Royal Borough of Kensington & Chelsea

Strategic Flood Risk Assessment

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FINAL REPORT

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CONTRACT

This report describes work commissioned by the Royal Borough of Kensington & Chelsea and the London Borough of Hammersmith and Fulham under contract dated June 2007.
The Royal Borough of Kensington & Chelsea's representative for the contract was David Broadley, The London Borough of Hammersmith and Fulham's representative was Pat Cox. Francesca Hurt, Liu Yang and Tony Green of JBA Consulting and James Glynn of Entec UK carried out the work.

PURPOSE

This document has been prepared solely as a Strategic Flood Risk Assessment for The Royal Borough of Kensington and Chelsea. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

ACKNOWLEDGMENTS

The considerable help and data provided by the Royal Borough of Kensington and Chelsea, the London Borough of Hammersmith and Fulham and the Environment Agency.

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EXECUTIVE SUMMARY

Introduction

This report is a Strategic Flood Risk Assessment (SFRA) for London Borough of Hammersmith and Fulham and Royal Borough of Kensington and Chelsea.

This SFRA has been prepared in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25).

The SFRA is a planning tool that enables each council to select and develop sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on the existing site allocations within the boroughs but also sets out the procedure to be followed when assessing additional sites for development in the future. The SFRA will assist each council to make the spatial planning decisions required to inform the Local Development Framework (LDF).

High level planning, policy and guidance documents have been identified which have to be taken into account in preparing this SFRA. The documents which have been reviewed include national, regional and local planning legislation (including the London Plan), together with Environment Agency policy guidance.

Methodology and Results

A thorough review of existing information, and additional modelling work, was used to identify the level of flood risk at present within the boroughs from tidal and other sources. The SFRA identified that the significant sources of flood risk within Royal Borough of Kensington and Chelsea and London Borough of Hammersmith and Fulham are surface water and sewer flooding, and the risk which arises from a failure in the Thames tidal defences.

Tidal Flood Risk

There is no fluvial flood risk within either of the boroughs, the tidal flood risk suffered by the boroughs was determined by the Environment Agency Flood Zone Maps and was delineated into four flood zones in line with PPS25:

- Zone 1: Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of flooding in any year (<0.1%). The percentage coverage of this flood zone within each borough is as follows: RBKC = 92% LBHF = 39%
- Zone 2: Medium Probability. This zone comprises land assessed as having between a 1 in 200 and 1 in 1000 annual probability of flooding (0.5% - 0.1%) in any year. The percentage coverage of this flood zone within each borough is as follows: RBKC = 2% LBHF = 7%
- Zone 3a: High Probability. This zone comprises land assessed as having a 1 in 200 or greater annual probability of flooding (>0.5%) in any year. The percentage coverage of this flood zone within each borough is as follows: RBKC = 6% LBHF = 54%
- Zone 3b: The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. The SFRA has identified a negligible area of

Zone 3b at Chiswick Mall near the border of London Borough of Hammersmith and Fulham and London Borough of Hounslow.

Residual Risk

Tidal flood risk is extensive, but at present Kensington and Chelsea and Hammersmith and Fulham are fully defended against the 0.1% annual probability extreme tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard from a breach or overtopping.

The SFRA has undertaken a detailed investigation into the effect of defences on flood risk, and the risk that remains behind these defences, by failure or overtopping within each borough. The assessment of residual risk was undertaken by modelling a series of breaches using a 2-D inundation model. A series of breach locations were chosen to provide complete coverage of the boroughs. The defences were breached during a 1 in 200 year event (0.5% probability of occurring each year), which is in line with Flood Zone 3 (the extent of Flood Zone 3a assumes there are no defences present). Once the breaches had been modelled the flood extents were classified to provide a further delineation of the Flood Zones to be utilised when during the sequential and exception testing of future development sites, and to inform future Flood Risk Assessments. The classification was split into three classes: High Residual Risk, Medium Residual Risk, and Low Residual Risk. Maps 8 and 16 show the residual risk classification of each borough.

Surface Water and Sewer Flood Risk

Sewer and surface water flooding is particularly problematic, with both boroughs experiencing significant problems historically and during the recent heavy rainfall events of 20th July 2007.

Surface water modelling was undertaken for both boroughs to indicate areas within the borough which are susceptible to surface water flow paths and ponding. Maps 9 and 17 show the results of the surface water modelling for each borough.

The locations of the properties flooded during the 20th July 2007 event, and other historic incidents correlated reasonably well with the outputs of the surface water modelling, specifically the ponded areas. Therefore the localised areas of ponding shown by the modelling are indicative of areas which may be more susceptible to problems such as impassable roads or risk of flooding to ground floors and basements

Some properties did not correlate, but it should be noted that the properties flooded on the 20th July 2007 suffered a mixture of surface water and sewer flooding, whereas the modelling results only show indicative areas of surface water flooding.

Thames Water provided details of sewer flooding on a postal area basis. Maps 10 and 18 show the spatial distribution of sewer flooding events for each borough. Thames Water have stated that the areas which have in the past been affected by such flooding should not be seen as areas to avoid future development and that the reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure discharge capacity exists and that flood risk is not increased.

As sewer and surface water flooding is significant, it is recommended that both Royal Borough of Kensington and Chelsea and London Borough of Hammersmith and Fulham take an active role in future strategic surface water management plans for London, plan for future emergencies, and provide some guidance to residents on how they to can mitigate against the impacts of this type of flooding.

Future Planning and Development Control

The SFRA is the basis upon which initial planning decisions with regard to flooding are made. The Council will be required to prioritise the allocation of land for development in ascending order from Flood Risk Zones 1 to 3. However, as development becomes necessary because of lack of suitable zone 1 space, or for socioeconomic reasons, then it will become necessary to consider development allocations in higher risk zones. Where development is allocated within medium flood risk zone (Zone 2) or high flood risk zone (Zone 3) PPS25 requires the Council to demonstrate that there are no reasonable alternative development sites in lower flood risk zones. Once the Sequential Test has been satisfied it may be necessary to apply the Exception Test. The situations where it is necessary and appropriate to apply the Exception Test are outlined in Table D3 in PPS25, and in Section 2 Table 2.2 of this report. The table indicates where developments could be allowed, rejected or subject to the Exception Test.

What does that mean for Sites within Zone 1?

From a flood risk perspective all land uses are acceptable within Flood Zone 1. Flood risk is not considered to be a significant constraint to development and all land uses listed below are appropriate in this zone:

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable
- Water compatible development.

Due to their potential impact on the local flood risk, a Flood Risk Assessment will be required for all developments greater than 1 ha in size. This will include further consideration of surface water drainage, the recommendation of approach to control surface water discharge, and onsite mitigation measures that may be required, particularly where the capacity of the surface water sewer or receiving watercourse is limited.

A Flood Risk Assessment will not usually be required for development less than 1 ha in size in this zone unless there are, for example, historical records of localised flooding or site-specific considerations such as surface water issues that necessitate further investigation and identification of onsite mitigation measures.

A Flood Risk Assessment will be undertaken by the potential developer of the site. The Environment Agency will be able to advise potential developers as to their specific requirements on a site by site basis.

What does that mean for Sites within Zone 2?

Subject to the application of the Sequential Flood Risk Test, PPS25 specifies suitable types of development in Zone 2 as:

- Essential infrastructure
- More vulnerable
- Less vulnerable
- Water compatible development.

Highly vulnerable development is subject to the Exception Test.

A Flood Risk Assessment will be required for all development in this zone. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

A further level of analysis of the affects of a breach in or overtopping of the defences in an extreme event (usually the 0.5% plus climate change) may be required if the site falls within an area which is classified as being at High or Medium Residual Risk in order to test the sustainability and robustness of the mitigation measures. Other flood risk constraints, such as incidents of localised flooding and other site specific considerations will need to be addressed. Site-specific Flood Risk Assessments will be undertaken by the developer of the site and the Environment Agency, who will be able to advise developers as to their specific requirements on a site by site basis.

What does that mean for Sites within Zone 3a?

Subject to the application of the Sequential Flood Risk Test, PPS25 specifies suitable types of development in Zone 3a as:

- Less vulnerable
- Water compatible development.

Essential Infrastructure and more vulnerable development are subject to the Exception Test. Highly vulnerable development should not be permitted in this zone.

Any proposals for development within Flood Zone 3 will require developers to undertake a detailed site specific Flood Risk Assessment. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

Where the site falls within an area which is classified as being at High or Medium Residual Risk the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.5% plus climate change). It should be noted that constraints to development are likely to be significant and developers should seek advice from the Environment Agency as to the specific requirements for assessment.

The SFRA also contains:

- An initial review of flood risk at each of the boroughs preferred future development sites, to allow the councils to apply the Sequential Test;
- Recommended policies to aid the councils in managing the flood risk within their boroughs;
- An outline of requirements for detailed Flood Risk Assessments (FRAs); and
- Advice on Sustainable Drainage Systems (SuDS) and mitigation measures to consider as part of a development proposal.

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ABBREVIATIONS

CC	Climate Change
CIRIA	Construction Industry Research and Information Association
DEFRA	Department for the Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DPD	Development Plan Documents
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FWD	Flood Warnings Direct
GLA	Greater London Authority
ha	Hectare
JBA	Jeremy Benn and Associates
km	Kilometres
LBHF	London Borough of Hammersmith and Fulham
LDD	Local Development Document
LDF	Local Development Framework
LESLP	London Emergency Services Liaison Panel
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
m	Metres
mAOD	Metres above Ordnance Datum
NFCDD	National Fluvial and Coastal Defence Database
OS	Ordnance Survey
OS NGR	Ordnance Survey National Grid Reference
PPG4	Planning Policy Guidance Note 4
PPG25	Planning Policy Guidance Note 25
PPS1	Planning Policy Statement 1
PPS3	Planning Policy Statement 3
PPS12	Planning Policy Statement 12
PPS25	Planning Policy Statement 25
RBKC	Royal Borough of Kensington and Chelsea
RFRA	Regional Flood Risk Appraisal
RIZ	Rapid Inundation Zones
RPB	Regional Planning Bodies
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SPG	Supplementary Planning Guidance
SuDS	Sustainable Drainage Systems
TE2100	Thames Estuary 2100
TSKC	Thames Strategy: Kew to Chelsea
UDP	Unitary Development Plan

GLOSSARY

Actual Risk		The risk posed to development situated within a defended area (i.e. behind defences), expressed in terms of the probability that the defence will be overtopped, and/or the probability that the defence will suffer a structural failure, and the consequence should a failure occur
Brownfield		Brownfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has previously been developed'. Prior to PPS25 the term 'Brownfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Previously-developed land' See 'Greenfield'.
Core Strategy	CS	This is the strategic vision of the area and is a central pillar of the Local Development Framework, comprising: A vision; Strategic objectives; A spatial land use strategy; Core policies and; A monitoring and implementation framework. The Core Strategy is a Development Plan Document which will determine overall patterns of future development, identifying broad locations where future growth or conservation will take place. All other Development Plan Documents should be in broad conformity with the Core Strategy Document. The Core Strategy is a mandatory document, and a timetable for production is set out within the Local Development Scheme.
Defended Area		An area offered a degree of protection against flooding through the presence of a flood defence structure
DG5 register	DG5	Register held by water companies on the location of properties at risk of sewage related flooding problems
Development Plan Documents	DPDs	These documents have Development Plan Status and consequently form part of the statutory development plan for the area. A DPD will be subject to an independent examination. Typical documents that will have DPD status include the Core Strategy, Site-specific Allocations of Land, Proposals Map, and Area Actions Plans (where needed).
Extreme Flood Outline	EFO	Flood 'zone' maps released by the Environment Agency depict anticipated 0.1% (1 in 1000 year) flood extents in a consistent manner throughout the UK
Flood Risk Management		The introduction of mitigation measures (or options) to reduce the risk posed to property and life as a result of flooding. It is not just the application of physical flood defence measures
Formal Defence		A flood defence asset that is maintained by the Environment Agency

Flood Estimation Handbook	FEH	Provides current methodologies for estimation of flood flows for the UK
Floodplain		Any area of land over which water flows or is stored during a flood event or would flow but for the presence of defences
Flood Risk Assessment	FRA	A detailed site-based investigation that is undertaken by the developer at planning application stage
Fluvial Flooding		Flooding caused by the overtopping of river or stream banks
Freeboard		A 'safety margin' to account for residual uncertainties in water level prediction and/or structural performance, expressed in mm
Functional Floodplain		An area of land where water has to flow or be stored in times of flood (fluvial, not tidal).
Greenfield		Greenfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has not previously been developed'. Prior to PPS25 the term 'Greenfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Undeveloped land' See 'Brownfield'.
Informal Defence		A structure that provides a flood defence function, however is not owned nor maintained by the Environment Agency
JFLOW		2-Dimension hydraulic modelling package developed by JBA
Local Development Framework	LDF	The Local Development Framework is made up of a series of documents that together will form part of the Development Plan. Broadly Local Development Framework documents fall into two categories: Development Plan Documents Supplementary Planning Documents
Measure		A deliverable solution that will assist in the effective management (reduction) of risk to property and life as a result of flooding, e.g. flood storage, raised defence, effective development control and preparedness, and flood warning
Mitigation		The management (reduction) of flood risk
Probability	1%	A measure of the chance that an event will occur. The probability of an event is typically defined as the relative frequency of occurrence of that event, out of all possible events. Probability can be expressed as a fraction, % or a decimal. For example, the probability of obtaining a six with a shake of a fair dice is 1/6, 16% or 0.166. Probability is often expressed with reference to a time period, for example, annual exceedance probability
Rapid Inundation Zone		An area immediately behind defences which, should they fail, will generate a combination of high velocities and flood depths that would cause a risk to life.
Residual Risk		The risk that inherently remains after implementation of a mitigation measure (option)

Return Period		The expected (mean) time (usually in years) between the exceedance of a particular extreme threshold. Return period is traditionally used to express the frequency of occurrence of an event, although it is often misunderstood as being a probability of occurrence.
Risk		The threat to property and life as a result of flooding, expressed as a function of probability (that an event will occur) and consequence (as a result of the event occurring)
Standard of Protection	SoP	The return period to which properties are protected against flooding
Strategic Flood Risk Assessment	SFRA	The assessment of flood risk on a catchment-wide basis for proposed development in a District
Strategic Flood Risk Management	SFRM	Considers the management of flood risk on a catchment-wide basis, the primary objective being to ensure that the recommended flood risk management 'measures' are sustainable and cost effective
Supplementary Planning Documents	SPD	Supplementary Planning Documents or SPD support DPDs in that they may cover a range of issues, both thematic and site specific. Examples of SPD may be design guidance or development briefs. SPD may expand policy or provide further detail to policies in a DPD. They will not be subject to independent examination.
Sustainability Appraisal	SA	A Sustainability Appraisal is a systematic process to predict and assess the economic, environmental and social effects likely to arise from DPDs and SPDs, enabling each document to be tested and refined, ensuring that it contributes towards sustainable development.
Sustainable Drainage System	SuDS	Current 'best practice' for new urban development that seeks to minimise the impact upon the localised drainage regime, e.g. through the use of pervious areas within a development to reduce the quantity of runoff from the site
Thames Estuary 2100 Project	TE2100	The Thames Estuary 2100 (TE2100) Project is an initiative to develop a Flood Risk Management Plan for London and the Thames Estuary for the next 100 years.
Tidal Flooding		Flooding caused as a result of tidal activity
Uncertainty		A reflection of the (lack of) accuracy or confidence that is considered attributable to a predicted water level or flood extent

1 INTRODUCTION

1.1 Overview

In May 2007 JBA Consulting was commissioned by The Royal Borough of Kensington and Chelsea (RBKC) and The London Borough of Hammersmith and Fulham (LBHF) to undertake a Strategic Flood Risk Assessment (SFRA) for the two boroughs.

This SFRA has been prepared in accordance with current best practice, Planning Policy Statement 25 *Development and Flood Risk* (PPS25)[1].

The SFRA is a planning tool that enables the councils to select and develop sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on the existing site allocations within the districts but also sets out the procedure to be followed when assessing additional sites for development in the future. The SFRA will assist the councils to make the spatial planning decisions required to inform their Local Development Framework (LDF).

This is the SFRA final report for both RBKC and LBHF and contains analysis of flood risks and planning implications and recommended policies for each borough.

1.2 SFRA Objectives

Current policy requires local authorities to demonstrate that due regard has been given to the issue of flood risk as part of the planning process. It also requires that flood risk is managed in an effective and sustainable manner. To this end, the key objectives of the RBKC and LBHF SFRA are:

- To investigate and identify the extent and severity of flood risk to the area.
    - Determine the actual flood risk in Zone 3 given the presence of defences.
    - Identify the rapid inundation zone (RIZ) resulting from defence failure.
    - Identify the effect of flood defence failure and overtopping, including extent, depth and velocity of flooding.
    - Assess the potential increase in flood risk resulting from climate change.
- To establish the flood risk to proposed development sites included in the emerging LDF documents within the delineated PPS25 zones.

[1] Communities and Local Government. 2006 *Planning Policy Statement 25: Development and Flood Risk.* December 2006. http://www.communities.gov.uk/pub/955/PlanningPolicyStatement25DevelopmentandFloodRisk_id1504955.pdf

- To determine the effect of an increase in surface water drainage as a result of the proposed development sites and highlight any areas where the drainage system is known to be inadequate.
- To supplement current policy guidelines and to provide a straightforward risk based approach to development control in the local area.
- To contribute to each council's Strategic Environmental Assessment (SEA) and LDF.
- To provide a reference document to which all parties involved in planning and flood risk can reliably turn to for initial advice.

1.3 Study Area

The study area comprises the London Borough areas of Kensington, Chelsea, Hammersmith and Fulham.

1.3.1 The Tidal Thames

The River Thames through central London is primarily a tide dominated river and the most severe flood risks come from tidal surges. Teddington is the normal tidal limit although high fluvial flows can affect parts of west London and extreme surges can affect upstream of Teddington. The Tidal Thames floodplain is currently defended through a combination of raised banks and barriers, the most important being the Thames Barrier at Woolwich though there are also eight other major barriers, 36 major industrial floodgates, 400 minor moveable structures and 337 km of tidal walls and embankments[2]. These defences provide protection against tidal flooding to an estimated 1 in 1000 year standard for 2030 (as estimated when the defences were designed), which equals a less than 0.1% chance of flooding each year. So far the rate of sea level rise has not exceeded that expected and the defences are thus currently providing a greater level of protection than 1 in 1000 years.

The Thames Barrier does not eliminate normal tidal movements and thus high water levels can be reached in the river that, without the river walls and banks, would flood lower lying parts of Hammersmith, Fulham, Kensington and Chelsea. These are similar to the areas shown on the Environment Agency's Flood Zone maps, which represent an undefended condition.

The Environment Agency has a comprehensive programme of study (Thames Estuary 2100) that is ongoing to establish the best approaches to manage the effects of climate change on the level of defence provided. A number of measures have been identified that could be implemented depending on the sea level rise and increase in surges that may be experienced over the next 100 years.

The River Thames throughout the two boroughs is strongly influenced by tides, for any given tide the peak river levels are influenced by fluvial flows, although this influence is often small.

[2] Lavery, S. and Donovan, B. (2005) Flood Risk management in the Thames Estuary looking ahead 100 years. *Phil. Trans. R. Soc.* A, 363, 1455-1474.

1.3.2 Flood Risks

The two boroughs face flood risks from a number of sources, the nature of which differs significantly. Flood risk can be considered in terms of probability of occurrence and consequence.

The probability of flooding from the Tidal Thames is small but the consequences are potentially high due to the high flows giving a rapid inundation and potential threat to life. The last major flood from the Thames in the area occurred in 1928 and resulted in a number of people being killed in basements. Flood protection is now much better but the area under threat is considered further in the study. The two possibilities for flooding from the River Thames are:

- A major failure of a defence wall due to breaching
- Failure of the Thames Barrier and consequent overtopping.

Surface water flooding due to intense rainfall overcoming the capacity of the sewer system is much more likely but would have localised impacts and a less severe threat to life. Failure of water mains or small temporary defences is also more likely though has less impact.

Other possible sources of flood risk within the boroughs include the Grand Union Canal and the Serpentine in Hyde Park.

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2 STRATEGIC FLOOD RISK ASSESSMENT – OVERVIEW AND APPROACH

2.1 Overview of the SFRA Process

The SFRA is a planning tool that can be used to inform the spatial planning process. The SFRA process is outlined in Figure 2.1. The SFRA should be used to refine the information relating to the areas within each borough which may flood, taking into account all sources of flooding and climate change. This information should form the basis of the boroughs future flood risk management policies. In addition the SFRA will inform the LDF, and provide the information to enable the sequential and exception tests to be applied during the site allocation and development control process.

In line with PPS25 guidelines, allocations should be made outside of the flood risk areas (i.e. in Zone 1) wherever possible. If there are no reasonably appropriate Flood Zone 1 sites, allocations should be made in Zone 2 first, considering flood risk vulnerability of land uses. Only where there are no reasonably available sites in Flood Zone 1 or 2 should Zone 3 allocations be made. In order to demonstrate that there are no lower risk sites available the Sequential Test needs to be carried out.

The information provided in the SFRA should allow the LPAs to carry out the Sequential Test.

Only on completion of the Sequential Test should the Exception Test be used, where allowed, to justify allocations or developments in high risk areas where the need to develop is considered exceptional.

An SFRA is a project with defined start and end points. The deliverables are a report and suite of maps to allow the sequential testing to take place within the LDF. The SFRA itself cannot determine where additional replacement sites in low-risk areas can be found.

The LPAs have the information and options to sequentially test and provide more detailed evidence to support the Exception Test within this SFRA. The SFRA will recommend removal of allocations at the extreme of flood risk policy, e.g. sites in the functional floodplain or rapid inundation zone.

The SFRA provides some indication of deliverability, and hence whether the site should be considered in more detail.

Risk is defined as a function of both probability of an event occurring and the consequence should that event take place. When considering the residual risk associated with the failure of a flood defence, consideration must be given to both overtopping and the structural integrity of the defence.

To assess residual risk, it will be necessary to model the consequence of a breach in, or the overtopping of, the flood defences in an event with a 0.5% chance of occurring each year (1 in 200 year return period). Generally, the worst case scenario will coincide with a failure of the defences at the peak of the flood event. A two dimensional inundation model (which has the ability to predict depth and velocity) of the defended area will be required to examine the impact of either a breach failure or overtopping during the design event. The extent of inundation

behind the defence should be identified, and the depth and velocity of flow (within the inundated area) monitored over time throughout the duration of the event.

2.1.1 Sequential Test

PPS25 provides the basis for the sequential approach, it recommends that LPAs use a risk based approach to development planning and specifies the need, for undertaking RFRAs and SFRAs in Annex E.

When allocating or approving land for development in flood risk areas, those responsible for making development decisions are expected to demonstrate that there are no suitable alternative development sites located in lower flood risk areas.

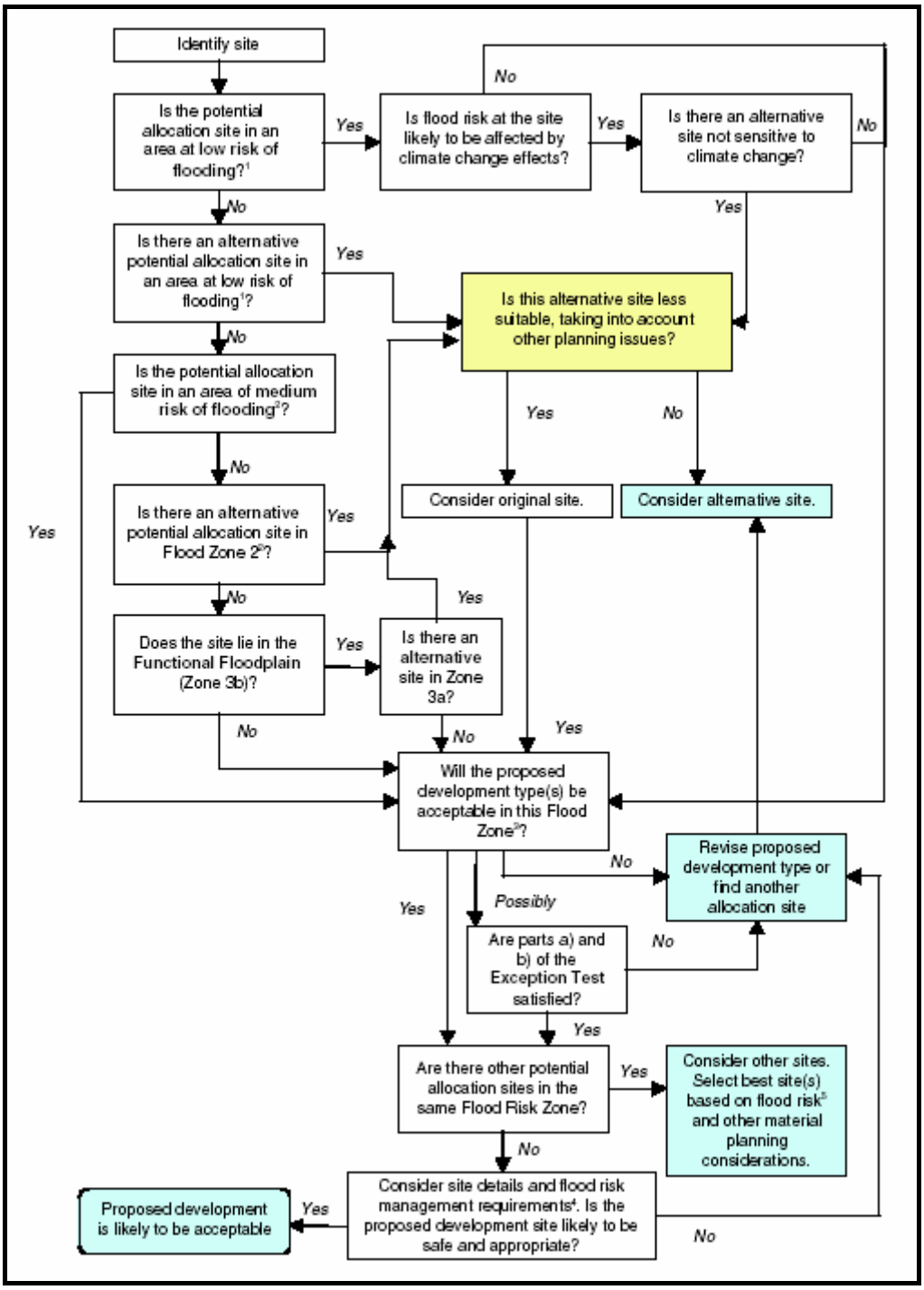
The methodology introduces a Sequential Test that is core to the SFRA process. The Sequential Test is the key driver for the SFRA. The Environment Agency Flood Zone Map will provide the basis of the test, which will be undertaken a number of times, considering a greater resolution and understanding of flood risk at each stage taking into account flooding from other sources. At each step, sites of lower flood risk are identified and prioritised in order of vulnerability to flood risk and their safety in terms of allocation for development.

A further level of analysis may be required where development is planned behind or adjacent to existing defences in order to test the sustainability and robustness of the mitigation measures.

This SFRA provides the Council with flood zone classifications for all present locations identified for development as well as the information required to classify future allocations. The information provided by the SFRA will assist the Council in developing their LDFs and prioritise allocations.

The Council will be required to prioritise the allocation of land for development in ascending order from Flood Risk Zone 1 to 3, including the subdivisions of Flood Risk Zone 3, if necessary. The Environment Agency has statutory responsibility and must be consulted on all development applications allocated with medium and high risk zones, including those in areas with critical drainage problems and for any development on land exceeding 1 hectare outside flood risk areas. In these circumstances, the Environment Agency will require the Council to demonstrate that there are no reasonable alternatives, in lower flood risk categories, available for development. Where appropriate, the Exception Test is to be applied.

Figure 2.1 The Sequential Test: its practical application



Notes:

1. Flood Zone for fluvial and tidal flooding and with a low risk of flooding from other sources.
2. Flood Zone for fluvial and tidal flooding with a medium risk of flooding from other sources.
3. As defined by the Sequential Test.
4. Development to be safe and to not increase flood risk elsewhere. Required to pass part c) of the Exception Test, where applicable.
5. Including susceptibility to future climate change and residual flood risk.

Source PPS25 Practice Guide (Figure 3.1)

2.1.2 The Exception Test

Once the Sequential Test has been satisfied, it may be necessary to apply the Exception Test. PPS25 acknowledges that flood risk is one of many issues (including transport, housing, economic growth, natural resources, regeneration and the management of other hazards) which need to be considered in spatial planning.

The Exception Test is "only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons, taking into account the need to avoid social or economic blight and the need for essential infrastructure to remain operational during floods." It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

PPS25 explains where and for what type of development the Exception Test needs to be applied. In some situations, for certain types of development, it is not appropriate to use the Exception Test to justify development, for example, development which is highly vulnerable to flooding cannot be justified within the high risk zone through the use of the Exception Test. The situations where it is necessary and appropriate to apply the Exception Test are outlined below.

Where the Exception Test is required, it should be applied as soon as possible to all Local Development Document (LDD) allocations for development and all planning applications other than for minor development[3]. All three elements of the Exception Test have to be passed before development is allocated or permitted. For the Exception Test to be passed:

a. *It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by an SFRA, where one has been prepared. If the Development Plan Document (DPD) has reached the 'submission' stage the benefits of the development should contribute to the Core Strategy's Sustainability appraisal.*

b. *The development should be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable, previously developed land; and*

c. *A Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

Compliance "with each part of the Exception Test should be demonstrated in an open and transparent way".

[3] Definition of minor development:
-Minor non-residential extensions: Industrial/Commercial/Leisure etc. extensions with a footprint less than 250m^2
-Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
-'Householder' development: e.g. sheds, garages, games rooms etc. within the curtilage of the existing dwelling in addition to physical extensions to the existing dwelling itself. This definition EXCLUDES any proposed development that would create a separate dwelling within the cartilage of the existing dwelling e.g. subdivision of houses into flats.

Table 2.2 summarises the applicability of the exception test for different development sites; housing allocations are classified as 'more vulnerable' and employment allocations are 'less vulnerable' (see Table 2.1)

2.1.3 Flood Risk Vulnerability Classification

In PPS25 different types of development are divided into five flood risk vulnerability classifications:

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable
- Water compatible development.

Subject to the application of the Sequential Test, PPS25 specifies which of these types of development are suitable within each zone:

- Zone 1: All the uses of land listed above are appropriate in this zone.
- Zone 2: The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate in this Zone. The highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.
- Zone 3a: The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable and essential infrastructure uses should only be permitted in this zone if the Exception Test is passed.
- Zone 3b: Only the water-compatible uses and the essential infrastructure that has to be there should be permitted in this zone. Essential infrastructure in this zone should pass the Exception Test and be designed and constructed to meet a number of flood risk related targets. The less vulnerable, more vulnerable and highly vulnerable uses should not be permitted in this zone.

Table 2.1 Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. • Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
More Vulnerable	• Hospitals, residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwellings, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping. • Non–residential uses for health services, nurseries and education. • Landfill and waste management facilities for hazardous waste.
Less Vulnerable	• Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities), minerals working and processing (except for sand and gravel). • Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	• Flood control infrastructure, water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves, navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. • Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

Notes:

1) *This classification is based partly on DEFRA/Environment Agency research on Flood Risks to People (FD2321/TR2) and also on the need of some uses to keep functioning during flooding.*
2) *Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.*
3) *The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.*

(Source: PPS25 Table D2)

Table 2.2 Flood Risk Vulnerability and Flood Zone Compatibility

Vulnerability classification		Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception test	✔	✔
	Zone 3a	Exception test	✔	**x**	Exception test	✔
	Zone 3b	Exception test	✔	**x**	**x**	**x**

Key: ✔ Development is appropriate **x** Development should not be permitted (Source: PPS25 Table D3)

2.2 SFRA Approach

This SFRA was undertaken in two stages, the approach to each stage of the SFRA is as follows:

2.2.1 Stage 1

Data Collection

A critical phase in the project delivery is the collection and review of existing information. A summary of data sources used in this assessment is provided below:

- Areas likely to be developed in the Local Development Framework (LDF)
- Historical records of flooding including cause and extent
- Known and perceived flood risk areas, including Flood Zone Maps and details of flood risk areas associated with groundwater and surface water drainage issues. Catchment topography (LiDAR (Light Detection and Ranging) data and Ordnance Survey (OS) Mapping)
- Existing investigations for the River Thames
- Current flood risk management strategies including details of flood defence assets
- Hydrometric data
- Sewer Map
- DG5 Sewer Flooding Records

Assessment of Flood Risk

The primary objective is to assess and categorise, in accordance with Table D.1 of PPS25 flood risk within the developing areas. In general, the following considerations have been addressed as part of the flood risk assessment process:

- Identification of known and/or perceived flood risk areas, including the nature of the flooding problem (e.g. river, canal, sewer, and groundwater flooding; surface water flooding and local under-capacity drainage; culvert blockage), providing the initial 'filter' for key flood risk issue areas within the district.
- Review of current Environment Agency Flood Zone Map to provide an initial definition of High Risk Zone 3.
- Identification of or critical floodplain areas.
- Identification of significant structures (bridges, culverts, embankments, outfalls etc) that will influence local hydraulics.
- Identification of formal and informal flood defences that reduce flooding to developing and regeneration areas
- Definition of areas subject to development pressure and/or regeneration.
- The hazard associated with rapid inundation following failure of existing defences, breaching and overtopping will be identified and where possible modelled.

Review Climate Change and Land Use Impacts

Consideration has been given to the implications of wider land management practices on flood risk in the area. The delineation of Flood Zones 2 and 3,

coinciding with the 1 in 1000 year event (0.1% chance of occurring each year) and 1 in 200 year (0.5% chance of occurring each year) events respectively, has been used as an indication of how flood risk may alter laterally as a result of climate change. Where existing river models were available, further interrogation of modelling results has been used to determine more accurately the potential impact of climate change and land use change on design levels.

2.2.2 Stage 2

Categorisation of Sites in Accordance with PPS25

This involves identifying those areas in the borough that fall within Flood Risk Zones 1, 2 and 3. The local authorities have put forward a large number of potential key development areas and preliminary sites to be considered in the LDF. The individual sites are overlain onto the defined flood risk zones and reviewed with respect to the degree of flood risk posed to them. The filtering process used to categorise these sites is summarised below.

Preferred location for development ***(least risk and greater range of compatible land use)***

1. **Sites within Flood Zone 1**: Sites located outside the medium and high Flood Risk Zones 2 and 3, respectively. PPS25 considers areas within low Flood Risk Zone 1 to be at little or no risk of fluvial flooding. Flood risk zones are defined by the Environment Agency's Flood Zone Maps.

2. **Sites within Flood Zone 2**: Sites located outside the high flood risk zone 3 but wholly or partially located within the medium Flood Risk Zone 2.

Development less/not acceptable ***(highest risk and least range of compatible land use)***

3. **Sites within Flood Zone 3a**: Previously developed or undeveloped areas wholly or partially located within high Flood Risk Zone 3a.

4. **Sites within Flood Zone 3b**: Sites located wholly or partially within the functional floodplain. These are areas where water has to flow or be stored in times of flood.

Planning Review Sites within Flood Risk Zones 1 and 2

Recommendations for the future management of development and redevelopment sites in low to medium Flood Risk Zones are provided to meet the requirements of national planning guidance and regional and local flood risk policy.

Planning Review of Sites within High Risk Zone 3

Consideration has been given to the actual risk posed to individual sites in high Flood Risk Zone 3 and recommendations for development allocations have been made. Development constraints within these areas are dependent on the strategic importance and requirement for development (within a planning context).

Recommendations for the future management of development within the high Flood Risk Zone have been provided on a site-by-site basis to meet the requirements of PPS25, as well as regional and local flood risk policy.

Detailed Assessment Requirements and Exception Test

In order to assist the councils in determining whether housing and employment requirements can be met, without affecting existing areas of medium to high flood risk, detailed assessment has been carried out at a number of sites. At these sites the potential impact and feasibility of generic mitigation measures has been considered.

Where necessary sites are assessed to determine what is required to pass part c of the Exception Test.

Establishment of Guidance for LPA and Developers at Planning Application Stage

Concise and pragmatic guidance has been developed to assist the council and developers to ensure that the outcomes and recommendations of the SFRA are followed through to the planning application and implementation stage.

It is imperative to ensure that the requirements placed upon developers at planning application are robust and fit for purpose. Similarly, the ownership, roles and responsibilities of the LPA and Environment Agency as appraisal bodies must also be clearly understood to ensure that the intent of the SFRA and planning process are not lost.

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3 THE PLANNING FRAMEWORK

3.1 Introduction

The purpose of this section of the report is to identify and outline those high level documents which have to be taken into account in preparing this SFRA. The documents which have been reviewed include the London Plan together with national planning legislation and policy guidance.

3.2 National Policy Guidance

3.2.1 Planning and Compulsory Purchase Act

The SFRA has been prepared in a period during which planning authorities have been implementing the provisions of the Planning and Compulsory Purchase Act 2004 and accompanying planning guidance, including PPS 1 Delivering Sustainable Development and PPS 12 Local Development Frameworks. This affected all tiers of the planning system and has necessitated major changes at both the regional and local level which will impact on the way in which planned development is approached in the regional strategy and delivered locally.

3.2.2 PPS25 Development and Flood Risk

In December 2006 the Government published PPS25: Development and Flood Risk.

The aim of PPS25 is to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. The key planning objective is that “Regional Planning Bodies (RPBs) and Local Planning Authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by:

- Identifying land at risk and the degree of risk of flooding from river, sea and other sources in their areas;
- Preparing Regional or Strategic Flood Risk Assessments (RFRAs/SFRAs) as appropriate, either as part of the Sustainability Appraisal of their plans or as a freestanding assessment that contributes to that Appraisal;
- Framing policies for the location of development which avoid flood risk to people and property where possible and manage any residual risk, taking account of the impacts of climate change;
- Only permitting development in areas of flood risk when there are no suitable alternative sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding;
- Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences;

- Reducing risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SuDS);
- Using opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SuDS; recreating functional floodplain and setting back defences;
- Working effectively with the Environment Agency and other stakeholders to ensure that best use is made of their expertise and information so that decisions on planning applications can be delivered expeditiously; and
- Ensuring spatial planning supports flood risk management policies and plans; River Basin Management and emergency planning."

In addition to setting out the roles and responsibilities for LPAs and RPBs, PPS25 identifies that landowners also have a primary responsibility for safeguarding their land and other property against natural hazards such as flooding. Those promoting sites for development are also responsible for:

- Demonstrating that is consistent with PPS25 and Local Development Documents (LDDs);
- Providing a Flood Risk Assessment (FRA) demonstrating whether the proposed development: is likely to be affected by current or future flooding; satisfies the LPA that the development is safe; and identifies management and mitigation measures.

PPS25 also introduces an amendment to Article 10 of The Town and Country Planning (General Development Order) 1995 which makes the Environment Agency a Statutory Consultee on all applications for development in flood risk areas.

The introduction of PPS25 enables local authorities to make a direction under Article 4 of the Town and Country Planning (General Permitted Development) Order 1995. This will enable Local Authorities to remove permitted development rights where those rights threaten to have a direct, significant and adverse effect on a flood risk area, or its flood defences and their access, or the permeability and management of surface water, or flood risk to occupants.

A Practice Guide Companion to PPS25 *Living Draft*

The Government has produced a consultation companion guide to PPS25 during February 2007. The practice guide provides guidance on the implementation of the policy set out in PPS25. The guide provides further guidance on the preparation of SFRA's and FRA's, the Sequential and Exception Test, outlines potential mitigation measures e.g. SuDS and risk management techniques. The consultation will end during August 2007.

3.2.3 Other Planning Policy Statements

PPS1 *Delivering Sustainable Development* published in February 2005 sets out the overarching planning policies for the delivery of sustainable development across the planning system and sets the tone for other PPSs that will follow. PPS1 explicitly states that development plan policies should take account of flooding, including flood risk. It proposes that new development in areas at risk of flooding should be avoided. Planning authorities are also advised to ensure that developments are

"*sustainable, durable and adaptable*" including taking into account natural hazards such as flooding.

Whilst not directly relevant to the development of a SFRA, it is important to recognise that the exercise takes place within the context of other planning policy statements, some of which also require sequential testing of site allocations and development proposals. PPS3 *Housing*, PPG4 *Industrial and Commercial Development and Small Firms* and PPS6 *Planning for Town Centres* are intrinsic within the planning process, and therefore an understanding of the constraints faced as a result of this additional policy guidance is imperative.

3.3 Regional Policy Drivers

The creation of the Greater London Authority and the provisions of Greater London Authority (GLA) Act 1999 require the Mayor to produce a spatial plan which deals with matters which are of strategic importance to Greater London.

3.3.1 The London Plan

The London Plan, prepared by the Mayor of London sets out the strategic principles for the continued growth and development of Greater London. The London Plan was adopted in 2004 with Further Alterations published in September 2006. The London Plan contains a series of objectives identified by the Mayor. The overarching objective of the plan is to promote sustainable development.

In assessing the need for additional housing in London an annual target of securing 30,500 additional homes per annum identified (following changes adopted in 2006). The RBKC have a target of providing 3,500 additional new homes between 2007/08 and 2016/17 and the LBHF have a requirement to secure 4,500 additional new homes over the same timescale.

The London Plan identifies five sub-regions (Central London, north, east south and west). LBHF is within the West London Sub-Region. The priorities for this sub-region, which in addition to Hammersmith and Fulham also includes Brent, Ealing, Harrow, Hillingdon and Hounslow, are:

- Capture the benefits of the economic generators, including Heathrow, within the sub-region while ensuring that this development improves, not degrades the environment;
- Identify capacity to accommodate new job and housing opportunities and appropriate mixed use development;
- Maximise the number of additional homes, including affordable housing;
- Promote and intensify retailing, services, employment, leisure and housing in town centres and opportunities for mixed use development;
- Ensure that new development is sustainable and safe, secure and well designed, improves the environment, particular air quality and takes account of the sub-regions heritage. The open space and Blue Ribbon Networks are key features, particularly the Royal Parks and Thames.

RBKC is identified as being within the Central London sub-region, however in the draft 'London Plan Further Alterations', published September 2006, the borough is

identified as being part of the West London Sub-Region alongside LBHF. The Central London sub-region strategic priorities were to:

- Promote and protect the vital mix of uses and levels of open space;
- Sustain and enhance the scale and mix of activities;
- Identify capacity to accommodate new job and housing opportunities;
- Maximise the number of additional homes, including affordable housing;
- Promote and intensify retailing, services, employment, leisure and housing in town centres;
- Improve the variety, quality and access to available employment sites;
- Ensure that new development is sustainable and safe, secure and well designed, improves the environment, particular air quality and takes account of the sub-regions heritage. The open space and Blue Ribbon Networks are key features, particularly the Royal Parks and Thames.

In addition the original London Plan (LP) published a series of policies; some of these policies have been recently proposed in the 'London Plan Further Alterations' (September 2006). The policies relevant to this SFRA include:

- Policy 4A.5v (4C.6 in LP) Flood plains - In reviewing their DPDs, boroughs should identify areas at risk from flooding (flood zones). Within these areas the assessment of development proposals should be carried out in line with PPS25.
- Policy 4A.5vi (4C.7 in LP) Flood defences and flood risk management – *For locations adjacent to flood defences, permanent built development should be set back from those defences to allow for the replacement/repair of the defences and any future raising to be done in a sustainable and cost-effective way. The Mayor will, and boroughs should, ensure that development does not undermine or breach flood defences in any way. Development associated with buildings and structures already within the statutory defence line should not increase the risk to occupiers of these buildings or inhibit the raising of future flood defences.*
- Policy 4A.5vii (4C.8 in LP) Sustainable drainage - *The Mayor will, and boroughs should, seek to ensure that surface water run-off is managed in line with following drainage hierarchy:*
    - *Store rainwater for use later*
    - *Use infiltration techniques, such as porous surfaces in non-clay areas*
    - *Attenuate rainwater in ponds or open water features for gradual release to a watercourse*
    - *Attenuate rainwater in tanks or sealed water features for gradual release to a watercourse*
    - *Discharge rainwater direct to a watercourse*
    - *Discharge rainwater to a surface water drain*

- *Discharge rainwater to the combined sewer, as a last resort.*

The use of sustainable urban drainage systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much run-off as possible on site and explore sustainable methods of managing the remainder as close as possible to the site.

The Mayor will encourage multi agency collaboration (GLA Group, Environment Agency, and Thames Water) to identify sustainable solutions to strategic surface water and combined sewer drainage flooding/overflows. Developers should aim to achieve Greenfield runoff from their site through incorporating rainwater harvesting and sustainable drainage.

3.3.2 Sustainable Design and Construction: The London Plan Supplementary Planning Guidance

The Supplementary Planning Guidance (SPG) published in May 2006 seeks to provide additional information to support the implementation of the London Plan. The guide seeks to identify a series of standards and measures to promote sustainable development around the themes of conserving energy, water and other resources, reducing noise, pollution, flooding, conserving and enhancing the natural environment and biodiversity and promoting sustainable waste behaviour.

With regard to water pollution and flooding the SPG identifies the following essential standards:

- Use of Sustainable Drainage Systems measures, wherever practical;
- Achieve 50% attenuation of the undeveloped site's surface water run off at peak times.

However, the SPG identifies that it is the Mayor's preferred standard to achieve 100% attenuation of the undeveloped site's surface water run off at peak times. The guidance identifies that SuDS provide an alternative method to dealing with the management of runoff. The guidance provides a helpful introduction to the various methods of SuDS which can be applied and adopted as part of a development proposal. The content of the SPG has been used to inform the planning policy recommendations contained within this SFRA.

3.3.3 The London Regional Flood Risk Assessment (2007)

The draft Regional Flood Risk Assessment (RFRA), published in June 2007, provides a strategic overview of flood risk across London. The RFRA contains a series of future flood risk management options and strategic recommendations.

Future Flood Risk Management options:

- West London Reach (Teddington Lock to Hammersmith Bridge)
    - Enhanced channel capacity to cope with fluvial flood flows. Pursue options for small scale set back of development from river walls to enable river walls to be modified, raised and maintained in a sustainable, aesthetically acceptable and cost effective way.
- City Reach (Hammersmith Bridge to Thames Barrier)

- Pursue options for small scale set back of development from river walls to enable river walls to be modified, raised and maintained in a sustainable, aesthetically acceptable and cost effective way.

The RFRA has made 23 recommendations, the ones applicable to the boroughs are:

- **Recommendation 2** - All Thames-side planning authorities should put in place policies to promote the setting back of development from the river edge to enable sustainable and cost effective upgrade of river walls/embankments, in line with London Plan Policy 4C.6 (Further Alterations Policy 4A.5vi)
- **Recommendation 6** - Developments all across London should implement the Drainage Hierarchy set out in Policy 4A.5vii of the Further Alterations.
- **Recommendation 7** - Regeneration and redevelopment of London's fluvial river corridors offer a crucial opportunity to reduce flood risk. Strategic Flood Risk Assessments and policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in PPS25 and the Thames Catchment Flood Management Plan. In particular opportunities should be sought to:
  - Set back of development from the river edge to enable sustainable and cost effective flood risk management options (Policy 4A.5vi).
  - Ensure that the buildings with residual flood risk are designed to be flood compatible or flood resilient (Policy 4A.5vi).
  - Use open spaces within developments which have a residual flood risk to act as flood storage areas
- **Recommendation 10** - Organisations responsible for development with large roof areas should investigate providing additional surface water run-off storage.

3.3.4 Water Matters: The Mayor's Draft Water Strategy (2007)

The London Mayor's draft water strategy, published in March 2007, has been derived to promote improved water management. The strategy considers all aspects of water management and how they interact, with focus on integrating land and water management. The strategy seeks to ensure that new developments do not compromise existing water and sewerage services whilst recognising the role of water in London's natural environment.

The strategy outlines 5 Hierarchies one for each aspect of water management in London. Hierarchy 3 and 5 are most relevant to this study.

Hierarchy 5: Managing Floods in London:

1. Avoid types of development that are vulnerable to flooding in flood risk areas
2. Where this is not avoidable, reduce the vulnerability through design and construction techniques by providing space for rivers and tidal processes to occur. Also, by increasing the resilience of buildings to floods through design and construction techniques such as raising electrical services
3. Alleviate the risk of flooding through flood defences.

Hierarchy 3: Rainwater Drainage:

1. Store rainwater for use later
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release to a watercourse
4. Attenuate rainwater in tanks or sealed water features for gradual release to a watercourse
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water drain
7. Discharge rainwater to the combined sewer, as a last resort.

In addition proposal 13 promotes flood risk assessment stating that;

> Developers should determine, in consultation with the Environment Agency, the sewerage undertaker, Transport for London and the relevant London Borough, whether their proposed development site is at risk from flooding. Developers seeking to develop a site at risk from flooding should undertake an appropriate flood risk assessment. All flood risk management proposals should avoid increasing flood risk to neighbouring areas. In Opportunity Areas, an Integrated Water Management Plan supported by a flood risk assessment should be incorporated into development frameworks.

3.4 Local Planning Policy

Following the introduction of the Planning and Compulsory Purchase Act 2004, the way in which development plans are prepared is changing. With the aim of speeding up and simplifying plan preparation and improving community involvement, development plans in their current form are to be abolished and replaced with a new development plan system, the LDF.

3.4.1 Royal Borough of Kensington and Chelsea

Unitary Development Plan

In May 2002 RBKC adopted the Unitary Development Plan (UDP).

Following a direction issued by the Secretary of State for Communities and Local Government in September 2007, policies STRAT13 and PU10 of the UDP (relating to flood defences and sustainable urban drainage techniques) no longer form part of the Unitary Development Plan and are substituted by the relevant policies in the London Plan.

The Emerging LDF

The LDF will take the form of a portfolio of plans and documents made up of several LDDs. The full RBKC LDF will eventually comprise the following documents:

Table 3.1: Forthcoming LDDS identified in the Local Development Scheme March 2007

Document	Subject Matter	Adoption Date
Statement of Community Involvement	Sets out when and how the Council will involve the community and others within an interest in the Royal Borough in the preparation, alteration and review of all LDD and planning applications.	August/September 2007
The Core Strategy (including Development Management Strategies)	Strategic document setting out the Council's vision and spatial strategy and core policies for achieving them. A suite of policies setting out the criteria against which planning applications will be considered.	2009-2010
North Kensington Area Action Plan (NKAAP)	The NKAAP will set out how development and change within this neighbourhood can be delivered by identifying the future distribution of different uses, their inter-relationships and the timetable for the implementation of proposals.	2009-2010
The Site Specific Allocations and Policies	The allocations will identify land to be used for specific uses, including mixed uses in order to address needs. The criteria based policies will set the framework for assessing unforeseen proposals.	2010
The Proposals Map	Illustrates the policies and proposals contained in the Development Plan Documents (DPDs).	2010
The Annual Monitoring Report	Annual report to the Secretary of State	Not later than December

In addition, the Council has identified Supplementary Planning Documents (SPDs) to be produced which will supplement policies within the Core Strategy. There are no plans to develop any SPD's relating specifically to flooding and sustainable drainage techniques.

3.4.2 London Borough of Hammersmith and Fulham

UDP

The LBHF UDP was adopted by the Council in August 2003, replacing the 1994 plan.

Following a direction issued by the Secretary of State for Communities and Local Government in September 2007, policy EN39 of the UDP (relating to flood defences and sustainable urban drainage techniques) no longer form part of the Unitary Development Plan and are substituted by the relevant policies in the London Plan.

The Emerging LDF

The LDF for Hammersmith and Fulham will be comprised of the following documents:

Table 3.2: Forthcoming LDDs identified in the Local Development Scheme March 2007

Document	Subject Matter	Adoption Date
The Core Strategy	Primary DPD providing the vision and objectives and spatial strategy.	June 2009
Generic Development Control Policies	Criteria based policies	December 2009
Site Specific Allocations	Will identify policies and proposals	December 2009
Proposals Map	Illustrates DPD policies	June 2009

The LBHF Core Strategy preferred options has the Council's emerging approach to Flood Risk Management in the borough, further details will be found in the Generic Development Management preferred options

3.5 Additional Documents of Relevance

3.5.1 The Thames Strategy: Kew to Chelsea (TSKC) (2002)

The TSKC is a 100 year strategy to protect and enhance the river and its environment in west London. TSKC is a partnership; its members include Environment Agency, English Heritage, Port of London Authority, Greater London Authority, The West London River Group and the main riparian boroughs. The partnership seeks to deliver a co-ordinated approach to help rediscover the Thames, reconnect it to the rest of the city, improve the riverside environment, promote high quality urban design and to bring the River Thames back to life. The focus of activities for the coming year has been identified as:

Hammersmith and Fulham

- To work with planning officers and applicants on Riverside sites;
- Explore the feasibility of restoring the Dolphin at Rose Wharf;
- Establish a Thames path working party to coordinate the renewal and restoration of riverside paths and pocket parks.

Kensington and Chelsea

- Identify and work up key projects;
- Encourage the TSKC to be included within the LDF; and
- Provide TSKC seminars for officers.

3.5.2 Flooding in London: A London Assembly Scrutiny Report (2002)

The scrutiny report clearly identifies that London is vulnerable to flooding, whether it be tidal from the Thames, from rivers during periods of heavy rainfall or from the drainage system. These risks will also increase with the effects of climate change. The report also identifies that it is not feasible to simply construct further defences, but rather there is a requirement to manage floods better.

The scrutiny report identifies a total of 47 recommendations to the Mayor of London covering the provision of information to the public on flood risk, the requirement for funding for improvements to the Thames Barrier, the need to improve flood defences on London's rivers, the need to ensure that buildings are flood proofed and the need to improve our understanding of the scale of sewer flooding.

3.5.3 Thames Tideway Strategic Study

The aim of the study is to protect the Thames Tideway from the adverse effects of wastewater discharges. The three principal objectives are:

- To protect the ecology of the Tideway;
- To reduce the aesthetic pollution due to sewage-derived litter; and
- To protect the health of recreational water users.

A selection of possible scheme options has been assessed, but the preferred solution is a large diameter storage-and transfer tunnel, that would run from Hammersmith in the west, largely under the river, to Crossness Sewage Treatment Works (STW)

The focus of this study on improving water quality however in theory the provision of a tunnel connection should reduce flooding risk for a number of properties. However, it is thought that the benefit would actually be quite small, although this would need to be tested by comprehensive modelling.

3.5.4 The Environment Agency's TE2100 Project

The Thames Estuary 2100 (TE2100) Project is an initiative to develop a Flood Risk Management Plan for London and the Thames Estuary for the next 100 years.

TE2100 endorses the Making Space For Water approach. TE2100 is identifying land that could provide a strategic flood storage capacity which reduces peak water levels in estuary as a whole. These spaces will be used infrequently (perhaps only for 1:50 or 1:100 year events initially) and should be designed to provide other uses beside flood storage.

PPS25 sets planning authorities the key planning objective to identify land for flood storage, TE2100 endorse this, and want to see the local identification of flood storage areas along with associated multifunctional benefits, to store fluvial, pluvial and potentially tidal water.

The draft TE2100 plan will be reported by the end of 2008, with a number of interim outputs and consultations will provide updated information.

Currently the TE2100 project has suggested a number of 'options for responding to increasing flood risk' along the West London and City reaches (which encompass RBKC and LBHF). These options have been put out to consultation, but no decision has been made with regards the most appropriate approach for each location.

Table 3.2 shows the proposed future options for the West London and City reaches, the options have been highlighted to show the most appropriate options for each degree of increased flood risk. It is likely that the main requirement for changes in the flood defences for the tidal Thames due to sea level rise will be at or downstream of the Thames Barrier but no firm indications have been given at this time.

Table 3.3: TE2100 Future Options for Responding to Increasing Flood Risk from the River Thames

Control Structures	Flood Storage	Flood Warning and Changing Behaviour
Flood Barriers	Controlled inundation and regulated tidal exchange	Public awareness and preparedness
Flood walls and embankments	Floodplain restoration and managed realignment	Forecasting and warning
Land raising	Sustainable drainage	Flood fighting
Secondary defences	Urban floodplain storage (tributaries)	Damage Avoidance
Throttles (restriction in estuary width)	Channel restoration (tributaries)	Land-use management
	Rural flood storage (tributaries)	Flood proofing
		Land-use planning
		Building codes
		Financial and economic recovery
		Health and social options

Key: High increase Medium Increase Medium or Low Increase Low Increase Any Increase

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4 DATA SOURCES

4.1 Flood Zone Maps

The Environment Agency Flood Zone Maps show the 1 in 200 year (tidal) return period event (an event with a 0.5% chance of occurring each year) and 1 in 1000 year (tidal) return period event (an event with a 0.1% chance of occurring each year). They were prepared using a methodology based on modelling of the estuary and two dimensional flood routing using LiDAR ground data.

The Environment Agency Flood Zone Maps do not take account of flood defences and, therefore, represent a theoretical maximum extent of tidal flooding. The actual extent of flooding is mitigated by flood defences. Therefore, the Environment Agency Flood Zone Maps provide a worst case assessment of the extent of flooding and are consistent with PPS25, which categorises flood risk ignoring the effects of defences. Map 1 shows the extent of Flood Zones 2 and 3 across the boroughs.

4.2 Flood Defences

As discussed above in section 4.1 the Environment Agency **Flood Zone Maps do not take account of the presence of flood defences**. PPS25[4] states that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding, and therefore sites within these areas must be assessed with respect to the adequacy of the defences.

The Tidal Thames is defended to a 1 in 1000 year standard (protection against an event with a 0.1% chance of occurring each year), by a series of walls, embankments, flood gates and barriers, with the Thames Barrier being the major protection for the study area. The statutory defence level (the level to which the defences must be maintained) within the study area is 5.41m downstream of Putney Bridge, and 5.54m upstream.

The location and condition (Table 4.1 shows how condition is rated) of all flood defences within the two boroughs has been provided by the Environment Agency via the National Fluvial and Coastal Defence Database (NFCDD).

Table 4.1: NFCDD Condition Ratings

Condition Rating	Condition	Condition Description
1	Very Good	Fully serviceable.
2	Good	Minor defects.
3	Fair	Some cause for concern. Requires careful monitoring.
4	Poor	Structurally unsound now or in the future.
5	Very Poor	Completely failed and derelict.

[4] Communities and Local Government. 2006 *Planning Policy Statement 25: Development and Flood Risk.* Annex G para G2.

Table 4.2 shows a series of photographs of the food defences which stretch from Hammersmith to Chelsea. Photo 1 shows the flood gates on the front of the houses located in Chiswick Mall, just outside the LBHF boundary. Photo 2 is an example of the many demountable defences found upstream of Hammersmith Bridge providing access to the river. Photo 3 shows how the defence includes sheet piling on the riverside. Photos 4 to 7 show how the defence height above ground level varies as you travel through Hammersmith and Fulham. Photo 8 shows how the wall height increases at the Chelsea Embankment.

Table 4.2: Photographs of Typical Flood Defence Walls in the Local Area

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4.3 Hydraulic Modelling

An Environment Agency Thames ISIS Model covers the study area, and was used in the 2005 Tidal Thames Extreme Water Levels study, from which the Environment Agency provided water levels from Hammersmith Bridge to Chelsea Bridge for 2002 (Table 4.3). The predicted modelled levels are based on a joint probability analysis of fluvial flows, storm surges in the North Sea and barrier closure events. The ISIS model used had a expected accuracy of ± 0.2m.

From Table 4.3 it may be noted that there is only a 0.2m difference between the 10 year and 1000 year water level. This is due to the operation of the Thames Barrier.

In addition to the 2002 condition modelled water levels the Environment Agency also provided water levels for future climate conditions (2052, 2102) which show no significant increase in expected peak levels for a given return period between Fulham and Kensington. However, this analysis was carried out using the old DEFRA guidance for climate change allowances and the Environment Agency states that "It will be re-run later this financial year (2007/08) to take account of the new guidance in PPS25". Increased tidal peaks due to climate change and sea level rise in the study area are thus not currently expected.

Table 4.3: Modelled Water Levels (mAOD) for the Tidal Thames as supplied by the Environment Agency

Node		Return Periods (Years) 2002 Condition						Comments
Label		10 (10%)	20 (5%)	50 (2%)	100 (1%)	200 (0.5%)	1000 (0.1%)	(% = chance of occurring each year)
2.19	Chiswick Eyot	5.22	5.28	5.34	5.37	5.40	5.44	Interpolated Levels
2.20	Hammersmith Bridge	5.20	5.25	5.31	5.34	5.37	5.41	Tidal JPL Halcrow
2.21		5.19	5.25	5.30	5.33	5.36	5.40	Interpolated Levels
2.22		5.18	5.24	5.29	5.33	5.35	5.39	Interpolated Levels
2.23	Putney Bridge	5.17	5.23	5.28	5.32	5.34	5.38	Interpolated Levels
2.25	Wandsworth Bridge	5.15	5.21	5.26	5.29	5.31	5.36	Interpolated Levels
2.27	Battersea Bridge	5.13	5.18	5.23	5.26	5.29	5.33	Interpolated Levels
2.28	Albert Bridge	5.10	5.16	5.21	5.24	5.26	5.30	Interpolated Levels
2.29	Chelsea Bridge	5.08	5.13	5.18	5.21	5.24	5.28	Tidal JPL Halcrow

4.4 Topography

Remotely sensed ground level data (LiDAR) have been made available for use in the SFRA by the Environment Agency. This information is in the form of a land surface level grid with a 2m grid resolution. The nominal vertical accuracy of LiDAR data is typically ± 0.25 m. LiDAR data are available for most of the borough areas and have been utilised. Map 2 shows the topography of the study area.

4.5 Lost Rivers

Lost Rivers where once tributaries of the River Thames before they became culverted over or turned into sewers. There are four Lost Rivers within the study area, one within RBKC (Westbourne River), one forming the borough boundary line (Counter's Creek), and two in the west of LBHF (Stamford Brook and Parr's Ditch). Map 1 shows the location of these lost rivers.

The Westbourne rose in West Hampstead, flowed southwest where it crossed the Bayswater Road and entered Hyde Park, from here the Westbourne passed out under Knightsbridge, and then meandered southwards through the grounds of the Royal Hospital Chelsea to meet the Thames[5]. The part of the Westbourne through Hyde Park was dammed in 1730 to form the Serpentine[6]. In 1856-7 the Westbourne was completely covered and is now the Ranelagh Sewer, although it is carried above ground at Sloane Square tube station[5].

Counter's Creek rose near Kensal Green cemetery and flowed roughly straight in a south-south-east direction passing close to the present sites of Olympia, Earl's Court, and Stamford Bridge, it would have passed under the bridge carrying the King's Road and continued to the Thames as Chelsea Creek (which is still visible)[5]. In early 19th century Counter's Creek, south of the Olympia was converted to the Kensington Canal, but was later bought and drained by the West London Railway Company to build a line extension[7], the stream now runs underneath the railway line in Counter's Creek Sewer.

Stamford Brook encompasses the streams draining into the Thames at Hammersmith. The eastern streams rose west of Wormwood Scrubs, the western stream flowed down to Ravenscourt Park, when they joined they flow out to the Thames at Hammersmith Creek[5]. Stamford Brook was covered and made a sewer in the late 19th century[5].

Parr's Ditch was probably artificial, rather than a river, to divide the parishes of Hammersmith and Fulham, it remained open until 1876 when it was converted to a sewer[8].

4.6 Historical Flooding

Historical flooding events and issues have been identified and assessed utilising a number of information sources as identified below:

4.6.1 Environment Agency

- No recorded flood extents in either of the two boroughs.
- Levels recorded during extremely high tides in London (Table 4.4)

Table 4.4: Observed water levels (mAOD) across the boroughs during high tides

Location	7 Jan 1928	13 Feb 1938	1 Mar 1949	1 Feb 1953	10 Dec 1965	19 Jan 1975	12 Jan 1978	31 Dec 1978
Hammersmith Bridge	5.16	5.15	5.17	5.33	5.02	5.11	5.3	5.37
Chelsea Bridge	5.17	5.15	5.16	5.39	4.9	5.03	5.15	5.29

The following are some reports of how the boroughs were affected by the 1928 and 1953 flood events in London.

[5] Barton, N (2000) *The Lost Rivers of London*. Historical Publications Limited, chp 4, p.43-48.

[6] Barton, N (2000) *The Lost Rivers of London*. Historical Publications Limited, chp 9, p.112.

[7] Barton, N (2000) *The Lost Rivers of London*. Historical Publications Limited, chp 9, p.92.

[8] Barton, N (2000) *The Lost Rivers of London*. Historical Publications Limited, chp 7, p.67.

In 1928 "the flooding at Hammersmith Bridge reached a depth of five feet. There was widespread dislocation; phones were cut off, cars damaged and stranded, roads blocked by fallen debris. In all fourteen people died in the 1928 floods, most of them in their beds, including young female servants in the downstairs quarters of wealthy property owners in the Westminster and Chelsea areas."[9]

In 1953 "the water came dead level with the Chelsea Embankment."[10]

There has been no flooding major from the Thames within the two boroughs since the 1930 Flood Act when, following the 1928 flood event the level of the defences were raised.

4.6.2 Thames Water

Thames Water was able to provide information regarding sewer flooding events over the past ten years on a broad scale. The information was provided on postal area basis, no specifics were provided as this went against the data protection of Thames Water's customers.

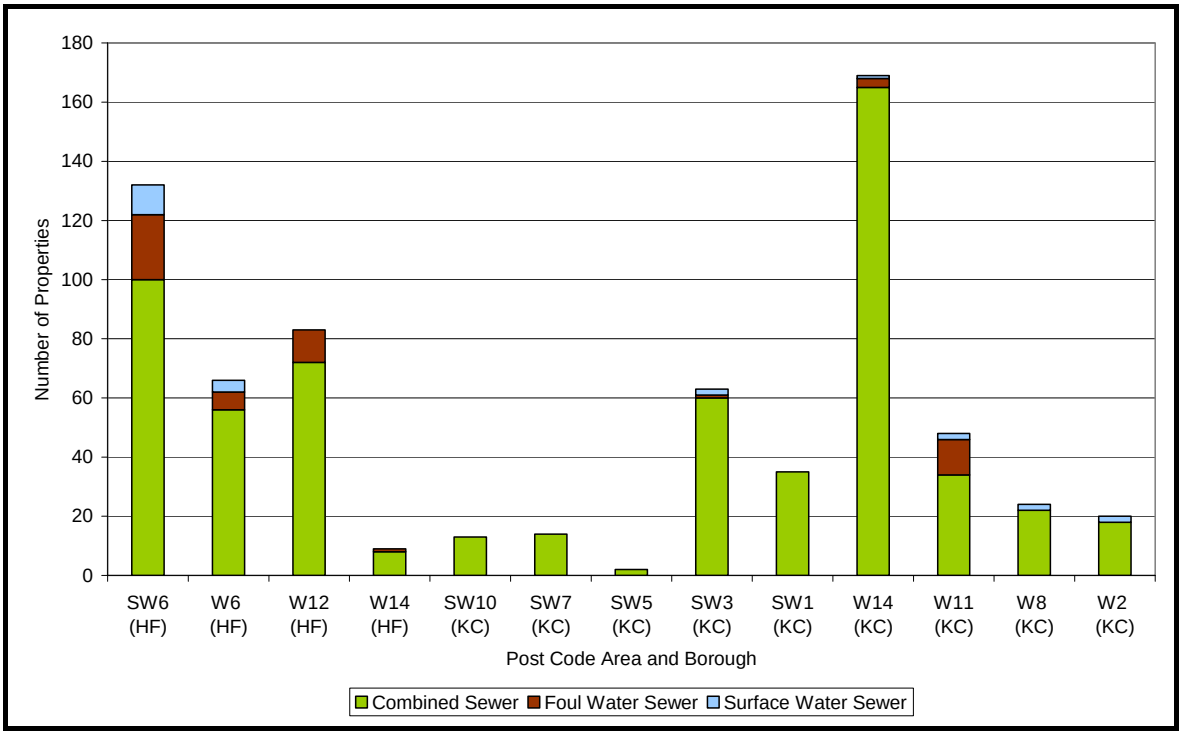
Figure 4.1 shows the number of properties flooded by overloaded sewers, distinguishing between the three different types of sewer, within RBKC and LBHF over the past ten years. In RBKC postal areas W12, W10, W9, NW10 have experienced no flooding from overloaded sewers in the last ten years. In LBHF postal areas W11, W10, NW10, W3 and W4 have experienced no flooding from overloaded sewers in the last ten years.

Maps 9 and 16 show the spatial distribution of sewer flooding across LBHF and RBKC respectively.

Figure 4.1: Total Number of Properties Flooded by Overloaded Sewers in the last 10 years

[9] Milne, A (1982) London's drowning. Thames Methuen, chp 1, p17.

[10] Milne, A (1982) London's drowning. Thames Methuen, chp 1, p7.



4.6.3 LBHF Historical Flood Events

- A storm, on the night of the May 30th 1979, resulted in a surcharge of the sewer system locally around Vera Road (SW6) and Tadmore Street (W12). This caused a number of basement properties to flood.
- In recent times there has been regular surcharging of the sewer on the north side of Shepherds Bush Green sufficient to cause flooding to the old public toilets which is now a nightclub.
- Thames water has elected to install anti-flood pumps on private drains in special localities like Bassein Park Road (W12) and elsewhere.
- On July 20th 2007 the borough suffered surface water flooding as a consequence of heavy prolonged rainfall with 148 calls being made to the councils Emergency Planning Team. The spatial distribution of the flooded areas can be seen in Map 9.

4.6.4 RBKC Historical Flood Events

- In October 2006 the London Underground Stations of Notting Hill and Sloane Square were affected by surface water flooding as a result of heavy rainfall, Notting Hill Station also suffered from sewerage seepage.
- The July 20th 2007 heavy rainfall resulted in surface water and sewer flooding. With 511 recorded incidents so far, with the greatest affected areas being the residential basements within the wards of Holland and Norland. The spatial distribution of the flooded areas can be seen in Map 17.

4.7 Flooding from Other Sources

In addition to tidal flood risk, alternative sources of flooding including groundwater, overland flow and drainage systems also need to be considered when planning

development. Although explicit consideration of these sources of flooding is not a requirement for flood zone allocation, local drainage issues have the potential to cause substantial damage and distress. When considering development proposals, known drainage and surface water problems need to be taken into account.

The Councils and Thames Water have provided some information with regards location and type of historical flooding events from other sources. The council also provided access to their sewer map to aid in the understanding of the local drainage network.

Further data has been derived analytically so as to better define the flood risk from other sources.

5 FLOOD RISK IN THE LONDON BOROUGH OF HAMMERSMITH AND FULHAM

5.1 Introduction

The guidance detailed below has been developed to provide a clear, concise and consistent means of assessing the feasibility and sustainability of sites and to determine appropriate flood risk mitigation measures where required. The framework will aid LPAs and others to assess flood risk associated with allocations and potential development sites. It will also allow policies on flood risk to be included in the LDD's, which draw upon national guidance for consistency, but provide the local detail and interpretation of these national policies.

PPS25 aims to direct development to lower flood risk sites wherever possible. "The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid **inappropriate** development in areas at risk of flooding, and to direct development away from areas at higher risk"[11]. Only when the Sequential Test has been employed and new development is, **exceptionally**, necessary and no other lower risk sites have been shown to be available should the Exception Test be applied.

PPS25 states that *"development should not normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of safety for the lifetime of the development taking into account climate change"*[12]. The Practice Guide was issued in February 2007 as a 'living draft' to accompany PPS25. The Practice Guide provides further information on the residual risks behind defences and on how to apply PPS25 policy to development in these defended areas. However, it should be noted that defences don't eliminate the risk, only reduce the frequency of flooding.

The guidance focuses on the technicalities of flood risk management rather than the other planning issues an LPA must consider in selecting allocations. It should, therefore, be assumed that:

- These other planning issues have been considered separately
- For land to be allocated within the high risk zone, the full range of planning issues has been evaluated.

It should also have been determined through the SEA (Strategic Environmental Assessment) and SA (Sustainability Appraisal) that the land is the most suitable for development.

It must be made clear that this SFRA does not preclude the need for site specific flood risk assessments. Table 2.2, Chapter 2, highlights the type of

[11] Communities and Local Government. 2006 *Planning Policy Statement 25: Development and Flood Risk.* HMSO, Para 5.

[12] Communities and Local Government. 2006 *Planning Policy Statement 25: Development and Flood Risk.* HMSO, Annex G, Para G2.

development considered appropriate for each Flood Zone, and whether development would only be allowed following the passing of the Exception Test.

This chapter will present the guidance for Flood Zone 3b; Flood Zone 3a (including defended and undefended areas, public safety and rapid inundation, and the feasibility of flood risk mitigation); Flood Zone 2; and Flood Zone 1. It will then discuss issues relating to flood risk from other sources.

5.2 Delineation of PPS25 Flood Zones

5.2.1 Flood Zone 1 – Low Probability

Map 1 shows the extent of the Flood Zones within the borough. Flood Zone 1 is the area outside Flood Zone 2, for LBHF this is mainly the area north of the Uxbridge Road.

Flood Zone 1 equates to a flood event with less than a 0.1% chance of occurring each year (1 in 1000 year event).

In accordance with PPS25 Annex D, Table D.1, all development (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) is allowed in Flood Zone 1. All development proposals should consider the following about the sites:

1. Their vulnerability to flooding from other sources as well as from river and sea flooding.
2. Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.

5.2.2 Flood Zone 2 – Medium Probability

Map 1 shows the extent of the Flood Zone 2 within the borough. Flood Zone 2 is mostly the same as Flood Zone 3 with a few areas where it extends a little further, areas like the Dawes Road vicinity and West Kensington.

Flood Zone 2 equates to a flood event which has a between a 0.1% and 0.5% chance of each year (between a 1 in 1000 and 1 in 200 year event).

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed.

All development proposals must consider the following information about the sites:

1. Their vulnerability to flooding from other sources as well as from river and sea flooding.
2. Their vulnerability to flooding over the lifetime of the development.
3. Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water run-off, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property.
4. A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resilient and resistant design, escape / evacuation, effective flood warning and emergency planning) are acceptable.

5.2.3 Flood Zone 3a – High Probability

Map 1 shows the extent of the Flood Zone 3 within the borough. Flood Zone 3 covers a large portion of the borough; much of the area south of the Uxbridge Road is Flood Zone 3.

Flood Zone 3 equates to a flood event with a greater than a 0.5% chance of occurring each year (1 in 200 year event).

PPS25 Annex D, Table D.1 states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to PPS25 Annex D, Table D.1 highly vulnerable development is not permitted and essential infrastructure and more vulnerable development need to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

According to PPS25 Annex D, Table D.1, developers and local authorities should implement the following policy aims:

1. Reduce the overall level of flood risk in the are through the layout and form of the development and the appropriate application of sustainable drainage techniques;
2. Relocate existing development to land in zones with a lower probability of flooding; and
3. Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage[1]

Regeneration of land or change in land use behind existing defended areas in the High Risk Zone will continue to require a more detailed assessment of the flood risk (i.e. whether the scale of risk is worth taking), and how sustainable and effective the mitigation measures would be (i.e. whether the risk could be managed).

Where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones then an assessment of the residual risk within Flood Zone 3 is required. For developments to proceed it must also be shown that the development will not increase flood risk elsewhere through a loss of breach storage or conveyance. Flood risk must be reduced or kept at current levels as contained in the Regional Spatial Strategy (RSS) policy statement.

5.2.4 Flood Zone 3b – The Functional Floodplain

Whilst prior to the development of London there would have been large areas of land close to the river that regularly flooded, within the borough there is now only a very small area of functional floodplain, associated with the small section of Chiswick Mall which falls within the LBHF boundary.

Although not strictly 'floodplain' the tidal foreshore exposed each tide should be protected as this plays an important role in the functioning of the Tidal Thames.

5.3 Residual Risk

Annex G in PPS25 deals with managing residual flood risk.

Paragraph G2 of PPS25 states that following application of the Sequential Test and Exception Test for Zone 3a development:

> *"Should **not** normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of **safety** taking into account climate change."*

It would be up to the developer to demonstrate how in planning terms this safety can be achieved and how the residual risks will be managed. A clear distinction between commercial flood standards of protection and management of loss of life should be explored in the FRA. A greater reliance on flood warning may be required, which is not always a tangible alternative to accepting a lower standard of protection.

The study area is a defended area, and is considered to be an area of floodplain where the defences substantially (but not necessarily completely) mitigate the flood risk associated with the event which has a 0.1% chance of occurring each year (1 in 1000 year return period).

Within defended areas flood risk is primarily associated with overtopping and breach of defences (and localised flooding associated with drainage systems in some locations). These risks are related to the likelihood (standard of protection and structural integrity of defences) and consequences of flooding (depth, speed and duration of flooding, and land use within defended area).

The consequences of defence overtopping or breach failure can be estimated using flood inundation modelling and mapping.

5.3.1 Breach Analysis

The Thames Barrier is designed to be robust and reliable and the Environment Agency maintain and operate the barrier to ensure that the level of security is maintained. The barrier gates are routinely operated for example and there is a high degree of redundancy in terms of power supply and hydraulic systems. The Thames Barrier has been closed in response to tidal conditions over 100 times without any problems arising and thus has proved reliable in practice. The Thames Barrier is not closed except for high surges (though it has also on occasion been used to reduce high level levels in Teddington and Richmond during fluvial flood events), and thus even with the barrier operating as intended the predicted peak tide levels can be significantly above ground level in the boroughs and the river walls provide an important defence. Therefore a source of residual risk arises from a breach in the flood defence wall.

An indication of the possible locations of a defence breach can be gained by reviewing the flood defence condition data held within the National Flood and Coastal Defence Database (NFCDD). It should be noted that this is only an indication as it fails to account for the possibility of human interference with the defence. Examples of human interference include vehicle impact, ship impact and excavation behind defences. The effects of these events on the defence are not always noticed immediately, and the defence may appear fine but later collapse under the pressure of a rising tide.

It is not possible to quantify the probability of a defence wall failure, but the probability will be greater than that of a highly engineered and managed defence, such as the Thames Barrier. It is also significant that referring to Table 4.3, there is not a large increase in predicted tidal level between a 10 year peak and a 200 year

or 1000 year peak and thus failure of a river wall during a high tide that could cause extensive flooding is that much greater a risk.

For the breach analysis it is assumed that the Thames Barrier will not fail but will be used more often in the future as sea levels rise and other actions being studied by the TE2100 are brought into effect. The consequence of this is that there is little change in residual risk from breaching of river walls but these remain a critical element in the tidal defence.

Breach Locations

The locations of the breaches were selected based on defence condition and ground level behind the defence wall. Most of the breaches are located at areas of the defence in 'fair' condition, which is the worst condition found in the area. A site visit was undertaken to check the plausibility of a breach actually occurring at these locations. Map 3 shows the breach locations and defence condition. The breaches remain open for one tide cycle before being closed. This assumes that repairs would be carried out within hours. The breaches drop from the statutory defence level to the level of the land behind the defence based on 1m LiDAR, and are 20m wide, a standard width for hard defences (Table 5.1 shows the breach dimensions).

Table 5.1: Breach Dimensions

Breach	HF1	HF2	HF3	HF4	HF5	HF6	HF7	HF8	HF9	HF10	HF11	HF12
Top Height	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.41	5.41	5.41	5.41	5.54
Bottom Height	4.19	4.5	4.75	4.75	4.6	4.4	3.3	4.7	4.4	3	3.2	4.4
Width	20	20	20	20	20	20	20	20	20	20	20	20
Defence Condition	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	Fair	Fair

Approach to Breach Analysis

The approach adopted was to use an existing calibrated model of the Thames Estuary (ISIS model) to obtain a stage-time hydrograph at Hammersmith Bridge. This hydrograph was then adjusted to the 200 year (0.5%) Environment Agency levels for 2002 provided in Table 4.3. Once a stage-time hydrograph was established for each breach location the weir equation was use to convert this to a hydrograph of flow through the breach. The defence was breached for one tide cycle as it was assumed that the following tide would not be as high as the first, therefore, as a result of the relatively high land levels along this part of the Thames, it would have a minimal impact. In addition the defence type around this stretch of the Thames are walls, and it was assumed that they would be able to be temporarily mended with greater ease than the larger earth embankments found downstream of the Thames Barrier.

JBA's 2D raster inundation model, JFLOW, was used to model flood flow routes following a breach in the Thames flood defences. JFLOW can route flood water across the floodplain from specified inflow points. The user provides a digital elevation model (DEM), flow time series and the OS co-ordinates of the inflow locations in a database.

In this case, the DEM was comprised of 1m LiDAR. Unfiltered LiDAR, with vegetation and obstructions (flyovers, bridges) removed, was used to represent the

floodplain with the present infrastructure. It was assumed that flow would not be able to re-enter the channel, because it would be full.

Map 4 shows the extent of the flooding suffered as a result of the series of breaches, and the areas where the flood depth is greater than 0.6m.

Appendix A shows the extent, over time, of each individual breach.

Model Accuracy

The accuracy of the modelled breach extents are subject to the accuracy of the:

- LiDAR - typical accuracy is ± 0.25m
- Water levels - these were derived using a probability analysis and an ISIS model with a tolerance of ±0.2m
- Breach widths – these were chosen based on standard Environment Agency Guidance and are in line with previous breaches that have occurred.

5.3.2 Failure of Flood Defences at Boat Access Points

It was noted that in the west of the borough where it fronts the River Thames there are a series of small demountable flood defences which are utilised by private clubs to gain access to the river at Hammersmith.

It has been noted that the chance of these demountable defences being stolen, damaged, or left open was far more probable than the main wall failing. Consequently, an analysis similar to the breach analysis above was carried out to assess the extent and severity of flooding which could occur if allowed to flow through one of these openings.

The failure of these defences was modelled in the same way as the previous breach analysis using the hydrograph adjusted to the 2002 200 year water level. The weir equation was then applied, taking into consideration the new smaller breach dimensions to obtain the flow. This flow was then routed across the 1m LiDAR using JFLOW.

Table 5.2: Comparison of Breach Dimensions

Breach	HF2	Boat Access 1	Boat Access 2
Top Height	5.54	5.54	5.54
Bottom Height	4.5	4.59	5.29
Width	20	2	2

Map 5 shows the two breach extent of the two boat access points in comparison with the main breach point HF2. The extent to which the flood water travelled, and the depths it achieved, were minimal compared to a larger breach. When comparing Boat Access 1 and HF2 it is clear that the flood extent is sensitive to the width of the breach. When comparing Boat Access 1 and Boat Access 2 it is clear that the extent of flooding is also sensitive to the depth of the breach.

5.3.3 Overtopping Analysis

Overtopping of the defence walls is unlikely given the operation of the Thames Barrier. However, in the unlikely event of non closure of the barrier overtopping could occur.

The likelihood of overtopping can be estimated by comparison of modelled water levels (where available) and defence crest levels.

Approach to Overtopping Analysis

The overtopping flows were calculated in the same way as the breach analysis using the hydrograph adjusted to the present day 1 in 200 year event 'no barrier closure' levels from the 2005 EA Joint probability analysis[13]. The levels used were 6.05m at Hammersmith Bridge and 5.97m at Chelsea Bridge, these were around 0.7m higher than the levels in Table 4.3 which take account of barrier closures. The weir equation was then applied to obtain the overtopping flow. This flow was then routed across the 1m LiDAR using JFLOW.

It should be noted that the overtopping analysis has been undertaken using the statutory defence levels. It is possible that the defence has actually been raised higher than these statutory levels therefore making overtopping less likely.

The overtopping extent can be seen in Map 6.

5.4 Climate Change

According to the water levels provided by the Environment Agency for future climate (2052 and 2102) the present day 1 in 200 year (0.5% chance of occurring each year) event levels associated with the Thames between Hammersmith and Chelsea would not increase with climate change. The Environment Agency state this is because the Thames Barrier will continue to function as intended, and its usage will increase as a result of climate change, resulting in less near closure events and therefore no increase in the peak water level expected upstream of the barrier in the study area.

However, for some reason if the Barrier should fail to close in an extreme event in the future then the resultant sea level rise as a consequence of climate change would affect the amount of overtopping occurring. Therefore an overtopping in 2102 scenario was run, using the model predictions for 200 year levels in 2102 from the Environment Agency defence levels study[13]. The levels used were 6.53m at Hammersmith Bridge and 6.44m at Chelsea Bridge.

The overtopping extent for 2102 can be seen in Map 7.

5.5 Residual Risk Classification

5.5.1 Rapid Inundation Zone

The Rapid Inundation Zone (RIZ) can be defined as the area that a flood will cover within half an hour of a breach occurring. For LBHF the RIZ equates to the area

[13] Environment Agency (2005) *Tidal Thames Extreme Water Levels - Reassessment of Joint Probability Analysis*. Halcrow group Limited.

within 500m of the defence line. The RIZ is often the area which suffers the highest depths and velocities.

For allocations where a development site is close to a defence (i.e. within 500m) consideration must be given to the risk to public safety associated with access and egress from properties.

5.5.2 Residual Risk Classification

For allocations where a development site is close to a defence consideration must be given to the risk to public safety (risk to life). Development should not be sited where risk unduly threaten public safety and/or the structural integrity of buildings and infrastructure. Consideration of the depth of flooding, rate of inundation and safe access/egress is required to assess these risks. This assessment is applicable to areas at risk from both breach and overtopping.

Environment Agency guidance suggests that all development should have a dry access and egress in the 1 in 200 year event (the event with a 0.5% chance of occurring each year). Greater depths may be permitted where elevated access/egress to safe ground is provided.

A simplified residual risk classification to delineate risk within Flood Zone 3a was thus derived (Table 5.3) taking account of recent work on Flooding Hazards to People[14] which gives consideration to both the depth of water and speed of flow that can affect people (Table 5.4) and the possible impact the proximity of a site to the river during a sudden surge of water resulting from the failure of a defence.

Map 8 shows the Residual Risk within the borough using the classification criteria are shown in Table 5.3.

Table 5.3: Residual Flood Risk Classification within Flood Zone 3

Classification	Criteria
HH: High	Areas within the RIZ of 500m with a water depth greater than of 0.25m. Areas outside the RIZ with a water depth of greater than 0.6m. Areas within the RIZ with no safe (dry) access or egress.
MH: Medium	Areas within RIZ of 500m and with a water depth of less than of 0.25m. Areas outside the RIZ with a water depth less than 0.6m.
LH: Low	Areas which has not been classified as medium or high risk but are still within the Environment Agencies Flood Zone 3.

DEFRA have produced a classification to determine the Flood Hazard to People as a function of depth and velocity (Table 5.4). The following text explains how the Flood Hazard rating has been incorporated into the Residual Risk Classification.

[14] FD2320 Flood Risk to people (phase 2) EA/Defra 2003

Table 5.4: FD2320 Flood Hazard to People as a function of Depth and Velocity

$d \times (v + 0.5) + DF$	Degree of Flood Hazard	Description
< 0.75	Low	Caution *"Flood zone with shallow flowing or deep standing water"*
0.75 – 1.25	Moderate	Dangerous for some (i.e. children) *"Danger: flood zone with deep or fast flowing water"*
1.25 – 2.5	Significant	Dangerous for most people *"Danger: flood zone with deep fast flowing water"*
> 2.5	Extreme	Dangerous for all *"Extreme Danger: flood zone with deep fast flowing water"*
DF is a debris factor. For urban areas it is recommended that DF=0 for depth <0.25m and DF=1 for depth > 0.25m		

The location of high velocities will depend on the location of the breach; consequently the modelled velocities for a limited number of breaches that can be simulated cannot give a full picture for Flood Hazard. In reality high velocities can be generated due to local features not picked up in the LiDAR or the grid used for flood modelling. Flow into a basement for example may be a high hazard if it occurs rapidly without warning.

Examining the simulated progression of a number of breaches, it was found that, in line with a number of other studies, within 30 minutes the extent of a breaching could reach an area of approximately 300m- 500m from where the failure occurs. This area in proximity to the river is thus potentially at high risk and is classed as a 'Rapid Inundation Zone (RIZ)'.

The Hazard Classification takes account of a debris factor and it is believed that this can increase significantly above a depth of 0.25m.

The high residual risk classification is thus chosen to indicate the areas that could be dangerous to people and incorporates the RIZ and FD2320 Hazard categories equivalent to moderate, significant and extreme flood hazard.

The medium residual risk classification is equivalent to low to moderate flood hazard incorporating areas within the RIZ and with water depths of less than 0.25m. Outside the RIZ velocities were generally lower than 0.75m/s therefore depths with less than 0.6m are seen as low or medium hazard.

The low residual risk part of Flood Zone 3 is that area that is not predicted to be affected by the breaching considered but could potentially be affected if breaches were not closed within the time assumed.

5.6 Other Sources of Flood Risk

5.6.1 Surface Water Drainage

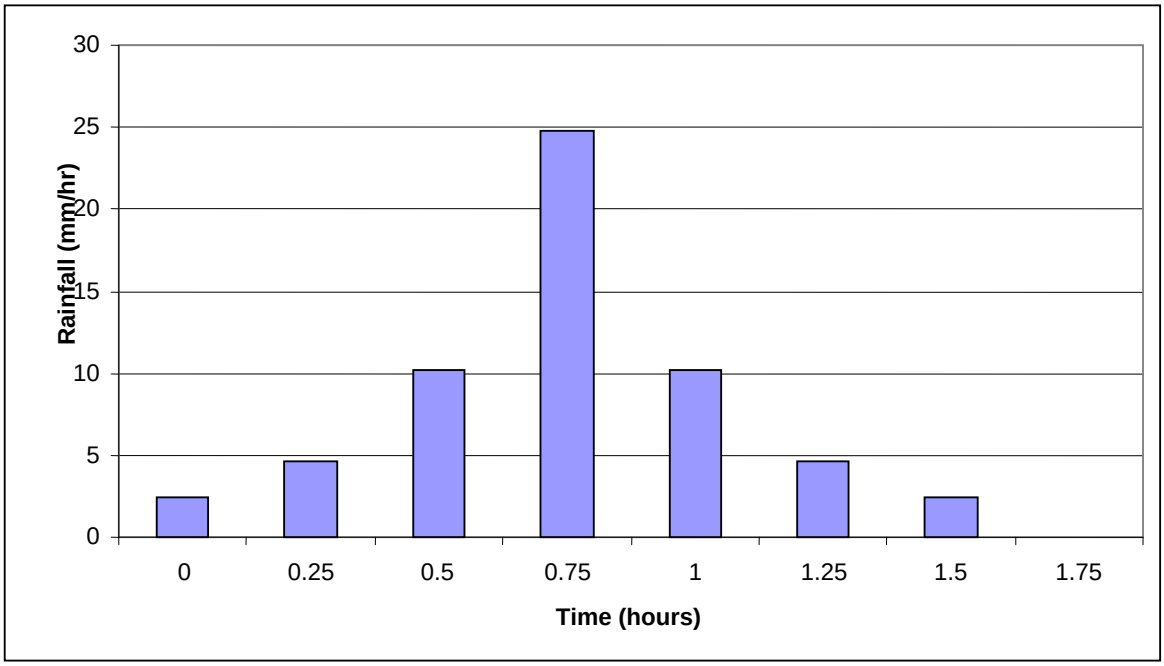
Surface Water Modelling

JFLOW was used to model surface water flooding from an intense storm across the natural catchments contributing to the boroughs to show surface water flow routes and locations where surface water may accumulate and cause flooding.

The FEH design rainfall prediction for a 100 year event for a representative catchment in the centre of the boroughs was 59.3mm, and this was found to be similar across the boroughs. When applied to a summer storm profile, this gives a hyetograph with a peak rainfall of 24.8mm/hr. The critical storm duration was used (1.75 hours). The 10 year storm (which had a peak rainfall of 11.9mm/hr) was subtracted from this hyetograph, to represent the capacity of the drainage/sewerage system to remove surface water.

JFLOW has a function to model rainfall falling across every cell of a DEM. The storm profile, shown in Figure 6.1, was entered into JFLOW as a rainfall inflow. The ground model used was 5m Nextmap due to the inadequacy of the filtering of the 1m LiDAR as a consequence of the study area being highly urbanised.

Figure 5.1: 100 Year Storm Profile



Map 9 shows the maximum depth experienced by each area of the borough. From Map 9 indicative surface water flow paths and indicative areas of ponding are visible. These localised areas of ponding may be highlighted as more susceptible to problems such as impassable roads or risk of flooding to ground floors and basements.

In addition to the surface water results Map 9 shows the locations of properties which suffered flooding as a result of the 20th July 2007 event (50.6mm of rain was recorded at the Holland Park Rain gauge on 20th July 2007). There is a visible correlation between the modelling results (specifically the ponded areas) and the observed incidents. In addition to the 20th July 2007 flooded properties, the area

around Shepherds Bush Green which suffers frequent surcharging also coincides with an area of ponding.

There are some properties which do not correlate, but it should be noted that the properties listed suffered a mixture of surface water and sewer flooding, whereas the modelling results only show indicative areas of surface water flooding.

Sewer Flooding

There was not enough detailed data forthcoming from Thames Water to provide a similar indicative map for sewer flooding. Thames Water did provide details of sewer flooding on a postal area basis. Map 10 utilises this data and provides an overview of the spatial distribution of sewer flooding events in the borough. Thames Water have stated that the areas which have in the past been affected by such flooding should not be seen as areas to avoid future development and that the reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure capacity exists within both the on and off site network.

5.6.2 Groundwater

No records of historical groundwater flooding in this area have been found.

The bedrock geology of the area consists of London Clay overlying a chalk aquifer[15]; this impermeable cap to the aquifer should prevent incidents of deep groundwater flooding. However issues may arise in the future as a result of the rebounding water table following a reduction in abstraction from the chalk aquifer[15]. This situation is being monitored by the Environment Agency as outlined in their "Groundwater Levels in the Chalk-Basal Sands Aquifer of the London Basin" annual reports.

The London Clay itself is overlain with superficial gravels in the lower part of the borough. These permeable gravels outline the historic floodplain of the River Thames and may contain a perched water table. If following heavy rainfall, the water table within this gravel layer rises then localised groundwater flooding can result in excavations and basements. Along the route of 'lost' rivers, springs and rivulets which would have usually joined the streams may still flow, as such finding their way underground, probably along the original course of the stream[16].

The risk of flooding from groundwater is subject to uncertainty as it is dependent upon the conditions at any location for any given time. Consequently, there is a lack of understanding with regards the risk of groundwater flooding. However, it is important to ensure that future developments are not subjected to, or cause, unnecessary risk, therefore FRAs should include a site based assessment of the potential risk of groundwater flooding to the development and neighbouring areas.

5.6.3 Grand Union Canal

The Grand Union Canal travels across the north of the borough. Along the length of the canal there are a few embanked parts, however most of the canal follows the

[15] EA (2006) Groundwater Levels in the Chalk-Basal Sands Aquifer of the London Basin. http://www.environment-agency.gov.uk/commondata/acrobat/2006_reportfinal_1410644.pdf

[16] Barton, N (1992) *The Lost Rivers of London*. Historical Publications Limited, chp 10, p 134.

land contour and thus there are very few places where failure of the canal bank is a risk to the borough. It is more likely that the canal will act as a conveyor of flow in an extreme event, and it is likely to convey flow out of the boroughs due to the topography.

British Waterways did not respond to a request for more detailed information. Without this information and adequate ground data (there is no LIDAR available for this area of the borough) we are unable to make further investigation into the few places where the canal bank could fail.

Map 1 shows the location of the canal within the two boroughs.

5.6.4 Flood Risk from outside the borough

Due to the topography of the Borough there is a risk of receiving surface runoff from the neighbouring boroughs of Kensington and Chelsea, Ealing, Brent and Hounslow.

Failures of the defences along the Thames at its frontage in Kensington and Chelsea, and Hounslow are unlikely to travel into the Borough.

5.6.5 Flood Risk to areas outside the borough

Flooding within Hammersmith and Fulham poses a possible flood risk to the neighbouring boroughs of Kensington and Chelsea, and Hounslow as a result of a breach in the defences near the borders. The risk to RBKC arises from flood waters travelling along the underground tube network into Earls court Station and from there entering the tube network within the borough. It is unlikely that the waters would be deep enough to emerge from the network into the streets; nevertheless this disruption to the underground tube network would be significant. The risk poised to Hounslow arises from the breach flood waters spreading out and crossing the border.

Additionally, surface water runoff from Hammersmith and Fulham could cross the border with Kensington and Chelsea, and the border with Hounslow.

5.7 Critical Infrastructure at Risk of Flooding

Critical infrastructure is infrastructure which would be critical in the event of an emergency. Map 11 shows the critical infrastructure at risk of flooding within the borough. Critical infrastructure at flood risk within the borough include fire, police and ambulance stations, hospitals, telephone exchanges, tube stations and main roads (including the A4).

6 FLOOD RISK IN THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA

6.1 Introduction

The guidance detailed below has been developed to provide a clear, concise and consistent means of assessing the feasibility and sustainability of sites and to determine appropriate flood risk mitigation measures where required. The framework will aid LPAs and others to assess flood risk associated with allocations and potential development sites. It will also allow policies on flood risk to be included in the LDD's, which draw upon national guidance for consistency, but provide the local detail and interpretation of these national policies.

PPS25 aims to direct development to lower flood risk sites wherever possible. "The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid **inappropriate** development in areas at risk of flooding, and to direct development away from areas at higher risk"[11]. Only when the Sequential Test has been employed and new development is, **exceptionally**, necessary and no other lower risk sites have been shown to be available should the Exception Test be applied.

PPS25 it states that *"development should not normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of safety for the lifetime of the development taking into account climate change*"[12]. The Practice Guide was issued in February 2007 as a 'living draft' to accompany PPS25. The Practice Guide provides further information on the residual risks behind defences and on how to apply PPS25 policy to development in these defended areas. However, it should be noted that defences don't eliminate the risk, only reduce the frequency of flooding.

The guidance focuses on the technicalities of flood risk management rather than the other planning issues an LPA must consider in selecting allocations. It should, therefore, be assumed that:

- These other planning issues have been considered separately
- For land to be allocated within the high risk zone, the full range of planning issues has been evaluated.

It should also have been determined through the SEA (Strategic Environmental Assessment) and SA (Sustainability Appraisal) that the land is the most suitable for development.

It must be made clear that this SFRA does not preclude the need for site specific flood risk assessments. Table 2.2, Chapter 2, highlights the type of development considered appropriate for each Flood Zone, if the development not permitted, if the development is allowed only when the Exception Test is passed, and whether a site specific Flood Risk Assessment is required.

This chapter will present the guidance for Flood Zone 3b; Flood Zone 3a (including defended and undefended areas, public safety and rapid inundation, and the

feasibility of flood risk mitigation); Flood Zone 2; and Flood Zone 1. It will then discuss issues relating to flood risk from other sources.

6.2 Delineation of PPS25 Flood Zones

6.2.1 Flood Zone 1 – Low Probability

Map 1 shows the extent of the Flood Zones within the borough. Flood Zone 1 is the area outside Flood Zone 2, for RBKC this is the majority of the borough, all the area north and some of the area to the south of the Kings Road is Flood Zone 1.

Flood Zone 1 equates to a flood event with less than a 0.1% chance of occurring each year (1 in 1000 year event).

In accordance with PPS25 Annex D, Table D.1, all development (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) is allowed in Flood Zone 1. All development proposals should consider the following about the sites:

1. Their vulnerability to flooding from other sources as well as from river and sea flooding.
2. Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.

6.2.2 Flood Zone 2 – Medium Probability

Map 1 shows the extent of the Flood Zone 2 within the borough. Flood Zone 2 is mostly the same as Flood Zone 3 with a few areas where it extends a little further, areas like the Westfield Park, Chelsea Manor Street and Christchurch Street.

Flood Zone 2 equates to a flood event which has a between a 0.1% and 0.5% chance of each year (between a 1 in 1000 and 1 in 200 year event).

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed.

All development proposals must consider the following information about the sites:

1. Their vulnerability to flooding from other sources as well as from river and sea flooding.
2. Their vulnerability to flooding over the lifetime of the development.
3. Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water run-off, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property.
4. A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resilient and resistant design, escape / evacuation, effective flood warning and emergency planning) are acceptable.

6.2.3 Flood Zone 3a – High Probability

Map 1 shows the extent of the Flood Zone 3 within the borough. Overall Flood Zone 3 covers a small portion of the borough. Flood Zone 3 mainly consists of the areas adjacent to the Cheyne Walk and the Chelsea Embankment with wider

extents around The Royal Hospital and Gardens, Ashburnham Road, Cremorne Road, Chelsea Manor Street and Christchurch Street.

Flood Zone 3 equates to a flood event with a greater than a 0.5% chance of occurring each year (1 in 200 year event).

PPS25 Annex D, Table D.1 states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to PPS25 Annex D, Table D.1 highly vulnerable development is not permitted, with essential infrastructure and more vulnerable development needing to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

According to PPS25 Annex D, Table D.1, developers and local authorities should implement the following policy aims:

1. Reduce the overall level of flood risk in the are through the layout and form of the development and the appropriate application of sustainable drainage techniques;
2. Relocate existing development to land in zones with a lower probability of flooding; and
3. Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage[1]

Regeneration of land or change in land use behind existing defended areas in the High Risk Zone will continue to require a more detailed assessment of the flood risk (i.e. whether the scale of risk is worth taking), and how sustainable and effective the mitigation measures would be (i.e. whether the risk could be managed).

Where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones then an assessment of the actual risk within Flood Zone 3 is required. For developments to proceed it must also be shown that the development will not increase flood risk elsewhere through a loss of breach storage or conveyance. Flood risk must be reduced or kept at current levels as contained in the Regional Spatial Strategy (RSS) policy statement.

6.2.4 Flood Zone 3b – The Functional Floodplain

There are effectively no areas of functional floodplain within the borough.

Although not strictly 'floodplain' the tidal foreshore exposed each tide should be protected as this plays an important role in the functioning of the Tidal Thames.

6.3 Assessment of Residual Risk

Annex G in PPS25 deals with managing residual flood risk.

Paragraph G2 of PPS25 states that following application of the Sequential Test and Exception Test for Zone 3a development:

> *"Should **not** normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of **safety** taking into account climate change."*

It would be up to the developer to demonstrate how in planning terms this safety can be achieved and how the residual risks will be managed. A clear distinction between commercial flood standards of protection and management of loss of life should be explored in the FRA. A greater reliance on flood warning may be required, which is not always a tangible alternative to accepting a lower standard of protection.

The study area is a defended area, and is considered to be an area of floodplain where the defences substantially (but not necessarily completely) mitigate the flood risk associated with the event which has a 0.5% chance of occurring each year (1 in 200 year return period).

Within defended areas flood risk is primarily associated with overtopping and breach of defences (and localised flooding associated with drainage systems in some locations). These risks are related to the likelihood (standard of protection and structural integrity of defences) and consequences of flooding (depth, speed and duration of flooding, and land use within defended area).

The consequences of defence overtopping or breach failure can be estimated using flood inundation modelling and mapping.

6.3.1 Breach Analysis

It is assumed that the Thames Barrier will not fail but will be used more often. Therefore the source of residual risk arises from a breach in the flood defence wall.

An indication of the likely location of a defence breach can be gained by reviewing the flood defence condition data held within the National Flood and Coastal Defence Database (NFCDD). It should be noted that this is only an indication as it fails to account for the possibility of human interference with the defence. Examples of human interference include vehicle impact, ship impact and excavation behind defences. The effects of these events on the defence are not always noticed immediately, and the defence may appear fine but later collapse under the pressure of a rising tide.

Breach Locations

The locations of the breaches were selected based on defence condition and ground level behind the defence wall. Most of the breaches are located at areas of the defence in ‘good’ condition, which is the worst condition found in the area. A site visit was undertaken to check the plausibility of a breach actually occurring at these locations. Map 12 shows the breach locations and defence condition. The breaches remain open for one tide cycle before being closed. This assumes that repairs would be carried out within hours. The breaches drop from the statutory defence level to the level of the land behind the defence based on 1m LiDAR, and are 20m wide, a standard width for hard defences (Table 6.1 shows the breach dimensions).

Table 6.1: Breach Dimensions

Breach	KC1	KC2	KC4	KC3
Top Height	5.41	5.41	5.41	5.41
Bottom Height	4.75	4.75	4.75	4.6
Width	20	20	20	20
Defence Condition	Fair	Good	Good	Good

Approach to Breach Analysis

The approach adopted was to use an existing calibrated model of the Thames Estuary (ISIS model) to obtain a stage-time hydrograph at Hammersmith Bridge. This hydrograph was then adjusted to the 200 year (0.5%) Environment Agency levels for 2002 provided in Table 5.3. Once a stage-time hydrograph was established for each breach location the weir equation was use to convert this to a hydrograph of flow through the breach. The defence was breached for one tide cycle as it was assumed that in such an important area (a) the main threat to people occurs on the initial breaching (b) the breach could be temporarily mended with greater ease than the larger earth embankments found downstream of the Thames Barrier, (c) the following tide would not be as high as the first (and could be reduced by the effect of the Thames Barrier if necessary), therefore, as a result of the relatively high land levels along this part of the Thames, it would have a limited effect and (d) the large diameter sewers passing through the area could evacuate much of the initial breach flow.

JBA's 2D raster inundation model, JFLOW, was used to model flood flow routes following a breach in the Thames flood defences. JFLOW can route flood water across the floodplain from specified inflow points. The user provides a digital elevation model (DEM), flow time series and the OS co-ordinates of the inflow locations in a database.

In this case, the DEM was comprised of 1m LiDAR. Unfiltered LiDAR, with vegetation and obstructions (flyovers, bridges) removed, was used to represent the floodplain with the present infrastructure. It was assumed that flow would not be able to re-enter the channel, because it would be full.

Map 13 shows the extent of the flooding suffered as a result of the series of breaches, and the areas where the flood depth is greater than 0.6m.

Appendix A shows the extent, over time, of each individual breach location

Model Accuracy

The accuracy of the modelled breach extents is subject to the accuracy of the following:

- LiDAR – typical accuracy is ±0.25m
- Water levels – these were derived using a probability analysis and an ISIS model with a tolerance of ±0.2m
- Breach widths – these were chosen based on the standard Environment Agency guidance and are seen as appropriately conservative.

- Model grid used was 5m cell size which results in an averaging of water level over such an area. The effect of garden walls or flow into basements is not simulated.
- The sewer system could carry away some of the breach flow limiting the extent predicted.

6.3.2 Overtopping Analysis

Overtopping of the defence walls is unlikely given the operation of the Thames Barrier. However, in the unlikely event of non closure of the barrier the overtopping would occur.

The likelihood of overtopping can be estimated by comparison of modelled water levels (where available) and defence crest levels.

Approach to Overtopping Analysis

The overtopping flows were calculated in the same way as the breach analysis using the hydrograph adjusted to the present day 1 in 200 year event 'no barrier closure' levels from the 2005 EA Joint probability analysis[13]. The levels used were 6.05m at Hammersmith Bridge and 5.97m at Chelsea Bridge, these are around 0.7m higher than the levels in Table 4.3 which take account of barrier closures. The weir equation was then applied to obtain the overtopping flow. This flow was then routed across the 1m LiDAR using JFLOW as above.

It should be noted that the overtopping analysis has been undertaken using the statutory defence levels. It is possible that the defence has actually been raised higher than these statutory levels therefore making overtopping less likely.

The overtopping extent can be seen in Map 14.

6.4 Climate Change

According to the water levels provided by the Environment Agency for future climate (2052 and 2102) the present day 1 in 200 year (0.5% chance of occurring each year) event levels associated with the Thames between Hammersmith and Chelsea would actually decrease with climate change. The Environment Agency state this is because the Thames Barrier will continue to functions as intended, and its usage increase as a result of climate change, resulting in less near closure events and therefore a reduction in the peak water level can be expected upstream of the barrier.

However, if the Barrier fails to close during a critical storm surge event in the future then the resultant sea level rise as a consequence of climate change would affect the amount of overtopping occurring. Therefore an overtopping in 2102 scenario was run, using the 2102 200 year levels from the 2005 report[13]. The levels used were 6.53m at Hammersmith Bridge and 6.44m at Chelsea Bridge. However, these were derived prior to PPS25 and as a result are due to be recalculated in 2007/2008.

The overtopping extent for 2102 can be seen in Map 15.

6.5 Residual Risk Classification

6.5.1 Rapid Inundation Zone

The Rapid Inundation Zone (RIZ) can be defined as the area that a flood will cover within half an hour of a breach occurring. For RBKC the RIZ equates to the area within 500m of the defence line. The RIZ is often the area which suffers the highest depths and velocities.

For allocations where a development site is close to a defence (i.e. within 500m) consideration must be given to the risk to public safety associated with access and egress from properties.

6.5.2 Residual Risk Classification

For allocations where a development site is close to a defence (i.e. within 500m) consideration must be given to the risk to public safety. Development should not be sited where risk unduly threaten public safety and/or the structural integrity of buildings and infrastructure. Consideration of the depth of flooding, rate of inundation and safe access/egress is required to assess these risks. This assessment is applicable to areas at risk from both breach and overtopping.

Environment Agency guidance suggests that all development should have a dry access and egress in the 1 in 200 year event (the event with a 0.5% chance of occurring each year). Greater depths may be permitted where elevated access/egress to safe ground is provided.

Map 16 shows the Residual Risk within the borough and the classification criteria are shown in Table 6.2. The derivation of the risk bands used was given in Section 5.5.

Table 6.2: Residual Flood Risk Classification within Flood Zone 3

Classification	Criteria
HH: High	Areas within the RIZ of 500m with a water depth greater than of 0.25m. Areas outside the RIZ with a water depth of greater than 0.6m. Areas within the RIZ with no safe (dry) access or egress.
MH: Medium	Areas within RIZ of 500m and with a water depth of less than of 0.25m. Areas outside the RIZ with a water depth less than 0.6m.
LH: Low	Areas which has not been classified as medium or high risk but are still within the Environment Agencies Flood Zone 3.

6.6 Other Sources of Flood Risk

6.6.1 Surface Water Drainage

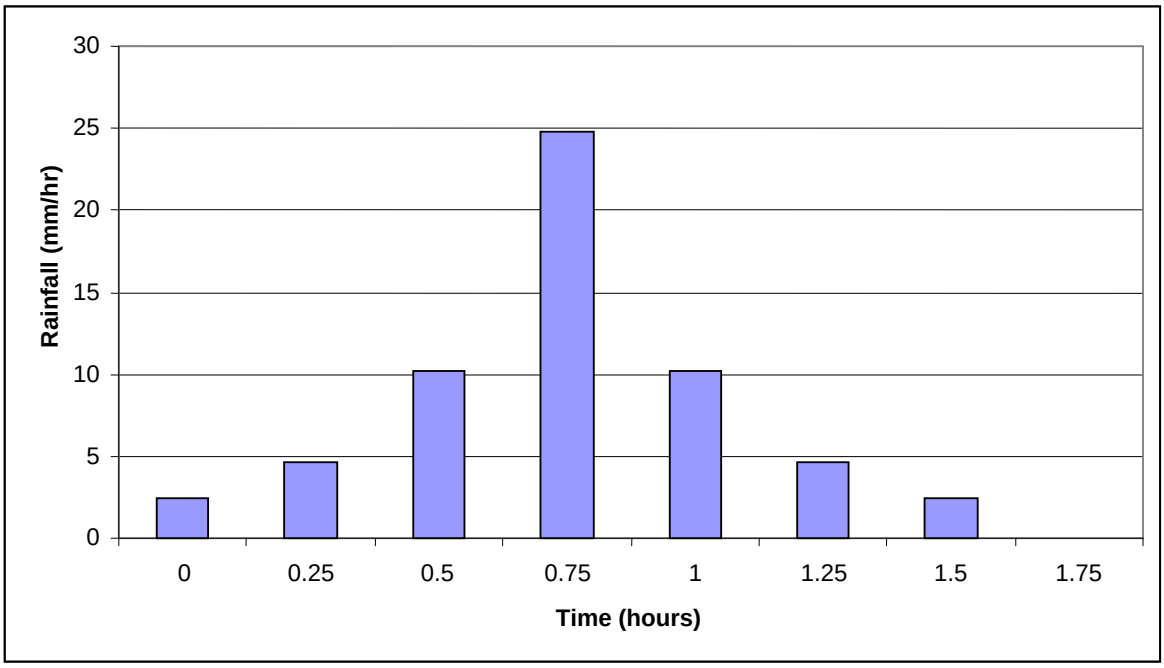
JFLOW was used to model surface water flooding from an intense storm across the natural catchments contributing to the boroughs to show surface water flow routes and locations where surface water may accumulate and cause flooding.

The FEH design rainfall prediction for a 100 year event for a representative catchment in the centre of the boroughs was 59.3mm, and this was found to be similar across the boroughs. When applied to a summer storm profile, this gives a hyetograph with a peak rainfall of 24.8mm/hr. The critical storm duration was used

(1.75 hours). The 10 year storm (which had a peak rainfall of 11.9mm/hr) was subtracted from this hyetograph, to represent the capacity of the drainage/sewerage system to remove surface water.

JFLOW has a function to model rainfall falling across every cell of a DEM. The above storm profile was entered into JFLOW as a rainfall inflow. The ground model used was 5m Nextmap due to the inadequacy of the filtering of the 1m LiDAR as a consequence of the study area being highly urbanised.

Figure 6.1: 100 Year Storm Profile



Map 17 shows the maximum depth experienced by each area of the borough. From Map 17 indicative surface water flow paths and indicative areas of ponding are visible. These localised areas of ponding may be highlighted as more susceptible to problems such as impassable roads or low risk flooding of ground floors and basements.

In addition to the surface water results Map 17 shows the locations of properties which suffered flooding as a result of the 20th July 2007 event (50.6mm of rain was recorded at the Holland Park Rain gauge on 20th July 2007). There is a visible correlation between the modelling results (specifically the ponded areas) and the observed incidents.

There are some properties which do not correlate, but it should be noted that the properties listed suffered a mixture of surface water and sewer flooding, whereas the modelling is only indicative of surface water flooding.

6.6.2 Sewer Flooding

There was not enough detailed data forthcoming from Thames Water to provide a similar indicative map for sewer flooding. Thames Water did provide details of sewer flooding on a postal area basis. Map 18 utilises this data and provides an overview of the spatial distribution of sewer flooding events in the borough. Thames Water have stated that the areas which have in the past been affected by such flooding should not be seen as areas to avoid future development and that the

reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure capacity exists within both the on and off site network.

6.6.3 Groundwater

No records of historical groundwater flooding in this area have been found.

The bedrock geology of the area consists of London Clay overlying a chalk aquifer[17]; this impermeable cap to the aquifer should prevent incidents of deep groundwater flooding. However issues may arise in the future as a result of the rebounding water table following a reduction in abstraction from the chalk aquifer[15]. This situation is being monitored by the Environment Agency as outlined in their "Groundwater Levels in the Chalk-Basal Sands Aquifer of the London Basin" annual reports.

The London Clay itself is overlain with superficial gravels in the lower part of the borough. These permeable gravels outline the historic floodplain of the River Thames and may contain a perched water table. If following heavy rainfall, the water table within this gravel layer rises then localised groundwater flooding can result in excavations and basements. Along the route of 'lost' rivers, springs and rivulets which would have usually joined the streams may still flow, as such finding their way underground, probably along the original course of the stream[16].

The risk of flooding from groundwater is subject to uncertainty as it is dependent upon the conditions at any location for any given time. Consequently, there is a lack of understanding with regards the risk of groundwater flooding. However, the RBKC have commissioned a study into the affects of subterranean development which may aid in understanding the groundwater conditions of the area.

It is important to ensure that future developments are not subjected to, or cause, unnecessary risk, therefore FRAs should include a site based assessment of the potential risk of groundwater flooding to the development and neighbouring areas.

6.6.4 Grand Union Canal

The Grand Union Canal travels across the north of the borough, along its length there are a few embanked parts, however most of the canal follows the land contour and thus there are very few places where failure of the canal bank is a risk to the borough. It is more likely that the canal will act as a conveyor of flow in an extreme event, and it is likely to convey flow out of the boroughs due to the topography.

British Waterways did not respond to a request for more detailed information. Without this information and adequate ground data (there is no LIDAR available for this area of the borough) we are unable to make further investigation into the few places where the canal could fail.

Map 1 shows the location of the canal within the borough.

[17] EA (2006) Groundwater Levels in the Chalk-Basal Sands Aquifer of the London Basin. http://www.environment-agency.gov.uk/commondata/acrobat/2006_reportfinal_1410644.pdf

6.6.5 The Serpentine

The Serpentine Lake in Hyde Park in the borough of Westminster was created by damming the River Westbourne in 1730. Subsequently, there is a potential risk of dam failure for the Serpentine dam at the east end of the impoundment. Large raised dams containing more than 25,000m^3 are subject however to stringent safety measures under the Reservoirs Act and the probability of the dam overtopping and breaching may be seen as unlikely and with less than a 1:10,000 chance of occurring.

Unfortunately, there has been no response from the Royal Parks with regards the management of the Serpentine and more detailed information, therefore the assessment of risk from the Serpentine could not be further investigated. Westminster Council are beginning a more detailed assessment of the Westbourne as part of their SFRA and will inform Kensington and Chelsea on the outcome.

Map 1 shows the location of the Serpentine.

6.6.6 Flood Risk from areas outside the borough

There is a possible flood risk from Hammersmith and Fulham as a result of flood waters travelling along the tube network into Earls Court Station and from there entering the tube network within the borough. It is unlikely the waters would be deep enough to emerge from the tube network to the streets of the borough; nevertheless the disruption of the tube network within the borough would be significant.

The possible flood risk arising from the City of Westminster is the Serpentine as mentioned above. Failures of the defences along the Thames at its frontage in Westminster are unlikely to travel into the borough.

Due to the topography of the area the borough is also at risk of receiving surface runoff from the neighbouring boroughs of Hammersmith and Fulham, Brent and Westminster.

6.6.7 Flood Risk to areas outside the borough

Failures of the defences along the Thames at its frontage with Kensington and Chelsea are unlikely to travel into the neighbouring boroughs.

However, surface water runoff from Kensington and Chelsea could cross the border with Hammersmith and Fulham, and the border with the City of Westminster.

6.7 Critical Infrastructure at Flood Risk

Critical infrastructure is infrastructure which would be critical in the event of an emergency. Map 19 shows the critical infrastructure at risk of flooding within the borough. Critical Infrastructure at flood risk includes tube stations and main roads (including the A3212).

7 PROPOSED DEVELOPMENT SITES

RBKC and LBHF provided a list of proposed development sites within the boroughs. An initial review of flood risk for each of the boroughs proposed development sites has been undertaken, allowing the councils to apply the Sequential Test.

7.1 Categorisation of Proposed Future Development Sites in Accordance with PPS25

In this section, LBHF's preferred site options, as a result of the LDF 'Issues and Options' stage consultation, are categorised in Table 7.1. RBKC's preferred options have not yet been chosen, therefore all their LDF 'Issues and Options' sites have been categorised in Table 7.2.

The sites have are categorised according to their flood risk with reference to PPS25, and their residual risk rating, to enable the councils to carry out the Sequential Test.

Tables 7.1 and 7.2 list the proposed sites, their area, which Flood Zone they are in, what residual risk rating they have and whether an FRA will be required under PPS25. The Flood Zone and Residual Risk information has been colour coded. Where the sites intersect with several Flood Zones, the colour of the highest risk Flood Zone with which it intersects has been used. The determination of whether an FRA is required for proposed sites in Flood Zone 1 is based solely on the size of the proposed development, drainage issues with the site have not been considered, but will need to be to fully determine whether a FRA is required.

Table 7.1: Categorisation of LBHF Sites in Accordance with PPS25

Borough	Development Site	Flood Zone	Residual Risk	FRA Required?
LBHF	Hammersmith & City Line Car Park	3a	LH	Yes
LBHF	Hammersmith Palais, Shepherds Bush Road	3a	LH	Yes
LBHF	White City Opportunity Area	1	-	Yes site 24.6ha
LBHF	Hammersmith Embankment Phase 2	3a	HH	Yes
LBHF	Seagrave Road Car Park	3a	HH	Yes
LBHF	National Grid Land, Imperial Road	3a + 2 + 1	HH	Yes
LBHF	Fulham Wharf	3a	HH	Yes
LBHF	Comleys Wharf and Swedish Wharf	3a	HH	Yes
LBHF	Albert Wharf	3a	LH	Yes
LBHF	Hurlingham Wharf	3a	HH	Yes
LBHF	Whiffen Wharf	3a	HH	Yes
LBHF	Riverside Studios	3a	HH	Yes
LBHF	Queens Wharf	3a	HH	Yes
LBHF	Hammersmith Island Site Phase 4	2 + 1	-	Yes
LBHF	Land Adjacent to Hammersmith Town Hall	3a	HH	Yes
LBHF	84-88 Fulham High Street and adjoining Land	3a	HH	Yes
LBHF	Former Savoy Bingo Club, Westway	1	-	No site 0.16ha
LBHF	Former Odeon Cinema, Shepherds Bush Green	1	-	No site 0.3ha
LBHF	Old Oak Common Sidings	1	-	Yes site 32.5ha
LBHF	Old Oak Sidings	1	-	Yes site 2.21ha
LBHF	EMR Site	1	-	Yes site 4.4ha

Table 7.2: Categorisation of RBKC Sites in Accordance with PPS25

Borough	Development Site	Flood Zone	Residual Risk	FRA Required?
RBKC	Kensal Green Gasworks 1	1	-	Yes site 4.2ha
RBKC	Kensal Green Gasworks 2	1	-	Yes site 3.3ha
RBKC	Canalot Studios	1	-	No site 0.32ha
RBKC	321/335 Kensal Road	1	-	No site 0.13ha
RBKC	The Grand Union Centre	1	-	No site 0.59ha
RBKC	Factory Site, Meanwhile Gardens	1	-	No site 0.12ha
RBKC	The Shaftsbury Centre	1	-	No site 0.25ha
RBKC	Ladbroke Hall	1	-	No site 0.23ha
RBKC	The Pall Mall Deposit	1	-	No site 0.20ha
RBKC	130/136 Barlaby Road, and 2/6 Exmoor Road	1	-	No site 0.73ha
RBKC	St Thomas's School	1	-	No site 0.50ha
RBKC	Princess Louise hospital	1	-	No site 0.34ha
RBKC	Westbourne Studios	1	-	No site 0.32ha
RBKC	167/185 Freston Road	1	-	No site 0.30ha
RBKC	40/46 Bard Road	1	-	No site 0.10ha
RBKC	Land at Rear of 91/121 Freston Road	1	-	Yes site 1.30ha
RBKC	Former London Electricity Board Depot	1	-	No site 0.32ha
RBKC	Newcombe House	1	-	No site 0.20ha
RBKC	Holland Park School	1	-	Yes site 1.59ha
RBKC	Site with access from Maclise Road	2	-	Yes
RBKC	The Commonwealth Institute	1	-	Yes site 1.37ha
RBKC	High Street Kensington Underground Station	1	-	Yes site 2.40ha
RBKC	The Odeon Cinema	1	-	No site 0.20ha
RBKC	TA Centre	1	-	No site 0.83ha
RBKC	Warwick Road Telephone Exchange	1	-	No site 0.37ha
RBKC	Land bounded by Brompton Road, Sloane Street, Basil Street and Hans Crescent	1	-	Yes site 1.39ha
RBKC	Ombeter Site	1	-	No site 0.16ha
RBKC	Phase II Fenelon Place	1	-	No site 0.26ha
RBKC	Iranian Embassy Site	1	-	No site 0.22ha
RBKC	South Kensington Underground Station	1	-	No site 0.79ha
RBKC	Clearings I & II, Draycott Avenue	1	-	No site 0.50ha
RBKC	Brompton Hospital	1	-	Yes site 2.42ha
RBKC	Chelsea Farmer's Market	1	-	No site 0.27ha
RBKC	Chelsea College of Art and Design	1	-	No site 0.30ha
RBKC	Kingsgate House	1	-	No site 0.25ha
RBKC	Jamahirya School	1	-	No site 0.43ha
RBKC	73/79 Chelsea Manor Street	3a + 2	LH	Yes
RBKC	75/77 Lots Road	2	-	Yes
RBKC	Site at Lots Road bordered by Upcerne Road, Telcott Road and Burnaby Street	2 + 1	-	Yes
RBKC	Cremorne Wharf	3a	HH	Yes
RBKC	Lots Road Power Station	3a	LH	Yes
RBKC	Kensington Close Hotel & Copthorne Tara Hotel	1	-	Yes site 1.60ha
RBKC	Chelsea Delivery Office Kings Road	1	-	Yes if site > 1ha
RBKC	Kensington Delivery Office Kensington High Street	1	-	Yes if site > 1ha

Borough	Development Site	Flood Zone	Residual Risk	FRA Required?
RBKC	West Brompton Station	3a	HH	Yes
RBKC	Vicarage Gate Care Home Site	1	-	No site 0.17ha
RBKC	Wornington Green	1	-	Yes if site > 1ha
RBKC	Kensington and Chelsea College for Adult Education	1	-	No site 0.43ha
RBKC	EDF Energy Site	3a	LH	Yes
RBKC	Charles House	1	-	Yes if site > 1ha
RBKC	Sidings West Philbeach Gardens	3a	LH	Yes
RBKC	Sidings North Lille Bridge	2	-	Yes
RBKC	Chelsea Fire Station	1	-	No site 0.16ha
RBKC	Earl's Court	3a + 2 + 1	LH	Yes
RBKC	St Charles Hospital	1	-	Yes if site > 1ha

7.2 Review of Proposed Future Development Sites within LBHF

A planning review of individual site allocations already identified for the LDF has been undertaken. In this instance only the sites which fell completely or partly within flood zones 3 or 2 have been reviewed.

The reviews provide an overview of flood risk suffered by the individual sites, however this review does not negate the need for a detailed Flood Risk Assessment where applicable.

Where it is stated whether the exception test is applicable this is based on current information of preferred development uses. When the actual development uses are finalised the applicability of the exception test will need to be revisited.

It is not for the SFRA to assess whether the site will pass parts a. and b. of the Exception Test. The Council must be able to demonstrate the need for development through the spatial planning process. Nevertheless, the overview does provide details of would be required for the proposed development to pass part c of the exception test.

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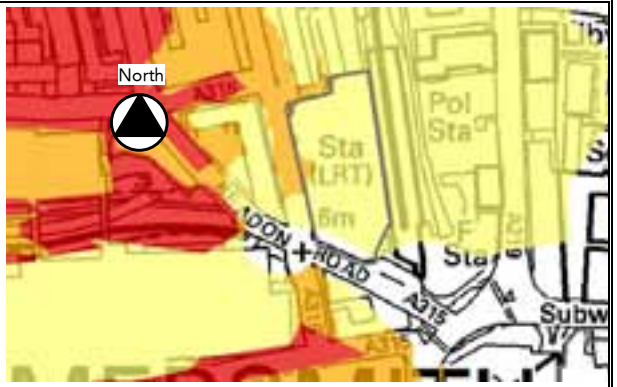
Table 7.3 Development Site at Hammersmith & City Line Station Car Park

Site 1		**Hammersmith & City Line Station Car Park**					
OS NGR:	TQ 3297 7939	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area
Sources of Flooding		Breach, Surface Water		**Residual Risk Rating**		LH – area affected by breach. Dry access/egress via Beadon Road.	
Proposed Development Usage		Office, residential, retail and significant element of leisure uses. Active frontage with Lyric Square		**Within Rapid Inundation Zone (RIZ)?**		No	
Exception Test Applicable?		Yes as proposed use is to include residential development, drinking establishments, nightclubs.		**Range of Modelled Flood Depths (m):**		0.00m – 0.55m in the road	
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1		**Time to inundations from point of overtopping or breach (hrs):**		1 - 2 hours	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*				**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*			

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.4 Development Site at Hammersmith Palais, Shepherds Bush Road

Site 2		Hammersmith Palais, Shepherds Bush Road					
OS NGR:	TQ 3351 8750	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		n/a			**Residual Risk Rating**		LH – area not affected by breach or overtopping.
Proposed Development Usage		Leisure, residential, and other to ensure active street frontage.			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		Yes as proposed use is to include residential development, drinking establishments, nightclubs.			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.5 Development Site at Hammersmith Embankment Phase 2

Site 4		Hammersmith Embankment Phase 2					
OS NGR:	TQ 3297 7939	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		Breach, Overtopping, Surface Water		**Residual Risk Rating**		HH – area affected by breach or overtopping. No dry access/egress	
Proposed Development Usage		Office and other uses including residential. Provision of Riverside walk.		**Within Rapid Inundation Zone (RIZ)?**		Yes	
Exception Test Applicable?		Yes as proposed use is to include residential development.		**Range of Modelled Flood Depths (m):**		0.00m – 2.75m in the road	
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1		**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*				**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*			

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.6 Development Site at Seagrave Road Car Park

Site 5		Seagrave Road Car Park					
OS NGR:	TQ 5447 7822	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		Breach, Overtopping, Surface Water			**Residual Risk Rating**		HH – area affected by breach.
Proposed Development Usage		Residential with open spaces and some Class B employment uses, car park for Earls Court maintained.			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		0.00m – 1.50m
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		3 - 4 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		
PPS25 Development Types Classification		**Essential Infrastructure**	**Water compatible**		**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a		**Exception Test**	✔		**x**	**Exception Test**	✔
SuDS		See Appendix A.3			**Mitigation Measures**		See Appendix A.2
Climate Change		See section 5.4			**Notes**		Detailed FRA Required

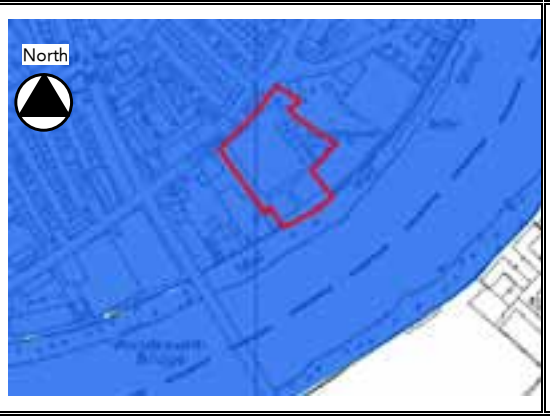
Table 7.7 Development Site at National Grid Land, Imperial Road

Site 6		National Grid Land, Imperial Road					
OS NGR:	TQ 6000 6925	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a + 2 + 1	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		Breach, Overtopping, Surface Water		**Residual Risk Rating**		HH – area affected by breach and overtopping.	
Proposed Development Usage		Residential, Class B employment uses, waste handling facility and open space.		**Within Rapid Inundation Zone (RIZ)?**		Yes	
Exception Test Applicable?		Not if sequential design is used (see Appendix A.2.2)		**Range of Modelled Flood Depths (m):**		0.00m – 2.00m	
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1		**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		North 		**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		North 	

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔
Flood Zone 2	✔	✔	**Exception Test**	✔	✔
Flood Zone 1	✔	✔	✔	✔	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.8 Development Site at Fulham Wharf

Site 7		Fulham Wharf					
OS NGR:	TQ 6029 5779	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		Breach, Overtopping		**Residual Risk Rating**		HH – the road frontage of area affected by breach or overtopping, site has no dry access/egress.	
Proposed Development Usage		Mixed (Some Residential if compatible with adjoining safeguarded wharf). Active river frontage and riverside walk.		**Within Rapid Inundation Zone (RIZ)?**		Yes, but ground has been raised	
Exception Test Applicable?		Yes as proposed use is to include residential development.		**Range of Modelled Flood Depths (m):**		0.00m – 1.00m in road	
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1		**Time to inundations from point of overtopping or breach (hrs):**		1 - 2 hours	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*				**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*			

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	Exception Test	✔	x	Exception Test	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.9 Development Site at Comleys Wharf and Swedish Wharf

Site 8		Comleys Wharf and Swedish Wharf					
OS NGR:	TQ 5973 5743	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		Breach, Overtopping.			**Residual Risk Rating**		HH – the road frontage of area affected by breach or overtopping, site has no dry access/egress.
Proposed Development Usage		Wharves should be safeguarded. Employment and Residential if does not impact safeguarded wharf. Active river frontage and riverside walk.			**Within Rapid Inundation Zone (RIZ)?**		Yes, but ground has been raised
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		0.00m – 1.00m in road
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		1 - 2 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.10 Development Site at Albert Wharf

Site 9		Albert Wharf					
OS NGR:	TQ 5912 5701	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		n/a			**Residual Risk Rating**		LH – as not affected by breach or overtopping and close to a bridge so has safe access/egress.
Proposed Development Usage		Mixed (Residential if compatible with adjoining safeguarded wharf). Active river frontage and riverside walk.			**Within Rapid Inundation Zone (RIZ)?**		Yes, but ground has been raised
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.11 Development Site at Hurlingham Wharf

<table>
<tr><th colspan="2">Site 10</th><th colspan="6">Hurlingham Wharf</th></tr>
<tr><td>OS NGR:</td><td>TQ 5599 5566</td><td>Brown / Greenfield</td><td>Brownfield</td><td>Flood Zone</td><td>3a</td><td>Historical Flooding</td><td>Historic Sewer Flooding within the SW6 area.</td></tr>
<tr><td colspan="2">Sources of Flooding</td><td colspan="3">n/a</td><td>Residual Risk Rating</td><td colspan="2">HH – although not affected by breach or overtopping, site has no dry access/egress.</td></tr>
<tr><td colspan="2">Proposed Development Usage</td><td colspan="3">Wharf should be safeguarded. Employment and Residential if does not impact safeguarded wharf. Active river frontage and riverside walk.</td><td>Within Rapid Inundation Zone (RIZ)?</td><td colspan="2">Yes, but ground has been raised</td></tr>
<tr><td colspan="2">Exception Test Applicable?</td><td colspan="3">Yes as proposed use is to include residential development.</td><td>Range of Modelled Flood Depths (m):</td><td colspan="2">n/a</td></tr>
<tr><td colspan="2">Requirements for passing part c of the exception test:</td><td colspan="3">The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1</td><td>Time to inundations from point of overtopping or breach (hrs):</td><td colspan="2">n/a</td></tr>
<tr><td colspan="2">Flood Zone coverage:
<u>Legend:</u>
Development Site
Flood Zone 3
Flood Zone 2
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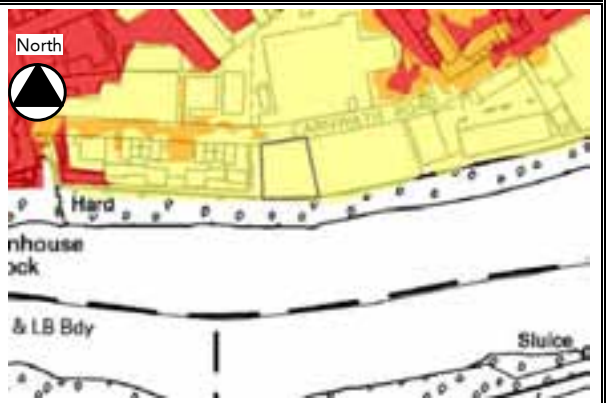
© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007</td><td colspan="3"> 
</td><td>Residual Risk
<u>Legend:</u>
Development Site
Residual Flood Risk within Flood Zone 3
HR: High Residual Flood Risk
MR: Medium Residual Flood Risk
LR: Low Residual Flood Risk
© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007</td><td colspan="2"> 
</td></tr>
<tr><td colspan="2">PPS25 Development Types Classification</td><td>Essential Infrastructure</td><td>Water compatible</td><td>Highly vulnerable</td><td>More vulnerable</td><td colspan="2">Less Vulnerable</td></tr>
<tr><td colspan="2">Flood Zone 3a</td><td>Exception Test</td><td>✔</td><td>x</td><td>Exception Test</td><td colspan="2">✔</td></tr>
<tr><td colspan="2">SuDS</td><td colspan="3">See Appendix A.3</td><td>Mitigation Measures</td><td colspan="2">See Appendix A.2</td></tr>
<tr><td colspan="2">Climate Change</td><td colspan="3">See section 5.4</td><td>Notes</td><td colspan="2">Detailed FRA Required</td></tr>
</table>

Table 7.12 Development Site at Whiffen Wharf

Site 11		Whiffen Wharf					
OS NGR:	TQ 5533 5556	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		n/a			**Residual Risk Rating**		HH – although not affected by breach or overtopping, site has no dry access/egress.
Proposed Development Usage		Mixed ((Residential if compatible with neighbouring safeguarded wharf). Active river frontage and riverside walk.			**Within Rapid Inundation Zone (RIZ)?**		Yes, but ground has been raised
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.13 Development Site at Riverside Studios

Site 12		Riverside Studios					
OS NGR:	TQ 3135 8095	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		Breach, Overtopping.		**Residual Risk Rating**		HH – area affected by breach or overtopping, site has no dry access/egress.	
Proposed Development Usage		Mixed (arts, culture, entertainment and residential). Active river frontage and riverside walk.		**Within Rapid Inundation Zone (RIZ)?**		Yes	
Exception Test Applicable?		Yes if proposed use is to include residential development, drinking establishments, nightclubs.		**Range of Modelled Flood Depths (m):**		0.00m – 1.00m in road	
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1		**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*				**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*			

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.14 Development Site at Queens Wharf

Site 13		Queens Wharf					
OS NGR:	TQ 3112 8139	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		Breach, Overtopping.			**Residual Risk Rating**		HH – area affected by breach or overtopping, site has no dry access/egress.
Proposed Development Usage		Mixed (B Class and residential). Active river frontage and riverside walk.			**Within Rapid Inundation Zone (RIZ)?**		Yes
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		0.00m – 4.00m in road
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.15 Development Site at Hammersmith Island Phase 4

Site 14		**Hammersmith Island Phase 4**					
OS NGR:	TQ 3454 8566	**Brown / Greenfield**	Brownfield	**Flood Zone**	2 & 1	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		Surface Water			**Residual Risk Rating**		n/a.
Proposed Development Usage		B class employment, residential, and bus station extension.			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		No if proposed uses remain as outlined. If a highly vulnerable land use is considered then sequential design should negate the need for exception testing			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		n/a.			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		n/a

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 2	✔	✔	**Exception Test**	✔	✔
Flood Zone 1	✔	✔	✔	✔	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.16 Development Site at Land Adjacent to Hammersmith Town Hall

Site 15		**Land Adjacent to Hammersmith Town Hall**					
OS NGR:	TQ 2650 8493	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the W6 area.
Sources of Flooding		Breach, Overtopping, Surface Water			**Residual Risk Rating**		HH – area affected by breach or overtopping, site has no dry access/egress.
Proposed Development Usage		Civic accommodation and mixed town centre uses			**Within Rapid Inundation Zone (RIZ)?**		Yes
Exception Test Applicable?		Yes if proposed use is more vulnerable or essential infrastructure			**Range of Modelled Flood Depths (m):**		0.00m – 1.50m in road
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

Table 7.17 Development Site at 84-88 Fulham High Street and adjoining land

Site 16		**84-88 Fulham High Street and adjoining land**					
OS NGR:	TQ 4373 6054	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW6 area.
Sources of Flooding		Breach, Overtopping, Surface Water			**Residual Risk Rating**		HH – area affected by breach or overtopping, site has no dry access/egress.
Proposed Development Usage		Mixed (retail on ground floor for active street frontage and residential on upper floors)			**Within Rapid Inundation Zone (RIZ)?**		Yes
Exception Test Applicable?		Yes as proposed use is to include residential development.			**Range of Modelled Flood Depths (m):**		0.00m – 2.00m in road
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		< 0.5 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HH: High Residual Flood Risk MH: Medium Residual Flood Risk LH: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	x	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 5.4	**Notes**	Detailed FRA Required

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7.3 Review of Proposed Future Development Sites within RBKC

A planning review of individual site allocations already identified for the LDF has been undertaken. In this instance only the sites which fell completely or partly within flood zones 3 or 2 have been reviewed.

The reviews provide an overview of flood risk suffered by the individual sites, however this review does not negate the need for a detailed Flood Risk Assessment where applicable.

Where it is stated whether the exception test is applicable this is based on current information of preferred development uses. When the actual development uses are finalised the applicability of the exception test will need to be revisited.

It is not for the SFRA to assess whether the site will pass parts a. and b. of the Exception Test. The Council must be able to demonstrate the need for development through the spatial planning process. Nevertheless, the overview does provide details of would be required for the proposed development to pass part c of the exception test.

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Table 7.18 Development Site at 73/79 Chelsea Manor Street

Site 37		73/79 Chelsea Manor Street					
OS NGR:	TQ 7446 7893	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a + 2	**Historical Flooding**	Historic Sewer Flooding within the SW3 area.
Sources of Flooding		Surface Water			**Residual Risk Rating**		LH – not affected by breach or overtopping
Proposed Development Usage		Unknown			**Within Rapid Inundation Zone (RIZ)?**		Yes
Exception Test Applicable?		Yes if proposed use is either Essential Infrastructure or More Vulnerable development.			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔
Flood Zone 2	✔	✔	**Exception Test**	✔	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

Table 7.19 Development Site at Cremorne Wharf

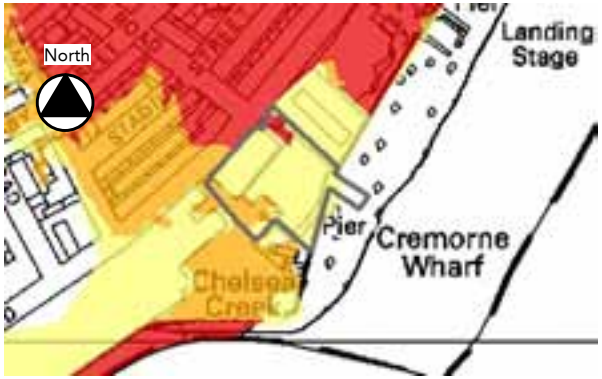
<table>
<tr><th colspan="2">Site 40</th><th colspan="6">Cremorne Wharf</th></tr>
<tr><td>OS NGR:</td><td>TQ 6553 7125</td><td>Brown / Greenfield</td><td>Brownfield</td><td>Flood Zone</td><td>3a</td><td>Historical Flooding</td><td>Historic Sewer Flooding within the SW10 area.</td></tr>
<tr><td colspan="2">Sources of Flooding</td><td colspan="3">Breach, Overtopping, Surface Water</td><td>Residual Risk Rating</td><td colspan="2">HH - area affected by breach or overtopping. No dry access/egress</td></tr>
<tr><td colspan="2">Proposed Development Usage</td><td colspan="3">Unknown</td><td>Within Rapid Inundation Zone (RIZ)?</td><td colspan="2">Yes</td></tr>
<tr><td colspan="2">Exception Test Applicable?</td><td colspan="3">Yes if proposed use includes Essential Infrastructure or More vulnerable development.</td><td>Range of Modelled Flood Depths (m):</td><td colspan="2">0.00 – 1.50m in the road</td></tr>
<tr><td colspan="2">Requirements for passing part c of the exception test:</td><td colspan="3">The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1</td><td>Time to inundations from point of overtopping or breach (hrs):</td><td colspan="2"><0.5 hours</td></tr>
<tr><td colspan="2">Flood Zone coverage:
<u>Legend:</u>
Development Site
Flood Zone 3
Flood Zone 2
© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]
© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007</td><td colspan="3"> 
</td><td>Residual Risk
<u>Legend:</u>
Development Site
Residual Flood Risk within Flood Zone 3
HR: High Residual Flood Risk
MR: Medium Residual Flood Risk
LR: Low Residual Flood Risk
© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007</td><td colspan="2"> 
</td></tr>
<tr><td colspan="2">PPS25 Development Types Classification</td><td>Essential Infrastructure</td><td>Water compatible</td><td colspan="2">Highly vulnerable</td><td>More vulnerable</td><td>Less Vulnerable</td></tr>
<tr><td colspan="2">Flood Zone 3a</td><td>Exception Test</td><td>✔</td><td colspan="2">x</td><td>Exception Test</td><td>✔</td></tr>
<tr><td colspan="2">SuDS</td><td colspan="3">See Appendix A.3</td><td>Mitigation Measures</td><td colspan="2">See Appendix A.2</td></tr>
<tr><td colspan="2">Climate Change</td><td colspan="3">See section 6.4</td><td>Notes</td><td colspan="2">Detailed FRA Required</td></tr>
</table>

Table 7.20 Development Site at Lots Road Power Station

Site 41		Lots Road Power Station					
OS NGR:	TQ 6392 7011	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW10 area.
Sources of Flooding		Surface Water			**Residual Risk Rating**		LH – not affected by breach or overtopping
Proposed Development Usage		Unknown			**Within Rapid Inundation Zone (RIZ)?**		Yes
Exception Test Applicable?		Yes if proposed use is to include residential			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

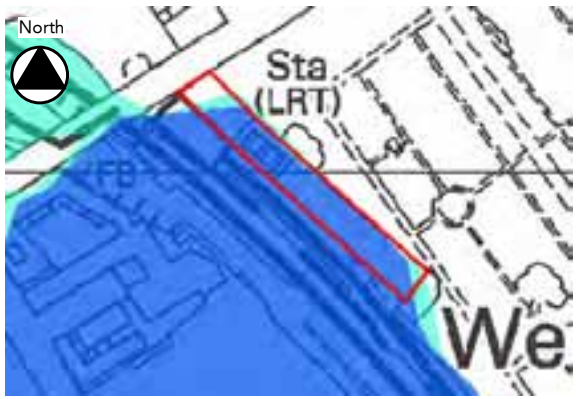
Table 7.21 Development Site at West Brompton Station

Site 45		West Brompton Station					
OS NGR:	TQ 5387 8020	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW5 area.
Sources of Flooding		Breach.			**Residual Risk Rating**		HH - area affected by breach
Proposed Development Usage		Commercial/retail and apartments above			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		Yes if proposed use is to include residential			**Range of Modelled Flood Depths (m):**		0.00 – 2.75m (mainly in railway line cut)
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		3 – 4 hours
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

Table 7.22 Development Site at EDF Energy Site

Site 49		EDF Energy Site					
OS NGR:	TQ 5448 7985	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW10 area.
Sources of Flooding		n/a			**Residual Risk Rating**		LH - area not affected by breach
Proposed Development Usage		Multi-storey residential scheme and off street parking			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		Yes if proposed use is to include residential			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	**Essential Infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less Vulnerable**
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

Table 7.23 Development Site at Sidings West Philbeach Gardens

Site 51		Sidings West Philbeach Gardens					
OS NGR:	TQ 5028 8382	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a	**Historical Flooding**	Historic Sewer Flooding within the SW5 area.
Sources of Flooding		Surface Water			**Residual Risk Rating**		LH – not affected by breach or overtopping
Proposed Development Usage		unknown			**Within Rapid Inundation Zone (RIZ)?**		No
Exception Test Applicable?		Yes if proposed use is to include residential			**Range of Modelled Flood Depths (m):**		n/a
Requirements for passing part c of the exception test:		The development must be safe, not increase flood risk elsewhere, and, where possible, reduce flood risk overall. See Appendix C.2.1			**Time to inundations from point of overtopping or breach (hrs):**		n/a
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*					**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*		

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

Table 7.24 Development Site at Earls Court

Site 55		Earls Court					
OS NGR:	TQ 5210 8189	**Brown / Greenfield**	Brownfield	**Flood Zone**	3a + 2 + 1	**Historical Flooding**	Historic Sewer Flooding within the SW5 area.
Sources of Flooding		Breach water may flow underneath through underground tunnel		**Residual Risk Rating**		LH – the tunnel underneath may be affected by breach	
Proposed Development Usage		Mixed development		**Within Rapid Inundation Zone (RIZ)?**		No	
Exception Test Applicable?		Unlikely given the small area which is in FZ 2 & 3a. Sequential design should negate the need for exception testing.		**Range of Modelled Flood Depths (m):**		n/a	
Requirements for passing part c of the exception test:		n/a		**Time to inundations from point of overtopping or breach (hrs):**		n/a	
Flood Zone coverage: *Legend:* Development Site Flood Zone 3 Flood Zone 2 *© Crown Copyright. All rights reserved Environment Agency 10002638, [2007]* *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*				**Residual Risk** *Legend:* Development Site Residual Flood Risk within Flood Zone 3 HR: High Residual Flood Risk MR: Medium Residual Flood Risk LR: Low Residual Flood Risk *© Crown copyright. All rights reserved. London Borough of Hammersmith and Fulham Licence number 100019223, 2007*			

PPS25 Development Types Classification	Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone 3a	**Exception Test**	✔	**x**	**Exception Test**	✔
Zone 2	✔	✔	**Exception Test**	✔	✔
Zone 1	✔	✔	✔	✔	✔

SuDS	See Appendix A.3	**Mitigation Measures**	See Appendix A.2
Climate Change	See section 6.4	**Notes**	Detailed FRA Required

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8 CONCLUSIONS AND RECOMMENDATIONS

The SFRA has identified that the significant sources of flood risk within Royal Borough of Kensington and Chelsea and London Borough of Hammersmith and Fulham are surface water and sewer flooding, and the residual risk which arises from a possible failure in the Thames tidal defences.

Tidal flood risk is extensive, but at present Kensington and Chelsea and Hammersmith and Fulham are fully defended against the 0.1% annual probability extreme tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard should a breach occur. Although a breach in the wall is not expected this is a possibility that needs to be taken into account in planning and areas of higher risk have been defined and mapped.

It is thought most unlikely that the Thames Barrier should fail to close during a significant tidal surge in the North Sea but should this occur then the areas that could be affected by overtopping have also been defined.

In the future, with sea level rise and climate change, the Environment Agency studies predict little change in expected high levels in the Tidal Thames within the boroughs. The reason for this is the functioning of the Thames Barrier and associated defences. The Environment Agency is also planning for the replacement or enhancement of defences in a major project the TE2100 study. Unfortunately there is little that can currently be made available from the TE2100 study as options are still being considered.

The SFRA has thus fully assessed the extent and variation of the residual risk remaining behind defences within the boroughs. Maps and GIS layers have been provided with the report showing the areas suffering residual risk and their classification.

Sewer and surface water flooding is particularly problematic, with both boroughs experiencing significant problems historically and during the recent heavy rainfall events of 20th July 2007. It is recognised that this is a larger scale issue and it is recommended that both Royal Borough of Kensington and Chelsea and London Borough of Hammersmith and Fulham take an active role in future strategic surface water management plans for London in liaison with the Greater London Authority and Thames Water. The recent surface water and sewer flooding highlight the risk posed to the boroughs. Future climate change predictions imply that this type of flooding is/will be becoming more frequent, therefore the Councils need to plan for future emergencies, become proactive in mitigating against the risk, and provide guidance to residents on how they to can mitigate against the impacts of this type of flooding.

Guidance has been given for the LPA on what types of development are suitable in each of these Flood Zones according to PPS25. The proposed development sites in both boroughs have been categorised in order to allow the councils to apply the Sequential Test.

A series of guidance notes on SuDS, mitigation measures, requirements for FRAs, and recommended policies have been provided to the council in a separate document.

MAPS

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APPENDICES

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Appendix A: - Guidance documents for RBKC and Developers

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A.1 THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA GUIDANCE FOR THE COMPLETION OF DETAILED FLOOD RISK ASSESSMENTS

In accordance with current planning policy guidance, the planning process discourages development in areas vulnerable to flooding. This SFRA is not intended to be a prescriptive document, but a planning tool to guide future development away from flood risk areas. Once the Sequential Test has been demonstrated, developers should refer to the SFRA and PPS25 when considering future planning applications. This appendix, A.1, will present the guidance for the developers on the requirements of a FRA for development in proposals in Flood Zones 1, 2, 3.

The following appendices, A.2 and A.3, provide guidance on how specific flood risk management issues can be achieved.

Prior to development, site specific flood risk assessments will need to be undertaken to ensure that all forms of flood risk, at a site, are fully addressed. An initial assessment of flood risk will be required for all proposed developments and change of use to establish that they have met the requirements for FRAs and flood risk reduction set out in table D.1 of PPS25.

A FRA will be required for proposed developments:

- that fall in the medium and high flood risk zones (Flood Zones 2 and 3).
- in Flood Zone 1 which are greater than 1 ha in size.

It is normally the responsibility of the applicant/developer to prepare a FRA, in consultation with the LPA. The SFRA cannot provide this level of site specific information.

The aim of a Flood Risk Assessment (FRA) is to demonstrate how flood risk to the development and flood risk to others, from all sources, will be managed now and in the future.

Flood Risk Assessments for proposed development in the boroughs should follow the approach recommended by:

- The Environment Agency (see its National Standing Advice to Local Planning Authorities for Planning Applications – Development and Flood Risk in England (June 2004);
- DEFRA/Environment Agency, 2005. Flood Risk Assessment Guidance for New Development Phase 2: Framework and guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools. R&D Technical Report FD2320/TR2;
- PPS25 and its Practice Guide Companion.

A.1.1 Flood Risk Assessments for Flood Zones 2 and 3

Householder and Other Minor Extensions

Apart from habitable basements, domestic extensions within the curtilage of the dwelling (see GDPO definition of “minor development”) and non-domestic extensions with a footprint of less than 250 m^2 will not require a detailed FRA.

These applications should show either; Floor levels within the proposed development set at no lower than existing levels AND, flood proofing of the proposed development has been incorporated where appropriate

Or;

Floor levels within the extension set at 300mm above the known or modelled 0.5% (1 in 200 chance each year) tidal and coastal flood.

See:
http://www.lbhf.gov.uk/Images/MINOR_EXTENSIONS_ADVICE_NOTE_tcm21-81074.pdf

Change of Use from a less to a more vulnerable use

Table D.2 in PPS 25 classifies uses by their vulnerability to flooding. For example, most commercial buildings are less vulnerable than residential buildings and basement dwellings are more vulnerable than other residential uses. Therefore a FRA will be required where the ground floor and/or basement of a building in Flood Zone 2 or 3 changes from a use that is less vulnerable to one that is classified as 'more vulnerable' or 'highly vulnerable'. Similarly, an FRA will also be required in Flood Zone 3 where a use changes from a 'water compatible' use to a 'less vulnerable' use.

The FRA will need to show how any increase in vulnerability will be dealt with and in some cases the change of use may not be permitted.

Non-Major Development

Non-major developments are where the number of additional dwellings to be constructed, or to be created as a result of a conversion, is less than 10 and/or the site is less than 0.5ha, and for all other uses, where the floorspace to be built is less than 1000sqm and/or where the site area is less than 1ha.

Most developments in H&F and RBKC that fall into this category are small infill developments where the proposed development is constrained by the adjoining buildings and by the streetscape in the surrounding area. The FRA therefore needs to balance the benefits of development against the flood risk to the development and the FRA should be appropriate to the scale of development and to the constraints of an infill site in relation to the mitigation measures that may be possible. Where a site specific FRA is required the FRA must be undertaken by a suitably qualified professional.

Prior to undertaking a FRA the developer needs to address the requirements of the Sequential Test in accordance with PPS 25 Development and Flood Risk Practice Guide (Chapter 4) and parts a and b of the Exception Test (if applicable). Evidence that the Sequential Test (A.1.5.4), and if required the Exception Test, have been passed will need to be included in the FRA.

The FRA should:

- Determine whether the development is at flood risk from any source (e.g. surface water, sewer, and groundwater), not just tidal flood risk. (The details and maps provided in the SFRA identify possible areas at risk from all sources of flooding, these are not definitive. Thames Water should be contacted to determine the risk of surface water and sewer flooding in the vicinity and to determine whether the proposed development will increase flood risk elsewhere. Each source of flooding will need further detailed

investigation specific to the location being developed – see Section A.1.3 and A.1.4).

- Determine whether the development will be at flood risk from any source in the future as a result of climate change. (The effect of climate change on flooding from the Thames was not found to be significant in this SFRA (see Sections 5.4 and 6.4); therefore it will be the effect of climate change of rainfall events which will be the primary focus).
- Assess the level of residual flood risk behind the flood defences. The SFRA identifies those areas that are at high and medium residual risk (Maps 8 and 16) and also estimates the speed of flooding from a number of possible breach locations. This does not mean that development in this area would necessarily be in an area of high or medium residual risk but rather that a more detailed study needs to be carried out at site specific level to prove that there is an appropriate level of understanding of flood risk related to the site. The site specific FRA should assess whether a detailed breach analysis is required. Where a detailed breach analysis is required see advice in Section A.1.3.
- Demonstrate that the development will be safe (see Section A.2.1.1 and A.2.4.2), without increasing flood risk elsewhere (A.2.1.2), and, where possible, will reduce flood risk overall (see Section A.2.1.3).
- Determine whether the development will increase flood risk elsewhere.
- Demonstrate the ability of the development to avoid increasing flood risk elsewhere (see Section A.2.1):
- Demonstrate how flood risk will be managed (see sections A.2 and A.3) and ensure any proposed flood risk management measures will be sufficiently funded so the site can be developed and occupied safely throughout its proposed lifetime.
- Demonstrate that where proposed developments are adjacent to the River Thames they have been set back by 16m to allow for the future maintenance, replacement or repair of the Thames Tidal Defences. Where this is not feasible and setback is less than 16m the FRA must prove that the EA have been consulted and agree on the reduced set back distance.
- Demonstrate that the development is compliant with national, regional and local policy.
- Demonstrate, where possible, that the developer has contributed to reducing flood risk over a wider area.

Further information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance at www.environment-agency.gov.uk/ planning, CIRIA report 624 (Development and flood risk: Guidance for the construction industry), and the PPS25 Practice Guide. A useful checklist is provided in Appendix C of the PPS25 Practice Guide. Advice on making development safe, avoiding increase to flood risk elsewhere, and reducing flood risk overall are given in the following sections, and in the Practice Guide to PPS25.

Major Development

Major developments will need to carry out a FRA in accordance with the advice in relation to non major developments above, but in addition the FRA will need to consider the potential for more mitigation measures.. All major developments within the high and medium residual risk zones should carry out a breach analysis, see advice in Section A.1.3. 3.

A.1.2 Flood Risk Assessments for Flood Zone 1

Flood Risk Assessments are required where proposed developments within flood zone 1 are greater than 1ha in size. The FRA must be undertaken by a suitably qualified professional and should be appropriate for the scale of development. The potential impact upon areas and receiving drainage systems, following the increase in runoff as a result of increase in impermeable area, needs careful consideration.

The FRA should:

- Determine whether the development is at flood risk from other sources now and in the future (e.g. surface water, sewer, and groundwater). (The details and maps provided in the SFRA identify possible areas at risk from all sources of flooding, these are not definitive. Each source of flooding will need further detailed investigation specific to the location being developed – see Section A.1.3 and A.1.4).
- Where flood risk from other sources is identified:
    - Demonstrate how flood risk will be managed.
    - Ensure that development is safe (see Section A.2.4.2);
    - Ensure that where possible flood risk is reduced overall; through sequential design, flood resilience, mitigation measures and the use of SuDS (see Sections A.2 and A.3).
- Assess the impact of a proposed development upon surface water drainage following an increase in impermeable area, including the potential impact upon surrounding areas, and ensure that flood risk is not increased elsewhere (see section A.2.1 and A.3)
- Recommend the approach to control surface water discharge
- Ensure any proposed SuDS techniques and flood risk management measures will be sufficiently funded to enable them to be maintained and the site occupied safely throughout its proposed lifetime.

The FRA should then conclude with an assessment of the scale of the impact, and the recommended approach to controlling surface water discharge from a proposed development.

Further Information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance www.environment-agency.gov.uk/ planning, CIRIA report 624 (Development and flood risk: Guidance for the construction industry), and the PPS25 Practice Guide.

A.1.2.1 Developments <1ha

Proposed developments should include the appropriate application of sustainable drainage techniques so as to maintain, or preferably reduce the existing runoff and flood risk in the area.

Further Information on the best practice advice with regards sustainable drainage can be found in the Environment Agency's Guidance (www.environment-agency.gov.uk/ planning).

A.1.3 How to Assess Tidal Flood Risk from a Breach

Where a site specific breach analysis is required (see Section A.1.1 above) the following information should be assessed.

Extreme tide levels at RBKC and LBHF from the Tidal Thames model should be obtained from the Environment Agency. The SFRA has shown using these water levels that RBKC and LBHF is protected by well-maintained defences that will not overtop.

Consultation with the Environment Agency will be required to agree what breach location would cause the greatest water levels at the site. A detailed site-specific analysis should be carried out by a qualified professional and will involve:

- Locating appropriate breach locations and determining the relative dimensions to be modelled. The Environment Agency will be able to offer guidance on location of a breach, defence heights and proposed breach widths.
- 2D modelling of a breach in a defence for the tidal flood event with a 0.5% annual probability, including the impact of climate change. The breach should occur for a duration of two tide cycles.
- Extraction of detailed site specific data including depths, velocities, UK flood hazard index and speed of onset.

The depths, velocities and speed of onset can then be used to assess the risk to life and test the robustness of mitigation schemes. The FRA also should review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator.

NB: Although a breach analysis has been undertaken as part of the SFRA, it was on a broader scale and does not provide the site specific quantitative details required for a FRA to fully determine the residual risk to life and mitigation measures required.

A.1.4 How to Assess Flood Risk from Other Sources

Flood risk from 'other sources' in LBHF and RBKC is described in Section 5.6 and 6.6 (respectively) of the SFRA. All developers should refer to Maps 9, 10, 17 and 18 prior to submitting a planning application and use this information to assess whether the site may be susceptible to flooding from surface water or sewer flooding. This SFRA has found no evidence of groundwater flooding in the boroughs, yet it should still be considered as information relating to local or groundwater flooding may become available in the future.

Guidelines to use should be:

- Within 100m of a known surface water flooding incident or where surface water flooding shown as 0.2m or deeper, shown as yellow, orange or red on Map 9 and 17 (see also Section 5.6.1 and 6.6.1).
- Thames Water should be contacted for information relating to the risk of sewer flooding at the site. (see also Section 5.6.1 for H&F and 6.6.1 for RBK&C)

If the SFRA indicates that the site may be at risk then the level of risk will need to be quantified in greater detail at the site by a qualified flood risk management professional using appropriate local data:

- The capacity of the existing drainage system and any planned improvements.
- The nature and behaviour of local aquifers.

After initial scoping, the need for drainage or groundwater modelling using appropriate software should be sensibly assessed depending on the severity of the problem. Any existing surface water flow routes (including routes that groundwater flooding takes overland) must be preserved by the development. Mitigation against the likely depths of flooding should be provided up to the 1% annual probability plus climate change event. Some suggested methods are given in Section A.2.3. The required precautionary climate change allowances for peak rainfall intensity are given in Table B.2 of PPS25, and must be modelled for an FRA. These are: 5% added to peak rainfall intensity up to 2025, 10% to 2055, 20% to 2085 and 30% to 2115. The appropriate period for climate change assessment is the designed lifetime of the development.

A.1.5 Additional Considerations for Flood Risk Assessments

A.1.5.1 Basements

The content of the FRA will be similar to the above guidance with a specific focus on:

- Whether the site has a history of flooding (including groundwater, surface water and sewer flooding);
- Proposed ground levels, floor levels and threshold levels of any openings to the basement;
- The distance of the proposed site to the Thames, and the subsequent residual risk;
- Flood water levels adjacent to the basement and ground levels at street level;
- Time to onset of flooding and velocities, when assessing the risk to basements. In rapid inundation areas (i.e. low lying and or close to the tidal river (Thames) the onset of flooding can take place rapidly without much notice from a breach in the flood defences. The applicant should be aware of the high risk to life and property in these areas.
- The use of permanent (as speed of onset is fast and flood warning is not realistic) flood resistance measures e.g. secondary flood defences to the basement, barriers on doors etc;
- The use of flood resilient materials and design to aid rapid recovery;

- Evacuation plan to a location within the building, a safe refuge at a level above flood water level.
- Protection against flooding from sewage system.
- Within the medium and high risk areas of Flood Zone 3 it is necessary to define residual risk. This may be determined by comparing proposed floor levels with the 1:200 year water level (Including climate change) in the Thames.
- This scenario may be refined by undertaking a site specific breach analysis (see A1.3) to determine the flood risk at the site and for use in the design of the proposed development.
- In cases of extensions to basements the propagation of flooding may be ascertained from the 'Individual Breach Extents' shown in Appendix B.

It should also be reiterated that under PPS25 self contained basements are not permitted with in Flood Zone 3.

A.1.5.2 Drainage Capacity

The capacity of drainage infrastructure is often limited and is at or near capacity under existing conditions. Development that leads to increased peak runoff within the drainage catchments may lead to infrastructure capacity being exceeded, with the potential for increased flood risk. Development locations should be assessed to ensure capacity exists within both the on and off site network. Thames Water state that:

"To ensure all future development is sustainable detailed computer modelling of development sites will be carried out to identify infrastructure requirements once the exact location and scale of development is known. Development will not be allowed to precede the delivery of essential infrastructure, identified as part of this modelling."

This reinforces the need for developments to satisfy the drainage requirements outlined in Sections A.1.1 and A.1.2 for surface water management. Contact should be made with Thames Water regarding foul water capacity and for any evidence of recent flooding.

A.1.5.3 Critical Infrastructure

Critical infrastructure is infrastructure which would be critical in the event of a flood. If critical infrastructure is to be located in flood risk areas an FRA must demonstrate that it has been designed to remain operational throughout the duration of a flood.

A.1.5.4 Application of Sequential Test to Planning Applications

Table A1.1: Environment Agency checklist to provide a framework for transparent demonstration of the application of the Sequential Test to planning applications

Question	Answer Yes/No	Sequential Test – passed or failed?
1. Is this application consistent in scale, development type and location, with a site allocation that has already been sequentially tested and included in the Local Development Document (LDD)?	If yes, state which allocation and the location in the development plan. **If the answer is 'No' go to Question 2.**	If the answer is Yes the Sequential Test has been passed – FINISH HERE
2. Does the application site fall within an area identified for 'windfall' development that has been agreed as part of the LDD in association with a Strategic Flood Risk Assessment (SFRA)?	If yes, state the location in the LDD. **If the answer is 'No' or there are no such areas identified in the LDD, go to Question 3.**	If the answer is Yes the Sequential Test has been passed – FINISH HERE
3. Does the LDD or background documents contain reasonably available, alternative site allocations that are situated in a lower flood risk zone?	If yes, state which allocation(s) and the location in the development plan. **If the answer is 'No' go to Question 4**	If the answer is Yes the Sequential Test has been failed – FINISH HERE
4. Does the development plan or background documents contain reasonably available, alternative site allocations that are within the same Flood Zone and subject to a lower probability of flooding from all sources as detailed by the SFRA?	If yes, state which allocation(s) and the location in the development plan.	**If the answer is No to Questions 3 and 4 the Sequential Test has been passed.** **If the answer is Yes to Question 4, the Sequential Test has been failed – FINISH HERE**
Source: PPS25 Practice Guide Table 1.3.		

A.2 THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA GUIDANCE ON MITIGATION MEASURES

A.2.1 Meeting Part C of the Exception Test

Where allocations remain in high risk flood zone 3, following the sequential test and part a and b of the exception test, the development still needs to meet part c of the exception test:

A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

A.2.1.1 Safe access and egress

The requirements to ensure a development is 'safe' are outlined in appendix A.2.4.2.

A.2.1.2 Avoid increasing flood risk elsewhere

Developers should aim to achieve greenfield run off from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing, or at least not increasing, the amount of hard standing associated with existing homes.

Sustainable drainage techniques (SUDS) will be one of the keys to ensuring that long-term flooding risk is managed, particularly given the extent of hard surfaced area in London. The Mayor believes that managing London's surface water and combined sewer flooding/overflows should start with source control management – improving the permeability of the public realm through the incorporation of rainwater harvesting and sustainable drainage – before proceeding to enhanced drainage capacity. These techniques include permeable surfaces, storage on site, green roofs, infiltration techniques and even water butts. Many of these techniques also have benefits for biodiversity by creating habitat, and some can help to reduce the demand for supplied water (see also London Plan Policy 4A.11 Living roofs and walls).

To avoid increasing flood risk elsewhere developments will need to meet the following drainage requirements:

- Developers should aim to achieve greenfield run off from their site through the application of the London Plan drainage hierarchy (see Sections 3.3.1 and 3.3.4)
- Use of sustainable drainage systems (SuDs) (see section A.3)
- Flow paths for surface water runoff that exceeds drainage capacities and breach flows are not disrupted.
- Defended Floodplain storage capacity was not reduced, and where necessary compensated for on a level for level basis outside of the floodplain.

- If the site is adjacent to the river and defences, building works throughout the course of development should not increase the risk of the defences breaching.

A.2.1.3 Overall reduction in flood risk

For developments to reduce flood risk overall, they would need to make sure that:

- The site is designed sequentially (see appendix A.2.2).
- Flood resilience and mitigation measures are provided in response to identified flood risk (see Sections A.2.3 and A.2.4)
- Where appropriate, floor levels are raised 300mm above the 1 in 100 year climate change flood level (see appendix A.2.4.1).
- Adequate flood warnings and evacuation plans are in place (A.2.4.3)
- Where appropriate scheme layout and design contribute towards the strengthening of flood defences.

A.2.2 Mitigation through Sequential Design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Future developments may take place in any of the three Flood Zones. Most large development proposals include a variety of land uses of varying vulnerability to flooding.

The Practice Guide to PPS25 states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. parking, recreational space) can be located in more high risk areas.

A.2.3 Mitigation against Surface and Sewer Flooding

Following the intense rain storm on the 20th July 2007 the borough suffered notable flooding. It is evident that flood risk from sewers and surface water is a major issue in the borough. Current climate change predictions suggest that this type of intense rain storm is likely to become more frequent. The data provided by the council about the 20th July event highlighted that the main problem was basements becoming flooded. Thames Water are responsible for the sewer network (the majority being combined sewer in this area) and have a program to reduce sewer flooding within the borough. The sewer network cannot accommodate the more extreme rainfall events, consequently sewer and surface water flooding can occur. To mitigate against the effects of flooding from these extreme events the homeowner/developer can install permanent and temporary flood proofing measures.

A.2.3.1 Flood Resistance Measures

Flood resistant construction can prevent or minimise the entry of water to a building when there is flooding outside.

Temporary Flood Barriers are moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum, especially with much of the borough being conservation areas. On a smaller scale

temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water. Temporary flood barriers do require property occupiers to pre-empt a flood event. Flooding from the sewerage systems in the borough is primarily flash-flooding as a result of short duration, intense rainfall. With short lead times and no flood warning system in place for the sewerage systems, there are limitations to the value of temporary flood barriers to prevent property flooding from surface water or sewer flooding. The Environment Agency provides a list of manufacturers, with the Kitemark, of temporary defences on their website www.environment-agency.gov.uk/floodline.

Permanent Flood Barriers can include built up doorsteps, rendered brick walls and toughened glass barriers. Even though both RBKC and LBHF contain conservation areas there are sympathetic permanent flood defences which could be installed, as is evident from the flood defences found on buildings along Chiswick Mall, which is in the Conservation Area 'Old Chiswick'.

The clear flood barrier is visually unobtrusive so as to not detract from the character of the area. Such clear flood barriers can also be installed behind railings. English Heritage considers these designs appropriate for historic buildings, yet they would still need approval from the council's conservation officer.

Figure A.2.1: Clear Permanent Flood Barriers at Chiswick Mall

Resistance to Sewer Flooding

Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains, within the property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. The CIRIA publication, 'Low cost options for prevention of flooding from sewers', provides further information.

Manhole covers within the property's grounds could be sealed to prevent surcharging. However, in densely urbanised areas of flat topography, sealing covers may simply move the flooding to adjacent properties. This option should only be considered following an assessment of the likely consequences during a sewer surcharge event.

Pumped Drainage: Some low-lying properties or basements many not be able to discharge by gravity to the foul/combined sewerage systems, and a pumped installation will be required. Even where a gravity discharge is possible, a pumped discharge can be installed if there is a risk of property flooding due to sewer surcharge. This is particularly true for basements. In some parts of the borough, basement floor levels are below the soffit level of the public sewer. Advice should be sought from the borough Building Standards officers and Thames Water Developer Services (Developer.Services@thameswater.co.uk or 0845 850 2777).

A.2.3.2 Flood Resilience Measures

Flood resilience reduces the consequences of flooding and increases the ability of people or buildings affected to recover from flooding.

When developing basements or property with a risk of flooding from other sources the following should be considered to make the building resilient to flooding:

- New electrical circuitry installed higher level with power cables being carried down from the ceiling not up from the floor level.
- Water-resistant materials for floors, walls and fixtures.

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA.

The 2003 'Preparing for Floods' document published by the Office of the Deputy Prime Minister and the 2007 Communities and Local Government document 'Improving the Flood performance of New Buildings – Flood Resilient Construction' provides further details on resilience measures.

A.2.4 Mitigation against Residual Risks

The residual risks posed to the borough as a consequence of the Thames flood defence walls breaching require a different mitigation approach to that of surface and sewer flooding.

A.2.4.1 Raising Floor Levels

The raising of floor levels within a new development avoids damage occurring to the interior, furnishings and electrics in time of flood. Ideally floor levels should be raised to a height of 300mm above the water level occurring as a result of a flood defence breach during the 1 in 200 year plus climate change event (the event with a 0.5% chance of occurring each year plus a 20% increase for climate change). This 300mm height that the floor level is raised is referred to as the 'freeboard'.

It is however recognised that it may not be practical or economic to raise floor levels to a height that would avoid property damage, particularly for extensions and infill development, or for developments which require disabled access. Although the consequences of a breach would be severe the chances of a breach happening is low, compared to sewer or surface water flooding. Other mitigation measures may therefore need to be considered, particularly measures that would allow for the safe evacuation of the occupants of the property.

A.2.4.2 Safe Access and Egress

Safe access/egress in a flood event will minimise the impact upon the emergency services in the event of an evacuation. 'Safe' will be a function of depth and velocity of water surrounding the development and along access/egress routes, and

also the time it takes for the flood to reach the site relative to the time it would take to evacuate the site. These details would be calculated as part of the site specific assessment (section A.1.1.1).

'Safe' access should remain dry for residential developments and 'more' and 'highly vulnerable' uses and should preferably be dry for other uses such as educational establishments and 'less vulnerable' land use classifications. Dry escape for residential dwellings should be available in the instance of a flood defence breach during the 1 in 200 year event (the event with a 0.5% chance of occurring each year) taking into account climate change.

Developments at Residual Flood Risk from failure of the Thames Tidal Defences will have to demonstrate that:

- 'Safe' access includes ability to escape to higher levels without having to pass through flood waters.
- A robust Flood Warning Plan is developed.
- For major highly vulnerable development and essential infrastructure safety will also need to be ensured through demonstration that a robust evacuation plan to dry land is developed.

The developer will be asked (if this is not already included in the FRA) to review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator. In this instance it needs to be demonstrated that depths and velocities of flood water will be acceptable to the 'risks to some' category of this calculator.

A.2.4.3 Flood Warning and Evacuation

PPS25 recommends that warning and evacuation arrangements should be in place for managing residual flood risks to developments behind river and coastal flood defences. All homes and businesses within Flood Zone 2 and 3 are eligible for the Environment Agency's Floodline Warnings Direct (FWD) service, and should be encouraged to sign up to it. However, currently in the SFRA area FWD is primarily used to alert the occupiers of properties with moveable dams to impending conditions. At present FWD is unlikely to have information of a breach in the flood defences until some while after it has occurred. Information on the availability of FWD can be obtained from the local Environment Agency office.

Safe access and egress for evacuation and the emergency services is required for any new development in high and medium residual risk zones (see Section A.2.4.2). Safe dry access/egress in a flood event will minimise the impact upon the emergency services in the event of an evacuation.

Where significant new population is being added to a residual flood risk area formal consultation with the council's Emergency Planning team is required. Emergency/evacuation plans should be in place for all properties, large and small, at residual risk of flooding; those developments which house vulnerable people (i.e. care homes and schools) will require more detailed plans. Advice should be sought from the council's Emergency Planning Team when producing an emergency/evacuation plan for developments as part of an FRA. Detailed emergency/evacuation plans for developments should undertake consultation not only with the Council's Emergency Planning team but also the Emergency Services so they know what is expected of them in the event of an emergency.

The Local Authority is designated a category 1 responder under the Civil Contingencies Act 2004. In an event of an emergency coordination with the other

category 1 responders (including the emergency services and the Environment Agency) is essential to guarantee the safety of residents. It is recommended that both the Royal Borough of Kensington and Chelsea and the London Borough of Hammersmith and Fulham review their Emergency Plan with respect to flooding, in light of the details provided in the SFRA.

A.3 THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA GUIDANCE ON SUSTAINABLE DRAINAGE SYSTEMS

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner.

RBKC and LBHF are susceptible to surface water and sewer flooding. To avoid excessive surface water discharge and/or pollution, all development proposals should incorporate sustainable drainage systems to ensure that surface water run-off is managed as close to its source as possible in line with the drainage hierarchy. The **drainage hierarchy** is:

- Store rainwater for use later
- Use infiltration techniques, such as porous surfaces in non-clay areas
- Attenuate rainwater in ponds or open water features for gradual release to a watercourse
- Attenuate rainwater in tanks or sealed water features for gradual release to a watercourse
- Discharge rainwater direct to a watercourse
- Discharge rainwater to a surface water drain
- Discharge rainwater to the combined sewer, as a last resort.

These sustainable drainage systems should achieve **at least 50 % attenuation, preferably 100% attenuation**, of surface water run-off in a brownfield situation and 100% attenuation on greenfield sites, up to the 1 in 100 year plus climate change event.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography, geology (soil permeability), and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential. Additionally, for infiltration SuDS it is imperative that the water table is low enough and a site specific infiltration test is undertaken. Where sites lie within or close to the groundwater source protection zone in the Brompton area of RBKC further restrictions may be applicable, and guidance should be sought from the Environment Agency.

A.3.1 SuDS Techniques for Flood Control

There are many different SuDS techniques which can be implemented. The Environment Agency Thames Region (October 2006) issued a practical guide on SuDS (this is available upon request from the Environment Agency development control teams), in which they suggest a sustainability based hierarchy of appropriate techniques (Table A.3.1).

The suitability of the following list of techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

Table A.3.1: The SuDS Hierarchy

Most Sustainable ↓ Least Sustainable	SuDS technique	Flood Reduction	Pollution Reduction	Landscape and Wildlife Benefit
	Living roofs	✔	✔	✔
	Basins and ponds • Constructed wetlands • Balancing ponds • Detention basins • Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices • Soakaways • Infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains • Gravelled areas • Solid paving blocks • Porous pavements	✔	✔	
	Tanked systems • Over-sized pipes/tanks • Storm cells	✔		

Living (Green) Roofs and Walls

Living Roofs and walls can vary in type from Roof Gardens, Roof Terraces, Green Roofs and Green Walls. This approach utilises plants and their substrate provide temporary storage of rainfall. The water retained by the substrate and lost through evaporation and evapotranspiration minimises runoff from the roof.

An award winning example of a green roof within the boroughs is Beaufort Court, Lillie Road, Fulham. This is a social housing development created in 2003 with sedum roofs to reduce surface water run-off and provide a visual amenity.

Figure A.3.1: Example of a Green Roof Project in Fulham

Photograph taken from the Mayor of London's 'Living Roofs: Case Studies'.

Other examples of successful green roof projects can be found in the Mayor of London's 'Living Roofs: Case Studies' document.

Basins and Ponds

Basins and Ponds enhance flood storage capacity by providing temporary storage for storm water through the creation of landscape features within a site (which can often provide opportunities for the creation of wildlife habitats). Basins, ponds and wetlands can be fed by swales, filter drains or piped systems. In some instances, storm water runoff from a development can feed a pond which overflows into a vegetated wetland area to act as a natural soakaway. Even in impermeable site conditions a sealed pond or even a storage tank can be used to discharge water at a steady rate.

Filter Strips and Swales

Filter Strips are vegetated areas that are intended to treat sheet flow from adjacent impervious areas. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice. However, in the most heavily urbanised areas this approach is unlikely to be practical.

Swales provide temporary storage for storm water to help reduce peak flow runoff. This approach to SuDS also provides scope for the creation of wildlife habitats and biodiversity gain.

Infiltration Devices

Infiltration Devices drain water directly into the ground. They may be used at source or the runoff can be conveyed in a pipe or swale to the infiltration area. They include soakaways, infiltration trenches and infiltration basins as well as swales, filter drains and ponds. Infiltration devices can be integrated into and form part of the landscaped areas.

Permeable Surfaces and Filter Drains

Pervious pavements such as permeable concrete blocks, crushed stone, asphalt will allow water to infiltrate directly into the subsoil before soaking into the ground. According to the London Plan SPG on Sustainable Design and Construction this technique may be particularly appropriate on London Clay where infiltration is slow, where, if necessary, an overflow can keep the pavement free of water in all conditions

Filter Drains are gravel filled trench which trap sediments from run-off and provide attenuation. Flow is directed to a perforated pipe which conveys run-off either back into the sewerage network or into a water body. Filter drains are used mainly to drain road and car park surfaces.

Rainwater Harvesting

Rainwater harvesting techniques, such as the installation of water butts, can aid in increasing the attenuation of rainfall as well as encouraging the reuse of water. Rainwater harvesting has beneficial impacts in reducing sewer overspills in minor events but has limited impact for larger events. There is also the risk that they may not be empty when required therefore reducing the amount of attenuation which can be achieved.

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Appendix B: - Individual Breach Extents

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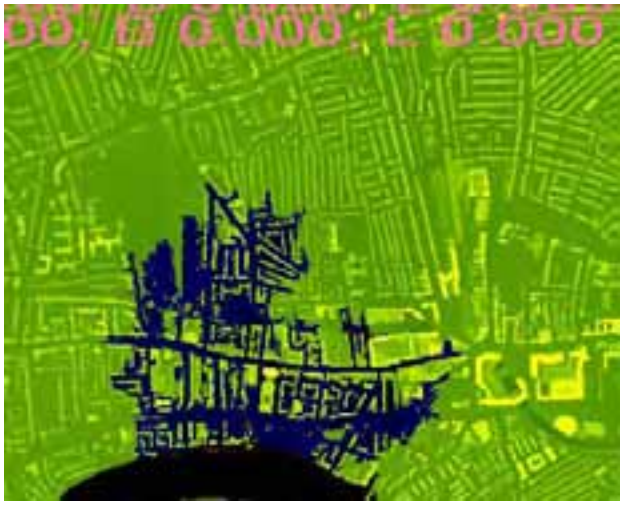
B.1 INDIVIDUAL BREACH EXTENTS

The following figures show the breach extent over time of each individual breach location. They have been included within this SFRA to provide an idea of the speed and extent such a failure in the defence would result in.

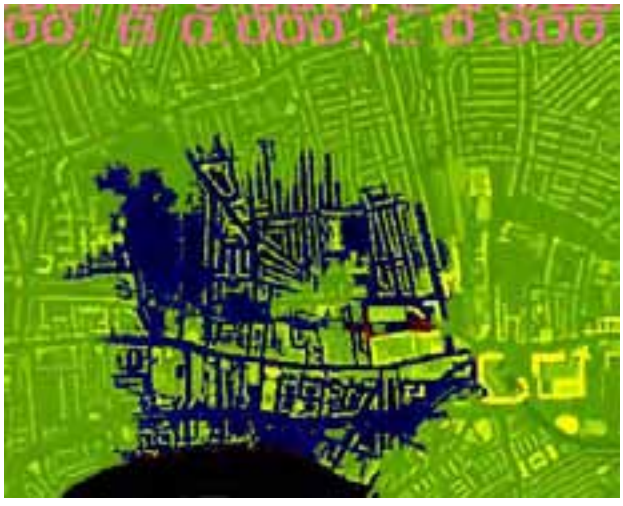
B.1.1 Breach HF1 Extent Over Time

0.5hrs

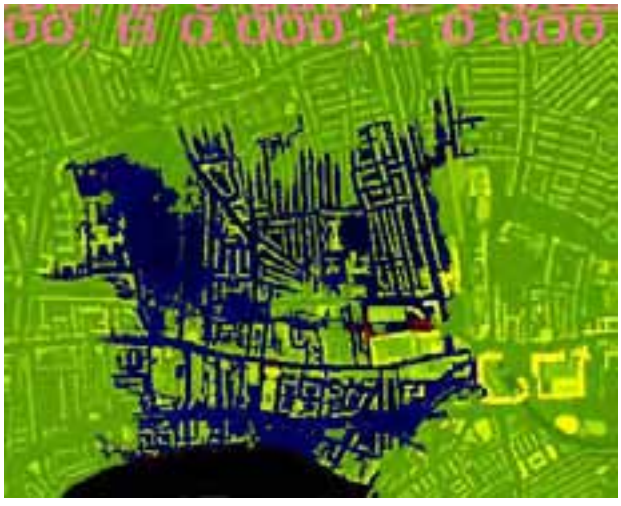
1hr



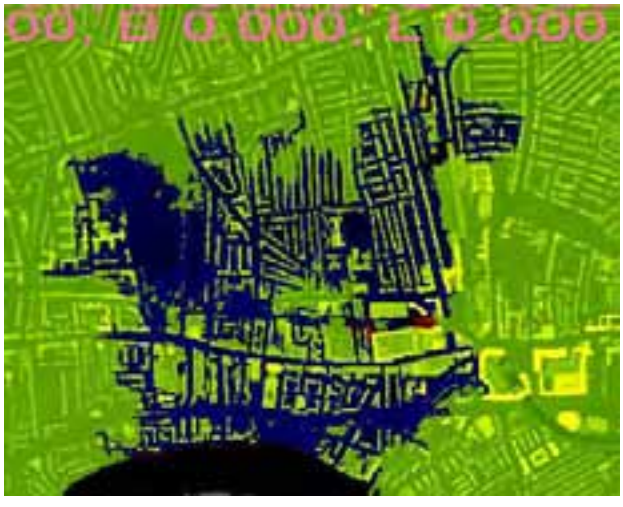
2hrs



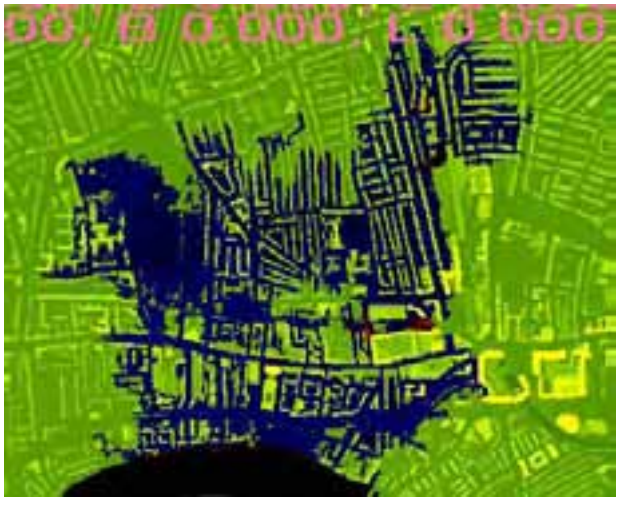
3hrs



4hrs



6hrs



B.1.2 Breach HF2 Extent Over Time

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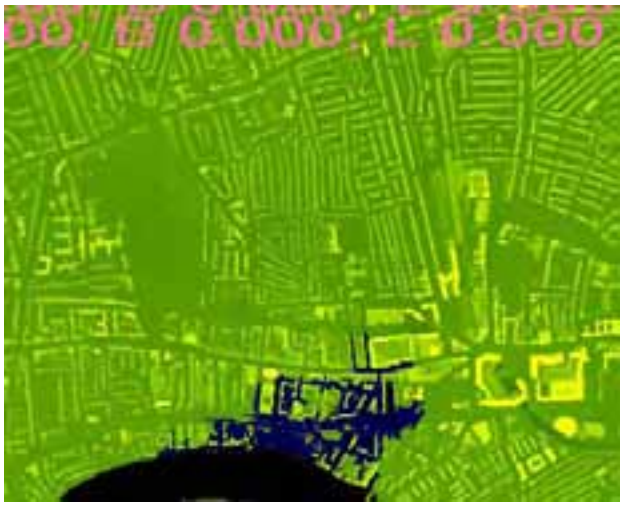

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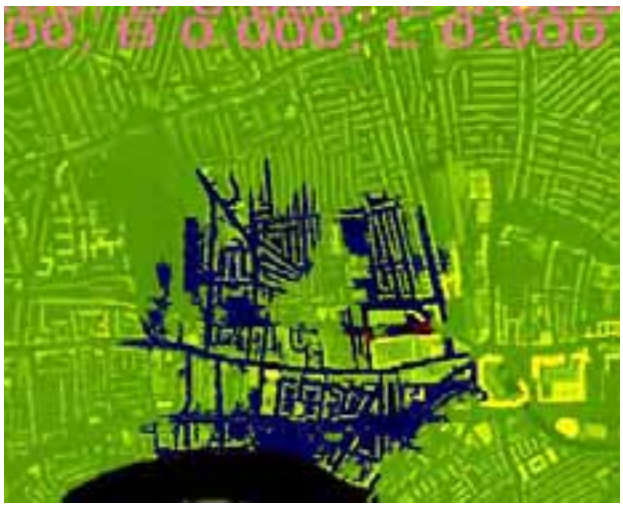
2hrs



3hrs

4hrs

6hrs

B.1.3 Breach HF3 Extent Over Time

0.5hrs

1hr

2hrs

3hrs

4hrs

6hrs

B.1.4 Breach HF4 Extent Over Time

0.5hrs

1hr

2hrs

3hrs

4hrs

6hrs

B.1.5 Breach HF5 Extent Over Time

0.5hrs

1hr

2hrs

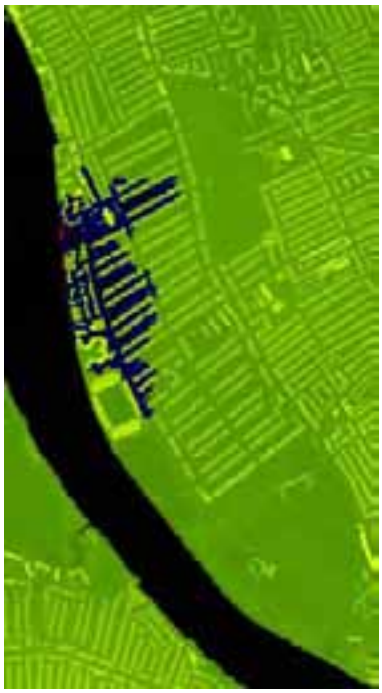
3hrs

4hrs

6hrs

B.1.6 Breach HF6 Extent Over Time

0.5hrs



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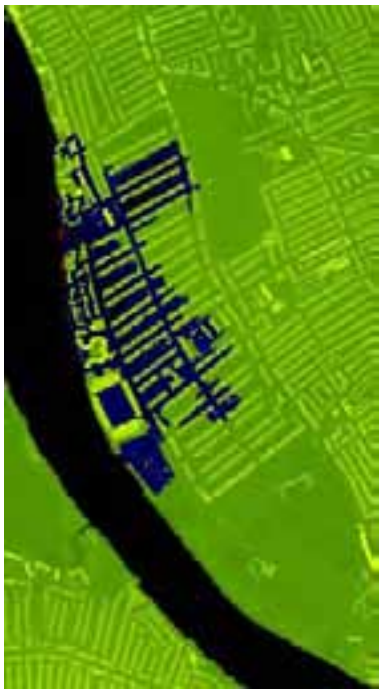

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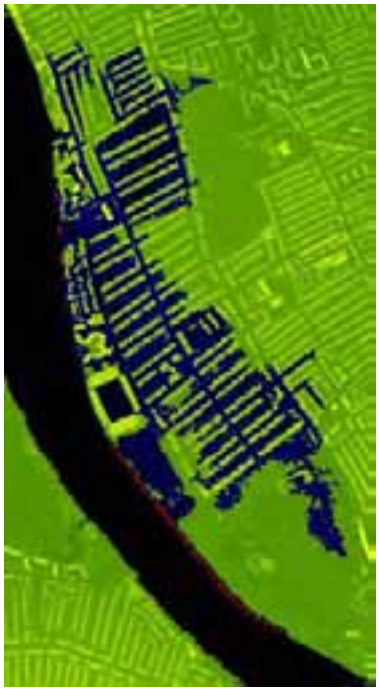
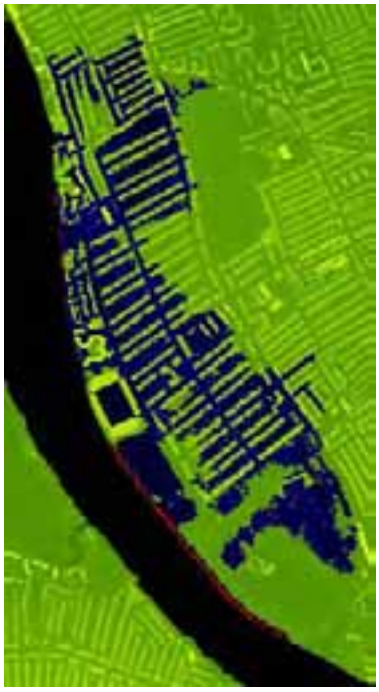
3hrs



4hrs

6hrs

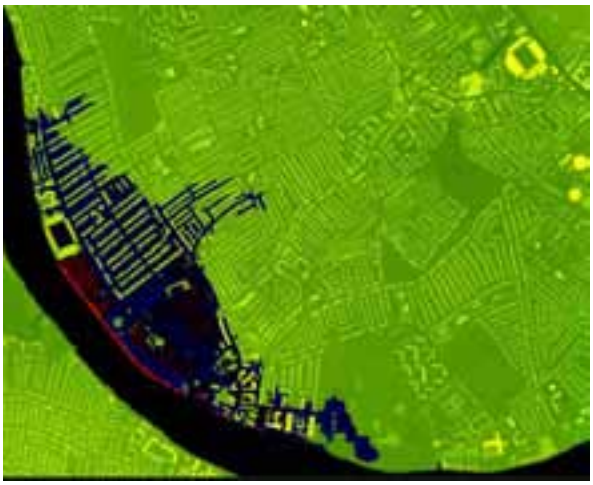


B.1.7 Breach HF7 Extent Over Time

0.5hrs

1hr

2hrs



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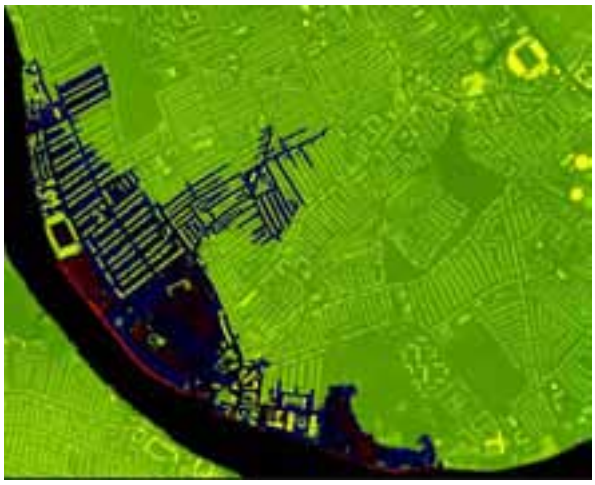

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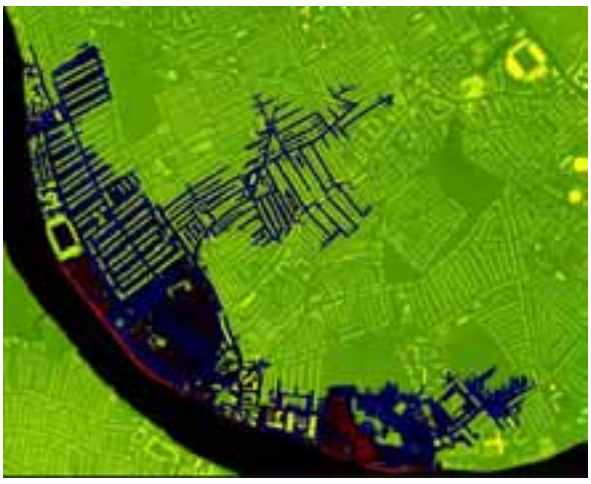

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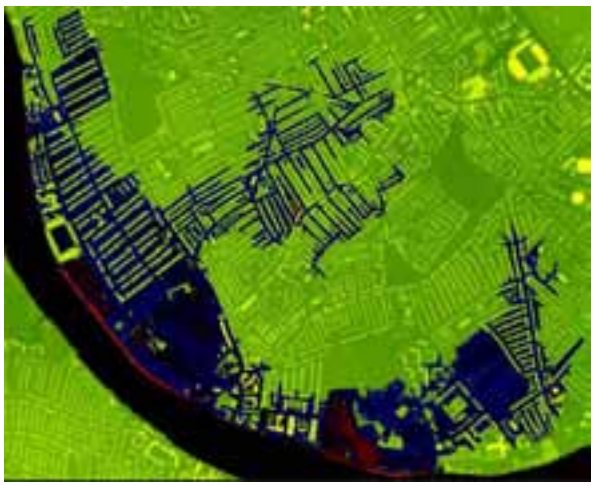


B.1.8 Breach HF8 Extent Over Time

0.5hrs

1hr

2hrs

3hrs

4hrs

6hrs

B.1.9 Breach HF9 Extent Over Time

0.5hrs

1hr

2hrs

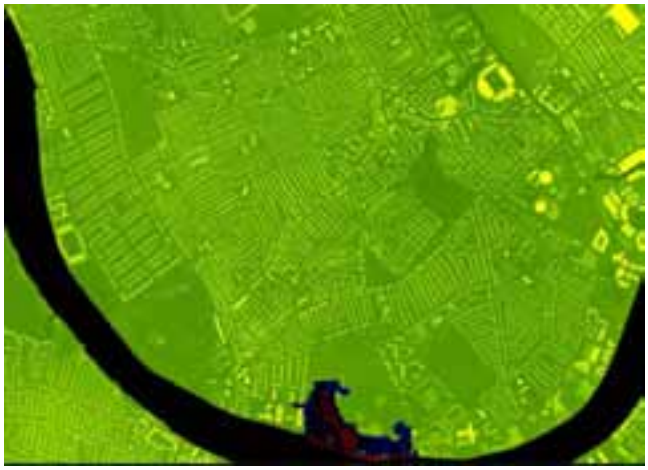
3hrs

4hrs

6hrs

B.1.10 Breach HF10 Extent Over Time

0.5hrs



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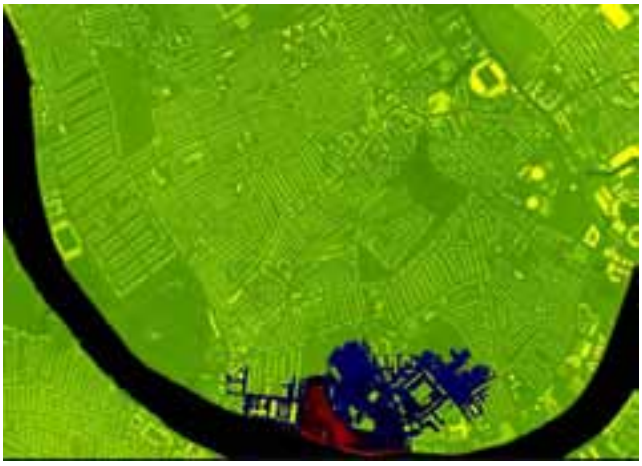

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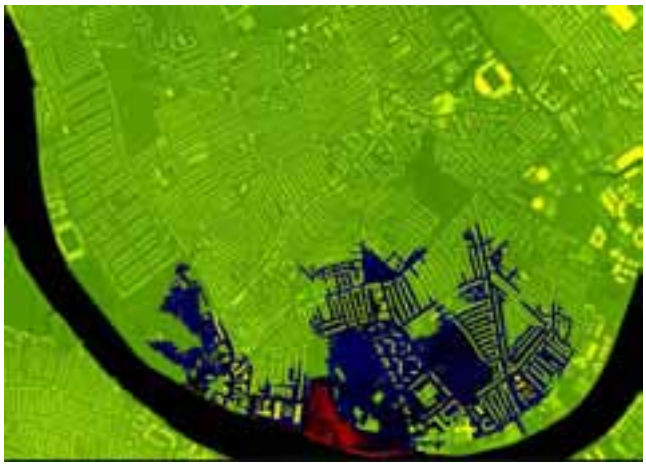

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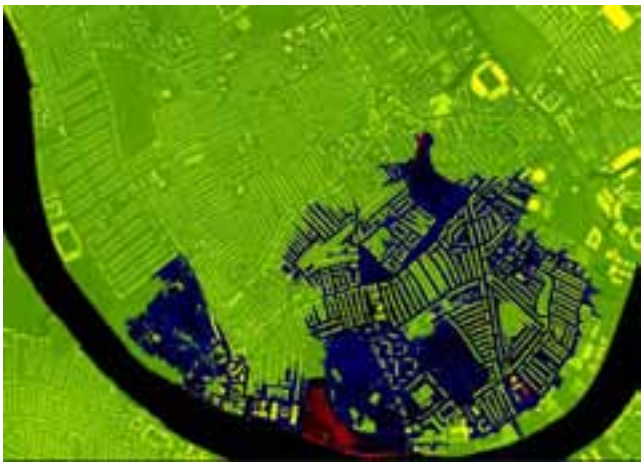

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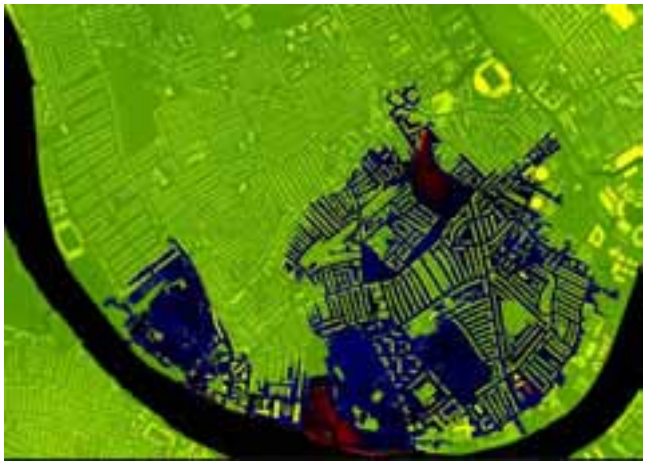

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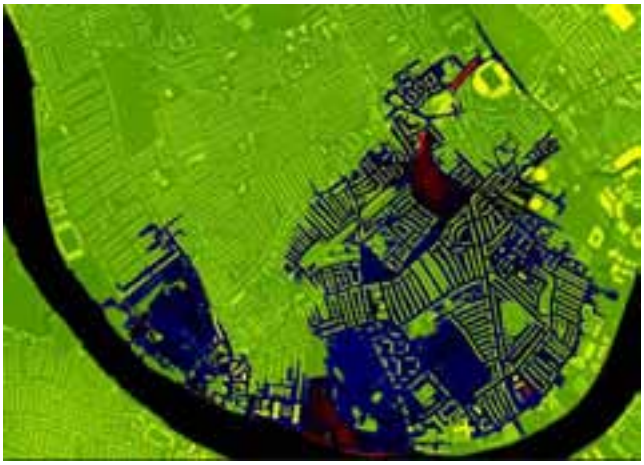

B.1.11Breach HF11 Extent Over Time

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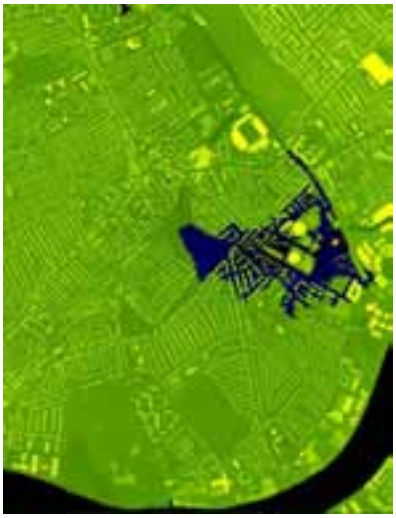

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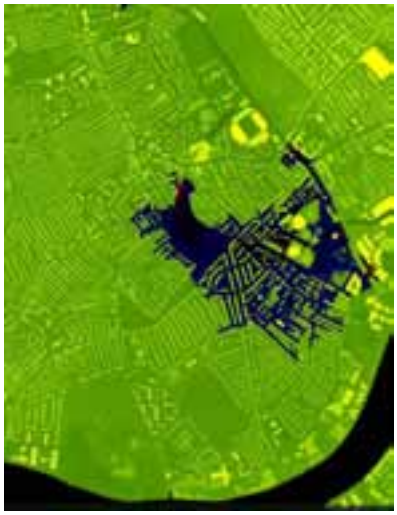

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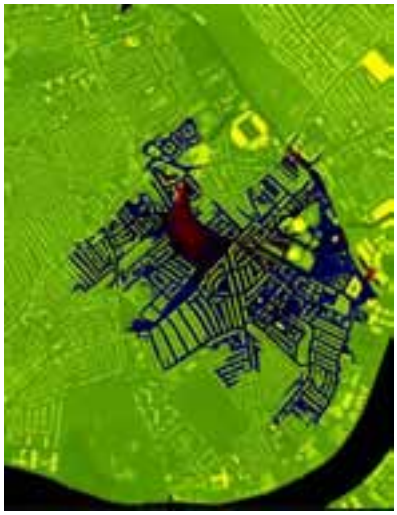

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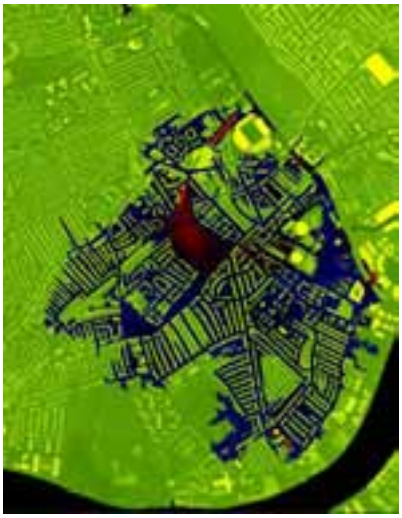

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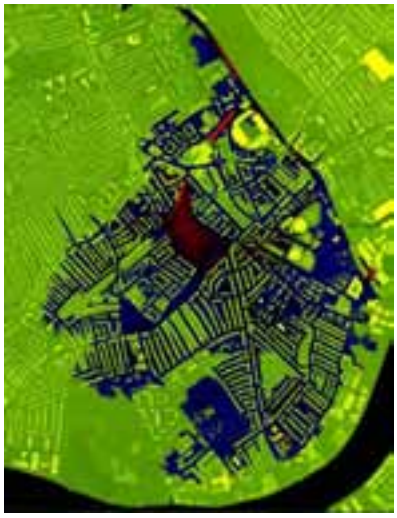

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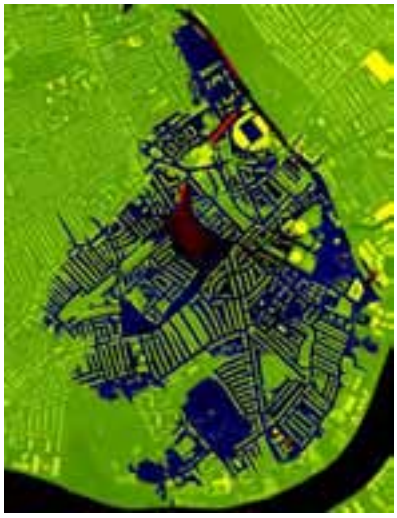
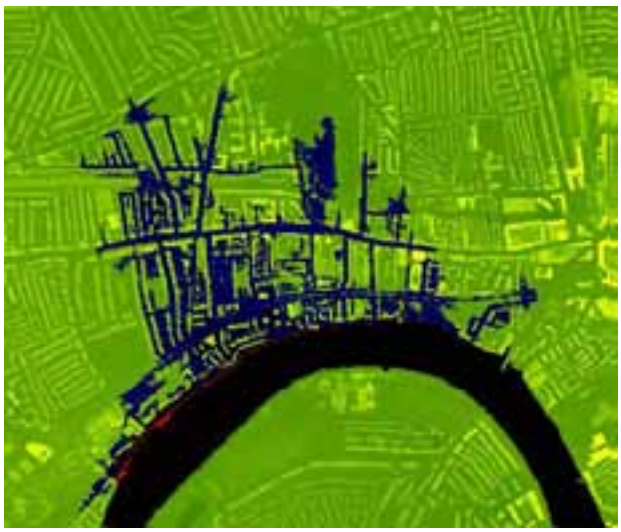


B.1.12 Breach HF12 Extent Over Time

0.5hrs

1hr

2hrs



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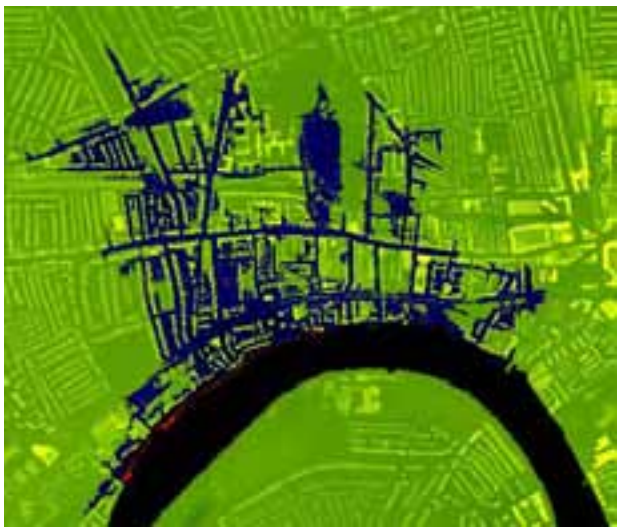

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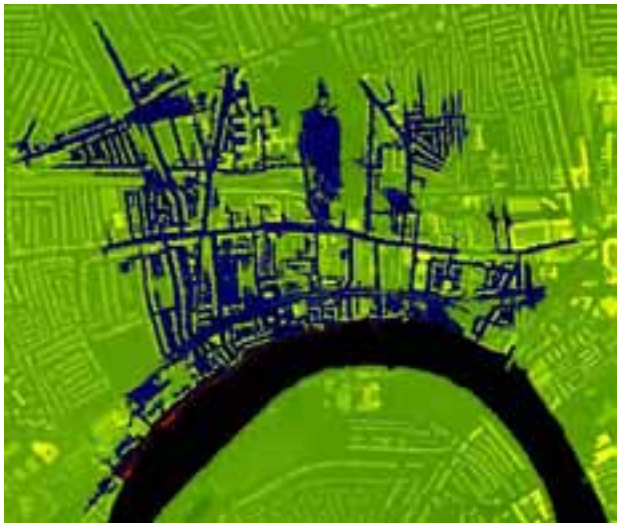
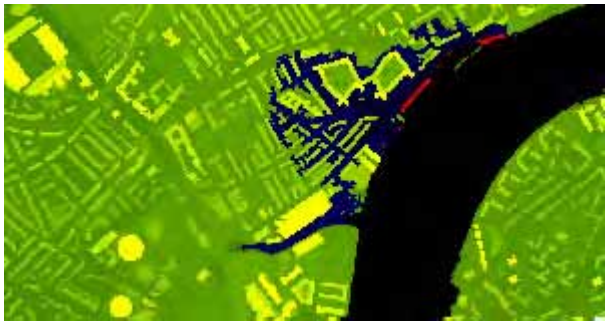


B.1.13Breach KC1 Extent Over Time

0.5hrs

1hr



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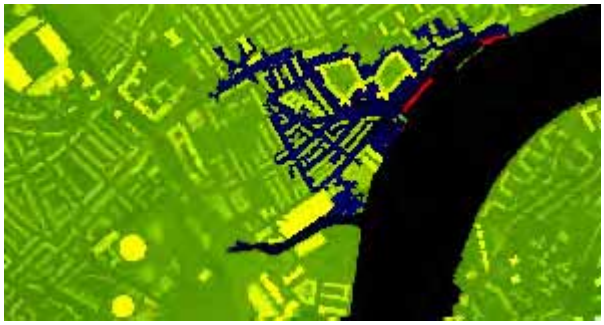

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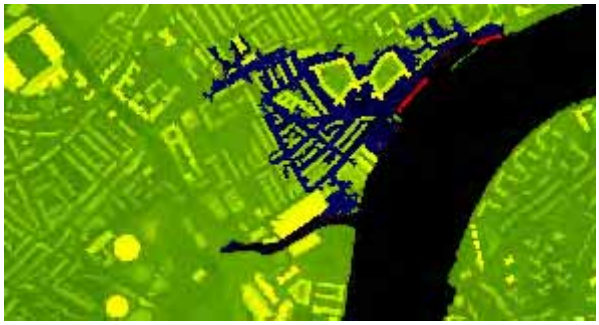

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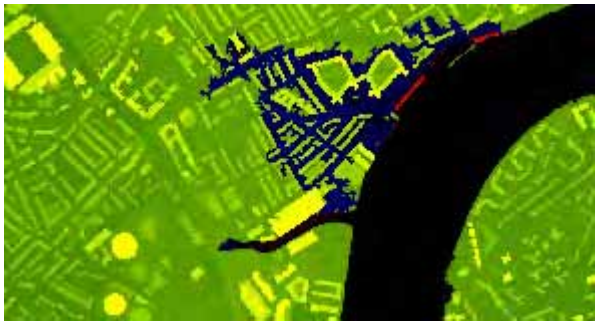

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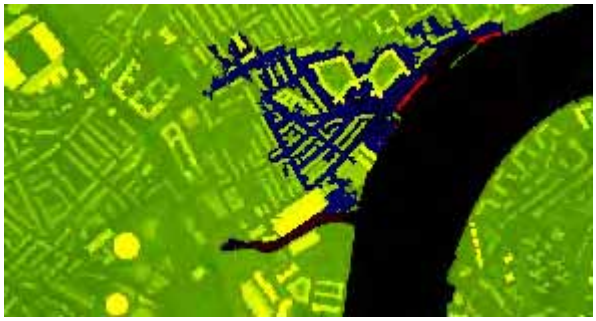
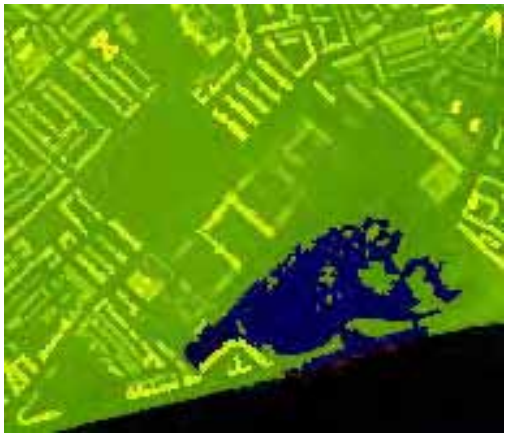


B.1.14Breach KC2 Extent Over Time

0.5hrs



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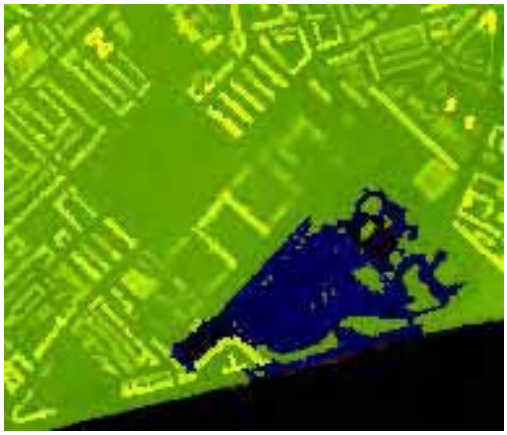

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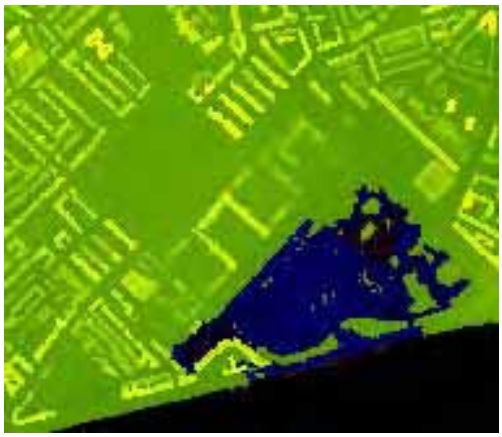
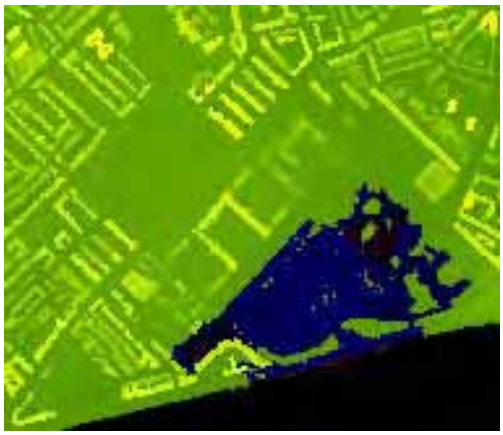


3hrs



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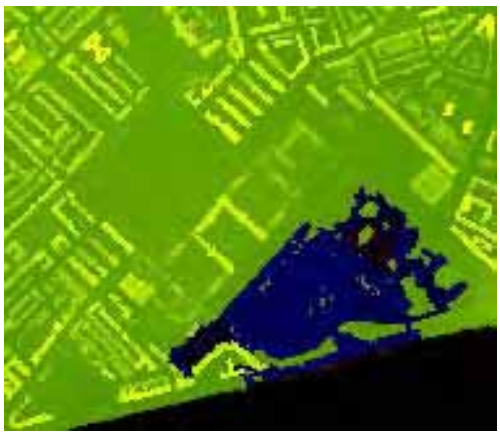

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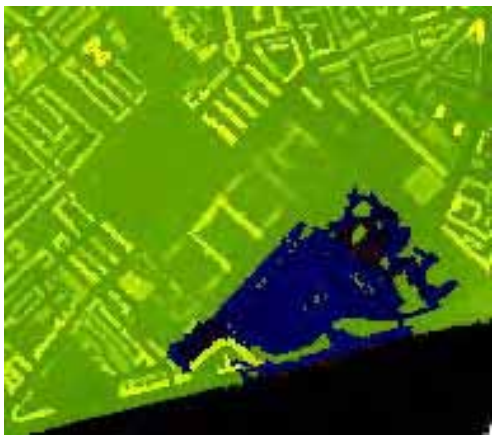
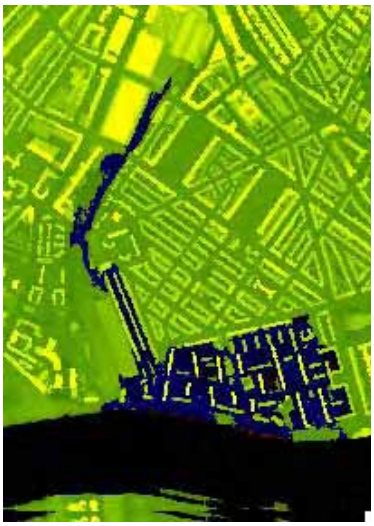


B.1.15Breach KC3 Extent Over Time

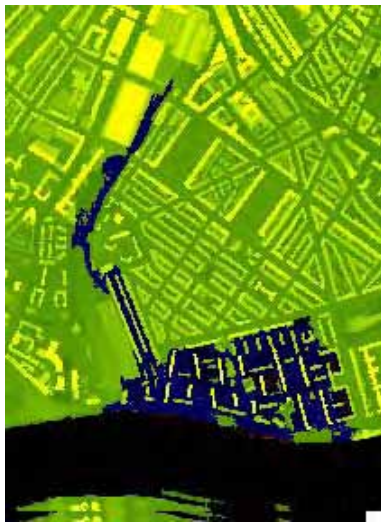
0.5hrs

1hr

2hrs



3hrs



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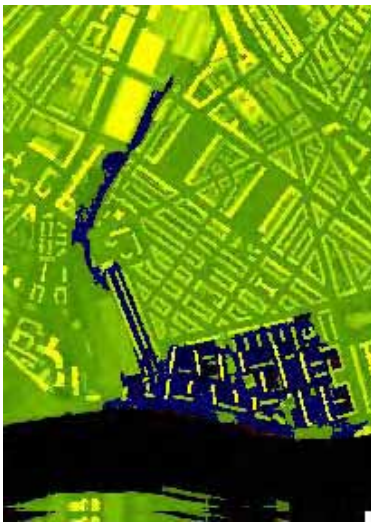

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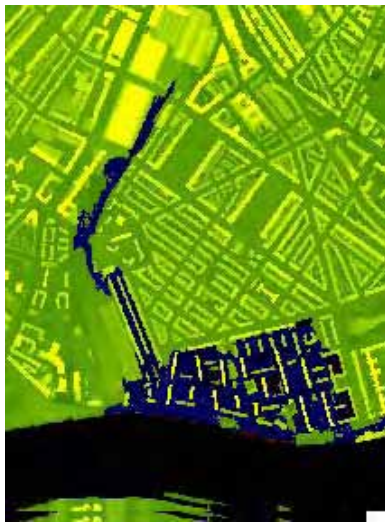
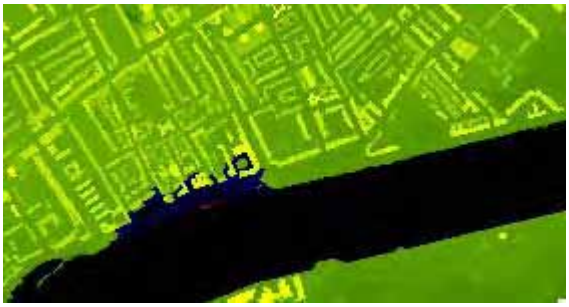


B.1.16 Breach KC4 Extent Over Time

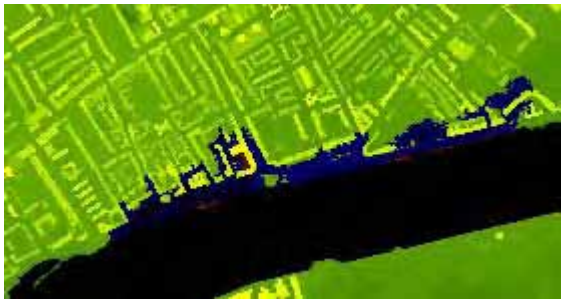
0.5hrs



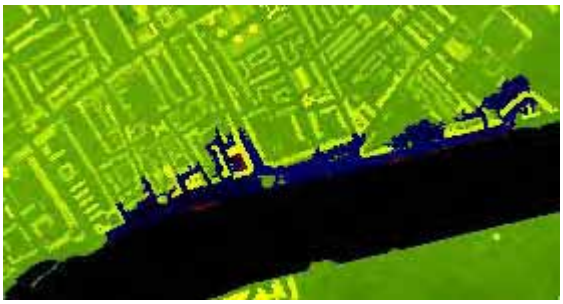
1hr

2hrs

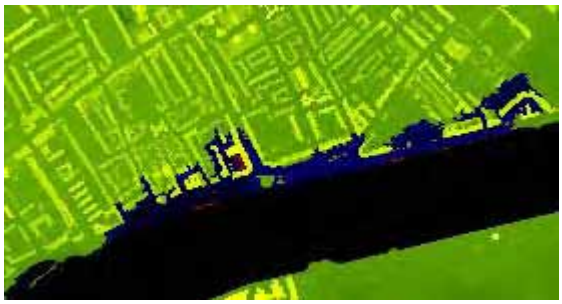
3hrs



4hrs



6hrs



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