west of the borough, estimated to have the lower SPRHOST value (Highgate), correspond well to those areas on the Claygate Member and Bagshot Formation.

Using the information derived from Figures Figure 5-5 and Figure 5-6, a number of Runoff Zones have been derived. These are shown in Figure 5-7. These are summarised below:

- Zone 1 is based on areas where the bedrock is of 'London Clay' and there are no superficial deposits. These are areas of poor infiltration and high runoff.
- Zone 2 is based on areas to the west of the borough around Fortis Green that have a superficial deposit of 'Sand and Gravel' or 'Diamicton'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 3 is based on areas to the west of the borough near Alexandra Palace that has a superficial deposit of 'Sand and Gravel'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 4 is based on areas to the west of the borough near Muswell Hill that has a superficial deposit of 'Sand and Gravel'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 5 is based on areas along the northern boundary of the borough near Woodside Park and St Thomas More Catholic School that has a superficial deposit of 'Sand and Gravel'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 6 is based on areas in the extreme east of the borough that are shown to be covered in a superficial deposit of 'Silty, Peaty, Sandy Clay' and 'Clay, Silt, Sand and Gravel'. These are areas considered to have poor infiltration and high runoff.
- Zone 7 is based on areas to the east of the borough near Tottenham Hale with 'Clay and Silt' or 'Sand and Gravel' superficial deposits. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 8 is based on areas to the west of the borough near Woodside Park that has a superficial deposit of 'Sand and Gravel'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 9 is based on areas along the northern boundary of the borough near Woodside Park and St Thomas More Catholic School that has a superficial deposit of 'Sand and Gravel'. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.
- Zone 10 is based on areas to the south west of the borough near Highgate which is shown to be of 'Claygate Member' and 'Bagshot Formation' bedrock geology. These are areas that are more permeable with higher rates of infiltration and should produce less runoff.

For the purpose of the SFRA the 10 Zones have been attributed with an estimate of their green field runoff coefficient. The 10 Zones are shown in Figure 5-8 coloured by their estimated green field runoff coefficient. From review of this Figure it can be seen that:

- Zones 1 and 6 are considered relatively impermeable in nature and have a high SPRHOST value, for simplicity the SPRHOST values have been attributed with an estimated runoff coefficient of 50%. This is based on the SPRHOST values for these zones being approximately 50%.
- Zones 2, 3, 4, 5, 7, 8, 9 and 10 are characterised as being more permeable than Zone 1 and 6. These zones have been attributed with an estimated runoff coefficient of 37%; also based on their approximate SPRHOST value.

It should be noted that these values are indicative only and based on national data. The simplified coefficients used in the SFRA should in, no way, be considered a substitute for local percolation and infiltration test results for individual sites.

Based on the information above, the estimated runoff coefficient has been attributed for each site. Where sites cross multiple runoff zones, these have been attributed with an estimated runoff coefficient based on the zone that their centroid (centre point) falls within.

For the purpose of reporting the results, the weighted average estimated green field runoff coefficient for each group of sites is summarised in Table 5-2. It should be noted that these values are for illustration only. Calculations for surface water runoff have been completed on the site by site values. These are shown in Appendix C in full and it is these values that have been used for all analysis. The grouped weighted average values are presented in the following tables in the main body of this report for the sake of providing a summary.

Table 5-2: Weighted average estimated green field runoff coefficient by site group

Site Group	Weighted average estimated green field runoff coefficient (%)
Group4_010	50
Group4_055	50
Group4_056	50
Group4_057	50
Group4_061	37
Group4_062	37
Group4_063	50
Group4_073	50
HDA_01	40
HDA_02	50
HDA_03	50
HDA_04	39
HDA_06	50
HDA_07	37

Figure 5-4 Small FEH Catchments categorised by SPRHOST

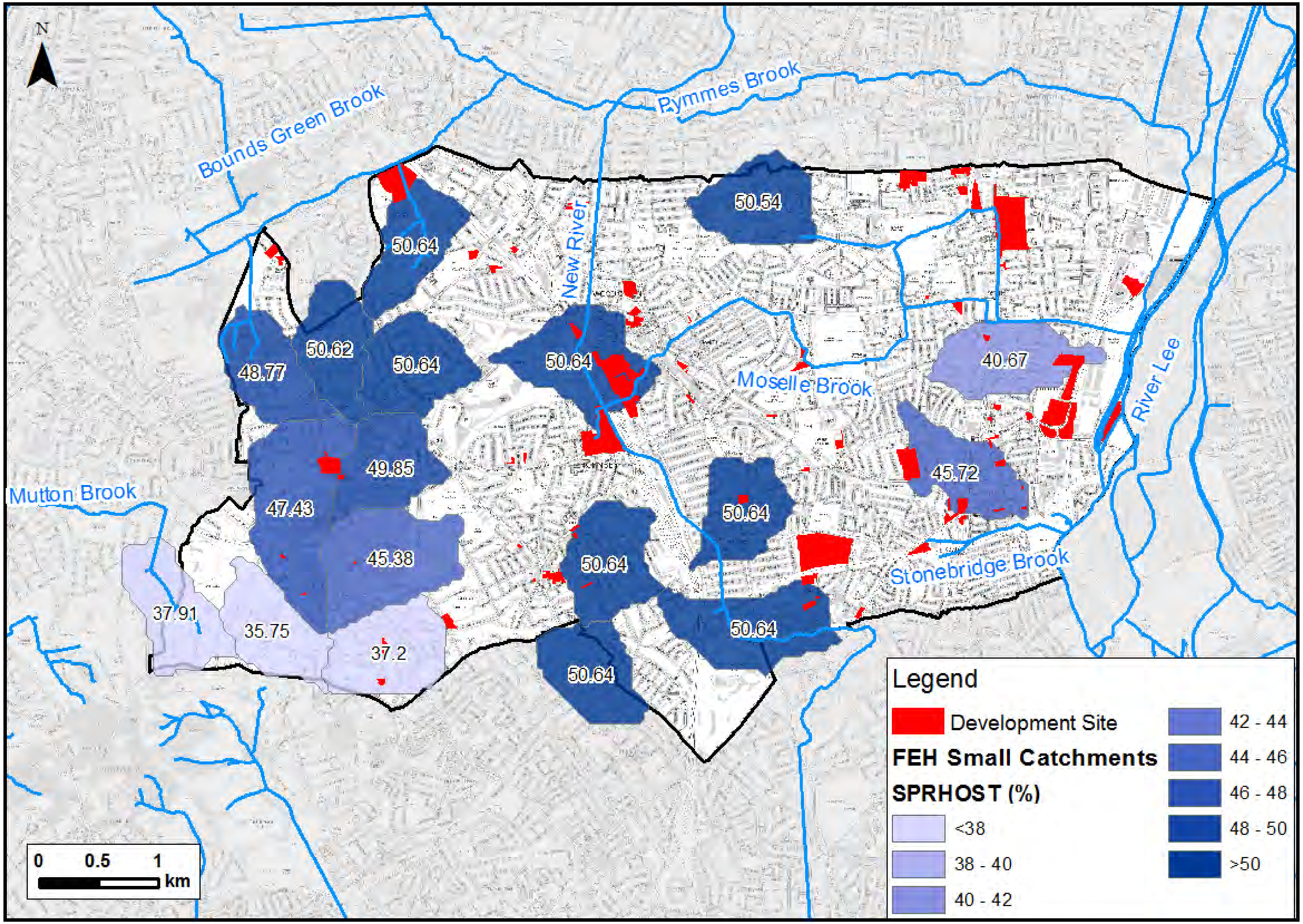


Figure 5-5 Small FEH Catchments overlaid on Superficial Deposits

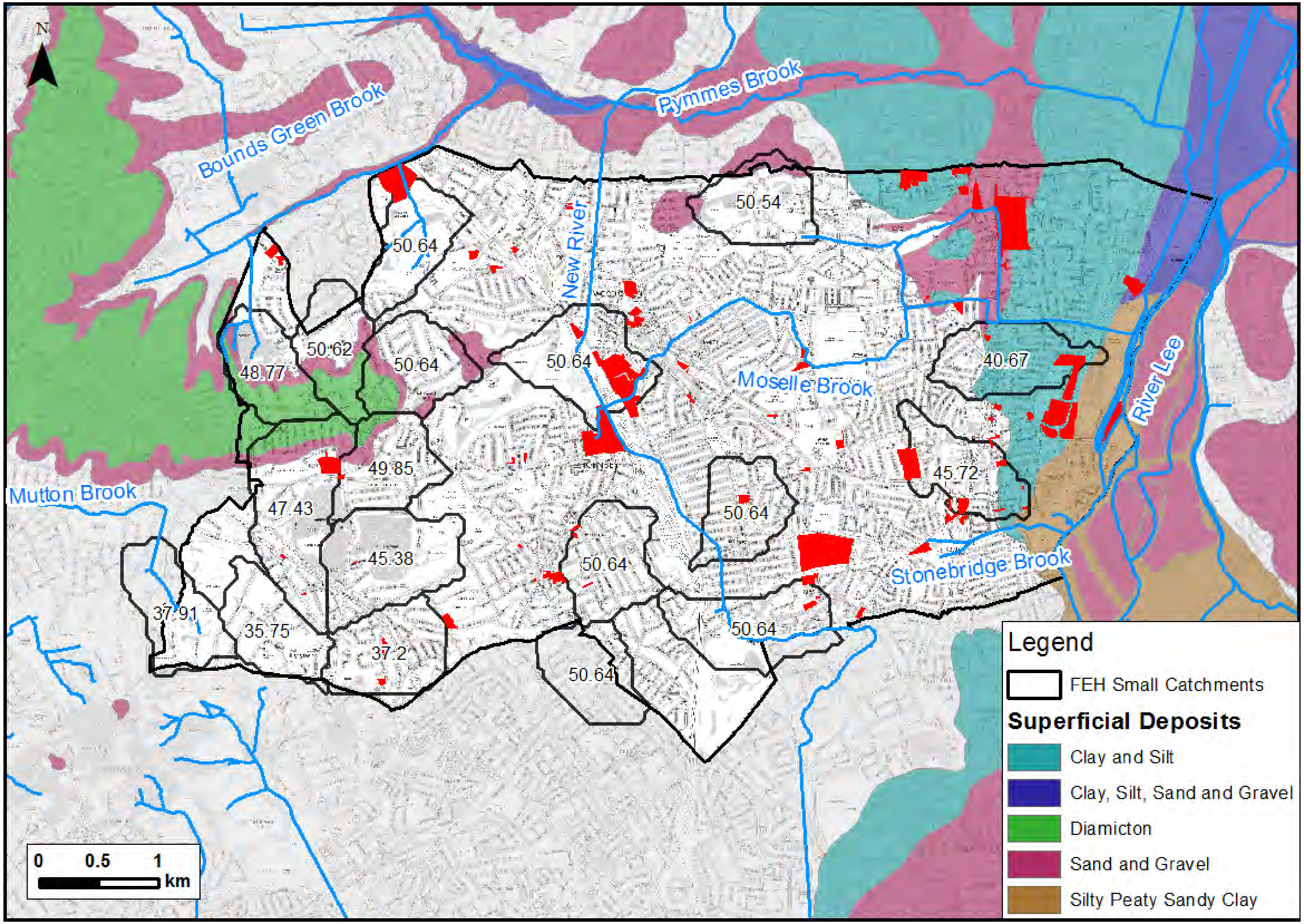


Figure 5-6 Small FEH Catchments overlaid on Bedrock Geology

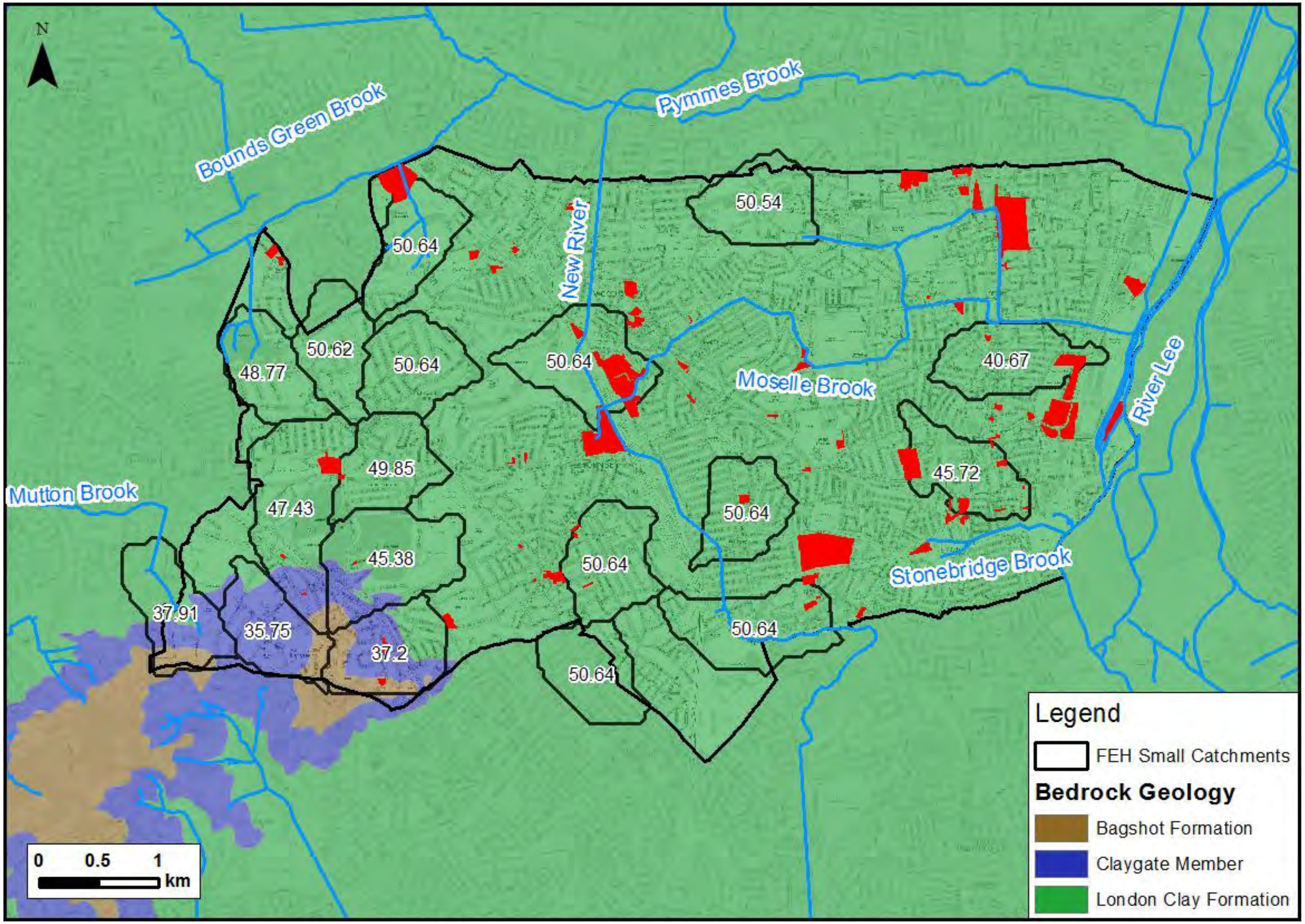


Figure 5-7 Runoff Zones informed by Bedrock Geology and Superficial Deposits

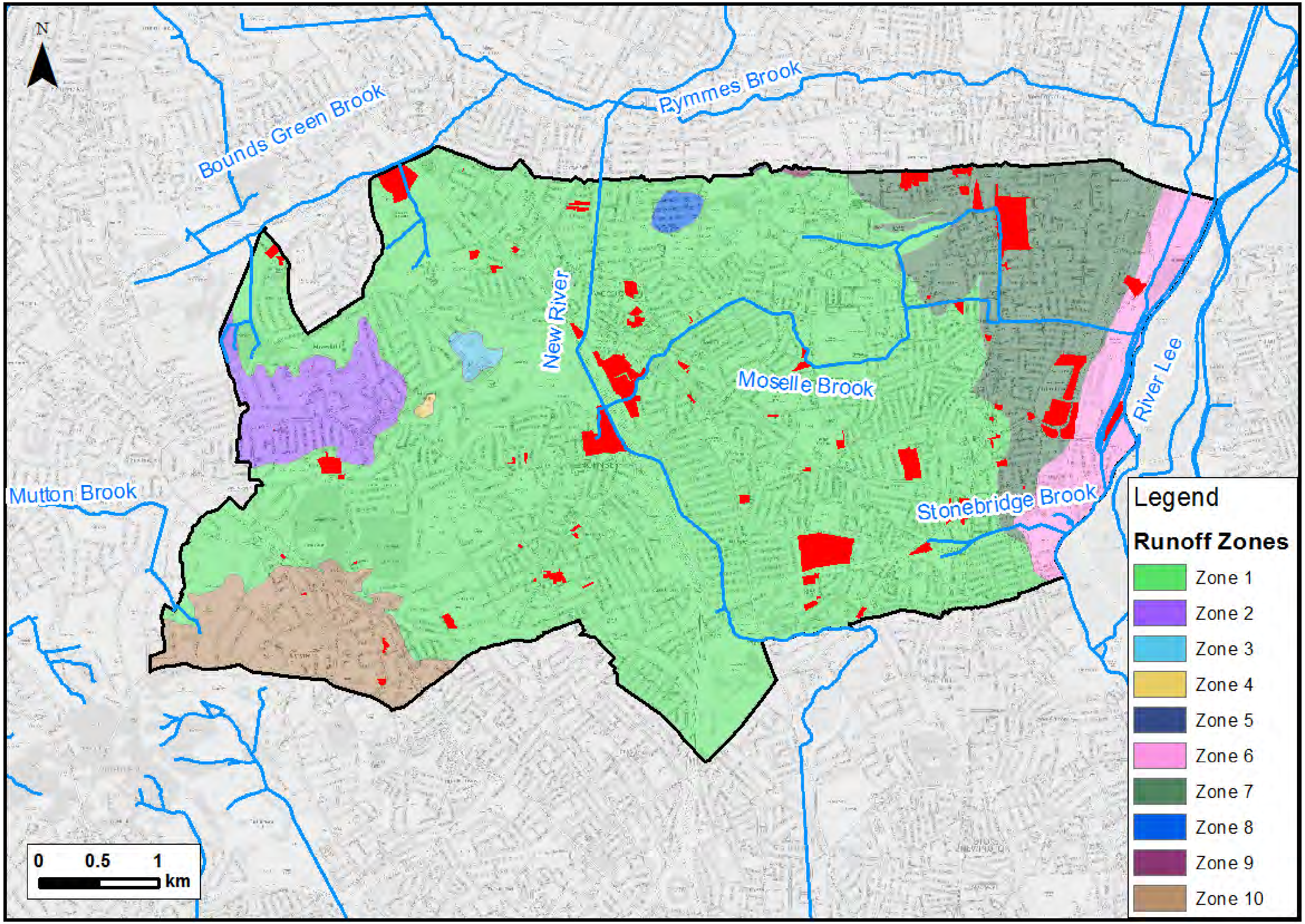


Figure 5-8 Runoff Zones parameterised with estimated runoff coefficients

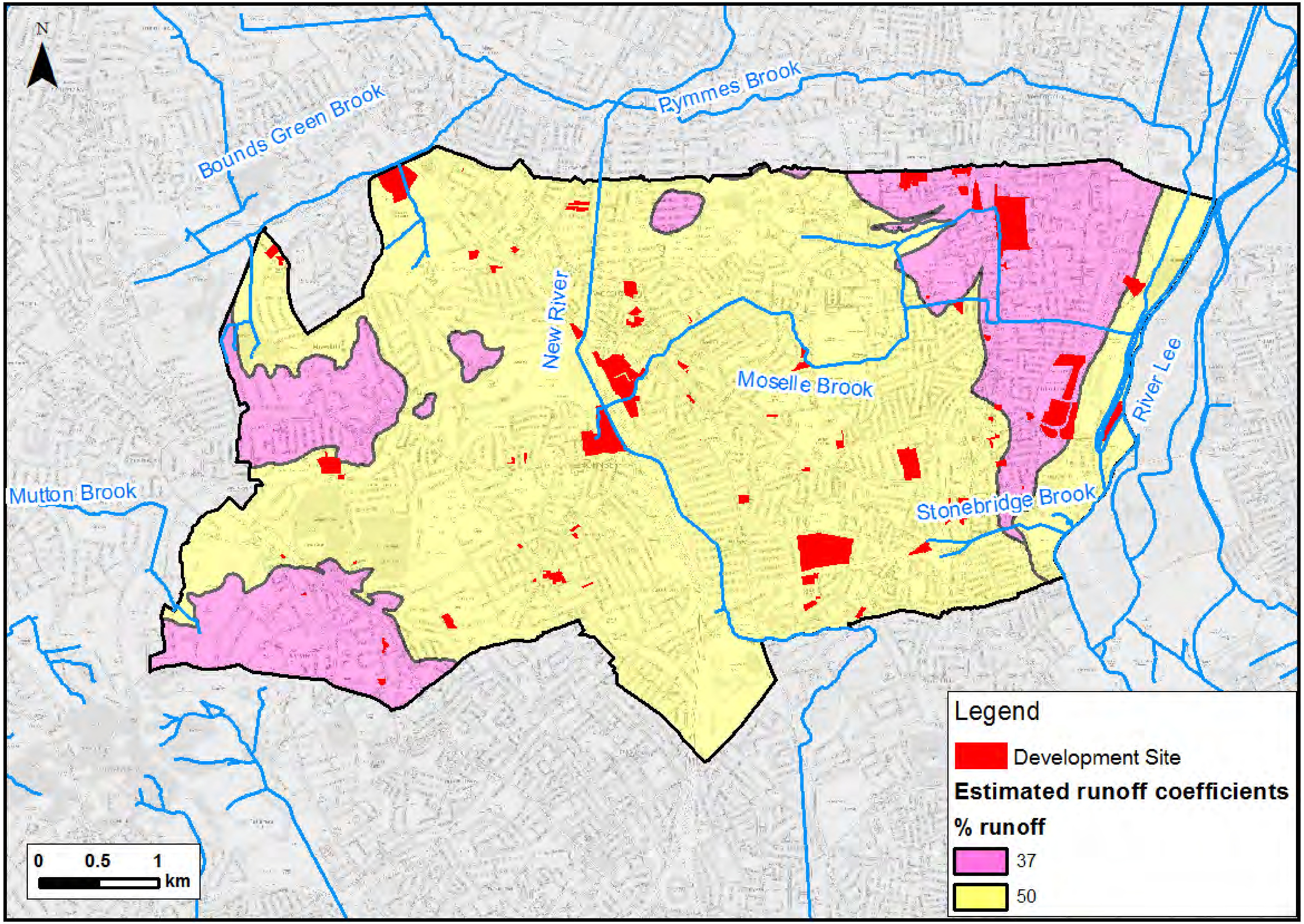


Figure 5-9 FEH DDF rainfall depth by 1km grid cell for 1:100 AEP 6 hour event

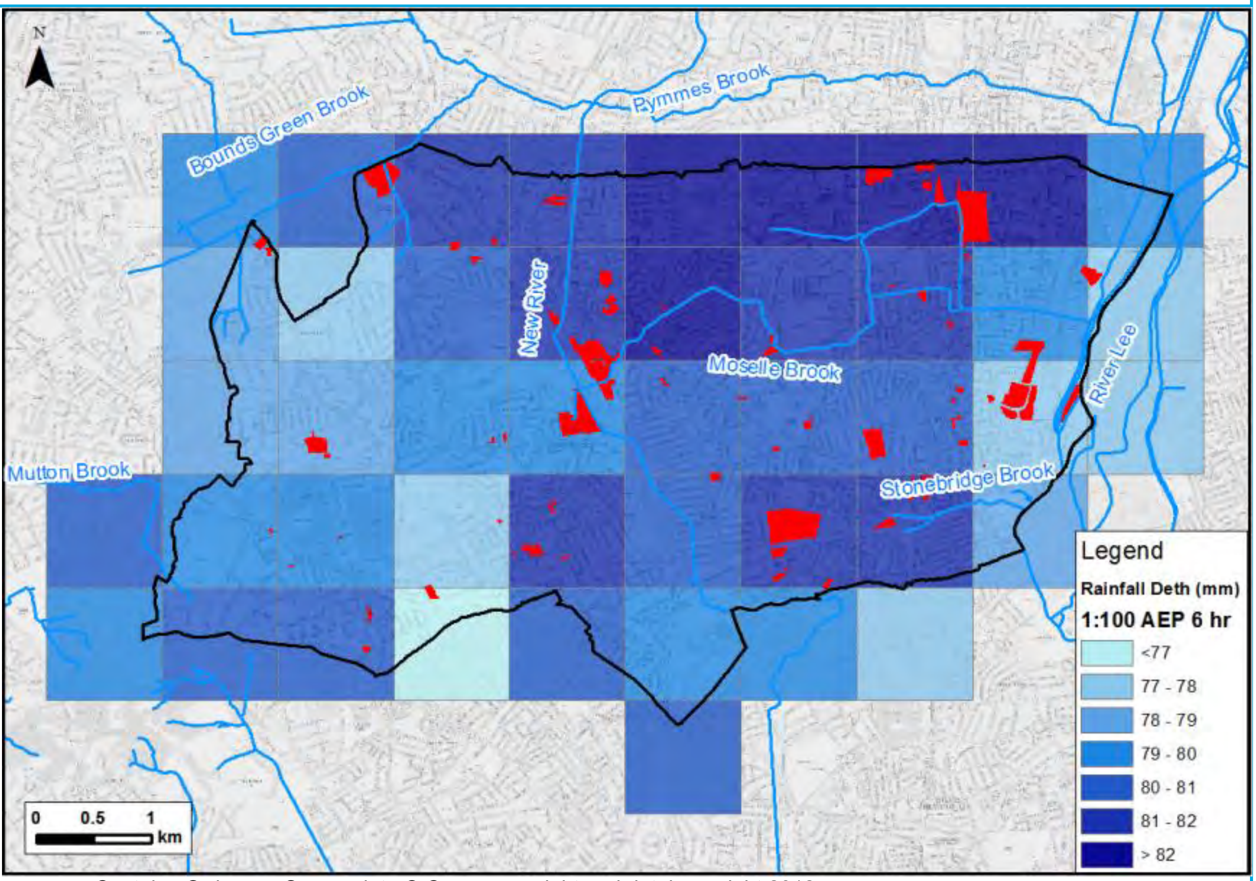


Figure 5-10 FEH DDF rainfall depth by 1km grid cell for 1:100 AEP 24 hour event

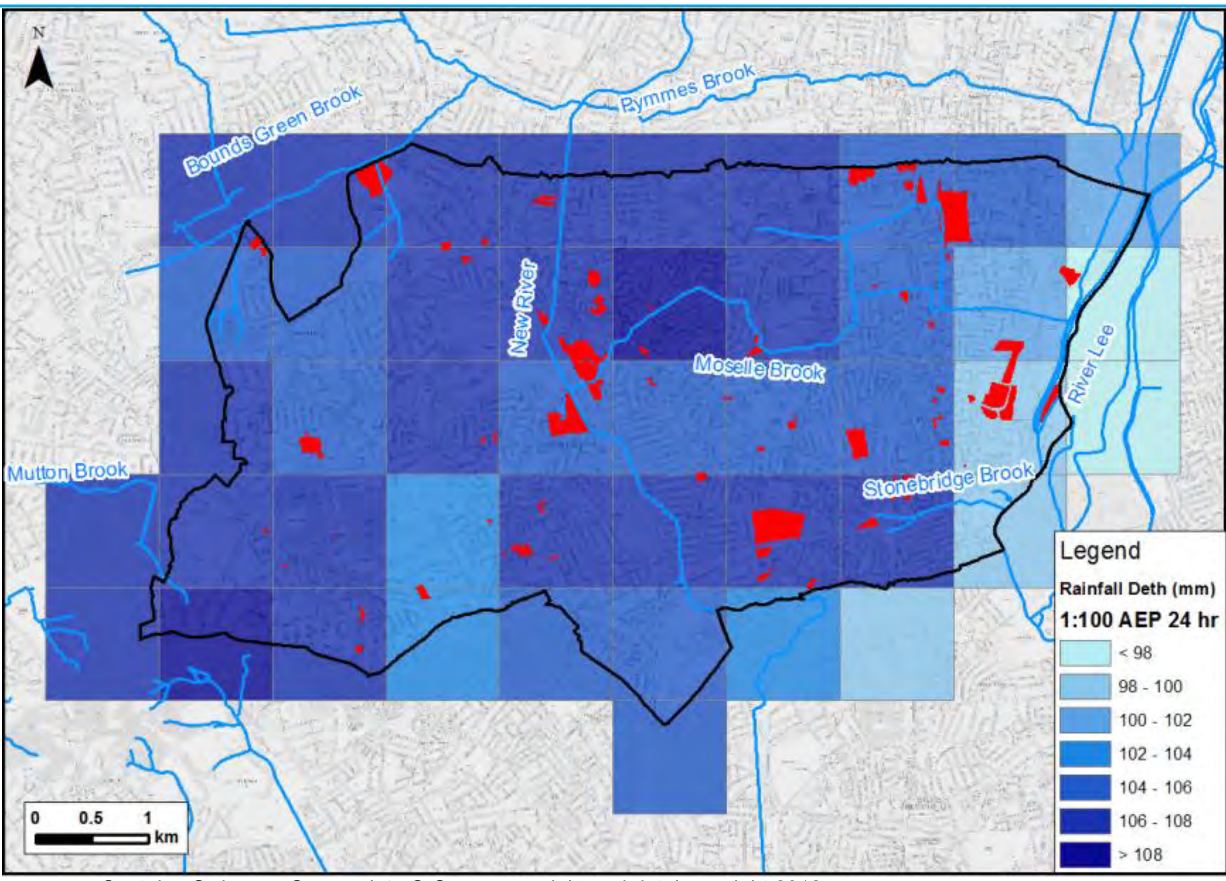


Figure 5-11 FEH DDF rainfall depth by 1km grid cell for 1:100 AEP 48 hour event

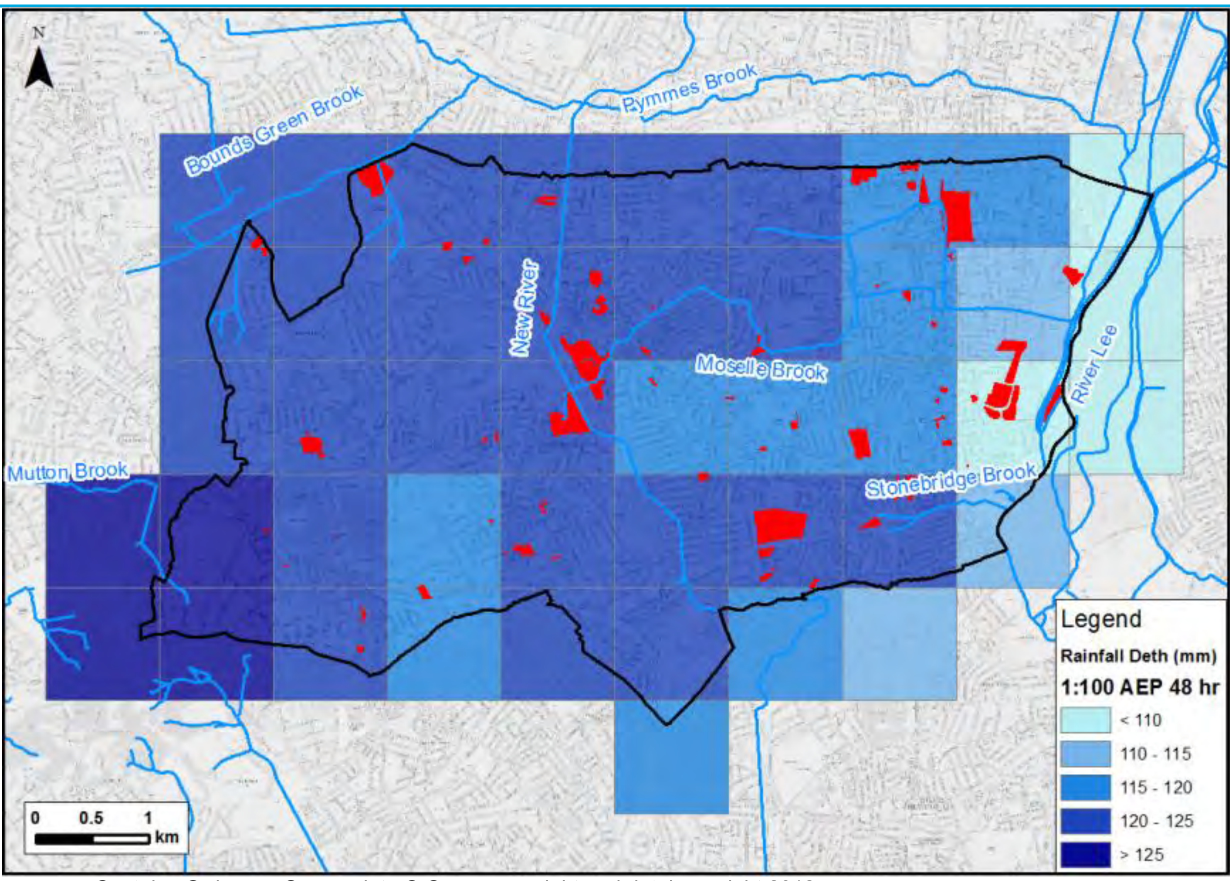
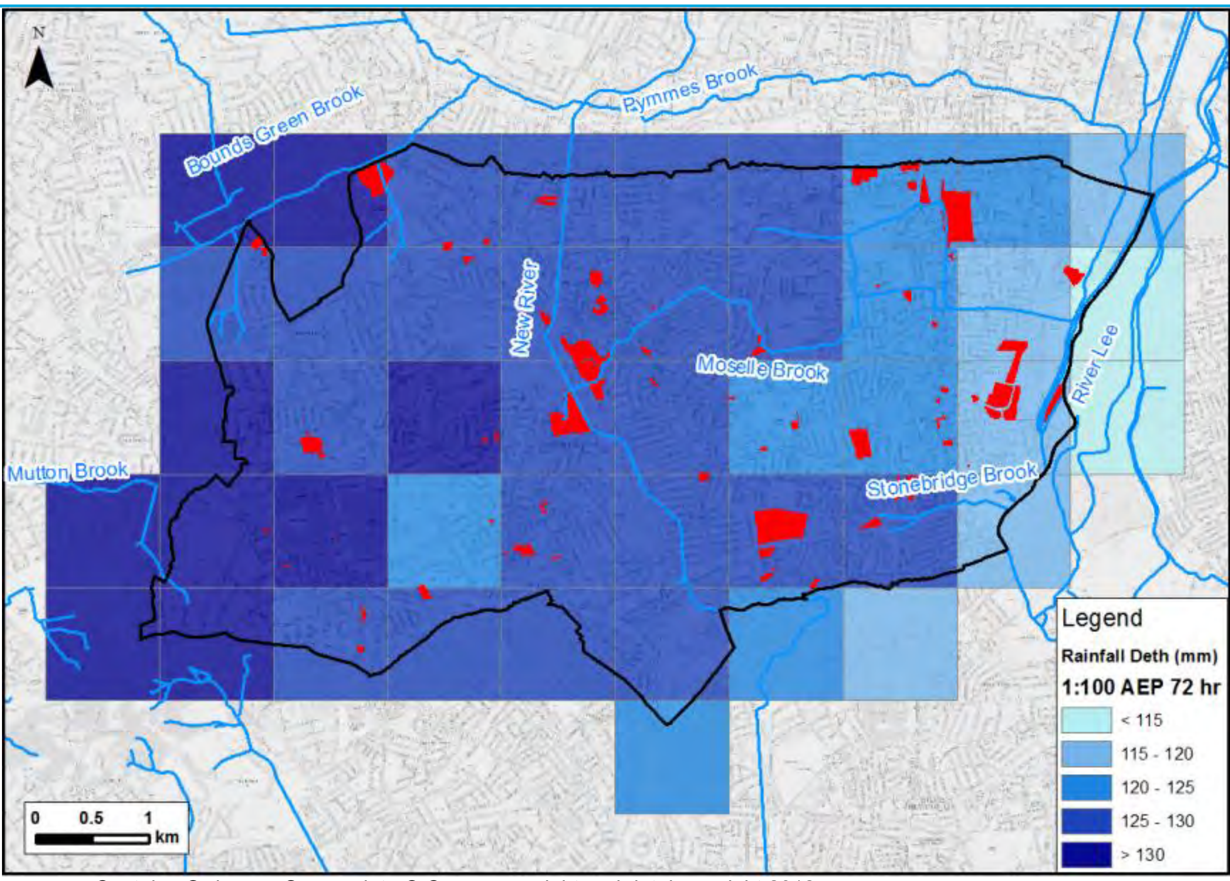


Figure 5-12 FEH DDF rainfall depth by 1km grid cell for 1:100 AEP 72 hour event



Design Rainfall

Design Rainfall is the term to describe the rainfall event used in the assessment of runoff from the baseline and future scenarios. To define the depth of rainfall predicted for the design event it was necessary to extract depths based on the depth duration frequency (DDF) data from the FEH CD-ROM on a 1km grid. This data was extracted for the 1:100 AEP for the 6 hour duration event as well as the 24, 48 and 72 hour events for reference.

The data was analysed and plotted geographically to provide estimated rainfall depth for each event across the LB of Haringey.

A number of factors influence the DDF values for a given kilometre grid cell, these include not only proximity to local gauges but also geo-regression results based on average elevation, slope, aspect and distance from sea. This gives rise to locally variable results (as shown in Figure 5-9 to Figure 5-12).

Figure 5-9 shows that DDF values vary across the LB of Haringey. For the purpose of the strategic assessment, a standard value of 80mm was taken forward for the 1:100 AEP 6 hour design event. An allowance of +30% was used to account for the potential effects of climate change. This allowance brings the estimated depth for the 1:100 AEP 6 hour design event including the effects of climate change up to 104mm. The relative effects of climate change are discussed in section 5.8. All values quoted in sections 5.5, 5.6, **Error! Reference source not found.** and 5.7 are xclusive of the effect of climate change.

Figure 5-10 and Figure 5-12 illustrate that there are limited geospatial trends to be seen when the depth differences are reviewed across the LB of Haringey. The figures show generally lower rainfall to the east of the borough along the River Lee and higher rainfall to the west. This correlates well with the relief of the borough with the higher ground being found to the west of the borough and the lower ground found along the River Lee to the east. The range in values found also increases with rarity, in the order of 15-20 mm for the 72 hour event.

Runoff Volume (assuming green field conditions)

The rainfall depth estimates can be converted to site rainfall volumes by multiplying the depth by the area of each site. Not all of this rainfall volume will become surface run-off, as part of all rainfall that falls is absorbed (or infiltrated) into the ground or is lost to other sources such as storage or vegetation. The percentage of water that becomes run-off is known as the runoff percentage and this value can be used to estimate the volume of runoff and the peak flow rate of the runoff. There are a number of factors that contribute to this process but for this strategic study a simplistic and consistent approach has been applied. This simplified approach only takes into consideration the land cover and potential infiltration. For green field runoff-rates it has been assumed that SPRHOST can be used as a suitable proxy for runoff rate.

Using this method, the pre-development runoff rates at the proposed sites will vary between 37% and 50% of the rainfall depending on the site in question (runoff volumes are aggregated by site groups). See Appendix C for a full break down of these figures.

Using the data summarised in Table 5-2 and the standard rainfall depth for the design event, a rapid estimation of runoff volume can be undertaken by multiplying the site area, the rainfall depth and percentage runoff.

For example, a site with an area of 100m^2 and a design rainfall depth of 80 mm (or 0.08m) and an estimated percentage runoff of 50% (or 50/100) provides a runoff volume of 4m^3.

$100m^2 \times 0.08m \times (50/100) = 4.0\ m^3$

Table 5-3 shows the estimated green field runoff volumes for each group of sites.

Table 5-3: Green field runoff volumes

Drainage Area	Total area of all sites within group (m^2)	Total green field runoff volume (m^3) for all site within group
Group4_010	18,053	722
Group4_055	890,615	35,625
Group4_056	15,897	636
Group4_057	357,504	14,300
Group4_061	278,810	8,253
Group4_062	59,977	1,775
Group4_063	8,846	354
Group4_073	9,233	369
HDA_01	223,686	7,130
HDA_02	97,918	3,917
HDA_03	535,987	21,439
HDA_04	1,016,677	31,344
HDA_06	19,757	790
HDA_07	27,555	816
Total for all sites	**3,560,515**	**127,470**

It should be noted that all values quoted in sections 5.5, 5.6, **Error! Reference source not found.** nd 5.7 are exclusive of the effect of climate change.

5.6 Part 3A - Development over the next 5 Years (up to 2020)

Of the 133 future developments reviewed in this SFRA, 27 are predicted to be complete within the next 5 years (by 2020). Development is anticipated to have started on a further 28 sites, leaving only 22 sites that are not part developed. In total, the area of proposed development that is currently estimated to have been completed within the first five years of the plan is approximately 510,597 m^2 or 51 hectares. This accounts for an average of 52% of the total 974,912 m^2 of development outlined in section 0 by site area. Table 5-4 shows the weighted average percentage complete of the 15 groups of sites. Fortis Green and Highgate (group 1) and St Ann's (group 9) are expected to be largely complete within the next 5 years. Other areas such as Tottenham (group 13) and Haringey Heartlands (Group 10) are predicted to be less than 20% complete. That is not to say that any individual site within the group area is not predicted to be complete ahead-of or behind these values shown but rather these figures present the average percentage complete weighted by site area.

Table 5-4: Predicted rate of development completion.

Drainage Area	Total area of development sites within group (m^2)	Average development up to 2020(% complete)
Group4_010	18,053	100
Group4_055	890,615	11
Group4_056	15,897	100
Group4_057	357,504	45
Group4_061	278,810	4
Group4_062	59,977	4
Group4_063	8,846	-
Group4_073	9,233	50
HDA_01	223,686	59
HDA_02	97,918	3
HDA_03	535,987	13
HDA_04	1,016,677	14
HDA_06	19,757	-
HDA_07	27,555	-
Total for all sites	**3,560,515**	**18**

2020 Design Runoff

For the purposes of this study it has been necessary to make some assumptions of post development runoff percentage since at this time there is no precise information available on the proposed layouts. A uniform approach has been devised that involves application of a consistent post development runoff percentage. It has been assumed that the allocation areas will have a runoff coefficient of 70%.

70% runoff represents an estimated figure for the purposes of a strategic assessment. Well-designed residential development will feature lots of open green space that allows for a natural drainage pattern; in such cases runoff may be much lower than 70%. Conversely in poorly designed commercial or retail development, where all surfaces are covered over with buildings or car parking leaving little or no open green space, the runoff coefficient can be much higher than70%.

During the stages of development a weighted average approach has been undertaken to provide estimates of runoff volume in 5 years time.

The weighted average approach takes into consideration the percentage of the site that will be developed and the percentage that remains as green-field as evidenced in the development schedule. A worked example of the weighted average approach is shown below.

50% of site undeveloped with a green field runoff rate of 50%

50% of site developed with an assumed post development of 70% runoff

(0.5 x 0.5) + (0.5 x 0.7) = a weighted average runoff co-efficient of 0.6 or 60%.

It is recognised that the approach has limitations, principally with respect to the assumptions of critical storm duration and 70% post development runoff. However, for a strategic assessment of this nature the application of a consistent approach across the catchments will provide an indication of the order of magnitude of potential effects. It is recognised that other storm durations will result in different depths and consequently volumes. The longer the duration, the greater the depth estimated. It is also recognised that the post development runoff will be partly dependent on the density of development. Table 5-5 shows the estimated pro-rata runoff rates and the subsequent runoff volumes by site groups. See Appendix C for a full site by site break down of these figures.

Table 5-5: Estimated runoff pre- and post-development runoff rates and volumes (up to 2020)

Drainage Area	Pre-development Weighted average estimated green field runoff coefficient (%)	Total pre-development (Green field) runoff Volume (m^3) for all site within group	Post Development Weighted average estimated runoff coefficient (%) up to 2020	Total post-development (up to 2020) runoff Volume (m^3) for all site within group
Group4_010	50	722	70	1,011
Group4_055	50	35,625	52	37,188
Group4_056	50	636	70	890
Group4_057	50	14,300	59	16,853
Group4_061	37	8,253	38	8,549
Group4_062	37	1,775	38	1,847
Group4_063	50	354	50	354
Group4_073	50	369	120	434
HDA_01	40	7,130	59	10,536
HDA_02	50	3,917	51	3,960
HDA_03	50	21,439	53	22,537
HDA_04	39	31,344	42	34,474
HDA_06	50	790	50	790
HDA_07	37	816	37	816
Total for all sites	**45**	**127,470**	**49**	**140,239**

It should be noted that all values quoted in sections 5.5, 5.6, **Error! Reference source not found.** nd 5.7 are exclusive of the effect of climate change

Runoff Volume

It can be seen in Table 5-5 that the estimated increase in runoff volume due to development up until 2017 is approximately at 9,600 m^3. This is enough water to fill 2.5 Olympic sized swimming pools or over 77 (New Routemaster) London Buses[40]. The values in Table 5-6 are indicative as to the amount of storage required to compensate for the developments. A more detailed assessment of post development runoff should be undertaken either, as part of an FRA, or as part

[40] Based on a new Route master Bus having a volume of 124.2m3 (11.23m long, 2.52m wide and 4.39m high)

of the master-planning process for each individual development before detailed proposals of how to provide this storage volume are proposed. In particular it should be noted that the values are based on a 6 hour 'critical duration storm' and all development proposals should be mindful of the discussion in section 5.5.1. A further exercise should be performed in site specific FRA's so that the flood conditions downstream are not exacerbated.

Table 5-6: Predicted storage requirements for each site group up until 2020

Drainage Area	Approximate Required Storage (m^3)
Group4_010	289
Group4_055	1,564
Group4_056	254
Group4_057	2,553
Group4_061	296
Group4_062	71
Group4_063	-
Group4_073	65
HDA_01	3,406
HDA_02	43
HDA_03	1,098
HDA_04	3,129
HDA_06	-
HDA_07	-
Total for all sites	12,768

It should be noted that all values quoted in sections 5.5, 5.6, **Error! Reference source not found.** nd 5.7 are exclusive of the effect of climate change

The required storage volume could be provided on site or as part of a larger more strategic scheme across the LB of Haringey.

5.7 Part 3B - Longer Term Development

It is assumed that in line with the predicted rate of development all sites proposed for development will be complete by within 15 years.

The total area of development across all sites is over 3,5 km^2. In order to assess the effect of these developments, the additional runoff from these sites must be estimated. As discussed in section 5.5.1 the critical storm duration has been kept constant so that the effects of the increased runoff as a result of the development can be assessed.

Using the 1 % AEP rainfall event it is possible to estimate the increase in runoff using some simplifying assumptions.

Design Runoff

A 70% post development runoff has been assumed for all the development sites within the LB of Haringey area other than those listed as existing or likely community gardens or protected open space therefore it is assumed that no development will occur. It is recognised that this assumption would depend on the density of the development sites.

Table 5-7 shows the estimated pre- and post-development runoff rates and the subsequent runoff volumes.

Table 5-7: Estimated runoff pre- and post-development runoff rates and volumes (up to 2027)

Drainage Area	Pre-development Weighted average estimated green field runoff coefficient (%)	Total pre-development (Green field) runoff Volume (m^3) for all site within group	Post-development Weighted average estimated runoff coefficient (%) up to 2027	Total post-development (up to 2027) runoff Volume (m^3) for all site within group
Group4_010	50	722	70	1,011
Group4_055	50	35,625	70	49,874
Group4_056	50	636	70	890
Group4_057	50	14,300	70	20,020
Group4_061	37	8,253	70	15,613
Group4_062	37	1,775	70	3,359
Group4_063	50	354	70	495
Group4_073	50	369	70	517
HDA_01	40	7,130	70	12,526
HDA_02	50	3,917	70	5,483
HDA_03	50	21,439	70	30,015
HDA_04	39	31,344	70	56,934
HDA_06	50	790	70	1,106
HDA_07	37	816	70	1,543
Total for all sites	45	127,470	70	199,389

It should be noted that all values quoted in section 5.5, 5.6, **Error! Reference source not found.** nd 5.7 are exclusive of the effect of climate change

Runoff Volume

It can be seen in Table 5-5 that the estimated increase in runoff volume due to development up until 2027 is approximately at 18,650 m^3. This is enough water to fill approximately 5 Olympic sized swimming pools or over 150 (New Routemaster) London Buses[41]. The values in Table 5-6 are indicative as to the amount of storage required to compensate for the developments. A more detailed assessment of post development runoff should be undertaken either, as part of an FRA, or as part of the master-planning process for each individual development before detailed proposals of how to provide this storage volume are proposed. In particular it should be noted that the values are based on a 6 hour 'critical duration storm' and all development proposals should be mindful of the discussion in section 5.5.1.

Table 5-8: Predicted storage requirements for each site group up until 2027

Drainage Area	Approximate Required Storage (m^3)
Group4_010	592
Group4_055	29,212
Group4_056	521
Group4_057	11,726
Group4_061	12,045
Group4_062	2,591
Group4_063	290
Group4_073	303
HDA_01	9,154
HDA_02	3,212
HDA_03	17,580
HDA_04	42,670
HDA_06	648
HDA_07	1,190
Total for all sites	131,735

It should be noted that all values quoted in section 5.5, 5.6, **Error! Reference source not found.** nd 5.7 are exclusive of the effect of climate change

The required storage volume could be provided on site or as part of a larger more strategic scheme across the LB of Haringey.

[41] Based on a new Route master Bus having a volume of 124.2m3 (11.23m long, 2.52m wide and 4.39m high)

A site by site break down is shown in Appendix C. For the reasons already stipulated in the sections above, these values are indicative as to the amount of strategic storage that might be required to compensate for the developments. A more detailed assessment of post development runoff should be undertaken either, as part of an FRA, or as part of the master-planning process for each individual development before detailed proposals of how to provide this storage volume are proposed.

It is apparent that when considering volumes of this magnitude an authority-wide strategic solution could prove to be more cost effective as well as providing scope to reduce the flood risk to the remainder of LB of Haringey in accordance with the Environment Agency's CFMP policy aims.

5.8 Part 4 - Impacts of Climate Change on Runoff

As stated in section 5.5.2 all values quoted in sections 5.5, 5.6, **Error! Reference source not ound.** and 5.7 are exclusive of the effect of climate change. This section of the report discusses the potential effects of Climate Change on runoff for the development sites and the rest of the LB of Haringey under a range of scenarios. For the purposes of this assessment and outlined in section 5.5.2 climate change has been assumed to result in a 30% increase in rainfall depth for the design event.

5.8.1 Existing development with Climate Change

It is assumed that prior to the proposed development the existing runoff coefficient for the whole of the LB of Haringey is approximately 70%. Using this assumption it is possible to explore the potential effects of Climate Change on the borough if either: no re-development were to occur; or the policy of mitigating runoff to green field runoff rates is not followed and no action was taken to mitigate runoff. The results of this analysis are shown in Table 5-9.

5.8.2 Green field with Climate Change

An assessment was undertaken to show the relative impact of climate change on the LB of Haringey assuming the policy that all future development and re-development should mitigate its runoff to green field runoff is enforced.

This assessment initially covers just the development sites, assuming the remainder of the borough has a runoff rate of 70% however a second stage assessment is made to provide an indication of what the effect may be, into the future in the event that the policy is carried on and the remainder of the borough is re-developed to the same standard.

The results of both stages of assessment are shown in Table 5-9.

5.8.3 Climate Change runoff volumes

Table 5-9 shows that if no action is taken to address runoff the LB of Haringey is predicted to experience a significant increase in runoff volume:

- Based on an assumed runoff rate of 70% the LB of Haringey can expect a runoff volume of 1,657,529 m^3 for a present day 1:100 AEP 6 hour duration rainfall event.
- Taking into account the effects of climate change, if no mitigation action is taken, this is predicted to increase by over 497,000 m^3 to 2,154,788 m^3.
- The proposed development sites discussed in this report account for approximately 59,817 m^3 (259,205-199,389) of the predicted increase in volume as a result of climate change or 12% of the total across the borough

By enforcing the policy that all development and redevelopment has to mitigate runoff to existing green field runoff rates for the life time of the development (i.e. taking into account the predicted effects of climate change) the borough can expect significant benefit:

- Table 5-9 shows that if the proposed development sites were all to be taken forward and runoff was mitigated to present day green field rates for the lifetime of the development, in accordance with the development policy, then the present day 1:100 AEP 6 hour duration rainfall event runoff volume would decrease by over 71,000 m^3 (199,389-127,470).
- When taking into account the effects of climate change this reduction provides even greater benefit by decreasing runoff by over 131,000 m^3 (259,205 - 127,470). for the development sites alone when compared to a scenario where no action is taken.

- If this policy was carried forward to the rest of the borough a present day reduction in runoff of over 540,000m^3 (1,657,529 - 1,115,390) could be expected.
- This increases to a reduction of runoff of over 1,039,000 m^3 (2,154,788 - 1,115,390) when taking into consideration the predicted effects of Climate change.

The predicted increase in runoff volumes as a result of climate change presents a significant obstacle to the LB of Haringey. However, by progressively implementing the policy that all development and re-development with the borough is required to mitigate runoff to present day green field runoff values for the life time of the development this obstacle can be overcome.

In reality it can be predicted that over the next 100 years the entirety of the LB of Haringey is unlikely to be completely redeveloped, and especially not over night. However, if even half of the borough were to take such action then the predicted runoff including the effects of climate change would still be a reduction of over 22,000m^3 of runoff than present day estimates. ((1,115,390+2,154,788)/2)-1,657,529).

Enforcement of this policy should be considered a Win-Win mitigation option as in the event that climate change does increase storm events as predicted, the borough will be producing less runoff during the event than existing levels. However, if the predicted effects of climate change are less than predicted, the development and re-development will provide significant local relief from existing drainage infrastructure, freeing up capacity in an already stretched system.

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Table 5-9: Predicted storage requirements for each site group including Climate Change

Drainage Area	Total area of all sites within group (m^2)	Total existing runoff volume - assuming 70% runoff - present day (m^3)	Total existing runoff volume - assuming 70% runoff + Climate Change (m^3)	Increase in existing runoff volume as a result of Climate Change (m^3)	Total Proposed runoff volume - assuming mitigation to a green field runoff - present day (m^3)	Change in runoff as a result of mitigation policy (present day) (m^3)	Change in runoff as a result of mitigation policy (including Climate Change) (m^3)
Group4_010	18,053	1,011	1,314	303	722	289	592
Group4_055	890,615	49,874	64,837	14,962	35,625	14,250	29,212
Group4_056	15,897	890	1,157	267	636	254	521
Group4_057	357,504	20,020	26,026	6,006	14,300	5,720	11,726
Group4_061	278,810	15,613	20,297	4,684	8,253	7,361	12,045
Group4_062	59,977	3,359	4,366	1,008	1,775	1,583	2,591
Group4_063	8,846	495	644	149	354	142	290
Group4_073	9,233	517	672	155	369	148	303
HDA_01	223,686	12,526	16,284	3,758	7,130	5,396	9,154
HDA_02	97,918	5,483	7,128	1,645	3,917	1,567	3,212
HDA_03	535,987	30,015	39,020	9,005	21,439	8,576	17,580
HDA_04	1,016,677	56,934	74,014	17,080	31,344	25,590	42,670
HDA_06	19,757	1,106	1,438	332	790	316	648
HDA_07	27,555	1,543	2,006	463	816	727	1,190
Total for all Sites	**3,560,515**	**1,011**	**1,314**	**303**	**722**	**289**	**592**
Total for all of LB of Haringey	**29,598,740**	**1,657,529**	**2,154,788**	**497,259**	**1,115,390**	**542,139**	**1,039,398**
Total for LB of Haringey excluding proposed sites	**26,038,225**	**1,656,518**	**2,153,474**	**496,956**	**1,114,668**	**541,850**	**1,038,806**

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6. Subterranean Development

6.1 Introduction

Since 2006 Haringey Council has received more than 60 planning applications for subterranean development. Due to the high land value and other pressures on development in the borough, development of basements to provide additional room for new and existing developments are popular as in many similar urban areas. The rate of applications is not as high as that found in the inner London Boroughs but the potential consequences make it worthy of particular discussion in this Strategic Flood Risk Assessment. This section of the SFRA gives guidance on the assessment of flood risk in relation to proposals involving the construction of new basements or change of use of existing basement structures.

6.2 Basement Development and Planning Policy

6.2.1 Existing Planning and Building Control

Not all basement developments require submission of a planning application as they fall under the residents' permitted development rights. [42] However, specific property types such as those listed below do require planning permission to be submitted:

- Flats, apartments and maisonettes planning to extend underground.
- Basement conversion (e.g. converting a basement to a dwelling), this may be classed as a "change of use"
- Light wells

Table 6-1 describes further details of the basement property types that are assigned by LB of Haringey and whether they require planning permission.

Table 6-1 Basement Property Types[43]

Property Type	Type of Development	Current Planning Permission
Type 1	Permitted Development Basement is less than 3m in depth and does not extend beyond the footprint of the original building.	No permission required May be the subject of a certificate of lawfulness.
Type 2	Householder Application Larger than the dimensions of permitted development; greater than 3 metres in depth and extends beyond 3-4 metres outside of the footprint of the original building.	Planning permission is required although no specific information on basement development issues is highlighted at the validation stage. Construction management plan condition will be applied if approved.
Type 3	New Building [Usually a new house] One level basement below footprint of the new house and less than 4 metres beyond the rear main wall of the building.	Planning permission is required although no specific information on basement development issues is highlighted at the validation stage. Hydrological and Hydrogeological condition and construction management plan condition, a considerate constructor's scheme condition.
Type 4	New Building with basement excavation Boundary to boundary excavation and/or more than one level and projecting beyond the footprint of the original building.	Planning permission is required as well as an individual Basement Impact Assessment which must cover groundwater flow, land stability, surface flow, flooding cumulative development and construction management. This must also include potential impacts, mitigation measures and monitoring of mitigation actions taken. Hydrological and Hydrogeological condition and construction management plan condition, a considerate constructor's scheme condition.

[42] You can make certain types of minor changes to your house without needing to apply for planning permission. These are called "permitted development rights" for further details go to website below

[43] LB of Haringey (2012) Draft Basement Development Guidance Note

6.2.2 Subterranean Development and Flood Risk Planning Policy

Basement dwellings are classified as 'Highly Vulnerable' according to the NPPG[44]. As such basement dwellings should not be permitted within Flood Zone 3a and must pass the Exception Test should they be proposed within Flood Zone 2. The SWMP for the LB of Haringey recommends that basements dwellings should be discouraged within areas at risk of fluvial, surface water or groundwater flooding.

6.3 Key Locations and Assessment of Risk

6.3.1 Key Locations

The flood risk impacts and concerns as a result of subterranean development in Haringey are dependent on a number of factors. These concerns chiefly apply to the location of the proposals in relation to hazards such as areas where there is a risk of surface water or river flooding or the effect proposals might have on the existing flow of water in the ground.

Figure 6-4 below shows the areas within Haringey where planning permission has been granted or is pending since 2006. The figure below has been recreated from data within the Haringey Council's Draft Basement Development Guidance Note (June 2012) and illustrates that recent planning permissions have been concentrated in and around Highgate. This is not to say that these are the only areas where basement development is being considered. The following sections outline the risks associated with fluvial, surface water, ground water and reservoirs to subterranean development within the LB of Haringey.

6.3.2 Areas of Fluvial Flood Risk

Existing Situation

Fluvial risk has been categorised as the primary source of flood risk and presents the hazard of greatest extent and severity[45]. The Lower Lee, New River, Moselle Brook and Stonebridge Brook are the river sources that are responsible for the highest fluvial flood risk. The potential flood risk from the River Lee is well mapped following completion of numerous flood mapping studies. Normally the flow in the New River is controlled by pumping stations thus limiting the flood risk from this watercourse. Figure 6-5 below illustrates the areas indicated to be at risk from fluvial sources according to the Environment Agency Flood Zone maps[46].

The risk to life for people residing in basement dwellings could be a real threat during a fluvial flood event, especially to those dwellings that are self contained and do not have internal access to an upper level.

Climate Change

The EA flood zones illustrated in Figure 6-5 do not include an allowance for climate change, however, the Lower Lee Valley study applied an adjustment of 20% to fluvial flows to determine the predicted increase, see section 11. Figure 6-6 illustrates the difference estimated by the modelled results of the Lower Lee Valley study on the defended 1 in 100 year outlines compared with the defended 1 in 100 year plus climate change.

1. The results describe an increase in flood extent is indicated at Hollickwood Park
2. The modelled results show that the area around Northumberland Park may be impacted as a result of climate change. The flood outline at the Lordship Recreation Ground is estimated to increase
3. The flood outline is shown to increase at the Markfield Recreation Ground, west of Warwick Reservoir West.
4. The flood extent along the Pymmes Brook is anticipated to increase with a notable increase at the South Tottenham Recreation Ground. The most notable increase in the estimated flood outline is on the left bank of the Moselle Brook. The modelled results

[44] Department for Communities and Local Government (March 2012) Technical Guidance to the National Planning Policy Framework available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/2115548.pdf
[45] North London Boroughs (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan available at http://www.nlwp.net/downloads/north_london_sfra_final_august_08.pdf
[46] Environment Agency Flood Maps http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

indicate that as a result of climate change the Moselle Brook will overtop its left bank at Poynton Road, bounded to the east by the railway, continuing northward.

6.3.3 Areas of Surface Water Flood Risk

Existing Situation

While fluvial flood risk predominantly affects land to the east of the LB of Haringey, surface water presents a risk throughout the borough; this is influenced by the impermeable geology of the London Clay which is typical of this area. When there are instances of heavy rainfall, very little water can infiltrate into the ground, which causes an increased risk of surface water flooding. Ponding generally occurs at low points in the topography or where water is constricted behind an obstruction or embankment. An example of constriction can be seen around Chadwell Lane and Great Amwell Lane in Hornsey, where water is estimated to back up behind the railway line between Alexandra Palace and Hornsey railway stations. Overland flow paths described by the modelled results tend to follow natural valleys within the borough such as in the south of Tottenham along the original course of the Stonebridge Brook before it was culverted. The flow path begins on Green Lanes and flows east roughly parallel to St Ann's Road resulting in ponding in the vicinity of Culvert Road. Given their nature, basements are more susceptible to surface water flooding than other conventional extensions.

The maps produced for the LB of Haringey SWMP show the predicted likelihood of surface water flooding, including flooding from sewers, drains, small watercourses and ditches that occurs in heavy rainfall, for defined areas. However, it should be noted that due to the coarse nature of the source data used and some of the simplifying assumptions incorporated into the modelling, the maps are not precise enough to describe the severity of flooding that might be experienced at individual addresses[47].

Climate Change

Figure 16 of the LB of Haringey SWMP describes 1 in 100 year plus climate change modelled results. The estimated depth grid indicates that water ponds over a number of roads and residential properties. The railway embankment is a barrier to surface water overland flow and the results from the SWMP indicate areas of deep ponding occur in Hornsey. Other areas of deep ponding that have been highlighted within the SWMP results are:

- Milton Park and Causton Road, Crouch End
- Glendish Road
- Halefield Road
- Poynton Road
- South Tottenham
- Tottenham

6.3.4 Reservoirs

The risk of inundation to the LB of Haringey as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Maps (NRIM)[48] study. The list of those reservoirs considered within this study is included in Section 4.1.4.

There are a number of other smaller reservoirs within the LB of Haringey including a few covered reservoirs but these are small and are seen to present little to no risk.

Reservoir flooding can be very different from other forms of flooding. It may happen with little or no warning and evacuation from the building will need to happen immediately. The likelihood of such flooding is very difficult to estimate, but it is probably less likely than flooding from rivers or surface water. It may not be possible to seek refuge from floodwaters upstairs as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure. The Reservoir Inundation Maps (RIM) obtained from the Environment Agency represents a credible worst case

[47] London Borough of Haringey (2012) Surface Water Management Plan for London Borough of Haringey -Section 3.2 of the LB of Haringey SWMP describes the limitations of the hydraulic models and their results

[48] Environment Agency - Risk of flooding from Reservoirs available at http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=reservoir

scenario. In these circumstances it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

Given the large areas at risk of inundation from reservoir breach and the close proximity of the LB of Haringey to the source reservoirs the consequences of a reservoir breach are likely to be very high. The time to inundation will be low, giving little warning and opportunity to evacuate an at risk location. The velocities are likely to be high resulting in high loads and forces acting on buildings and other structures that are inundated. This may result in structural damage. Where areas are below local ground level they may fill rapidly with flood water without warning. The event of a reservoir breach is extremely hazardous.

6.3.5 Areas of Ground Water Flood Risk

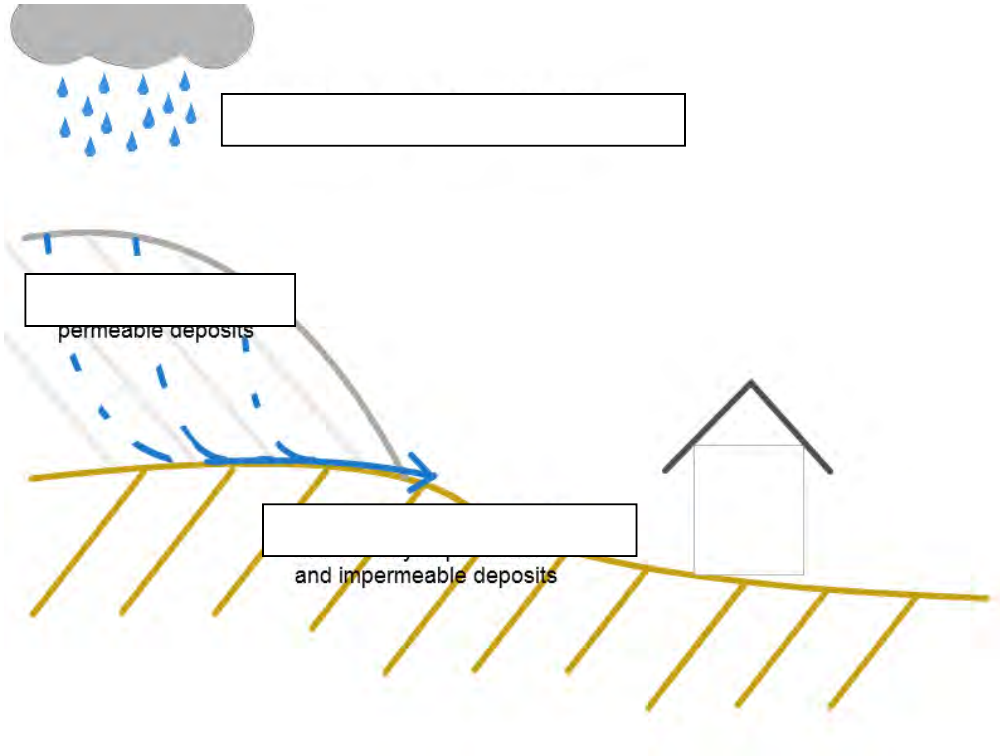
Existing Situation

The characteristics of the geology of Haringey have an impact on the hydrogeological regime of the borough. The presence of superficial deposits result in areas of the LB of Haringey having a perched water table[49] as such these areas are prone to groundwater flooding and are more sensitive to changes in the ground. .

Groundwater can become elevated and cause flooding for a number of reasons:

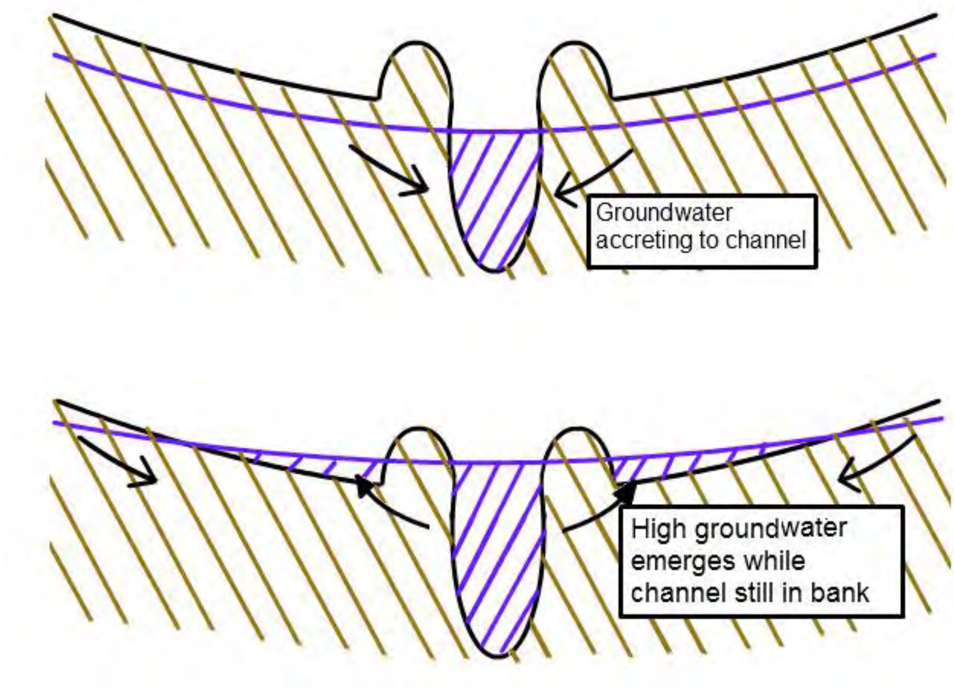
- Extreme rainfall (above national average) for extended periods in chalk outcrop areas,
- Extreme rainfall (above national average) for short periods on permeable superficial deposits overlaying London Clay, Figure 6-1,
- The scenarios above coupled with high water level in watercourses, see Figure 6-2 Reduction of groundwater abstraction causing a raised water table.

Figure 6-1 Illustration of Groundwater Level Rise in Response to Prolonged Extreme Rainfall[50]



[49] A perched water table (or perched aquifer) is an aquifer that occurs above the main water table. This occurs when there is an impermeable layer of rock or sediment (London Clay) above the main water table but is below the surface of the land.
[50] Jacobs (2011) Drain London Increased Potential for Elevated Groundwater , Technical Note - Figure 1.1 page 2

Figure 6-2 Mechanism of Groundwater Flooding from High in Bank Levels [51]



The LB of Haringey SWMP produced an increased Potential for Elevated Groundwater map (iPEG) which included an assessment of the potential groundwater to rise in both consolidated aquifers and from superficial permeable deposits (unconsolidated aquifers). The map also includes those areas close to rivers which are underlain by permeable superficial deposits where groundwater may rise to elevated levels driven by high water levels in the river[52].

Within the areas indicated as being affected by groundwater flows in the iPEG maps, it should be noted that the local rise of groundwater will also be heavily controlled by local geological features and artificial influences (e.g. structures, conduits or abstraction rates) which have not yet been represented.

Groundwater flooding can be localised in nature when compared with fluvial flooding and therefore the iPEG maps should not be interpreted in the same way as would be the case for fluvial flooding. The iPEG 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. 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 and ponding caused by groundwater flooding. When the LB of Haringey is considering potential planning applications, the iPEG map should not be used as a “flood outline” within which properties at risk can be counted. Rather the iPEG map should be used in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so where the major flow pathways are located.[53]

Climate Change

The impact of climate change on groundwater levels is highly uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents, but warmer drier summers and lower recharge of aquifers may counteract this effect[54]. This is further complicated by the changes to groundwater levels in London as a response to changes in term trends in ground water abstraction.

[51] Jacobs (2011) Drain London Increased Potential for Elevated Groundwater , Technical Note - Figure 1.2 page 3
[52] See Figure 10 of the LB of Haringey SWMP titled "Increased potential for Elevated Groundwater Map (iPEG)".
[53] London Borough of Haringey (2011) Surface Water Management Plan for London Borough of Haringey- Appendix C2 - Groundwater
[54] LB of Haringey (2011) LB of Haringey SWMP - Section 3.5.17

6.3.6 Areas of groundwater flow impact

Basement dwellings are vulnerable to groundwater flooding in locations where the flow of groundwater can be significant. Ensuring that the basement is water tight should mitigate against groundwater entering the basement dwelling, however the removal of permeable in situ ground material, replaced by an impermeable void (the basement) can affect the way groundwater flows locally at the development site, see Figure 6-3.

Displacing groundwater flows may increase the risk of groundwater emergence and flooding to neighbouring properties. Displacement can also have the potential to deprive water bodies of vital groundwater recharge due to underground streams being diverted by the presence of impermeable basement dwellings.

If development including a basement extension is proposed in areas indicated by the iPEG maps then an assessment should be carried out to show that any extension underground will not impact on the groundwater flow regime. This assessment is referred to as a "basement impact assessment".

Due to the high land value and other pressures on development in the borough, development of basements to provide additional room for new and existing developments are becoming more common within the LB of Haringey. Permitted development rights currently allow residents to build basements of less than 3m in depth as long as they do not extend beyond the footprint of the original building (Type 1) without applying for planning consent from the LB of Haringey, see Table 6-2. One basement extension, constructed under permitted development rights, may have little impact on the groundwater behaviour, however, the cumulative effect of many basement extensions within the LB of Haringey will impact on the hydrogeological regime.

A type 1 development does not require planning permission, which makes it difficult for the LB of Haringey to monitor and influence the implementation of basement extensions. The LB of Haringey Building Control team will report, as a minimum, the locations of proposed basement extensions. Building Control may also request a flood risk assessment of a basement's impact on the groundwater regime and an assessment of the safety of those who will be using the basement, prior to the issue of certification for commencement.

Where planning permission is required (Type 2, 3 & 4), LB of Haringey states that developers should provide risk assessments to show that the proposed basement extension has no adverse impacts on the hydrological regime and does not increase flood risk to third parties or to their development.

Climate Change

The impact of climate change on groundwater levels is highly uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents, but warmer drier summers and lower recharge of aquifers may counteract this effect[55]. This is further complicated by the changes to groundwater levels in London as a response to changes in term trends in ground water abstraction.

6.3.7 Areas Affected by Flooding From Sewers

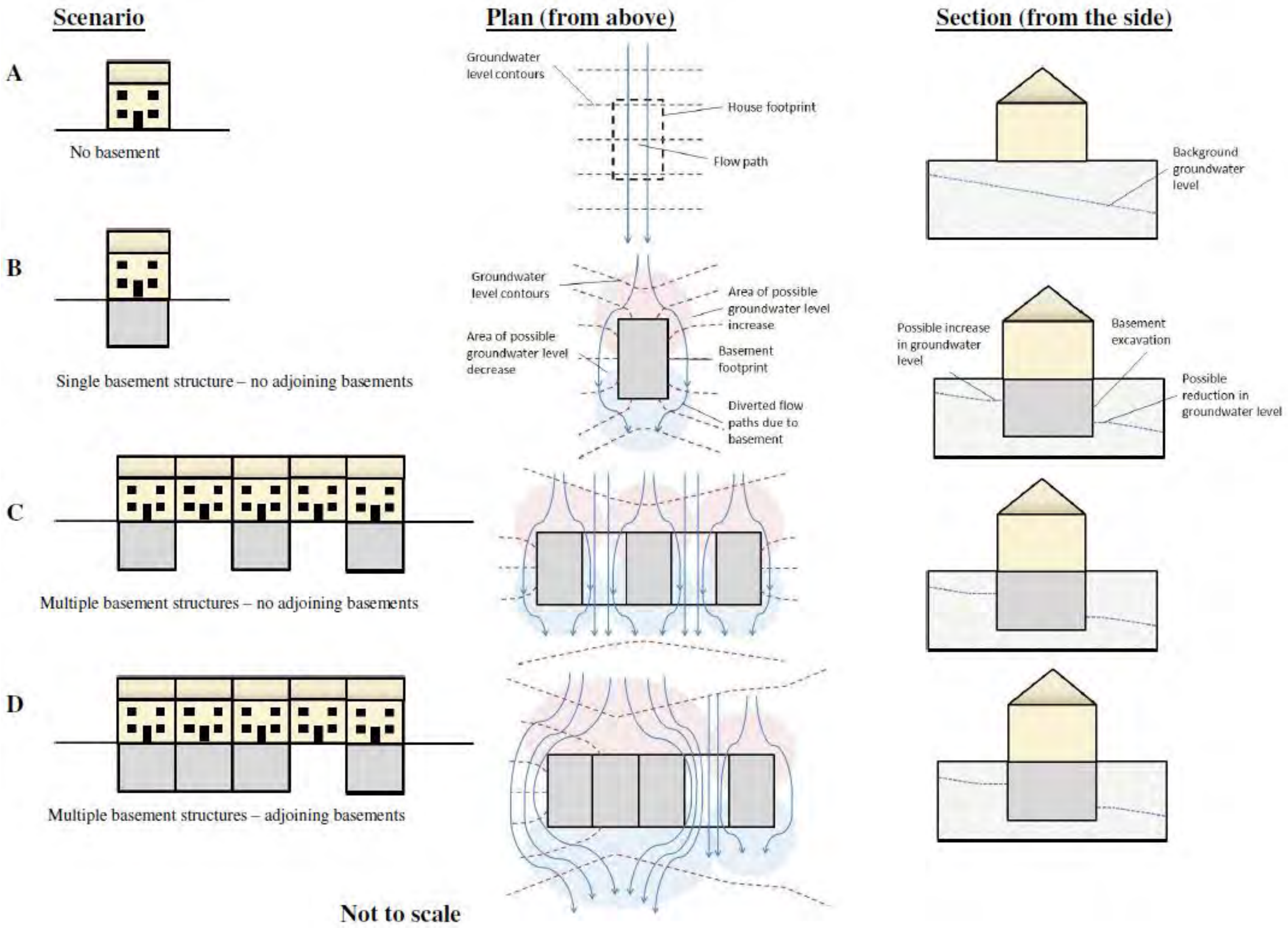
Existing Situation

The impact of sewer flooding is generally localised to where a blockage or failure of a sewer network occurs. Historic records indicate that areas; Tottenham, Crouch End, Highgate, Muswell Hill and Southeast Tottenham, have flooded due to sewers.

When proposing additional development within the LB of Haringey, it is the responsibility of a developer to make proper provision for drainage to a suitable sewer. In respect of surface water it is recommended that the applicant should ensure that storm flows are attenuated or regulated into the receiving public network through on or off site storage. When it is proposed to connect to a combined public sewer, the site drainage should be separate and combined at the final manhole nearest the boundary. Where the developer proposes to discharge to a public sewer, prior approval from Thames Water Developer Services will be required. Thames Water should be contacted to ensure that the discharges from the development shall not be detrimental to the existing sewerage system.

[55] LB of Haringey (2011) LB of Haringey SWMP - Section 3.5.17

Figure 6-3 Groundwater displacement due to basement



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6.3.8 Areas of groundwater flow impact

Basement dwellings are vulnerable to groundwater flooding in locations where the flow of groundwater can be significant. Ensuring that the basement is water tight should mitigate against groundwater entering the basement dwelling, however the removal of permeable in situ ground material, replaced by an impermeable void (the basement) can affect the way groundwater flows locally at the development site, see Figure 6-3.

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Where planning permission is required (Type 2, 3 & 4), LB of Haringey states that developers should provide risk assessments to show that the proposed basement extension has no adverse impacts on the hydrological regime and does not increase flood risk to third parties or to their development.

Climate Change

The impact of climate change on groundwater levels is highly uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents, but warmer drier summers and lower recharge of aquifers may counteract this effect[56]. This is further complicated by the changes to groundwater levels in London as a response to changes in term trends in ground water abstraction.

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When proposing additional development within the LB of Haringey, it is the responsibility of a developer to make proper provision for drainage to a suitable sewer. In respect of surface water it is recommended that the applicant should ensure that storm flows are attenuated or regulated into the receiving public network through on or off site storage. When it is proposed to connect to a combined public sewer, the site drainage should be separate and combined at the final manhole nearest the boundary. Where the developer proposes to discharge to a public sewer, prior approval from Thames Water Developer Services will be required. Thames Water should be contacted to ensure that the discharges from the development shall not be detrimental to the existing sewerage system.

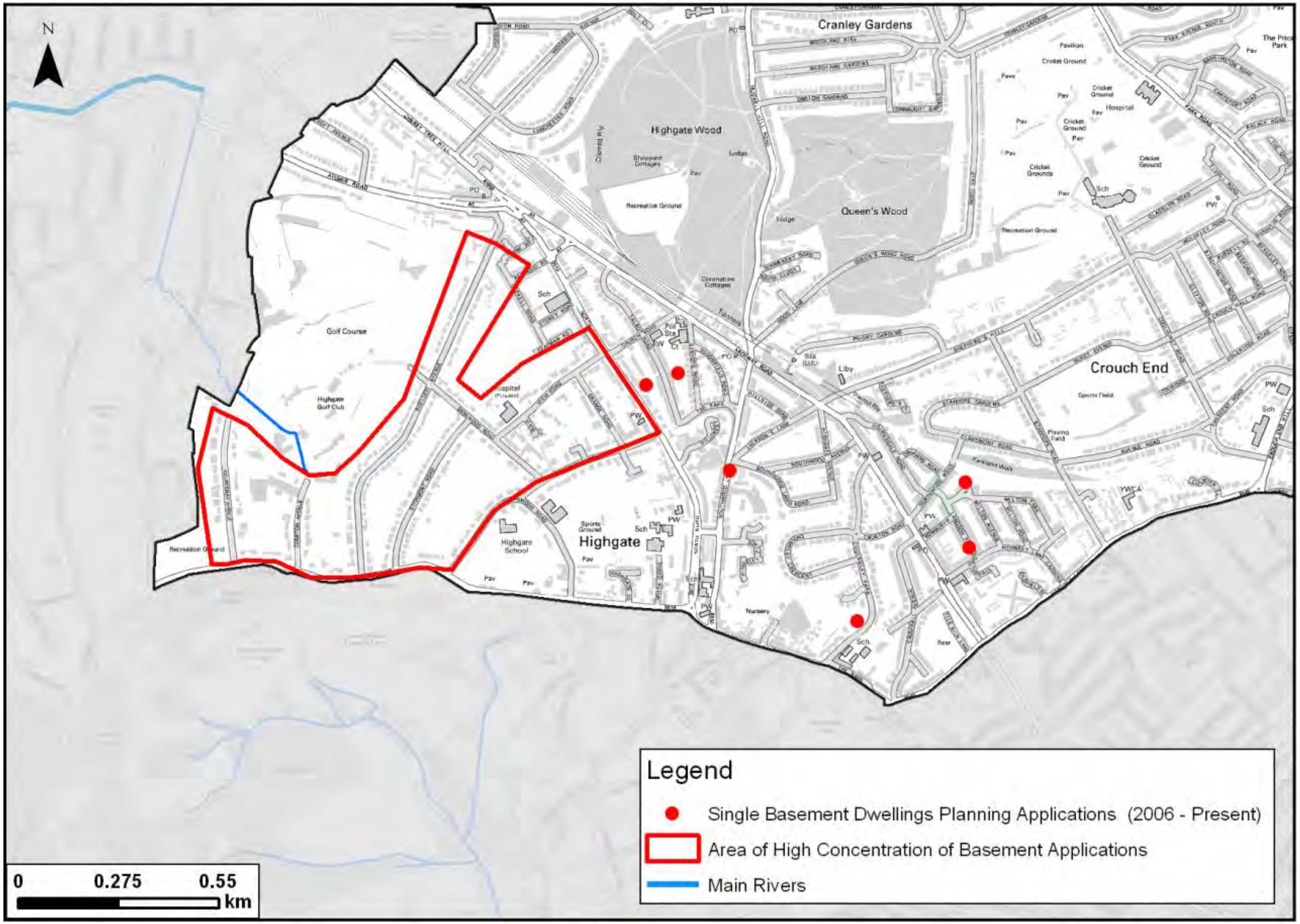
[56] LB of Haringey (2011) LB of Haringey SWMP - Section 3.5.17

6.4 Recommendations for Basements in Areas of Mapped Flood Risk

The following recommendations are suggested for proposed developments including basement extensions in areas of flood risk:

- It is recognised that not all types of basement developments require planning permission. Thus for Type 1 development (see Table 6-1) regulation and control should be applied through the building control process especially if such development is located within the Flood Zones 3a and 3b.
- New self-contained basement dwellings of any type (i.e. Types 1, 2, 3 or 4 in Table 6-1) should not be located in:
    - Flood Zone 3a and 3b or within the 1: 100 AEP plus climate change outline
    - Areas of flooding as described in the LB of Haringey SWMP surface water flood maps
- Basement development within the RIM outline should include an assessment of a breach in the reservoir that could affect the proposed development within their FRA. On the basis of the results from the FRA, consideration should be given to the flood risk from reservoir breach and the appropriate response (i.e. emergency plan or flood resistant design). Also consideration should be given within the proposed design to the potential forces on the structure that might be encountered during a breach event.
- Basement dwellings may be feasible with the proviso that there is internal access to an upper ground floor level and no sleeping accommodation is located within the basement level.
- For all basement development in these locations, an FRA and Emergency Plan should be submitted to the council for approval prior to commencement of development. This will be required as a supporting document for a planning application or a submission presented to building control.
- Provision should be made for the emergency plan to be attached to the deeds of the property so that in the event of transfer of ownership new residents are fully aware of the risk and emergency plan provisions.
- Surface water discharges from existing and proposed development will be restricted to green field rates and volumes. Provision should be made to accommodate the potential increased flows generated by climate change effects in accordance with the approach described in Section 5 of the SFRA.

Figure 6-4 Key locations for Basement Dwellings in Haringey



Contains Ordnance Survey data © Crown copyright and database right 2012

Figure 6-5 Environment Agency Flood Zones

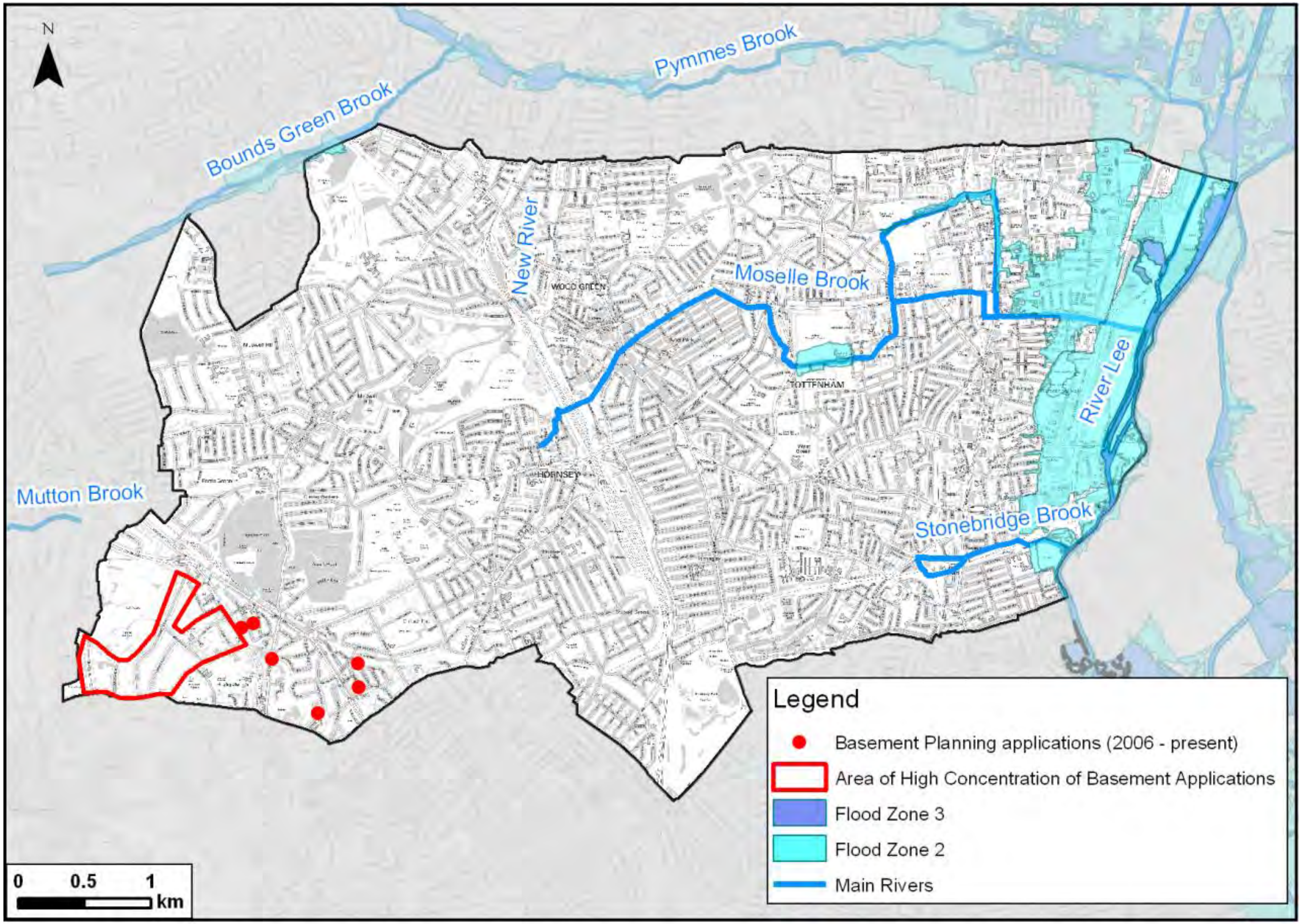


Figure 6-6 1 in 100 year Defended Flood Outlines with Climate Change

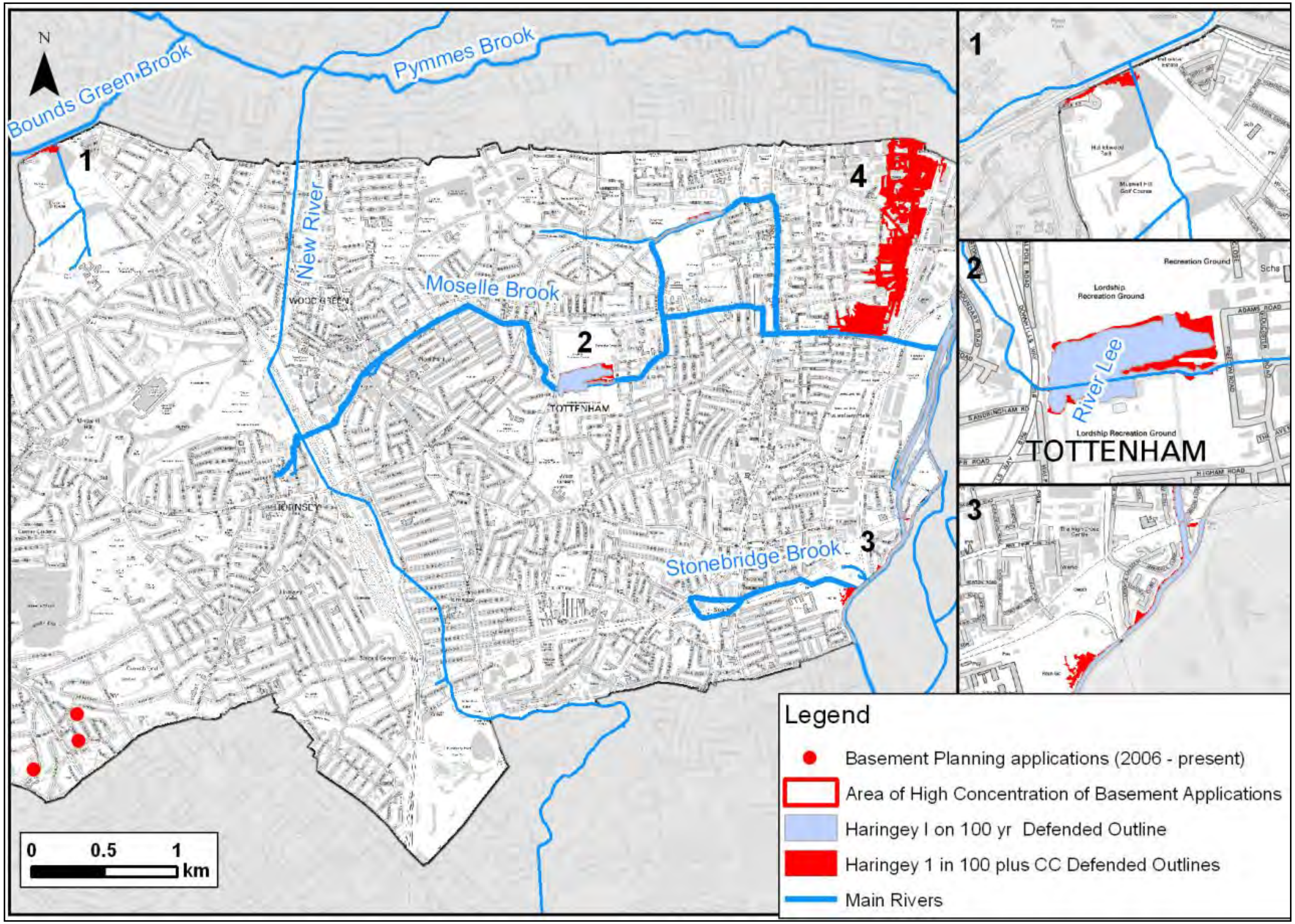


Figure 6-7 LB of Haringey SWMP (2012) - 1 in 200yr

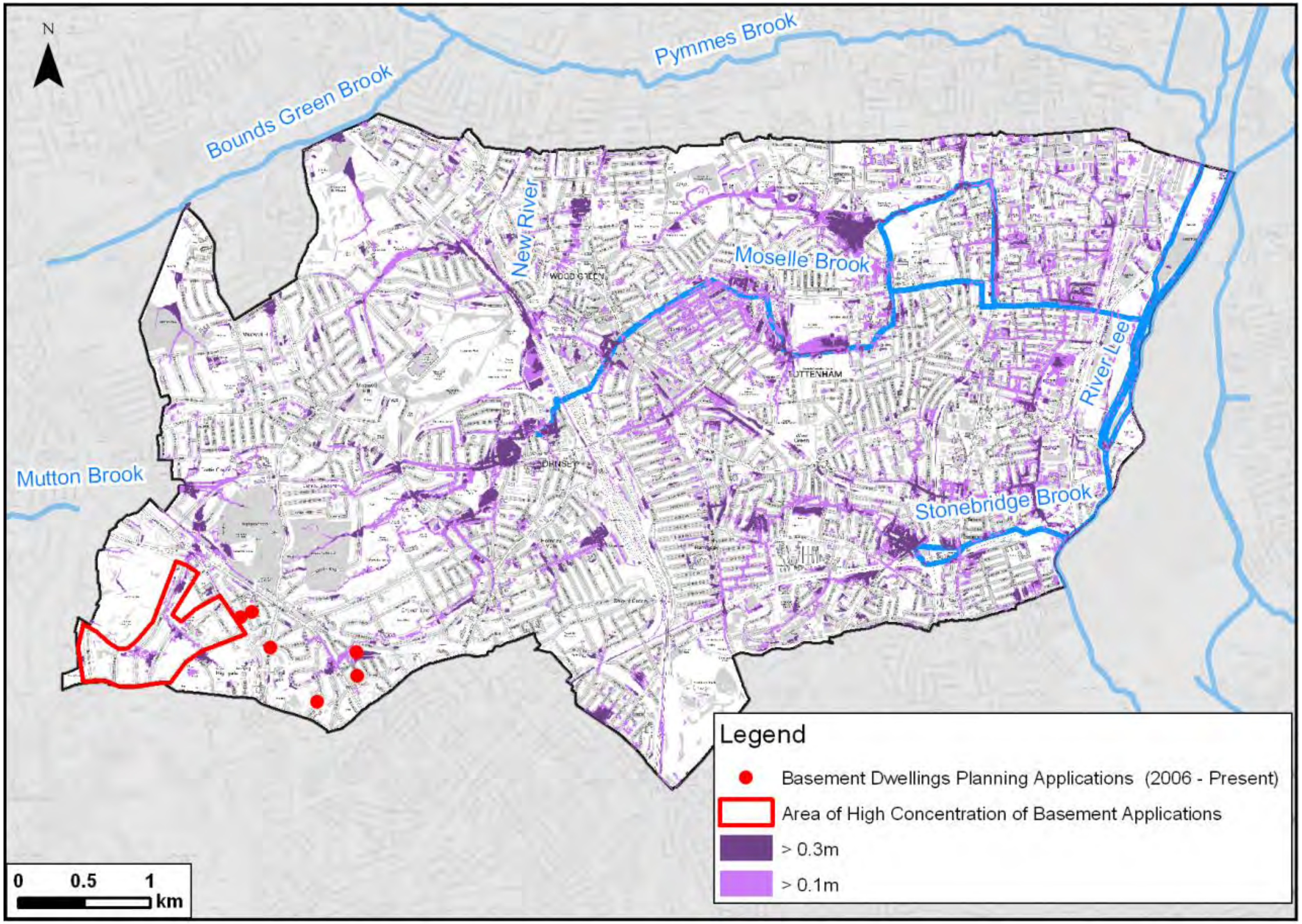
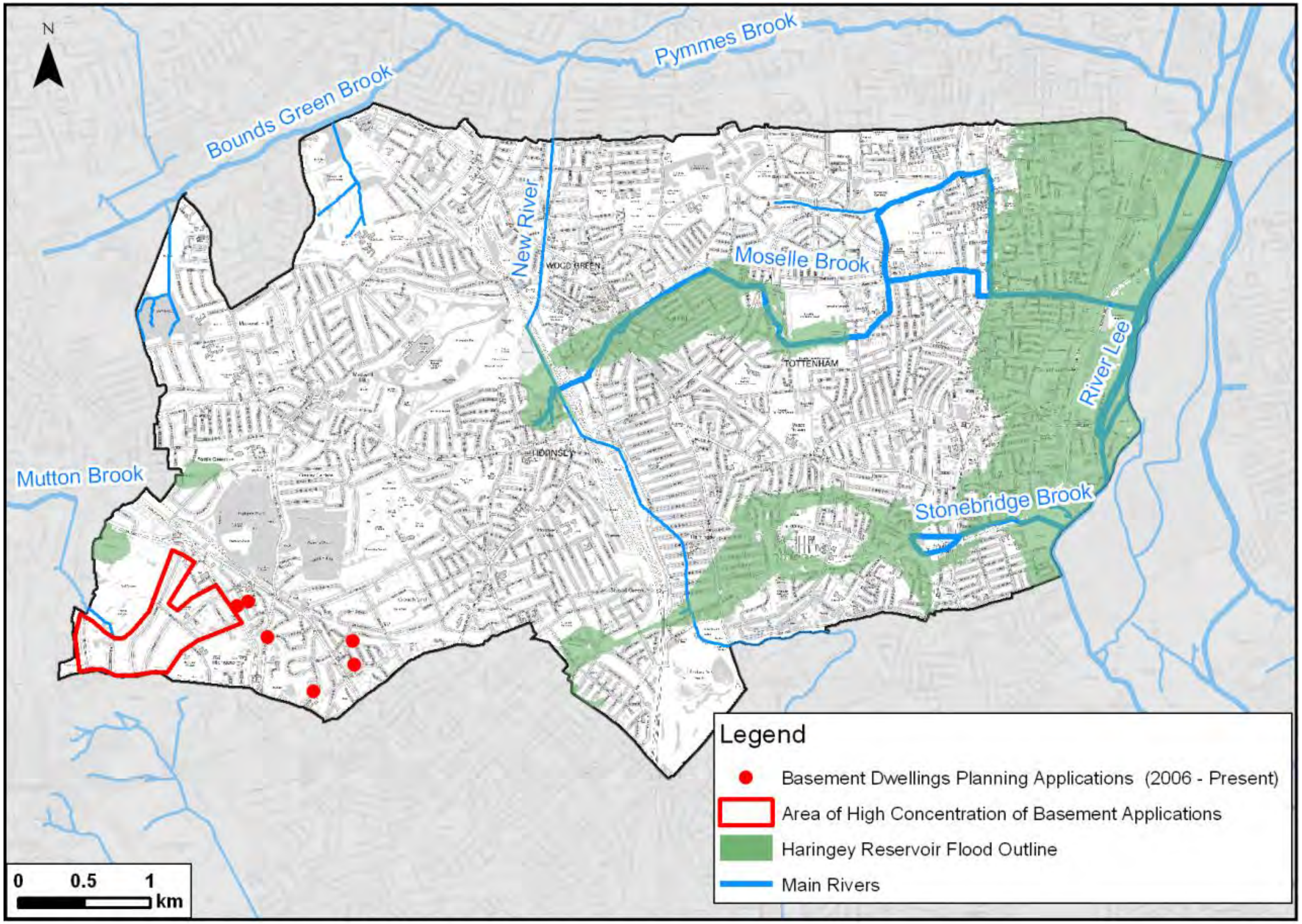


Figure 6-8 National Reservoir Inundation Maps



JBA consulting

6.5 Summary and Recommendations

Table 6-2 describes the basement property type and recommends whether a type is suitable depending on its location in the Environment Agency Flood Zones, the LB of Haringey SWMP surface water maps and the iPEG maps.

Table 6-2 Basement Property Types and Flood Risk

		Fluvial				LB of Haringey SWMP Surface Water Maps				Reservoir	Groundwater
Property Type	**Type of Development**	**FZ3a**	**FZ3b**	**FZ2**	**FZ1**	**30yr > 0.1m**	**30yr > 0.3m**	**200yr > 0.1m**	**200yr > 0.3m**	**NRIM**	**Permeable Superficial Deposits**
	Self Contained Basement Dwelling	✘	✘	✘	✔	✘	✘	✘	✘	✔ (i) (ii)	✘
Type 1	Permitted Development Basement is less than 3 metres depth and does not extend beyond the footprint of the original building.	✔ (i)	✘	✔ (i)	✔ (i)	✔ (i)	✔ (i)	✔ (i)	✔ (i)	✔ (i) (ii)	✔ (i)
Type 2	Householder Application Larger than the dimensions of permitted development; greater than 3 metres in depth and extends beyond 3-4 metres outside of the footprint of the original building.	✘	✘	✔	✔	✔	✔	✔	✔	✔ (ii)	✔
Type 3	New Building [Usually a new house] One level basement below footprint of the new house and less than 4 metres beyond the rear main wall of the building.	✘	✘	✔	✔	✔	✔	✔	✔	✔ (ii)	✔
Type 4	New Building with basement excavation Boundary to boundary excavation and/or more than one level and projecting beyond the building footprint of the original building.	✘	✘	✔	✔	✔	✔	✔	✔	✔ (ii)	✔

✘	**Development should not be permitted**
✔	The LB of Haringey should, as a minimum maintain a register in conjunction with Building Control of subterranean development that falls under permitted development rights, existing and proposed, to monitor the potential cumulative impact of subterranean development on the drainage regime. **Prior to commencement of construction on basement development, assessments shall be submitted and approved by the London Borough of Haringey to demonstrate:** • There are suitable assessments to demonstrate there is no risk from surface water, groundwater and/ or fluvial flooding. • Basement extensions in flood risk areas do not contain sleeping accommodation. • There is an internal access to upper levels from the basement extension.
(i)	It is recommended that regulation of basement development be applied through the building control process.
(ii)	If the proposal lies within a RIM outline a reservoir breach analysis should be included in a FRA. RIM outlines can be found at http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx
	The LB of Haringey should, as a minimum maintain a register in conjunction with Building Control of subterranean development that falls under permitted development rights, existing and proposed, to monitor the potential cumulative impact of subterranean development on the drainage regime.
✔	A FRA appropriate to the size and scale of the basement extension will be required to support the planning application.
✔	A FRA appropriate to the size and scale of the basement extension will be required to support the application, the FRA should be able to demonstrate that there will be no increase in surface water run off ,as a minimum, with an aim to reduce the overall surface water run off from the proposed development.
✔	There should be **no sleeping accommodation in the basement extension** and **internal access can be provided to upper levels**. A FRA must be submitted for approval In addition, it should be shown that there is egress from the development to an area outside of National Reservoir Inundation mapped flood outline.
✔	The FRA will need to demonstrate that the basement extension does not impact upon the existing hydro geological regime and that flood risk from groundwater is not increases to the development or to third parties.

7. Strategic Options

This section identifies opportunities for the implementation of strategic measures to meet the needs of sustainable development. Due to the highly urban nature of the LB of Haringey these opportunities will not just be large engineering schemes but will also involve strategic catchment based responses that result in less frequent flooding and reduced severity in the consequences. This strategic approach must encompass both local scale events and the cumulative effects of the local change on the larger River Lee system. The principle adopted involves a holistic approach to solving potential effects, rather than seeking to identify piecemeal solutions at individual sites. This proposed approach is then aligned with the principles endorsed by DEFRA as enshrined in the Resilience Partnership Funding arrangements.

As discussed in Section 2.4.2, there are a number of areas within the boundaries of LB of Haringey that are predicted to be at risk from flooding from a range of different sources. In order to ensure that growth and development in Haringey is sustainable, flood mitigation measures need to be considered for the LB of Haringey and the wider area which will involve cross boundary co-operation. The timescale of new development and its potential impact has been discussed in Section 5 of this SFRA. This section provides a high level overview of potential opportunities for mitigation in the LB of Haringey, and considers the potential strategic responses to address key flood risk issues in the LB of Haringey.

It should not be forgotten that fluvial flooding presents a significant risk to the east of the borough from the River Lee and its tributaries. To this end the options for addressing fluvial flood risk from the River Lee are discussed in section 7.5 below. However due to the nature of flood risk in the River Lee and the interlinked impacts on neighbouring boroughs works to address this source of flood risk need to be undertaken in partnership with others on a catchment, not borough scale.

One of the most significant local sources of flood risk in the LB of Haringey is from surface water; the recent SWMP undertook a review of mitigation options that are outlined in the following sections.

7.1 Proposed Development Sites

The LB of Haringey has provided details of the 133 proposed development sites at the time of preparing this SFRA and these are set out in their Draft Site Allocations Document Figure 5-1 shows how the proposed development sites are distributed within the LB of Haringey. It can be seen that the sites are distributed throughout the LB of Haringey, with more sites in the east of the borough. The cumulative area of all the proposed development sites identified for this study is just less than one square kilometre, representing over 3.3% of the total area of the LB of Haringey. These sites represent a significant opportunity for betterment of the current flood risk situation as well as a significant liability when it comes to managing future climate change as described in section 5.9 above.

For the purposes of the assessment within this version of the SFRA, the development sites have been divided up in to distinct drainage areas. These are based primarily on the Critical Drainage Areas (CDAs) identified in the SWMP but also eight additional Haringey Drainage Areas (HDAs) have been created to cover the remainder of the borough. Both are outlined in the following figures. Each of these drainage areas is then discussed in turn with reference to the strategic surface water management options.

7.2 Surface Water Management Plan (2012)

The SWMP identified a range of structural and non-structural measures (options) with the potential to alleviate flood risk for each of the local sources of flood risk (surface water). A number of preferred options were chosen, these are summarised in the SWMP (2012). The SWMP contained a review of mitigation options for specifically designated Critical Drainage Areas.

7.3 Catchment Flood Management Plan (2008)

As discussed in Section 2.6, the River Thames CFMP categorises the LB of Haringey into four policy units:

- The Lower Lee
- The Lower Lee Tributaries
- Brent
- TE2100 policy

Each of these zones (shown in Table 7-1) has a different flood risk management policy.

Table 7-1 Proposed Development Sites and CFMP Policy Units

Policy Unit	Policy	Number of development sites	Combined area of development sites	% of Policy Unit area* covered by development sites
The Lower Lee	P5	7	0.10	3.86
The Lower Lee Tributaries	P6	67	0.84	3.55
Brent	P4	4	0.03	1.19
TE2100	TE2100	0	0.00	0.00

* area within LB of Haringey
Where sites fall across more than 1 Policy Unit they are listed under the policy that contains the site's centroid to avoid double counting.

7.3.1 The Lower Lee

The Lower Lee has been identified as a policy 5 area within the Thames CFMP. Policy 5 covers areas of moderate to high flood risk where generally further action should be taken to reduce flood risk. This area is within the current Flood Zone 2, 3a or 3b, that is to say it ranges from functional flood plain through to medium probability of flooding on the basis that no flood defences or certain other manmade structures and channel improvements are present (refer to chapter 4 for a fuller explanation of the flood zones). The policy recommends reducing the risk or lowering the probability of exposure to flooding and/or the magnitude of the consequences of a flood.

The sources of fluvial flood risk defining this policy unit area within the LB of Haringey are the River Lee system (and its various distributaries) and the Pymmes Brook (including Bounds Green Brook). The River Lee system includes the River Lee, Lee Navigation, and Lee Flood Relief Channel with the associated sluice gates, radial gates and weirs which control water levels in the system. Combined, these flood defences are reported to provide a standard of protection of approximately 1.5% to 2% Annual Exceedance Probability (AEP) across the catchment, but locally the standard of protection can be higher or lower. The floodplain of the Lower Lee is developed with major flood defences. As a result of climate change, the effectiveness of the defence can be expected to decrease and as such the standard of protection may be reduced.

7 of the 133 sties fall within the Lower Lee policy 5 unit. These 7 sites cover an area of 0.1 sq km which represents 3.86% of the policy unit area within the LB of Haringey.

7.3.2 The Lower Lee Tributaries

The Lower Lee tributaries have been identified as a policy 6 area within the Thames CFMP. Policy 6 covers areas of low to moderate flood risk where action should be taken to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits. This policy covers the majority of the LB of Haringey including the Moselle Brook and the Stonebridge Brook.

The Lower Lee tributaries drain smaller, steeper and more urbanised catchments than those found in the upper Lee as a result of their catchment size, topography, geology and land use (especially the degree of urbanisation) and the Lower Lee tributaries respond rapidly to heavy rainfall. To manage the risk from these areas, opportunities for storage of water and run-off management should be explored within and alongside the development sites.

Of the development sites, 67 of the 79 fall within the Lower Lee tributaries policy 6 area. These 67 sites cover an area of 0.1 sq km which represents 4% of the policy unit area within the LB of Haringey.

7.3.3 Brent

A small area of the LB of Haringey has been included in the Brent policy unit. The Brent policy area is derived from the River Brent catchment and is not a reference to the LB of Brent. This area has been characterised as policy 4. Policy 4 covers areas of low, moderate or high flood risk where flood risk is currently managed effectively but where further actions may be required to keep pace with climate change.

The Brent policy unit is generally characterised by a highly developed floodplain with little open space and modified river channels. Only a small portion of the upper reaches of one of the sub-catchments lies in Haringey.

The emphasis in this policy unit is on the need for long-term adaptation of the urban environment and the reduction of flood risk through redevelopment. There is a need in most areas to change the character of the urban area in the floodplain through re-development to make it more resilient and resistant to flooding which results in a layout that recreates river corridors.

Whilst this is an important long term consideration for the LB of Haringey and its neighbouring boroughs, the development sites identified in the current allocations are not located near the river channel and as such are not conducive to the creation of river corridors. However, when assessing windfall sites located within this policy unit, consideration should be given to the opportunities for the creation of river corridors along the tributary watercourses. This can be achieved through redevelopment so that there is space for the river to flow more naturally and space in the floodplain where water can be attenuated.

The CFMP advises that where redevelopment occurs it should be made resilient and resistant to flooding and contribute to the building and maintenance of flood defences as part of an overall catchment plan. This is because more attenuation and more space in the river corridors is needed for defences to be sustainable which is more complex but represents better value for society in the long-run.

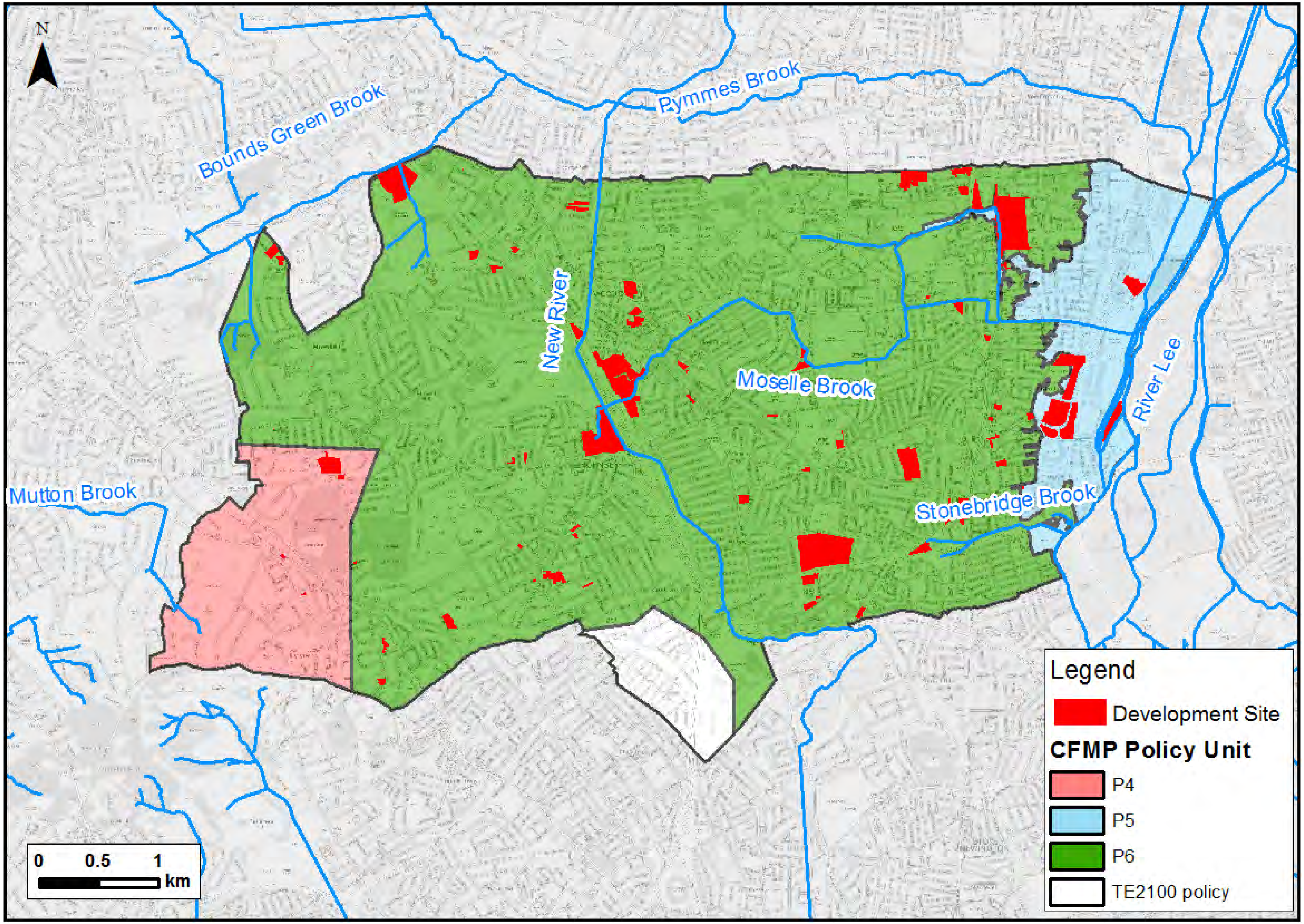
Like the Lower Lee Tributaries, these areas are very susceptible to rapid flooding from thunderstorms and emergency response and flood awareness are particularly important.

Four of the 133 development sites fall within the Brent policy 4 area. These sites cover an area of 0.03 sq km which represents 1.19% of the policy unit area within the LB of Haringey.

7.3.4 TE2100 Policy

Another small area of the LB of Haringey has been assessed separately in the TE2100 policy options. No development sites are located in this area. Should windfall sites occur at a later date then flood risk management strategies should be consistent with the TE2100 recommendations.

Figure 7-1 Proposed Development Sites within CFMP Policy Units



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7.4 Mitigation options

7.4.1 Managing the Source

A primary method of reducing surface water flood risk is though managing the source of the risk (see section 1.5.1 for discussion of source, pathways and receptors). To achieve this, use of Sustainable Drainage Systems (SuDS) is recommended. SuDS aim to mimic natural drainage processes so that developments do not increase surface water runoff and negatively impact water quality (which is a general consequence of conventional drainage techniques). Although the consideration of SuDS is a requirement of all new developments, these make up only a fraction of the urbanised area of the UK. There are many opportunities for retrofitting SuDS within existing green and urban spaces to create appealing spaces whilst actively mitigating flooding and water quality problems.

It should also be noted that with regards to SuDS and surface water drainage, the Flood and Water Management Act 2010 calls for the establishment of an Approving Body for SUDs (SAB) to be set up in LLFA. The SAB is responsible for the approval and adoption of SuDS which must meet the National Standards for sustainable drainage.

There are various SuDS techniques available, many of which are applicable in different situations. SuDS can be considered as a component of Green Infrastructure provision. Green Infrastructure affords the opportunity to improve the local environment through the implementation of green spaces, in particular within urban areas. Current best practice on the inclusion of SuDS facilities in Green Infrastructure space is generally considered to be the CIRIA SuDS manual (CIRIA, 2007)[57]; it provides a comprehensive overview of the techniques. Examples of these are listed below:

- **Permeable Pavements** such as permeable concrete blocks, crushed stone and porous asphalt will allow water to infiltrate directly into the subsoil before soaking into the ground. These features have potential to reduce the effect of urbanisation on runoff rates and volumes. Careful monitoring or maintenance is required to ensure they do not become blinded with fine silt material, which may reduce their permeability.
- **Green Roofs** can vary in type from Roof Gardens, Roof Terraces, Green Roofs and Green Walls. This SuDS technique utilises plants and their substrate to provide temporary storage of rainfall and minimise runoff from roof areas. Green roofs not only store water temporarily, they can reduce the volume of runoff through water use in the form of uptake by plants and subsequent evapotranspiration. Some types of green roof, and green walls in particular, require regular irrigation and can become net consumers of water (rather than net producers of runoff). Green roofs also offer additional biodiversity and in some cases amenity benefit. Green roofs can be used to aid climate control in buildings, insulating in the winter and cooling in the summer.
- **Rainwater Harvesting** such as the installation of water butts or more significant storage media aid in the management of runoff. By capturing all or part of the rainfall hitting roofs and hard surfaces of a development and storing the water for use on site either internally or externally for the replacement of potable water sources. Rainwater harvesting systems have significant potential to manage runoff and increase water security and are normally designed for annual average rainfall or to capture enough water for a specific purpose. By over designing these systems to have the capacity to store extreme rainfall events they are able to provide not only social and economic benefit in normal conditions but also flood generating conditions. It is important to note that such systems should be designed in such a manner as to ensure that this additional storage is available (e.g. empty) at the start of the event. This will also ensure that there is regular turnover and use of the stored water.
- **Infiltration devices** drain water directly into the ground and allow it to soakaway into the local geology. The most common example of this type of feature is an underground soakaway chamber that has capacity to hold water and, through either porous or

[57] It should be noted that at the time of writing this report, the CIRIA SuDS manual is under review. Users of this document should refer to the updated CIRIA SuDS manual.

perforated walls, allows water to infiltrate into the surrounding soils and geology. Devices may also include surface features such as ponds, vegetated rills or swales that can be used to convey runoff across the ground surface but allow water to infiltrate as it passes. Such features can be integrated into and form part of the landscaped areas. Vegetated options can act as filter strips by slowing runoff velocities and improve water quality by filtering out sediment and other pollutants. Where sites directly overlay impermeable soil types (such as where London Clay is found very close to the surface, see Figure 5-7 for further discussion of LB of Haringey soil types), the rate of infiltration can be problematic. Similarly in areas of superficial deposits, extensive long term increase in infiltration may increase the water table height of the perched water table, increasing the occurrence of ground water emergence. However this may also take the form of raising the baseflow of groundwater-fed watercourses which may provide potential enhancements to water ecology. Infiltration may not be possible in areas of contaminated land or land found to have or suspected to have issues related to soil pollution.

- **Rain gardens and detention basins / ponds** enhance flood storage capacity by providing temporary storage of runoff through the creation of landscape features within a site (which can often provide opportunities for the creation of wildlife habitats). These types of features range in both the scale of the storage they provide and the length of time they detain the stored volume. Rain Gardens typically detain the smallest volumes of water for the shortest period of time with basins and ponds providing larger storage volumes and detaining the storage volume for longer periods. All these types of features can be fed by swales, filter drains or piped systems.
- **Below ground storage** works in a similar way to rain gardens, detention basins / ponds (generically above ground storage options) outlined above. The benefit of below ground storage is that it reduces land take as the land above can be used for parking or recreational space. The disadvantage is that maintenance can be more difficult and little environmental or amenity value is provided.

The extensive use of SuDS such as those outlined above strongly supports the CFMP policy 6 as well as the SWMP CDA recommendations and requirements of Flood and Water Management Act.

7.4.2 Managing the Pathway

Whilst management of the source can provide local benefits it might not always result in the wider, long term strategic reduction of flooding arising from climate change effects. In these circumstances proposed developments should contribute to a range of other capital schemes that can also be used to reduce flood risk by improving the pathway of high flows. There are two approaches available to achieve pathway improvements:

- **Increased capacity** of the pathway or watercourse in terms of the volume of water it can carry before causing flooding. This is typically achieved by raising embankments or widening flood plains, creating off line storage and deculverting watercourses. These types of schemes work by holding water in areas designed to flood at higher flows. As a result, the situation is dealt with locally and should have limited downstream impact on the rest of the catchment.
- **Increased conveyance** of pathways or watercourse in terms of the rate water flows away from an area. This is typically done by straightening or culverting watercourses. These types of schemes work by funnelling water away from the area at risk and are only suitable where there are no areas at risk downstream. The rate of response of the catchment is increased and needs to be carefully managed. Such schemes would not be appropriate for areas of the LB of Haringey.

Due to the setting of the LB of Haringey, options to generally increase conveyance without considering the effect of the loss of flood storage would not be appropriate for the River Lee or its tributaries (due to the significant areas at risk downstream). However, it is recognised that there will be local circumstances where it would be preferable for conveyance capacity to be increased, such as at culverts where flow is restricted, or where there are frequent blockages. Where conveyance is increased, this should be accompanied by efforts to increase capacity of the existing waterways through deculverting, in conjunction with the establishment of offline or online storage areas that are designed to flood and store water for the duration of a flood event. This is particularly important for the lower Lee tributaries due to the response of the River Lee to flood events. The River Lee response to high flows is very prolonged with water levels raising in response to high flows and staying high for a long time before gradually subsiding. This can lead to drainage issues for connecting watercourses or culverts and drains that outfall to the River Lee as they may find their discharge perturbed or blocked by the high water levels in the River Lee for the duration of their response, which is likely to be much more rapid. Future proposals should ensure that development does not encroach into the river margins and impede opportunities for the implementation of sustainable and cost effective flood risk management options. Open spaces within developments, which have a residual flood risk, should be designed to act as flood storage areas. All proposals should encompass a strategic catchment approach that not only addresses local problems, but also considers the effects of the preferred solutions on the wider area and catchment.

7.4.3 Managing the receptor

In circumstances where it is difficult to identify measures to manage the source and the pathway, consideration must be given to the impact of flooding on the receptor. This is best summarised by addressing three factors:

- **Matching vulnerability of the receptor to the probability of flooding** the first opportunity to manage the risk is implicit within the risk based approach and enshrined in the application of the sequential and exception tests. By changing the type of development it is possible to achieve reduction in risk and the process through which this is achieved is described in Section 6 of the SFRA.
- **Property level resistance and resilience** where by properties are designed and constructed in such a way as to reduce the chance of water entering the property or reducing the impact of any water that does enter. This can be achieved with resistance measures such as flood gates, removable barriers or airbrick covers or by resilience measures such as tiling ground floors, raising electrical fittings and using water resistant cement render for walls rather than plaster.
- **Emergency planning** such as the proper preparation of emergency plans in consultation with the local emergency plan officer and emergency services. It is important to continue to improve flood warning & raising awareness of services already offered. People can register with the Environment Agency for a direct warning service so that they receive a direct warning if flooding is forecast in their area[58]. Flood warnings are more beneficial in areas where the runoff response is slow, as there is generally a long time between a flood being forecast and the start of flooding. It should be noted that within the LB of Haringey, the nature of the River Lee and its tributaries mean that flooding is usually "flashy" and the flood warning lead-time available is very short. Therefore very little action can be taken even if a warning is received.

It must be emphasised that flood resilience and resistance measures should not be seen as a way of avoiding other planning issues that need to be considered. The risk based approach must be applied at all times and as per planning requirements, vulnerable receptors should be considered using the sequential and exception tests before considering property level resistance and resilience and emergency planning measures outlined above. Where sites are at residual risk, managing the risk to the receptor is very important.

7.4.4 Developer contributions

In some cases and following the application of the sequential test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made for the maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

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[58] http://www.environment-agency.gov.uk/homeandleisure/floods/38289.aspx

It should be noted that the Flood and Coastal Risk Management Grant in Aid (FCRMGiA) funding arrangements introduced in 2011 do not make government funds available for any new development implemented after 2012. Accordingly it is essential that appropriate funding arrangements are established for new development proposed in locations where a long-term investment commitment is required to sustain Flood Risk Management measures. The strategic investment commitment is required so that in future the Flood Risk Management measures can be maintained and afforded for the lifetime of the development, since the available funds from FCRMGiA will potentially not reflect the scale of development that is benefitting.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the local planning authority and the Environment Agency.

The appropriate route for the consideration of strategic measures to address flood risk issues is the Local flood Risk Management Strategy (LFRMS)prepared by the Lead Local flood Authority. The LFRMS should describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is committed to working in partnership with Developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the EA request that Developers contact them to discuss potential solutions. The Partnerships and Strategic Overview Team who manage these partnerships can be contacted by calling 03708 506 506 (Mon-Fri, 9am - 5pm).

7.4.5 Preferred local options

From a review of the LB of Haringey SWMP, CFMP and other local documents a range of structural and non-structural measures (options) with the potential to alleviate flood risk have been identified. The preferred options chosen include methods such as; opening culverted watercourses; increasing storage both underground and overland; and improving the existing drainage network by increasing entry capacity and/ or pipe sizes. Table 7.1 below summarises these options. Any proposed development in these areas should seek to contribute to a long term reduction in the level of flood risk. The effect of the measures described below will need to be demonstrated as part of a comprehensive Flood Risk Assessment in order to support the associated planning application.

Table 7-2 Preferred Options [59]

Drainage Area CDA	Location	Preferred Options
Group4_010*	Green Lanes (A105) and neighbouring roads, Wood Green	• Flood resilience and resistance for Green Lane (short term) • Underground storage units beneath Tottenhall Road, Green Lanes, Berkshire Gardens and Grenoble Gardens • Increase the storage capacity in Woodside Park • Changing the FAS to a pond/wetland. • Improve the entry capacity to gullies and drains along Green Lanes.
Group 4_055*	Hornsey	• Increase the trunk sewer size near Chadwell Lane • Increasing the gully sizes to increase the volume of water entering the pipes • to provide storage in the upper catchment within Queens Wood • to use the cricket grounds as overflow storage • Speed bumps are also proposed for Palace Road to divert water along the road
Group4_056*	Rathcoole Gardens / Weston Park, Hornsey	• Installation of underground storage beneath Weston Park Road • The creation of a pond or wetland in Stationers Park. • The implementation of green roofs and permeable paving at Hornsey School for Girls • Improving the entry capacity along Rathcoole Gardens and Weston Park Road • Resilience and resistance measures for the highest risk properties are also recommended
Group4_057*	South Tottenham	• apply local improvements to conveyance if necessary, compensated for by providing additional storage in the railway 'triangle' and in Chestnuts Recreation Ground as either a detention basin or underground storage • implement flood resilience and resistance measures to properties at high flood risk and the development of a flood plan for the community, including St Ann‟s Hospital • The incorporation of SuDS is also recommended for future developments
Group4_061*	Tottenham High Road and suburbs	• de-culvert the Moselle Brook in Carbuncle Passage and Scotland Green, connecting to a pond or wetland in Hartington Park. • The surface water drainage network in this area can be increased and linked to also discharge into the storage area. • additional gullies to be installed in the A1010 High Street to convey more water into the Moselle Brook (off set by the downstream storage). • resilience of the High Road is improved through

[59] LB of Haringey (2011) Surface Water Management Plan Section 4.4 & Section 4.5

Drainage Area CDA	Location	Preferred Options
		regional emergency planning • Mid- to long-term strategic development should be used to reduce the load on the sewerage system
Group4_062*	Milton Park, Crouch End	• underground storage beneath the junction of Milton Park and Milton Avenue, • increasing the diameter of the drainage pipe in the area and improving the local entry capacity of the system • The retrofitting of flood resilience measures for basement properties is also recommended.
Group4_063*	The Roundway (A10) and Warkworth Road, Tottenham	• constructing a swale within the verge adjacent to the A10 • enlarging the cemetery pond to create additional storage capacity • opening up the culvert on the Moselle Brook • Flood resilience and resistance measures for properties at the highest flood risk • improved entry capacity in Cavell Road, Fryatt Road and Larkspur Close • the implementation of a transport flood management plan for the A10 to help reduce the consequences should a flood event occur
Group4_073*	Alexandra Palace Railway Station and mainline railway, Wood Green	• the construction of a stub wall to divert surface water away from properties and a swale parallel to railway line. • a regional flood emergency plan for the railway line is implemented
Group4_075*	Clapton Station, Upper Clapton	• provide flood resistance measures for properties along Ellenborough Road and Lordship Lane Junior School • storage beneath Ellenborough Road • increasing the size and/or number of gullies.
HDA01	Highgate School, Highgate Wood, St Luke's Hospital	• Green Infrastructure at Highgate School • Habitat creation in Highgate Wood • Green Infrastructure at St Lukes Hospital, green roofs
HDA02	Muswell Hill Golf Course and/ or Hollickwood Park	• SuDS/ Green Infrastructure at Muswell Hill Golf Course or Hollickwood Park
HDA_03	Haringey Heartlands, Lordship Recreation Ground	• Haringey Heartlands - Green roofs, green infrastructure • Overland pond/ SuDS Habitat Creation Lordship Recreation Ground • Deculvert Moselle Brook
HDA_04	Down Lane Park, Park View Moselle Brook Tottenham Marshes	• Overland Storage Down Lane Park • Increase gully capacity on Park View Road • Green roofs • Deculvert Moselle Brook • Flood Storage along the River Lee (Tottenham Marshes)
HDA_07	Tottenham Cemetery	• Overland pond/ SuDS Habitat Creation Fredrick Knight Sports Ground • Overland pond/ SuDS Habitat Creation Tottenham Cemetery •
* Preferred options as described by the LB of Haringey SWMP		

7.5 Non-local options

It is recognised that not all of the LB of Haringey's flood risk issues can be tackled locally. There is a need for non-local options to tackle flood risk where the LB of Haringey need to work in partnership with other local authorities and external parties such as the Environment Agency. These options are particularly relevant to flooding from the Lower Lee.

To prevent a long term exacerbation of local flood risk consideration must be given to the strategic provisions necessary to address problems identified in the CDAs and prevent exacerbation of flooding in HDAs. The strategic considerations relate to the effect of longer duration flood events that generate prolonged high water levels in the River Lee. It is probable that it will not be feasible to include source control measures that address the effects of such events and that contributions will be required for strategic infrastructure.

To ensure that the flood defences on the River Lee, can maintain their effectiveness and standard of protection the following should be considered:

- Any re-development should consider reducing the residual risk behind the River Lee defences.
- The LB of Haringey in conjunction with the Environment Agency should ensure that the natural River Lee floodplain retains its potential to accommodate floodwater.
- Maintain the existing defences.

7.6 Conclusions

There is a strategic requirement for the LB of Haringey to reduce flood risk across the borough. Both the scale and scope of the development along with the borough wide distribution of allocated sites indicate that management of the potential increase in surface water runoff is required. Therefore strategic measures for new developments within the allocated drainage areas (CDAs & HDAs) should focus on contributing to options, which not only satisfy statutory Sustainable Drainage requirements but also contribute to establishment of a wider sustainable surface water regime.

Whilst local Sustainable Drainage provisions will reduce the peak flow affecting other property and land in the immediate vicinity of the proposed development the volume of run-off will not be reduced and thus property within the wider drainage area will not necessarily receive any relief from existing problems. Accordingly it is appropriate that supplementary contributions are sought to address long term detriment caused by climate change effects.

Works to improve flooding along the River Lee and its tributaries should be undertaken at catchment scale and not at borough scale. The LB of Haringey should work closely with neighbouring boroughs and the EA to develop plans to maintain and improve these assets to ensure that no detrimental impacts are created for neighbouring boroughs.

8. Review of Development Sites

8.1 Introduction

This chapter provides the results of a review of each individual site. Due to the number of sites and the volume of this analysis, the site forms have been appended to this report as Appendix A. Section 8.2 provides a summary of the information presented. This should be used as a key for interpreting the results of the individual site sheets.

8.2 Summary Tables and Maps

Table 8-1 Summary Sheet Template

Site Name			
Site ID Site ID as per the LB of Haringey's Local Plan: Strategic Policies (formerly Core Strategy)	**OS NGR:** The National Grid Reference of the centroid of the site.	**Area**: Area of site in hectares	**Timing of development:** The rate of development based on assumptions made within using the LB of Haringey's Local Plan: Strategic Policies (formerly Core Strategy)

Existing Use: The existing use of the site.	**Proposed Use:** The proposed use and type of development for the site.

Percentage of the site that is located within a Flood Zone:	**Flood Zone 1:** Percentage coverage of the site within the Flood Zone 1 outline. Definition[60] This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).	**Flood Zone 2 :** Percentage coverage of the site within the Flood Zone 2 outline. Definition This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.	**Flood Zone 3a:** Percentage coverage of the site within the Flood Zone 3a outline. Zone 3a - high probability. Definition This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	**Flood Zone 3b:** Percentage coverage of the site within the Flood Zone 3b outline. Zone 3b - the functional floodplain. Definition This zone comprises land where water has to flow or be stored in times of flood.

Exception Test Required?: is the exception test required; 1. in accordance with the National Planning Policy Framework and associated technical guide; 2. based on the location of the site in relation to the Environment Agency Flood Zones; 3. and based on the type of development proposed on site?

Percentage of site at risk from surface water flooding	**1:30 AEP (>0.1m):** Percentage coverage of the site within the 1: 30 AEP event shallow (>0.1m) outline	**1:30 AEP (>0.3m):** Percentage coverage of the site within the 1: 30 AEP event deep (>0.3m) outline	**1:100 AEP (>0.1m):** Percentage coverage of the site within the 1: 200 AEP event shallow (>0.1m) outline	**1:100 AEP (>0.3m):** Percentage coverage of the site within the 1: 200 AEP event deep (>0.3m) outline

AStGWF: Area Susceptible to Ground Water Flooding (AStGWF) is an area classification based on a proportion of a 1 km square that is susceptible to groundwater flood emergence)[61]	**Percentage the site affected by Superficial Deposits:** In some areas within the LB of Haringey such as the Lee Valley, superficial deposits are prevalent (river deposits of alluvium and gravels). These superficial deposits are permeable and as a result, where superficial deposits are present there is a greater risk of groundwater flooding.	**Percentage of the site located within the NRIM outlines:** Percentage coverage of the site within the National Reservoir Inundation Mapped outline.

Flood Defence: A description of any defences recorded by	**Drainage Area:** Identification of which drainage area the site

[60] National Planning Policy Framework available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf
[61] http://www.geostore.com/environment-agency/WebStore?xml=environment-agency/xml/dataLayers_ASGWF.xml

the Environment Agency affecting the standard of protection of the site.	is located in and whether it falls within a critical drainage area (CDA) as per the LB of Haringey SWMP. Any areas that fall outside the CDAs have been designated into Haringey Drainage Areas (HDA) based on the SWMP results for the 1 in 200 AEP event modelled results, the Flood Zone, topography and historic flood outlines.

Flood Zones		Climate Change
Graphical representation of the Flood Zones in relation to the site	**Legend** Development Site **Flood Zones** Flood Zone 3b Flood Zone 3a Flood Zone 2 **Climate Change** 1:100 AEP + CC	Graphical representation of 1:100 AEP event plus climate change outline based on modelled results in relation to the site

Fluvial: A description of the fluvial flood risk to the site.

Groundwater		Reservoir[62]
Graphical representation of the Area Susceptible to Ground Water Flooding is described as a 1km grid in relation to the site	**Legend** Development Site **AStGWF** < 25% >= 25% <50% >= 50% <75% >= 75% **NRIM Outline** Reservoir Failure	Graphical representation of the National Reservoir Inundation Mapped outline in relation to the site. It should be noted that only flood maps for large reservoirs are displayed. Large reservoirs are considered those that hold over 25,000 cubic meters of water. Flood maps are not displayed for smaller reservoirs or for reservoirs commissioned after reservoir mapping began in spring 2009. These maps show the largest area that might be flooded if a reservoir were to fail and release the water it holds. The NRIM outlines display a worst case scenario and are suitable for emergency planning purposes.

Groundwater: A description of the potential risk of groundwater flooding. The Area Susceptible to Ground Water Flooding is described as a 1km grid. Each 1km grid square is classified as per its susceptibility to groundwater flood emergence):
< 25%;
>= 25% <50%
>= 50% <75%
>= 75%.

Reservoir: Whether the site is located within the National Reservoir Inundation Mapped outline and which reservoir it is described as being at risk from.

Surface Water - 1: 30 AEP event		Surface Water - 1: 100 AEP event
Graphical representation of the 1:30 AEP event surface water modelled results	**Legend** Development Site **SWMP Results** 0.3m 0.1m	Graphical representation of the 1:100 AEP event surface water modelled results

Surface Water: A description of the pluvial flood risk to the site.

Other Sources of Flood Risk: A description of other sources of risk as per the LB of Haringey PFRA and SWMP.

Surface Water Drainage: An indication of requirements to manage surface water runoff at the development site, an assessment of the soil types, green field runoff rate and attenuation storage volume and details of some of the assumptions made within the study.

Soil Type: Description of the underlying Soil type based on national mapping.	**Pre-development (Green field) Runoff Volume (m^3):** Estimated volume of runoff prior to the site being developed	**Climate change runoff (Development no attenuation) (m3):** The effect of climate change on run off volume without any attenuation.	**Estimated Attenuation Storage Volume (m^3):** The storage volume required on site based on estimates

SuDS Type	Potential Suitability	Comments
Source Control	Traffic light system:	Looking at the geology, soil and slope of the land, this section

[62] Reservoir Flooding Maps at :**http://www.environment-agency.gov.uk/homeandleisure/floods/124783.aspx**

Infiltration	Yes	provides a high level indication as to whether certain SuDS are suitable for a particular site allocation.
Detention	May be suitable	
Filtration		
Conveyance	Not suitable	

Flood Risk Implications for Site

A summary of what needs to be considered in relation to all sources of flood risk within the site allocation. These may include the following:

- Recommendations that all development should be located within Flood Zone 1.
- If the site is located in an area highlighted as being at risk from surface water, planning of the site should take place ensuring that the most vulnerable development is located in the lowest area of risk.
- Developers should consider the surface water catchment when looking at solutions for mitigation measures for surface water runoff from potential development. This may require developers to consider solutions outside of their site. Liaison with the appropriate SuDS Approving Body (SAB) and LB of Haringey should be carried out in the early stages of the development.
- Assessment for runoff should include an allowance for climate change effects.
- Any new or re-development should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Onsite attenuation schemes will need to be tested against the hydrograph of the receiving watercourse or drainage system to ensure flows are not exacerbated downstream within the catchment.
- If the site falls within an area susceptible to groundwater emergence, an assessment of suitable surface water mitigation techniques should be made.
- Self Contained Basement dwellings should not be located within areas of flood risk.
- Any basement extension will need to ensure that it does not disrupt the hydrogeological regime of the area. Basement extensions located in areas of risk should not have any sleeping accommodation and will require access to an upper level.
- An FRA will need to demonstrate that development at this location can be made safe.
- If the site is indicated by the NRIM outline to be at risk from inundation from a reservoir breach, any development located within this outline should demonstrate that there is egress from the development outside the area of risk.

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9. FRA Requirements

9.1 Over-Arching Principles

In line with the NPPF guidance and evidence from the LB of Haringey Level 2 SFRA, development proposals should:

- show development is not at risk of flooding or is compatible with the residual risk;
- not increase flood risk elsewhere, taking into account the impacts of climate change;
- not increase surface water peak flow rates or runoff volumes above green field levels including an allowance for climate change, as this would result in an increased flood risk to the receiving catchments;
- not increase the risk of groundwater flooding elsewhere or change the hydrogeological regime of the area;
- the location of basement development should be carefully considered within the LB of Haringey and attention should be paid to all sources of flood risk early within the planning process for new development (including the impact of potential future subterranean works that fall under permitted development);
- wherever possible use the opportunities offered by new development to reduce flood risk within the site and elsewhere; and
- ensure that where new development is necessary in areas of flood risk (in exceptional circumstances); it is made safe from flooding for the lifetime of the development, taking into account the impacts of climate change. This includes consideration of the potential effect of residual risks.

9.2 Requirements for Flood Risk Assessments

Flood Risk Assessments (FRA) should be carried out in accordance with relevant Government guidance, address the LB of Haringey SFRA Level 2 FRA over-arching principles and the following matters:

- There shall be no self-contained basement developments located in areas of fluvial, pluvial or groundwater flood risk. Any self contained developments located in an area shown on the National Reservoir Inundation Maps should include within their FRA, an emergency evacuation plan and should be designed to withstand the forces that might be encountered during breach event of reservoir or flood defences.
- Any development including, basement extensions, shall include within their FRA evidence that flood risk from fluvial, pluvial and groundwater sources are not increased to the development site itself and to third parties.
- Surface water discharge from proposed development sites should mimic that of a present day green field site, up to and including a 1:100 AEP critical storm event including an allowance for climate change. Green field runoff rates should be maintained irrespective of whether the site falls within an area designated as being effected by flood risk from any source[63].
- It is critical that the onsite drainage models should demonstrate that there is no increased flood risk to third parties.
- Use SuDS measures wherever practical and achieve 50% attenuation of undeveloped site's surface water runoff at peak times[64]. Exemplar SuDS schemes, should consult

[63] Haringey Local Plan: Sustainable Design & Construction SPD 2013 available at **http://www.haringey.gov.uk/index/housing_and_planning/planning-mainpage/policy_and_projects/local_development_framework/supplementary_planning_documents/sustainable_design_construction.htm**

[64] Mayor of London 2006 Sustainable Design and Construction Supplementary Planning Guidance - Summary of essential and Mayor's preferred standards pp 18

the best practices outlined in CIRIA C697 and follow the drainage hierarchy[65]: Developers should follow the drainage hierarchy, only moving to the next drainage type (i, ii, iii...) when it can be shown within an application's FRA that a drainage type is not suitable for their development site.

a. store rainwater for later use
b. use infiltration techniques, such as porous surfaces in non-clay areas
c. attenuate rainwater in ponds or open water features for gradual release
d. attenuate rainwater by storing in tanks or sealed water features for gradual release
e. discharge rainwater direct to a watercourse
f. discharge rainwater to a surface water sewer/drain
g. discharge rainwater to the combined sewer.

- Details of SuDS must be brought forward within the FRA. In particular it will be expected that a range of SuDS has been applied to ensure that water quality is not diminished and water quantity is not increased as a result of the development.
- The authority or company who will be adopting the SuDS drainage scheme must be clearly articulated.

Further detailed site specific FRA guidance is provided for each Local Plan: Strategic Policies strategic development site in Appendix A.

[65] Haringey Local Plan: Sustainable Design & Construction SPD 2013 available at **http://www.haringey.gov.uk/index/housing_and_planning/planning-mainpage/policy_and_projects/local_development_framework/supplementary_planning_documents/sustainable_design_construction.htm**

10. Outcomes

The SFRA provides the information on the areas that may flood, taking into account multiple sources of flooding as well as the impacts of climate change. The SFRA includes results from analysis and mapped results providing an evidence base to support other planning documents. The SFRA has included review of 133 proposed development sites within the LB of Haringey and included assessment of the impact of both development policy and climate change on site runoff for these sites and the remainder of the borough. The SFRA has included guidance on what level of detail would be required to support basement development. The SFRA provides generic guidance on what would be expected in a Site specific FRA as well as detailed recommendations for individual sites.

10.1 Summary of Work Undertaken

A review has been made of flood risk to the LB of Haringey from rivers and sea, surface water, reservoir breach and surcharge of drainage systems. This analysis has included the predicted impacts of climate change and local planning policies. The result is a comprehensive evidence base to help inform policies, action plans and other local development documents.

10.2 Key Outcomes

One of the key outcomes of this SFRA is the site assessment sheets that have been included in Appendix A. Each potential development site has been assessed and discussed individually within this document.

Another key outcome of the study is the evidence for supporting the mitigation of green field runoff rate for all new development. Climate change will present a significant threat to the LB of Haringey. Early action as part of the ongoing pattern of re-development provides an important opportunity to do something to help mitigate the situation. Development plans should include a review of various adaptation and mitigation strategies to this effect.

The SFRA has provided guidance on subterranean development and a key outcome of this assessment will be more clearly defined requirements for the assessments to be submitted in support of proposed development.

10.2.1 Individual Local Plan: Strategic Policies Development Sites

The degree of flood risk has been identified on all the sites highlighted within the Local Plan. By considering the risk during the lifetime of the proposed development and influencing the design and layout of the development sites in conjunction with the land uses proposed, it is feasible to mitigate flood risk on these sites.

The key requirements for future development are summarised below:

- All sites within Zones 2 and 3 will require a detailed Flood Risk Assessment in accordance with the NPPF and technical guide, making reference to the associated maps of this SFRA report. It will be necessary for all potential developers to carry out a topographic survey to establish more accurately ground levels within the site. Consultation with the Environment Agency is strongly recommended at an early stage in the FRA process.
- The layout of buildings and access routes should adopt a sequential approach, steering buildings (and hence people) towards areas of lowest risk within the boundaries of the site. This will also ensure that the risk of flooding is not worsened by, for example, blocked flood flow routes.
- The FRA requirements defined in Section 9 of the Level 2 SFRA must be applied to all future development brought forward. Further detailed guidance on the Local Plan: Strategic Policies proposed development sites is provided in Appendix A

Appendices

A. Strategic Site Summary Tables and Maps

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B. Maps

Map Number	Content
01	1:100 AEP Fluvial Depth
02	1:100 AEP Fluvial Hazard
03	1:1000 AEP Fluvial Depth
04	1:1000 AEP Fluvial Hazard
05	1:20 AEP Fluvial Depth
06	1:20 AEP Fluvial Hazard
07	1:100 AEP Fluvial including climate change Depth
08	1:100 AEP Fluvial including climate change Hazard
09	Flood Zones 3a, 3b, and 2
10	Reservoir Flood Outlines

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C. Strategic Runoff analysis - Site by site breakdown

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D. Challenge Flood Maps and Flood Zones

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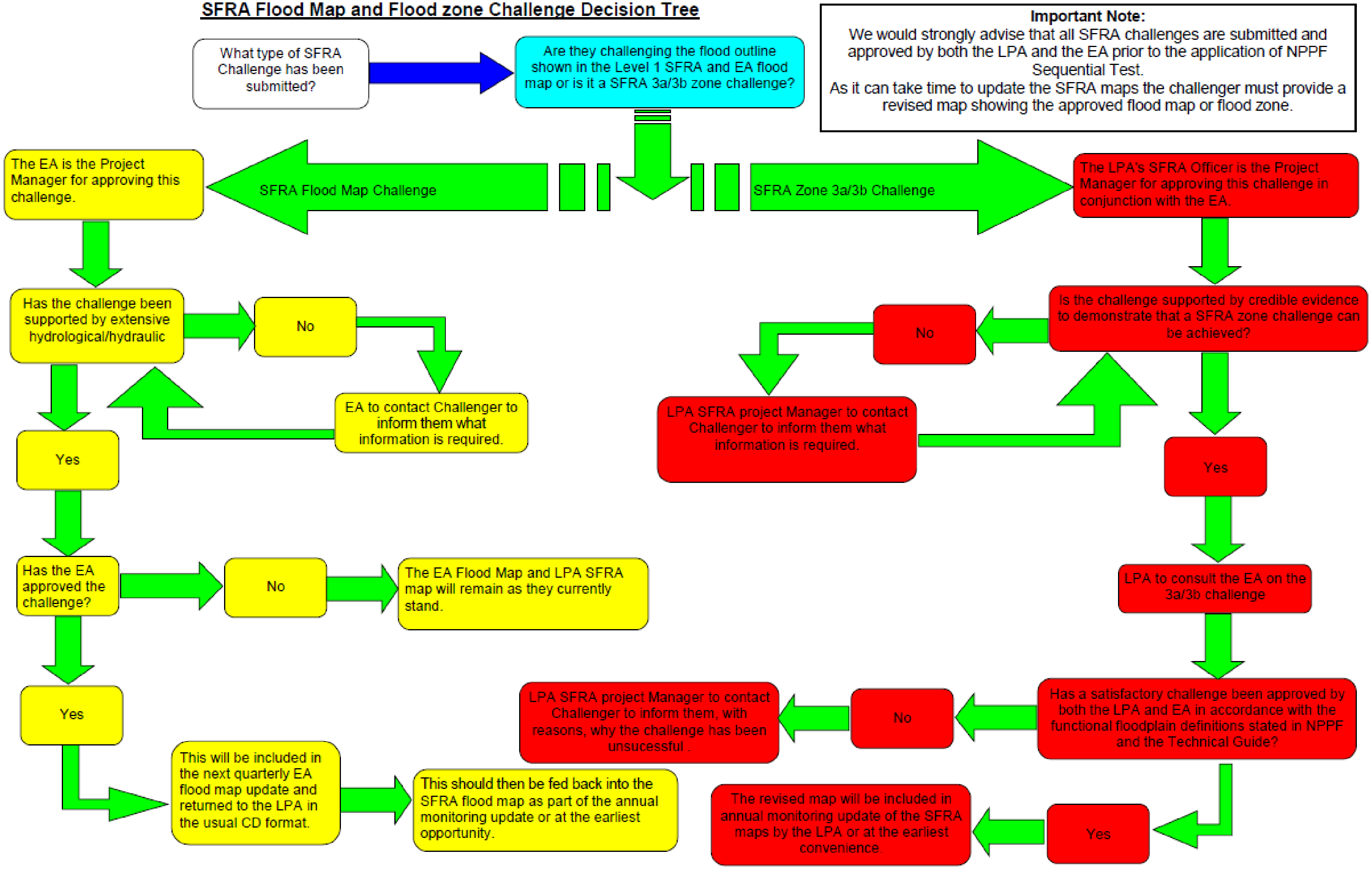
SFRA Flood Map and Flood zone Challenge Decision Tree



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