

Strategic Flood Risk Assessment

Final Report

October 2011

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FINAL REPORT	None	As above

Contract

This report describes work commissioned by the London Borough of Greenwich under the contract were Steve Tyler and Catherine Warburton. Paul Eccleston, Francesca Hurt and David Kearney of JBA Consulting and Nick Jarritt and John Rampley for Entec, carried out the work.

Purpose

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Executive Summary

This report is the Strategic Flood Risk Assessment (SFRA) for the London Borough of Greenwich.

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 will assist the 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 (including the London Plan) and local planning legislation, together with Environment Agency policy guidance.

A thorough review of existing information, and additional modelling work, has identified the level of flood risk at present within the Borough from fluvial, tidal and other sources. A detailed investigation has been carried out into the effect of defences on flood risk, and the risk that remains behind these defences, as a consequence of defence failure.

The SFRA has identified that there are significant areas at flood risk within London Borough of Greenwich. Fluvial flood risk, while limited to defined river corridors, affects areas of the Borough alongside the River Quaggy, Ravensbourne, Shuttle, Deptford Creek and Butts Canal. Some channel modifications and flood alleviation works have taken place in the Borough, most notably the flood alleviation scheme on the River Quaggy at Sutcliffe Park.

Tidal flood risk is extensive, but at present Greenwich is fully defended against the 0.1% annual probability extreme tide level with climate change to 2107. A breach in the defences, although a low probability of occurrence, would have a high consequence, causing significant flooding of the Thamesmead, New Charlton and Greenwich Peninsula areas of the Borough. A detailed additional study, "Guidance for housing development in areas of high residual flood risk" was prepared in order to address the specific issued of development within these areas, and is presented in Appendix F.

Surface water flooding does not appear to be problematic in the majority of Greenwich but areas such as Abbey Wood have experienced problems in the past, including during the recent heavy rainfall events of July 2007. Surface water modelling did however highlight areas of the Borough which are potentially at risk from surface water flooding. These included areas of Eltham, Kidbrooke, Greenwich Peninsula, New Charlton, Royal Arsenal East, Plumstead and Abbey Wood.

Sewer flooding does not appear to be problematic in the majority of Greenwich but areas such as Eltham have experienced problems in the past.

The Borough is underlain by a large area of minor aquifer, which coincides with the sand silt and gravel bedrock, and a small area of major chalk aquifer. This area of major aquifer has been classified by Defra as a groundwater emergence zone and could be at risk from significant ground water flooding when the water table is high. This emergence zone coincides with the reported incident of groundwater flooding in Abbey Wood.

Maps and GIS layers have been provided with the report showing the revised extents of Flood Zones 2, 3a and 3b, flooding from other sources, the effect of climate change, residual risk, and other supporting information.

Guidance for the LPA on the future management of development with respect to flood risk has been given, including recommendations for LDF policies. Advice has also been given regarding strategic flood risk management and emergency planning.

In addition an outline has been given of requirements for developers for Flood Risk Assessments (FRAs), with supporting guidance on reducing flood risk and making development safe, including Sustainable Urban Drainage Systems (SUDS) and mitigation measures. Advice is also given on other issues to consider as part of a development proposal.

This report was commenced in 2008 and, with the exception of the sections dealing with development in areas of high residual flood risk (principally chapter 10) was approved and finalised in 2009.

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Glossary and Abbreviations

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
Area Action Plan	AAP	Planning document to guide development in a specific area. Forms part of the Local Development Framework.
Area Benefiting from Defence	ABD	Those areas which benefit from formal flood defences in the event of flooding from rivers with a 1% chance in any given year or from the sea with a 0.5% chance in any given year. If the defences were not there, these areas would be flooded.
AEP		Annual Exceedance Probability
Brownfield		Brownfield (sites or land) is a term in common usage that { æ^ Á à ^ Á â ^ ~ ã } ^ á Á æ• Á ± á ^ ç ^ [] { ^] ! ^ ç ã [~ • ^ Á à ^ ^ } Á á ^ ç ^ [] ^ á q É Á ± Ó! [, } ~ ã ^ á q Á , æ• Á ~ • ã ã ã and Á Ö [ç ± Ú ! ^ ç ã [ç • [] ^ á Á æ} á q Á Ù ^ ^ Á ± Ó!
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 a 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).
Digital Elevation Model	DEM	A representation of the topography of an area that gives the elevation of the upper surface whether it is the ground, vegetation or a building.

Embayment		Distinct area in the shape of a bay liable to flooding from the estuary.
Extreme Flood Outline	EFO	June 2004 depict anticipated 0.1% (1 in 1000 year) flood extents in a consistent manner throughout the UK
Flood Alleviation Scheme	FAS	Works designed to provide protection from flooding.
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
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
Flood Storage Area	FSA	Area designed to store water in a flood and release it later when flood waters have subsided.
Flood Zone		Areas of land at risk from tidal or fluvial flooding as delineated by the Environment Agency. Zone 1: Low probability of flooding Zone 2: Medium probability of flooding Zone 3: High probability of flooding
Fluvial Flooding		Flooding caused by high flows in rivers or streams exceeding the capacity of the normal river channel.
Formal Defence		A flood defence asset that is maintained by the Environment Agency
Freeboard		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.
Greenfield		Greenfield (sites or land) is a term in common usage that Statements, but in PPS25 has been replaced with
Greenfield discharge rates		Greenfield discharge rates refer to the amount of discharge that would occur from a site if it was still natural greenfield land.
Hyetograph		A chart showing the distribution of rainfall over a particular period of time or a particular area
Informal Defence		A structure that provides a flood defence function, however is not owned nor maintained by the Environment Agency

JFLOW		2-Dimensional 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
Ordnance Survey	OS	`
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 Borough
Strategic Flood Risk Management	SFRM	Considers the management of flood risk on a catchment-wide basis, the primary objective being to ensure that the ! ^ & [{ { ^ } á ^ á Á ~ [[á Á ! ã • \ Á { æ } æ*
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 Systems	SUDS	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
Tidal Flooding		Flooding caused by extreme tide levels
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 Introduction

In April 2008 JBA Consulting and Entec were commissioned by the London Borough of Greenwich to undertake a Strategic Flood Risk Assessment (SFRA).

This SFRA has been prepared in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25). PPS25 reinforced the responsibility of LPAs to ensure that flood risk is managed effectively and sustainably as an integral part of the planning process, balancing socio-economic needs, existing framework of landscape and infrastructure, and flood risk.

1.2 Objectives

The SFRA is a planning tool that enables the Council to identify sites for development away from vulnerable flood risk areas. The assessment focuses on the existing site allocations within the Borough but also sets out the procedure to be followed when identifying future sites for development. The SFRA will assist the Council to make the spatial planning decisions required to inform the Local Development Framework (LDF).

In addition to informing site allocations the SFRA will inform decision making on planning applications on non-allocated sites, strategic flood alleviation measures and other measures to reduce flood risk to existing development, planning requirements for new development and emergency planning.

To this end, the key objectives of the SFRA are:

- To investigate and identify the extent and severity of flood risk from all sources to the area at present and in the future, under the terms of PPS25.
- To inform the Core Strategy, Site Specific Allocations Development Plan Document (DPD), Development Control Policies DPD and any subsequent Supplementary Planning Documents and Area Action Plans.
- To enable the Council to apply the Sequential Test and the Exception Test
- To identify the level of detail required for site-specific FRAs.
- To inform the emergency planning process.

1.3 Background to the study

In June 2005 a SFRA was published for East London, covering 11 London Boroughs. It was commissioned by the Thames Gateway London Partnership. The Environment Agency considers this adequate to inform the Core Strategy for London Borough of Greenwich.

However the Environment Agency do not consider that it is adequate to inform the Local
 Therefore, further work is necessary to make the East London SFRA more locally specific to Greenwich. The East London SFRA has its limitations partly due to its publication date (pre PPS25) and partly due to lack of local detail necessitated by the large study area.

The Environment Agency therefore recommend that the East London SFRA should be used as a starting point for a more detailed SFRA for Greenwich which covers all sources of flooding within the Borough.

2 The planning framework

2.1 Introduction

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

2.2 National planning policy

2.2.1 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 Spatial Planning. 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.

2.2.2 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 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 (as proved by passing the Exception Test);
- 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, a sequential approach to 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

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, and those within 20m of a Main River.

The introduction of PPS25 enables local authorities to make a direction under Article 4 of the Town and County 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.

2.2.3 A Practice Guide Companion to PPS25 Living Draft

In June 2008 the Government released the companion guide to PPS25. The practice guide provides guidance on the implementation of the policy set out in PPS25. The guide provides further guidance on the preparation of flood risk assessments and outlines potential mitigation measures e.g. SUDS and risk management techniques.

2.2.4 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 environmental issues, including flood risk. It proposes that new development in areas at risk of flooding should be avoided. Planning

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.

2.3 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.

2.3.1 The London Plan 2008 (consolidated with alterations since 2004)

The Mayor published the first London Plan in February 2004. In December 2006 the mayor published Early Alterations to the London Plan to address pressing housing provision, waste and minerals issues. In addition Draft Further Alterations, to the London Plan, were published for public consultation in September 2006. In February 2008 the Mayor incorporated both the

The London Plan sets out the strategic principles for the continued growth and development of Greater London. The London Plan contains a series of objectives identified by the Mayor. The overarching objective of the plan is to promote sustainable development. The policies relevant to flooding and flood risk management are listed below:

- Policy 4A.3 Sustainable design and construction - manage flood risk, through sustainable drainage systems (SUDS) and flood resilient design for infrastructure and property.
- Policy 4A.12 Flooding - In reviewing their DPDs, Boroughs should carry out strategic flood risk assessments to identify locations suitable for development and those required for flood risk management. Within areas at risk from flooding (Flood Zones) the assessment of flood risk for development proposals should be carried out in line with PPS25.
- Policy 4A.13 Flood risk management - Where development in areas at risk from flooding is permitted, (taking into account the provisions of PPS25), the Mayor will, and Boroughs and other agencies should, manage the existing risk of flooding, and the future increased risk and consequences of flooding as a result of climate change, by:
 - protecting the integrity of existing flood defences
 - setting permanent built development back from existing flood defences to allow for the management, maintenance and upgrading of those defences to be undertaken in a sustainable and cost effective way
 - incorporating flood resilient design
 - establishing flood warning and emergency procedures.

Opportunities should also be taken to identify and utilise areas for flood risk management, including the creation of new floodplain or the restoration of all or part of the natural floodplain to its original function, as well as using open space in the flood plain for the attenuation of flood water.

The Mayor will, and Boroughs and other agencies should, take fully into account the emerging findings of the Thames Estuary 2100 Study, the Regional Flood Risk Appraisal and the Thames Catchment Flood Management Plan.

- Policy 4A.14 Sustainable drainage - Boroughs should, seek to ensure that surface water run-off is managed as close to its source as possible in line with the drainage hierarchy. The use of sustainable urban drainage systems should be promoted for development unless there are practical reasons for not doing so. 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.
- Policy 4C.5 Impounding of rivers - The Mayor will and Boroughs should resist proposals for the impounding or partial impounding of any rivers unless they are clearly in the wider interest of London. Proposals that include the removal of such impounding structures should generally be welcomed.
- Policy 4C.6 Sustainable growth priorities for the Blue Ribbon Network - The uses of the Blue Ribbon Network and land alongside it should be prioritised in favour of those uses that specifically require a waterside location. These uses include water transport, leisure, recreation, wharves and flood defences. For sites that are not suitable or not needed for these priority uses, developments should capitalise on the water as an asset and enhance the Blue Ribbon Network in order to improve the quality of life for Londoners as a whole, as well as for the users of the development.
- Policy 5D.1 The strategic priorities for South East London - In relevant areas ensure that the effects of climate change and, in particular, potential tidal flood risk are assessed authoritatively and that effective measures are incorporated in the location, design and construction of development to address it.

The London Plan also introduces policies for the Blue Ribbon Network, which recognises the water bodies (e.g. canals, streams, rivers, docks, reservoirs, lakes), not just the River Thames. It aims to protect and enhance waterside areas, improve their accessibility, exploit potential for their use for transport, leisure and tourism, and improve biodiversity.

The London Plan assessed the need for additional housing in London. The strategy is to provide 305,000 additional homes in London between 2007/8 and 2016/17. At a Borough

level, Greenwich now has a requirement to secure 20,100 additional new homes between 2007/08 and 2016/17.

2.3.2 Sustainable Design and Construction: The London Plan Supplementary Planning Guidance (Mayor of London, 2006)

The Supplementary Planning Guidance (SPG) 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 Urban Drainage Systems (SUDS) measures, wherever practical;
- Achieve 50% reduction in runoff times.

The SPG identifies that SUDS provide an alternative method to dealing with the management of runoff. The content of the SPG has been used to inform the planning policy recommendations contained within this SFRA.

2.3.3 K U h Y f ' A U h h Y f g . ' H \ Y ' A U m c f D g ' f l d d h , 2007) h Y f ' G h f U h Y [m ' f l A U

management. The strategy considers all aspects of water management and how they interact, with focus on integrating land and water management. 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.

2.3.4 The London Regional Flood Risk Appraisal (Mayor of London, 2007)

The draft RFRA has gone through consultation in 2007, but the final version is not yet issued. It is a helpful overview of flood risk in the Greater London Area and contains a series of strategic recommendations, many of which are based on the findings of the Thames Catchment Flood Management Plan (see Section 2.5.1) and the Thames Estuary 2100 project (see Section 2.5.2).

Recommendations reinforce those outlined in the London Plan, for example concerning the setting back of development from the river edge, the implementation of the Drainage Hierarchy, and the application of PPS25 to new development, particularly with reference to residual risk. Those with a particular relevance to Greenwich include:

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

Boroughs at confluences of tributary rivers with the River Thames should pay particular attention to the interaction of fluvial and tidal flood risks. These are Havering, Barking and Dagenham, Newham, Tower Hamlets, Greenwich, Lewisham, Wandsworth, Hounslow, Richmond

The RFRA also examines flood risk for major London development areas, with the following recommendations for developments within Greenwich:

Table 2-1 Recommendations for Major Development Areas from the Regional FRA

Opportunity Areas	Current flood risk characteristics	Future flood risk considerations
Deptford / Greenwich Riverside	Intensively developed protected from daily tidal flooding and River Ravensbourne flooding by river walls and from tidal surges by Thames Barrier.	Raising river walls beyond 2030, setting development back from rivers edge.
Greenwich Peninsula & Charlton Riverside West	Intensively developed, protected from daily flooding by river walls and from tidal surges by Thames Barrier. Contains many shipping related industries requiring operational access to river.	Raising river walls beyond 2030, setting development back from rivers edge.
Woolwich, Thamesmead & Charlton Riverside East	Straddling the Thames Barrier, protected from storm surges by raised river walls but with land lying significantly below high tide levels.	Raising river walls and embankments beyond 2030 for normal tides and tidal surges. Open spaces to be retained for potential flood storage.
Kidbrooke AFI	Substantial area within the River Quaggy flood plain. A recently completed river restoration scheme has increased flood storage.	Need to consider the role of multi purpose open spaces within a wider development zone.

2.3.5 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.

2.3.6 London Borough of Greenwich Unitary Development Plan

In July 2006 the London Borough of Greenwich adopted their Unitary Development Plan and covers the period 2001 to 2011, and in the case of the high level strategy in part 1, to 2016.

- E17 %0CE| | Á à ^ ç ^ | [] { ^ } c Á , ã | | Á à ^ Á & [] c | [| | ^ á Á • [Á æ• Á } [c groundwater or aquifer pollution. Surface water should be disposed of as close to source as possible, or attenuated before discharge to a watercourse or surface water sewer. Û ~ | ~ æ& ^ Á , æc ^ | Á • @[~ | á Á } [c Á à ^ Á æ| | [, ^ á Á c [Á ^ } c ^ | Á
- E18 %0CE! ^ æ• Á , ã c @ã } Á Z [] ^ • Á G Á æ} á Á H Á æc Á ! ã • \ Á ~ | [{ Á ~ | ~ Proposals Map. Areas at risk from tidal flooding, but protected by existing flood defences, are shown on Map 7. Planning applications for development on sites of more than 1 hectare within these areas must be accompanied by a flood risk assessment appropriate to the scale of and nature of the development, the level of flood risk, and the protection afforded by the existing defences. Development in undeveloped areas at risk from fluvial flooding will only be permitted in exceptional circumstances. In developed areas at risk from fluvial flooding, development will only be permitted where appropriate flood defence measures are taken, and it can be á ^ { [] • c | æc ^ á Á c @æc Á c @^ | ^ Á ã • Á } [Á ã } & ! ^ æ• ^ á Á ! ã • \ Á [~ Á

These policies were developed prior to publication of PPS25, and therefore, as part of this SFRA, will require review and update following PPS25 and the Practice Guide Companion to PPS25.

The UDP will be replaced by the Local Development Framework, including the Core Strategy, which will cover the period 2010 to 2025.

2.4 Environment Agency policy

2.4.1 Thames Catchment Flood Management Plan (Environment Agency, 2007)

The Thames CFMP is a high level policy document covering the whole of the River Thames catchment (fluvial only). It aims to set policies for sustainable flood risk management covering the next 50 to 100 years.

The fluvial rivers in Greenwich (the River Ravensbourne, Quaggy and Kid Brook) form part of c @^ Á Ü æç ^ } • à [~ | } ^ Á] [| ã & ^ Á ~ } ã c É Á ~ [! Á , @ã & @Á c @^ Á] [| ã & ^ current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change). Environment Agency policy to managing flood risk in the long term is to therefore take action to ensure the flood risk does not increase from the current level.

The Ravensbourne policy unit is characterised by highly developed floodplains with little open space and modified river channels. The key messages for this type of catchment are outlined below:

- We need long-term adaptation of the urban environment. There are massive opportunities to reduce flood risk through redevelopment. In most areas we need to change the character of the urban area in the floodplain through re-development. It must be resilient and resistant to flooding and result in a layout that re-creates river corridors
- We are seeking to re-create river corridors through redevelopment so that there is space for the river to flow more naturally and space in the floodplain where water can be attenuated
- We will be seeking to build flood defences as redevelopment occurs and as part of an overall catchment plan. This is because more attenuation and more space in the river corridors are needed for defences to be sustainable. This is more complex but represents better value for society in the long-run even if it is more costly for the Environment Agency today
- These areas are very susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important

Using these messages and the actions contained in the Ravensbourne action plan, the future flood risk management recommendations for Greenwich are as follows:

- Flood risk reduction should be sought through the application of PPS25. The Sequential Test should be used to locate new development in less risky areas. If the Exception Test is passed, development should be appropriate to the level of flood risk,

and design should aim to reduce risk (and residual risk), build in resilience and ensure

- As sea levels rise due to climate change, the risk of tide-locking (when the fluvial Ravensbourne cannot drain into the tidal Thames) will increase. This has the potential to increase fluvial flood risk in the downstream areas of the Ravensbourne. In conjunction with the TE2100 project, investigate what to do when the current assets come to the end of their residual life or the tide-locking situation leads to unacceptable levels of protection.
- Riverside developments should be set back from rivers (8m in fluvial areas, 16m from the back of defences in tidal areas). They should look at opportunities for river restoration and reducing hard engineering structures. There should be a presumption against further culverting.
- SUDS are required on all new development. All sites greater than 1 ha in size require SUDS, greenfield discharge rates and on-site attenuation of a 1% annual probability event plus climate change. Space on land allocations should be set aside for SUDS.
- The functional floodplain should be defined, and greenfield functional floodplain protected from development.
- Areas that may be required for flood risk management in the future, including tidal flood storage areas, should be safeguarded.
- Sites where developer contributions could be used to fund future flood risk management schemes should be identified. Opportunities to make space for water to accommodate climate change should be looked at.
- SFRA should be used to inform the emergency planning process and educate local people to improve flood awareness.

2.4.2 The Thames Estuary 2100 Project (Environment Agency, ongoing)

The Thames Estuary 2100 (TE2100) Project is an Environment Agency initiative to develop a Flood Risk Management Plan for London and the Thames Estuary for the next 100 years, particularly looking at the effects of climate change scenarios beyond the original design life of the current tidal defences (2030). The TE2100 Project has split the Thames Estuary into 23 separate Policy Management Units (PMU) based upon the character of the local area and where the floodwaters would flow during a flood event. Each PMU offers different opportunities for managing flood risk, both at a local level and on an estuary-wide scale and has therefore been subject to a number of detailed studies and appraisals to assist TE2100 in identifying a flood risk management policy specific to the area.

Greenwich lies within the Bermondsey, Greenwich and Thamesmead PMUs. At present TE2100 are reviewing their initial set of flood risk management policies and so cannot commit to any specific policy, however it is likely that for Bermondsey and Greenwich PMUs the current level of flood risk management will be improved upon in order to ensure that the effects of climate change are mitigated against. For the Thamesmead PMU it is likely that action will be taken to ensure that the flood risk posed to people, property and essential infrastructure does not significantly increase with climate change. With this in mind, managing the consequences of flooding will become increasingly important and emphasis should be placed upon emergency planning and applying the sequential approach to new development when making land-use planning decisions.

2.4.3 Interim Position on Defining Safety Against Flood Risk

During the development of this SFRA, the Environment Agency issued an interim policy position with respect to development in areas of high residual flood risk. This accepts habitable rooms except sleeping accommodation being located below the 1 in 200 year breach, and places higher emphasis on non-structural measures, in particular emergency planning, to manage the residual risk. The Environment Agency has also informed the London Borough of Greenwich that it now takes a more advisory role with respect to the management of residual flood risk, and that the decision on what are appropriate responses to the residual flood risk in the Borough should now lie with the Borough itself. Consequently the requirements of the Interim Guidance should be seen as a starting point for the development of a policy for managing residual flood risk in the Borough.

This guidance document is reproduced in full in Appendix F (the design guidance for housing development in areas of high residual flood risk).

2.4.4 July 2007 Flood Review

The Environment Agency have produced a review of the summer 2007 floods, which includes some recommendations with potentially significant implications for flood risk management and drainage in England. The report has six recommendations, which are largely echoed by the final report of the Pitt Review (see section 2.5.1):

- Environment Agency should be given a strategic overview of inland flooding from all sources.
- Key utilities and public services must take responsibility for climate change proofing critical infrastructure, facilities and services.
- Flood risk management investment needs to increase to enable adaptation to climate change.
- Environment Agency to work with Met Office and other partners to develop flood warning techniques appropriate to severe weather events, for example leading to rapid flooding from surface water or minor watercourses.
- Environment Agency needs to ensure that its flood warnings trigger appropriate actions by businesses and the public.
- Multi-agency incident response plans need to consider the possible impact on critical infrastructure more effectively.

2.5 Additional documents of relevance

The Council and the SFRA should be informed by the wealth of strategies, plans and research studies covering flood risk in London and on the tidal River Thames.

2.5.1 The Pitt Review

The final report of the Pitt Review, set up in the wake of the flooding of summer 2007, was published in 2008. The report was produced by a team of experts from local authorities, including planning, emergency planning, building control and drainage functions. The report contains 92 recommendations. Those with specific implications for local authorities are reproduced below. Whilst they are only recommendations, they do indicate a strong probability of significantly greater flood risk management responsibilities for Local Authorities. The recommended timetable for implementation of recommendations foresees all in place by the end of 2010, and many during 2008 and 2009.

- RECOMMENDATION 7: There should be a presumption against building in high flood risk areas, in accordance with PPS25, including giving consideration to all sources of flood risk, and ensuring that developers make a full contribution to the costs both of building and maintaining any necessary defences.
- RECOMMENDATION 8: The operation and effectiveness of PPS25 and the Environment Agency's Flood Risk Management (FRM) Strategy should be reviewed and strengthened if and when necessary.
- RECOMMENDATION 9: Householders should no longer be able to lay impermeable surfaces as of right on front gardens and the Government should consult on extending this to back gardens and business premises. Note, this issue was covered in a Defra consultation on surface water drainage, due for publication in July 2008)
- RECOMMENDATION 10: The automatic right to connect surface water drainage of new developments to the sewerage system should be removed.
- RECOMMENDATION 11: Building Regulations should be revised to ensure that all new or refurbished buildings in high flood-risk areas are flood resistant or resilient.
- RECOMMENDATION 12: All local authorities should extend eligibility for home improvement grants and loans to include flood resistance and resilience products for properties in high flood-risk areas.

- RECOMMENDATION 13: Local authorities, in discharging their responsibilities under the Civil Contingencies Act 2004 to promote business continuity, should encourage the take-up of property flood resistance and resilience by businesses.
- RECOMMENDATION 14: Local authorities should lead on the management of local flood risk.
- RECOMMENDATION 15: Local authorities should positively tackle local problems of flooding by working with all relevant parties, establishing ownership and legal responsibility.
- RECOMMENDATION 16: Local authorities should collate and map the main flood risk management and drainage assets (over and underground), including a record of their ownership and condition.
- RECOMMENDATION 17: All relevant organisations should have a duty to share information and cooperate with local authorities and the Environment Agency.
- RECOMMENDATION 18: Local Surface Water Management Plans, as set out under PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk.
- RECOMMENDATION 19: Local authorities should assess and, if appropriate, enhance their technical capabilities to deliver a wide range of responsibilities in relation to local flood risk management.
- RECOMMENDATION 20: The Government should resolve the issue of which organisations should be responsible for the ownership and maintenance of sustainable drainage systems.
- RECOMMENDATION 26: The Government should develop a single set of guidance for local authorities and the public on the use and usefulness of sandbags and other alternatives, rather than leaving the matter wholly to local discretion.
- RECOMMENDATION 38: Local authorities should establish mutual aid agreements.
- RECOMMENDATION 41: Upper tier local authorities should be the lead responders in relation to multi-agency planning for severe weather emergencies.
- RECOMMENDATION 66: Local authority contact centres should take the lead in dealing with general enquiries from the public during and after major flooding,
- RECOMMENDATION 68: Council leaders and chief executives should play a prominent role in public reassurance and advice through the local media.
- RECOMMENDATION 76: Local authorities should coordinate a systematic programme of community engagement in their area during the recovery phase.
- RECOMMENDATION 83: Local authorities should continue to make arrangements to bear the cost of recovery for all but the most exceptional emergencies, and should

2.5.2 Flooding in London (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 covering the provision of information to the public on flood risk, the requirement for funding for improvements to the V @æ{ ^ • Á Óæ! | | ã ^ | Ê Á c @^ Á } ^ ^ á Á c [Á ã {] | [ç ^ Á ~ | [[á Á á ^ ~ ^ } & ^ • Á that buildings are flood proofed and the need to improve our understanding of the scale of sewer flooding.

2.5.3 London under threat? Flooding risk in the Thames Gateway (London Assembly Scrutiny Report, 2005)

This report updates the previous London Assembly Scrutiny report in the light of planned development in the Thames Gateway and events such as Hurricane Katrina. In particular it identifies the value of Strategic Flood Risk Assessments for areas at flood risk in London.

2.5.4 London Flood Response Plan (London Resilience, 2007)

This is a special plan that complements the Strategic Emergency Plan for London, produced and maintained by the London Resilience Team. Its objective is to ensure a coordinated response to flooding, protecting life and well-being, with the mitigation of property and environmental damage as a strong supporting objective.

2.5.5 Floodscape (2006)

Floodscape is a four year (2002-2006) transnational project to develop innovative solutions to flood risk management, part funded by the INTERREG IIIB North West Europe Programme. It used pilot studies to demonstrate that flood risk management can be combined with other land uses in ways which are acceptable to the public and compatible with present and future spatial planning needs. It particularly examines the decision making process, communication with the public and integration of other European Directives with flood risk management.

2.5.6 Coastal Flood Risk: Thinking for Tomorrow, Acting Today (Association of British Insurers, 2006)

This report was compiled from the perspective of the insurance industry, an important player in terms of people and assets.

With a background of the catastrophic 1953 east coast flooding, it assesses tidal flood risk on the east coast today and into the future with current climate change predictions. It makes recommendations for improving spending on coastal defences and for improvement in planning policy to enable insurers to continue to insure householders against flooding in the UK.

2.6 Summary

In accommodating future development in the London Borough of Greenwich, there is a range of planning policies to consider and balance on a national, regional and local level. Future development needs have been broadly specified in regional plans and are being refined on a local level in the emerging LDF.

The new PPS25 provides the overarching national guidance with respect to development and flood risk, emphasising the need to effectively manage flood risk within the planning system, rather than relying on reactive solutions to flooding. This includes a responsibility for LPAs to reduce flood risk to people and property as a result of new development. It also identifies the preparation of SFRAs as a key process in the understanding and management of flood risk for planning purposes.

It is widely recognised that flood risk is one of a whole raft of policy constraints placed upon the local planning system. Development must facilitate the socio-economic needs of a community, and spatially must sit within an existing framework of landscape and infrastructure. For this reason, a balance must be sought between development need and the risk it may pose upon existing and future dwellers of the area as a result of flooding.

The aim of this SFRA is to provide a better understanding of flood risk in the London Borough of Greenwich that can feed into the emerging LDF and enable informed and balanced planning decisions to be made.

3 Approach to Strategic Flood Risk Assessment

3.1 Overview

The SFRA is a planning tool that can be used to inform the spatial planning process. The SFRA should be used to refine the information relating to the areas within the Borough which may flood, taking into account all sources of flooding and climate change. This information 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. Land can be separated into four distinct Flood Zones which are at risk from different probability river (fluvial) and/or tidal flooding events.

Flood Zone 1 defined as an annual probability of flooding of less than 0.1%. This may also be referred to as a return period of greater than 1000 years. Flood Zone 1 essentially covers everywhere outside of Flood Zones 2 and 3.

Flood risk from other sources, such as groundwater, surface water and sewer flooding may also be present (see Section 6).

Flood Zone 2 sources, defined as an annual probability of flooding of between 0.1% and 1% in fluvial areas (a return period of between 100 and 1000 years) and 0.1% to 0.5% in tidal areas (a return period of between 200 and 1000 years)

Flood Zone 3a defined as:

- An annual probability of fluvial flooding of 1% or greater. This may also be referred to as a return period of 100 years or less.
- An annual probability of tidal flooding of 0.5% or greater. This may also be referred to as a return period of 200 years or less.

Where these two overlap, the one with the greatest extent defines the Flood Zone. Flood Zone 3a is entirely within the boundaries of Flood Zone 2.

Flood Zone 3b has to flow or be stored in times of flood. This is usually taken to be either the envelope defined by the 5% annual probability of flooding, also referred to as a return period of 20 years or less or an area that is designed to flood in a more extreme event.

It should be noted that Flood Zones do not take account of the presence of flood defences.

The Environment Agency publicly publishes maps of Flood Zone 2 and Flood Zone 3 on their website (www.environment-agency.gov.uk).

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

3.1.1 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.

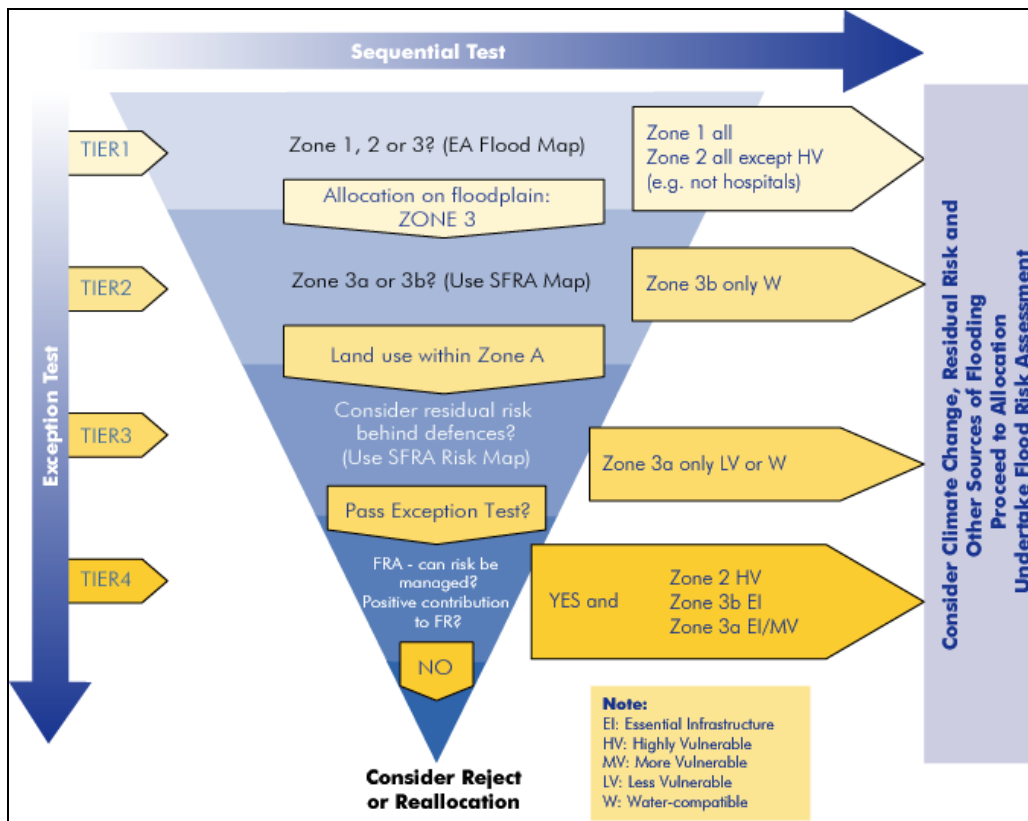
The methodology introduces a Sequential Test that is core to the SFRA process (Figure 3-1). The Sequential Test is the key driver for the SFRA. The Environment Agency Flood Zone Map will provide the basis of the test, which will be undertaken a number of times, considering a greater resolution and understanding 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 (Table 3-1) 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 3-1 The Sequential Test: its practical application



3.1.2 The Exception Test

Where departures from the Sequential Test are justified by the need to locate development in higher risk zones than is appropriate, in order to meet the wider aims of sustainable development, it is 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.

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 ~ | [[å • È + Á Á Qc Á { æ ^ Á æ | • [Á à ^ Á æ] | [] ; ã æ c ^ Á c and national designations such as landscape, heritage and nature conservation designations, e.g. Green Belt areas, 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 development¹. 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 local community that outweigh flood risk, informed by an SFRA, where one has been prepared. If the Development Plan Document (DPD) has reached the benefits of the development 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.*

PPS25 (paragraphs D11 and D12) states that the Exception Test should be applied to site allocations for development and used to draft criteria-based policies against which to allocations or in criteria-based policies, the local planning authority should include policies in Table 3-2 summarises the applicability of the Exception Test for different development sites;

Table 3-2 summarises the applicability of the Exception Test for different development sites;

3.1.3 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

¹ Definition of minor development:

-Minor non-residential extensions: Industrial/Commercial/Leisure etc. extensions with a footprint less than 250m²

-Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.

-Outillage 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.

targets. The less vulnerable, more vulnerable and highly vulnerable uses should not be permitted in this zone.

Table 3-1 Flood Risk Vulnerability Classification

Vulnerability	Type of use
Essential Infrastructure	<ul style="list-style-type: none"> Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Hospitals, residential institutions such as residential care 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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:

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.

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.

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 3-2 Flood risk vulnerability and Flood Zone compatibility

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

Key: U Development is appropriate x Development should not be permitted

(Source: PPS25 Table D3)

The SFRA was carried out as one study, divided into two stages: Level 1 and Level 2. The following sections outline the approach taken and the scope of each stage.

3.2 Level 1 Scoping Study SFRA

A Level 1 SFRA should be sufficiently detailed to allow the application of the Sequential Test and to identify whether the Exception Test is likely to be necessary². Existing data was used to make an assessment of flood risk from all sources now and in the future.

3.2.1 Data collection and review

A critical phase in the project delivery was the collection and review of existing data. The data sought related predominantly to known or perceived flood risk issues within the area, development pressures and constraints, and current policy governing development within flood risk affected areas.

3.2.2 Assessment of current fluvial and tidal flood risk

Flood risk within Greenwich was assessed, categorised and mapped to a level concurrent with the nature and availability of existing data. In general, however, the following key considerations were addressed:

- Identification of key flood risk issue areas within the Borough.
- Review of current Flood Zone Map and existing 1D hydraulic models, providing the broad (first pass) definition of High Risk Zone 3.
- Identification of critical floodplain areas and significant structures.
- Location and definition of the standard of existing defences and identification of areas that may be at risk from defence failure, requiring further investigation in Level 2.
- Identification of developing areas contributing to ordinary watercourses and/or known flooding issue areas to ensure impact upon upstream and downstream properties is adequately considered (irrespective of flood risk posed to proposed development).
- Definition of areas subject to development pressure and/or regeneration.
- Definition of the functional floodplain

3.2.3 Review climate change and land use management impact

Climate change and associated sea level rise has the potential to significantly increase the consequences of flooding, and consideration was given to the sustainability of new development under climate change and more extreme events. The future flood extents allowing for climate change were delineated using standard Defra guidelines.

Consideration was given to the implications of wider land management practices on flood risk in the area. This was based on existing information such as the Thames CFMP.

² Communities and Local Government, (June 2008). PPS25 Development and Flood Risk: A Practice Guide. p47. Greenwich SFRA_FINAL.doc

3.2.4 Surface Water Drainage Systems (SUDS)

This stage provided an indication of overland flow routes and areas prone to surface water flooding and sewer flooding. The assessment focused on storm events that exceed the available capacity of surface water systems and is particularly useful when assessing potential sources of flood risk associated with windfall sites.

3.3 Level 2 Increased Scope SFRA

According to the Practice Guide³, the principle purpose of the Level 2 SFRA is to facilitate the application of the Exception Test. It considers the detailed nature of flood hazard taking account of the presence of flood risk management measures such as flood defences. This also allows a sequential approach to site allocation within the Flood Zones.

3.3.1 Flood Defences

Further investigation was undertaken in areas protected by flood defences to allow a risk based approach to strategic planning. Tidal flooding from the River Thames is contained by the Thames Barrier and flood defences.

Modelling was carried out to provide an assessment of what is at risk with the defences in the area. The SFRA examined the probability, depth, velocity and rate of onset of flooding if defences are breached or overtopped. The risk to people will be assessed according to Defra R&D document FD2320⁴.

3.3.2 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.

³ Communities and Local Government, June 2008, PPS25: Development and Flood Risk Practice Guide.

⁴ Defra/Environment Agency, 2005, Flood Risk Assessment Guidance for New Development. R&D Technical Report FD2320/TR2.

4 Data sources

4.1 Flood Zones

The Environment Agency Flood Zone maps show the areas at risk from extreme events from river (fluvial) and tidal flooding.

The Flood Zone maps were prepared using a methodology based on the national digital terrain model (NextMap), derived river flows (Flood Estimation Handbook (FEH)) and two dimensional flood routing.

The theoretically derived Flood Zone extents have been adjusted in some locations where the results are inconsistent with historical flooding extents, more detailed flood mapping studies are available or where there are known errors in the digital terrain model. In Greenwich, the fluvial Flood Zones have already been updated with the results of detailed flood mapping studies (for example the Ravensbourne modelling, 2010). The Thames tidal Flood Zones have also been remodelled using the Thames ISIS model and TUFLOW flood routing.

The Environment Agency Flood Zone maps are precautionary in that they do not take account of the Thames Barrier or flood defences and, therefore, represent a worst-case extent of flooding. The actual extent of flooding is mitigated by flood defences. Map 1 shows the extent of Flood Zone 2 and 3, for an undefended situation, across the Borough.

4.2 Flood defences

As discussed above the Environment Agency Flood Zone maps **do not take account of the presence of flood defences**. PPS25⁵ 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.

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 been supplied and provides information about existing defences in the area, as well as categorising them by type and providing information on who owns and maintains them. Areas Benefiting from Defences (ABDs) have also been provided. ABDs are those areas which benefit from formal flood defences in the event of flooding from rivers with a 1% chance in any given year or from the sea with a 0.5% chance in any given year. If the defences were not there, these areas would be flooded. These two datasets are shown on Map 2.

4.3 Hydraulic modelling studies

4.3.1 Thames ISIS model

An Environment Agency ISIS model covers the Tidal Thames within the study area, from which the Environment Agency provided water levels from Deptford to King George V Docks downstream of the Thames Barrier for 2005, 2055 and 2107. Present day modelled water levels are shown in Table 4-1. The predicted modelled levels are based on a joint probability analysis of fluvial flows, storm surges in the North Sea and barrier closure events. These predicted model levels were published in May 2008 and take account of current Defra guidance for climate change allowances. The ISIS model used had an expected accuracy of $\pm 0.2\text{m}$.

For this SFRA therefore, the present day and 2107 modelled levels from the report will be used.

⁵ Communities and Local Government. 2006 Planning Policy Statement 25: Development and Flood Risk. Annex G para G2.

Table 4-1 Modelled water levels (mAOD) for the tidal Thames as supplied by the Environment Agency (updated May 2008)

Node label	Name	Return period (years) 2005 condition						
		10 (10%)	20 (5%)	50 (2%)	100 (1%)	200 (0.5%)	500 (0.2%)	1000 (0.1%)
2.42u	Deptford	4.708	4.748	4.786	4.81	4.828	4.848	4.863
2.43	Cutty Sark	4.688	4.725	4.764	4.786	4.806	4.824	4.837
2.44	Isle of Dogs	4.676	4.715	4.754	4.774	4.794	4.814	4.825
2.47	Bugsby Reach	4.633	4.671	4.708	4.73	4.747	4.767	4.779
a2.49	u/s Barrier	4.607	4.644	4.679	4.703	4.72	4.741	4.751
a3.1	d/s Barrier	5.349	5.55	5.822	6.04	6.258	6.528	6.734
3.4	King George V Dock	5.315	5.508	5.762	5.966	6.174	6.432	6.63
a3.5u	u/s Roding	5.313	5.503	5.75	5.949	6.153	6.41	6.606

4.3.2 River Ravensbourne Flood Mapping Study, 2006

The River Ravensbourne is covered by a 2006 modelling study managed by the Environment Agency. The Ravensbourne Flood Mapping Study was undertaken by Halcrow. It covers the River Ravensbourne and its tributaries the Kid Brook and Quaggy, which partly lie within the SFRA study area. Some details of the study have been supplied by the Environment Agency, including the modelling report and GIS layers of flood outlines and water depths and velocities on the floodplain. The flood outline data provided for these watercourses includes the 25, 100 year and 100 year plus 20% (climate change) for a defended scenario. The modelling was undertaken using ISIS and TUFLOW models. The modelling from this study differs from the results of the 2000 modelling study as the 2006 extents take account of the defences in place along the Ravensbourne. The area covered by the 2006 modelling is shown in Figure 4-1.

River Ravensbourne Modelling Review, 2009

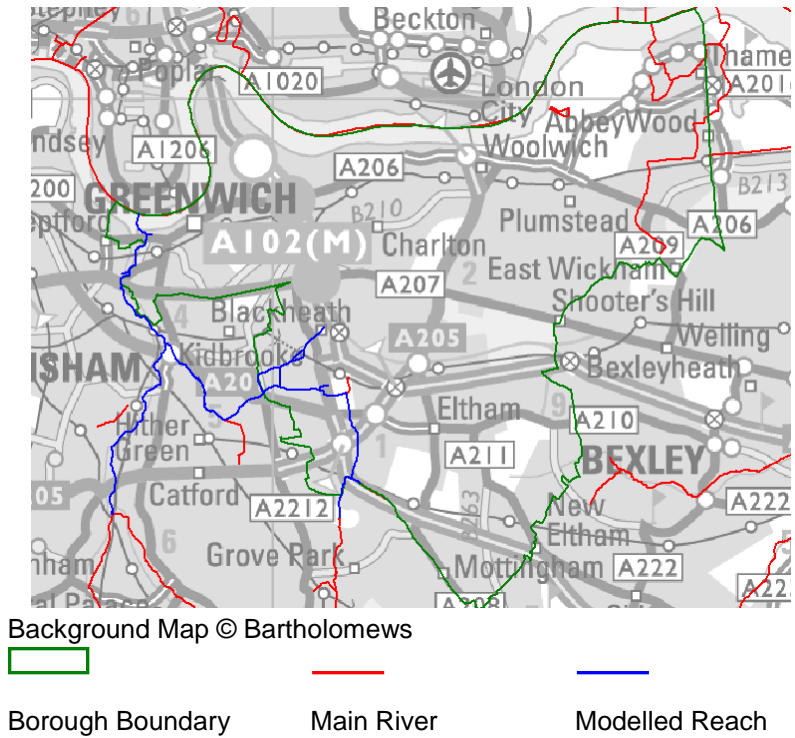
The River Ravensbourne Flood Mapping Study was reviewed in 2009 to take account of the new data available, and advancements in modelling techniques since the original study.

Notable amendments included:

- Conversion of the existing October 2006 model from mainly ISIS with some reaches of TUFLOW combined with ISIS and/or ESTRY to a full ISIS/TUFLOW/ESTRY model.
- Extension of the model to include a number of ex-Critical Ordinary Watercourses (now Main River) that were omitted from the previous study.
- Updating the existing model to incorporate the findings of recent surveys.
- Incorporating the recommendations of the April 2009 Edenvale Independent Review.
- Revising the hydrology through verification with PDM hydrology.

The outputs from this 2009 review have been used for this SFRA.

Figure 4-1 Extent of River Ravensbourne and tributaries hydraulic models



4.4 Topographic data

4.4.1 Digital elevation models

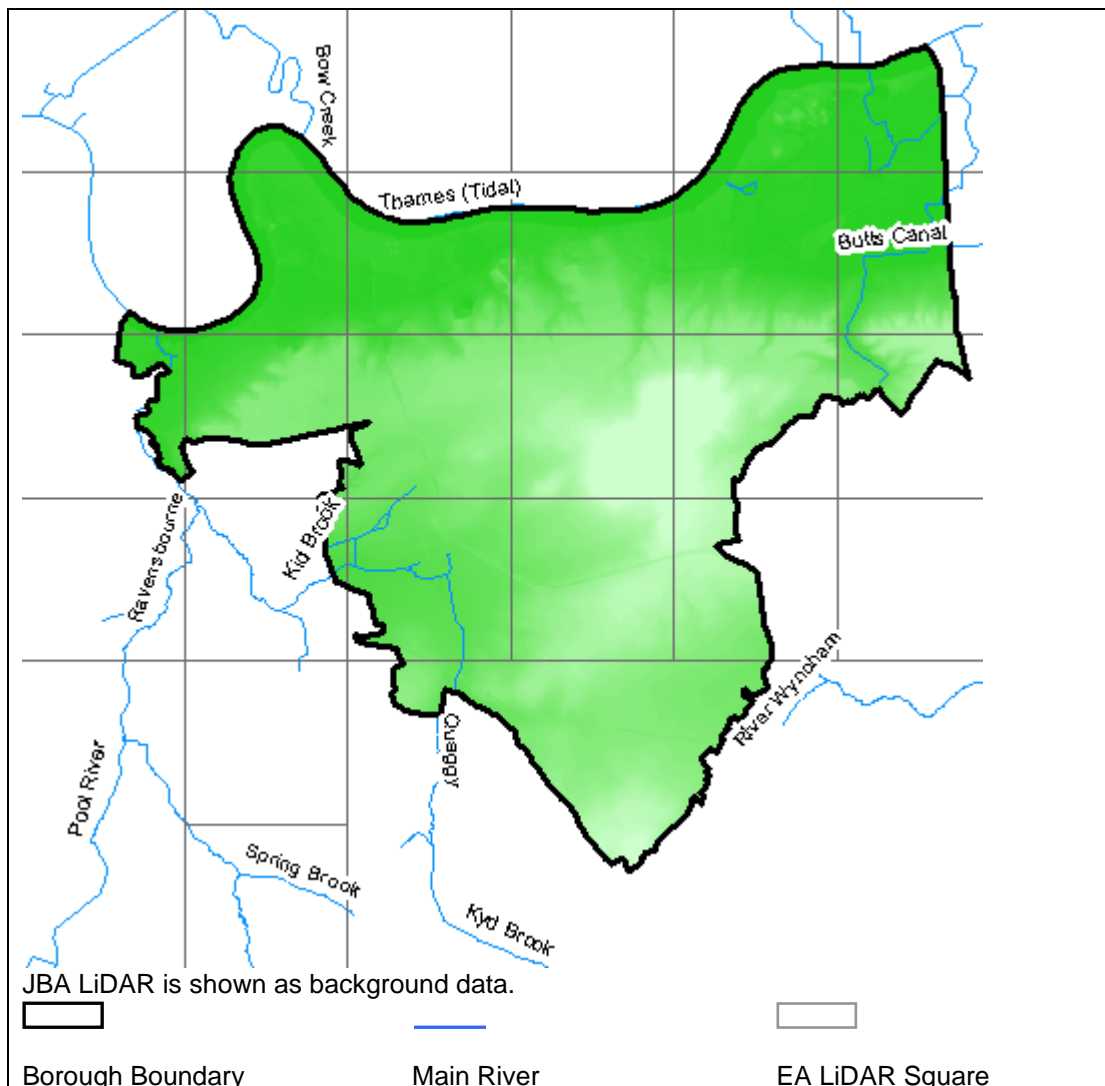
An essential dataset required for flood modelling and mapping is a Digital Elevation Model (DEM). A DEM is a representation of the topography of an area that gives the elevation of the upper surface whether it is the ground, vegetation or a building. There are three main sources of DEM data for Greenwich, as shown in Table 4-2.

Table 4-2 DEM availability

Data type	Owner	Resolution	Filtering	Coverage of Greenwich
NextMap SAR	Environment Agency	5m	Filtered	100%
LiDAR	Environment Agency	1-2m	Filtered and unfiltered	78%
LiDAR	JBA	5m	Filtered	100% (within M25)

LiDAR will be used in preference to NextMap SAR data as it has a higher vertical accuracy. The coverage of the LiDAR datasets available is shown in Figure 4-2. It will be necessary to use both the Environment Agency and JBA LiDAR to obtain full coverage of the catchment. Map 3 shows the topography of the Borough.

Figure 4-2 LiDAR coverage in Greenwich



4.5 History of flooding

A summary of the flood events about which information has been found is given in Table 4-3. This should not be considered a comprehensive list and there may well have been more events, particularly pre 20th century. Historic flooding information, where the flood extent has been mapped, is shown on Map 4. There are a variety of sources of flood history that can be consulted to build up a history of flooding in an area; sources of information for the Greenwich SFRA include:

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- Internet searches;
- Reports, photographs, flood level records and maps compiled for more recent events by the Environment Agency and its predecessors.
- Previous studies, such as the River Ravensbourne Flood Mapping Study carried out by Halcrow.

⁶ BHS Chronology of British Hydrological Events, <http://www.dundee.ac.uk/geography/cbhe/>
Greenwich SFRA_FINAL.doc

Table 4-3 Flood history for London Borough of Greenwich

Date	Type of flooding	Location	Source of information
1236	Tidal	Woolwich	CBHE
1809	Fluvial	Along the River Ravensbourne, particularly Lewisham and Deptford.	River Ravensbourne FRM study
November 1875	Tidal	River Thames overflowed from Gravesend to its tidal limit.	CBHE
1866	Fluvial	Along the River Ravensbourne, particularly Lewisham.	River Ravensbourne FRM study
April 1878	Fluvial	Along the Quaggy River.	CBHE
October 1882	Tidal	Flooding of areas adjacent to the River Thames.	CBHE
1928	Tidal	Flooding of areas adjacent to the River Thames.	Environment Agency
March 1947	Fluvial	Widespread flooding in River Thames catchment	Environment Agency Washlands FSA Improvement Works Report
1953	Tidal	Thamesmead	http://en.wikipedia.org/wiki/Thames mead
September 1958	Fluvial	Along the Quaggy River	Environment Agency Washlands FSA Improvement Works Report; http://www.environment-agency.gov.uk/commondata/acrobat/ea0226_open_sod.pdf
1965	Fluvial	Sutcliffe Park	Environment Agency
September 1968	Fluvial	Quaggy catchment	http://www.environment-agency.gov.uk/commondata/acrobat/ea0226_open_sod.pdf
1977	Fluvial	Along the Quaggy River	River Ravensbourne FRM study
1992	Fluvial	Along the Quaggy River	http://www.defra.gov.uk/news/2007/070605a.htm
1993	Fluvial	Along the Quaggy River	http://www.defra.gov.uk/news/2007/070605a.htm
Summer 1996	Fluvial	Kid Brook at Thomas Tallis School	Thomas Tallis School FRA, August 2007
June 2000	Groundwater	Shooters Hill	Environment Agency
August 2000	Groundwater	Abbey Wood	Environment Agency
November 2000	Groundwater	Eltham	Environment Agency
January 2001	Groundwater	Eltham	Environment Agency
February 2001	Groundwater	Plumstead	Environment Agency
April 2001	Groundwater	Eltham	Environment Agency
June 2001	Groundwater	Woolwich	Environment Agency
March 2002	Groundwater	Shooters Hill	Environment Agency
January	Groundwater	Eltham	Environment Agency

Date	Type of flooding	Location	Source of information
2004			
September 2005	Surface Water	Abbey Wood	London Borough of Greenwich
June 2006	Fluvial	Kid Brook at Thomas Tallis School	Thomas Tallis School FRA, August 2007
July 2007	Surface Water	Abbey Wood	http://www.newssshopper.co.uk/news/topstories/display.var.1561215.0.flash_floods_hit_news_shopper_area.php

4.6 Previous flood risk studies covering Greenwich

4.6.1 Flood Risk Assessments

There will have been numerous flood risk assessments carried out for development proposals in the past within the London Borough of Greenwich:

- **Redevelopment of Thomas Tallis School FRA** . Produced in August 2007 for the London Borough of Greenwich, this covers the proposed development area to the west of the Borough, adjacent to the Kid Brook and partly in Flood Zone 2.
- **Greenwich Millennium Village Phases 3, 4 & 5 FRA** . Produced in January 2005 for the site on the Greenwich Peninsula. The site is shown to be in Flood Zone 3a but is protected by defences.
- **Lovells, Granite, Pipers Badcock Wharf FRA** . Produced in June 2006. The site is within Flood Zone 3a of the River Thames but is protected by defences.
- **The Warren, Royal Arsenal, Woolwich FRA** . Produced in September 2005 for the site to the east of Woolwich ferry crossing. This covers the development by Berkeley Homes which is within both Flood Zone 3a but is protected by the Thames tidal defences and Flood Zone 3b.
- **Tripcock Point FRA** . Produced in July 2005 for a site in the Thamesmead area, adjacent to the River Thames. The site is in Flood Zone 3a but is protected by the Thames tidal defences.
- **Creeside Village East FRA** - Produced in for a site alongside Deptford Creek. The site is in Flood Zone 3a but is protected by the Thames tidal defences.
- **Greenwich Peninsula FRA** - Produced in for a site on the south bank of the River Thames on the Greenwich Peninsula. The site is protected by the Thames tidal defences.

4.6.2 Tilfen Land (2003) Thamesmead Lakes and Canals - Storm water drainage capacity review

Tilfen Ltd (previously Thamesmead Town) is the landowner / development facilitator of the majority of the area included in the study. In the study this area is referred to as its geographic area known as Thamesmead (Figure 4-3).

its approach and contains the essence of SUDS. The study devised a network of lakes and canals which would be built in line with development to manage the additional drainage from new development.

This approach has provided Tilfen, developers of the individual areas and the EA with an agreed, simple way to deal with surface water runoff over many years. The principles are still currently accepted within FRAs for developments in the area.

As development has progressed in the area so has the construction of a series of canals and lakes which act together and provide a large amount of surface water attenuation storage.

The features of the scheme provide additional environmental, ecological and aesthetic benefits, plus to benefits to groundwater as a result of minimising tanked attenuation solution.

In 2003 the current drainage capacity of the Thamesmead lakes and canals was reviewed to ensure it could accommodate additional runoff from future development. It assessed the capacity based on a short intense summer storm occurring at high tide (no discharge from sluices) over the 492ha of developable land. The study used a 1 in 200 year storm and modelled two different durations, 3.5 hours and 4.5 hours. The study concluded that the existing system had adequate capacity to accommodate runoff from existing development areas. Nevertheless, there is scope for future development of the lake and canal storage system, as presently the final system proposed by Tilfen does include making use of a link canal and Gallions Lake to the west. It is important that additions to the lakes and canals system are progressed in accordance with future development of the Thamesmead area to ensure a continued high level of flood protection.

This study is nearing the end of its life; a review is required to enable the continued use of this study. In the future it is highly recommended that this study be revised on the basis that it currently does not consider climate change, and only considers 3.5 and 4.5 hour duration storms (longer duration storms would need to be assessed). Additionally, the study relies on three out of four pumps working and no blockage. Therefore there is still a risk from blockage, under capacity structures or pumping station failure.

Figure 4-3 Lakes and canals network, Thamesmead



4.7 Other evidence of flood risk from all sources

Historical flooding events and issues of flood risk from other sources have been identified and assessed utilising a number of information sources as identified below.

4.7.1 Groundwater Flooding

There have been several reported incidents of groundwater flooding to the Environment Agency since 2000 and these are summarised in Map 5. The incidents range from springs appearing in gardens to periodic flooding of properties. Seven of the flooding incidents occurred in areas with bedrock of the London Clay formation. Three incidents occurred in areas of Lambeth and Harwich formations associated with sand and silt and sand and gravel respectively. The remaining incident occurred in an area of chalk formation.

