

London Borough of Southwark Strategic Flood Risk Assessment

January 2017



Executive Summary

The National Planning Policy Framework (NPPF) and accompanying Technical Guidance (NPPG) emphasise the responsibility of Local Planning Authorities (LPAs) to ensure flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

The Strategic Flood Risk Assessment (SFRA) for Southwark aims to facilitate this process by identifying the spatial variation in flood risk across the Borough, allowing an area-wide comparison of future development sites with respect to flood risk considerations.

The greatest risk to property and life from flooding within London Borough of Southwark (LBS) is as a result of tidal activity within the River Thames. However, the Borough is currently protected from combined tidal and fluvial flooding by the River Thames Tidal Defences (TTD) up to the 1 in 1000 year event. The risk is therefore of a residual nature, associated with overtopping or breaching of defences. Excepting the River Thames, there are no other watercourses within Southwark known to present a risk of fluvial flooding.

A potential risk of flooding from other (non-river related) sources exists throughout the Borough, including sewer surcharge and surface water flooding as a result of heavy rainfall and/or blocked drainage systems. Southwark plays a key role in managing this risk as a Lead Local Flood Authority, under the Flood and Water Management Act (2010) and the Flood Risk Regulations (2009).

Areas of the Borough are also thought to be susceptible to elevated groundwater levels, which may additionally interact with and exacerbate these sources of flood risk. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within Southwark.

This SFRA identifies the tidal floodplains associated with the River Thames and presents Flood Zone Maps that delineate the flood zones outlined in the NPPF. Breach modelling has additionally been undertaken to enable a greater understanding of the residual risk associated with this source. The resulting hazard, depth and velocity mapping contained within this SFRA provide further definition of the spatial variations of flood risk within Flood Zone 3.

A spatial planning solution to flood risk management should be sought wherever possible. The maps and supporting information presented in this SFRA are intended to provide the necessary understanding to facilitate the NPPF risk-based approach to planning. This is based upon determining compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and Exception Test (when needed). Guidance to undertaking these processes is included within the report.

The overall SFRA should be used to provide an overview of the risk of flooding across LBS, to assist in the development of policy formulation, strategic planning, development control and flood risk management. The report additionally contains specific recommendations, for both the Borough and local developers, for effectively managing and mitigating flood risk including guidance on the requirements for site specific Flood Risk Assessments and the use of Sustainable Drainage Systems (SuDS).

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Abbreviations

Acronym	Definition
AEP	Annual Exceedance Probability
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FWMA	Flood and Water Management Act
FRA	Flood Risk Assessment
FRMI	Flood Risk Management Infrastructure
GIS	Geographical Information Systems
LBS	The London Borough of Southwark
LFRMS	Local Flood Risk Management Strategy
LFRZ	Local Flood Risk Zone
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
m AOD	Metres Above Ordnance Datum. Elevations use Ordnance Datum, Newlyn
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
RBMP	River Basin Management Plan
RBD	River Basin District
RFRA	Regional Flood Risk Appraisal
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SPG	Supplementary Planning Guidance
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100 Plan
TTD	Thames Tidal Defences

Glossary

Term	Definition
Annual Exceedance Probability (AEP)	In flood risk terms, the AEP represents the probability of a particular return period event occurring in any given year. (e.g. 1 in 100 year return period event = 1% AEP – there is a 1% chance every year that this event will take place).
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Areas Benefiting from Defences	The area that is protected by a defence or defence system against flooding from a 1% (1 in 100) annual probability fluvial event and 0.5% (1 in 200) annual probability tidal event, assuming all defences remain intact and function perfectly.
Blue-green infrastructure	Combining green spaces and surface water management infrastructure within the urban environment to facilitate natural hydrological processes whilst minimising flooding, enhancing biodiversity, facilitating recreation and assisting adaption to climate change.
Breaching	Breaching of defences refers to structural or other failure of a flood wall or barrier, to create a gap allowing water to break through.
Brownfield Land	Previously developed land.
Catchment	The land (and its area) which drains (normally naturally) to a given point on a river, drainage system or other body of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Critical Drainage Area	A discrete geographic area where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding during severe weather, affecting people, property or local infrastructure.
Culvert	A channel or pipe that carries water below the level of the ground.
Exception Test	The Exception Test is required for certain development sites following application of the Sequential Test. The Exception Test must demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk, and that the site is safe from flood risk for its lifetime.
Flood Defence	Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding to a specified standard of protection (SoP).
Flood Map	A map produced by the Environment Agency providing an indication of the likelihood of flooding within all areas of England and Wales, assuming there are no flood defences.
Flood Risk Assessment	A study to assess the risk to an area or site from flooding from all sources, now and in the future, and to assess the impact that any changes or development on the site or area will have on flood risk to the site and elsewhere. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased.
Flood Risk Management	The activity of understanding the probability and consequences of flooding, and seeking to modify these factors to manage flood risk to people, property and the environment in line with agreed policy objectives.
Flood Warning	If a flood warning is issued in an area, it means flooding is expected and will cause disruption.

Flood Zone	A geographic area within which the flood risk is in a particular range as defined within NPPF and its Practice Guidance.
Flood Zone 1	Land where flooding from rivers and the sea is very unlikely. There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year.
Flood Zone 2	Land which has between a one in 100 and one in 1000 annual probability (chance) of river flooding (1% -0.1%); or between a one in 200 and 1 in 1000 annual probability (chance) of sea flooding (0.5%-0.1%).
Flood Zone 3	Land which has a greater than one in 100 annual probability (chance) of river flooding (>1%); or greater than one in 200 annual probability (chance) of sea flooding (>0.5%).
Flood Zone 3a (High probability)	This is a subset of Zone 3 (above), which is not within the functional floodplain (Flood Zone 3b), as defined below. Therefore this land is typically expected to have an annual probability of flooding between 1 in 20 and 1 in 100 (from fluvial sources) or 1 in 200 (from tidal sources) in any year.
Flood Zone 3b (Functional Floodplain)	Land where water has to flow or be stored in times of flood. Specifically, this land would flood with an annual probability of 1 in 20 (5 %) or greater in any year, or as otherwise agreed by the Local Authority and the Environment Agency.
Flooding Hotspot	Also known as flood prone areas. These are locations where concentrations of flooding incidents within a limited geographical context have appeared over time.
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist.
Flood Resilience	Flood resilience involves design and construction of buildings and structures to reduce the impact of flooding so that, although flood water may enter the building, its impact is minimised, structural integrity is maintained, and repair, drying & cleaning are facilitated.
Flood Resistance	Flood resistance involves design and construction of buildings or other structures to prevent entry of flood water or minimising the amount that may enter.
Greenfield Runoff Rate	The greenfield runoff rate is the rate at which rainfall would runoff from an undeveloped, naturally permeable catchment.
Main River	A watercourse designated on a statutory map of Main Rivers, on which the Environment Agency has permissive powers to construct and maintain flood defences.
Maximum Likely Water Level	Upstream of the Thames Barrier, the Maximum Likely Water Level is used to define expected River conditions, under current and future climate change scenarios. This is used instead of return period as water levels are controlled by the Thames Barrier.
National Planning Policy Framework	The NPPF is a framework which aims to simplify and accentuate accessibility on current policy in planning of development of an area, particularly for local planning authorities and decision makers.
National Planning Policy Guidance	This document provides additional technical guidance to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework.
Ordinary Watercourse	All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewers) and passages through which water flows which do not form part of a Main River. Southwark Council has similar permissive powers on Ordinary Watercourses as the Environment Agency has on Main Rivers.
Overtopping	The process of water rising over the top of a barrier intended to contain it (e.g. sea defence).

Pathway	A route that enables a hazard to move from a ‘source’ to a ‘receptor’, as in the ‘source-pathway-receptor’ concept. A pathway must exist in order for a hazard to be realised. Pathways can be constrained in order to mitigate the risks.
Reservoir	A large raised structure, raised lake or other area capable of storing at least 25,000 cubic metres of water above natural ground level, created artificially or enlarged. This is defined by the Reservoirs Act, 1975.
Residual risk	The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.
Return Period	The long-term average period between events of a given magnitude which have the same annual exceedance probability of occurring.
Run-off	The flow of water from an area caused by rainfall.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Site Allocation	Location identified by the Local Planning Authority as likely to experience change or development in the short to medium term.
Standard of Protection	The design event or standard to which a building, asset or area is protected against flooding, generally expressed as an annual exceedance probability.
Strategic Flood Risk Assessment	An area-wide study, undertaken by one or more local authorities, to assess the risks that all sources of flooding pose to a Borough or District, both now and in the future. It incorporates the impacts of further land changes and climate change in the development of an area and assesses whether these factors impact the risk of flooding.
Surface Water Flooding	In this context, surface water flooding describes flooding from pluvial runoff, drains, groundwater, small water courses and ditches that occurs as a result of heavy rainfall.
Sustainability Appraisal	An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles.
Sustainable Drainage Systems	A sequence of management practices and control structures, often referred to as SuDS, designed to mimic natural hydrological processes and drain water in a more sustainable manner (as opposed to conventional techniques).
Tidal Surge	A local high rise in sea level caused by climatic conditions, creating wind and low atmospheric pressure. Tidal flooding is of greatest risk when tidal surges combine with high tides.
Thames Estuary 2100 Plan	The Environment Agency’s plan for maintaining and improving the Thames tidal flood defence system for the period to 2100, taking account of climate change.
Vulnerability Classes	NPPF provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.
2014 Year Breach Scenario	Modelled flood characteristics (depth, velocity and hazard), considering a breach of the River Thames Tidal Defences, under 2014 climate change conditions.
2065 Year Breach Scenario	Modelled flood characteristics (depth, velocity and hazard), considering a breach of the River Thames Tidal Defences, under 2065 climate change conditions.
2100 Year Breach Scenario	Modelled flood characteristics (depth, velocity and hazard), considering a breach of the River Thames Tidal Defences, under 2100 climate change conditions.

1 Introduction

The National Planning Policy Framework (NPPF) and accompanying Technical Guidance (NPPG) emphasise the responsibility of Local Planning Authorities (LPAs) to ensure that flood risk is understood and managed effectively using a risk-based approach throughout all stages of the planning process. As such, LPAs are required to undertake Strategic Flood Risk Assessments (SFRA) to support the preparation of their Local Plan.

The London Borough of Southwark (LBS) has commissioned a review and update of the existing SFRA for the Borough, which was completed in 2008. The methodology followed in the study has been designed to comply with the NPPF and the NPPG as well as guidelines from the Environment Agency (EA). The SFRA has been carried out in close collaboration with a range of officers from LBS and the EA. The results of this assessment are described in this report and are intended to inform strategic land use planning and decision making, from a flood risk perspective.

1.1 SFRA Aims & Objectives

The aim of this SFRA is to collate and analyse the most up-to-date flood risk information from all sources, to provide an overview of flood risk across Southwark. The resulting report and mapping is intended to be used by the Borough as evidence to inform the New Southwark Plan, ensuring flood risk is taken into account when considering development options and in the preparation of strategic land use policies. In addition to providing an evidence base, the SFRA will enable LBS to:

- Determine the variations in risk from all sources of flooding across the Borough;
- Prepare broad policies for the management of flood risk;
- Steer development towards areas of lowest flood risk, through application of the Sequential Test and, where necessary, the Exception Test;
- Assist the decision making process on flood risk issues;
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for flood water;
- Identify the level of detail required for site-specific Flood Risk Assessments; and
- Determine the acceptability of flood risk in relation to emergency planning capability.

Based upon EA guidance, the key objectives of this SFRA are to:

- Provide maps showing the Local Planning Authority (LPA) area including main rivers, ordinary watercourses and flood zones, including the functional floodplain;
- Assess and map the distribution of flood risk from all sources across the Borough, including an assessment of the potential implications of climate change;
- Identify relevant flood risk management measures, including the location and standard of infrastructure and the coverage of flood warning systems;
- Undertake an appraisal of the current condition of flood defences and likely future flood management policy with regard to its maintenance and upgrade;
- Undertake an appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure, including an appropriate allowance for climate change;
- Provide advice on the preparation of site-specific flood risk assessments for sites of varying risk across the flood zones, including information about the use of sustainable drainage techniques;
- Identify policies and practices required to ensure development satisfies the Exception Test;
- Provide meaningful recommendations to inform policy, development control and technical issues; and

- Provide advice on appropriate mitigation measures, including the likely applicability of Sustainable Drainage Systems (SuDS) techniques for managing surface water run-off.

It is intended that this SFRA report will be complemented by further detailed assessment of the allocated development sites within the Borough, once these sites have been confirmed.

1.2 Using this SFRA

This SFRA is broadly divided into 6 sections, as described below:

- **Chapter 1** (this chapter) provides an overview of the aims and objectives of the updated SFRA, provides contextual background information about the Borough and summarises the methodology used to undertake this assessment.
- **Chapter 2** provides a brief overview of the legislative and national, regional and local planning policy context relevant to Southwark and referenced in the preparation of this SFRA.
- **Chapter 3** presents a broad overview of the flood risk associated with all sources across Southwark, including flood history and the anticipated impact of climate change.
- **Chapter 4** summarises the NPPF risk-based approach to managing flood risk through planning, including step-by-step guidance on the application of the Sequential Test and Exception Test. This is followed by specific recommendations to inform local planning policy, development control and emergency planning.
- **Chapter 5** provides guidance to developers in undertaking site-specific flood risk assessments and measures available for appropriately managing and mitigating flood risk
- **Chapter 6** summarises the key findings of the SFRA, including the primary recommendations for flood risk management in Southwark.

A number of appendices are also attached within this SFRA, as summarised below.

- **Appendix A** contains mapping, summarising contextual information for Southwark and illustrating the spatial variability of flood risk across the Borough.
- **Appendix B** provides more detailed information on commonly utilised SuDS techniques and their applicability.
- **Appendix C** provides a summary of the datasets collated throughout the SFRA preparation and describes each of the datasets contained within the SFRA maps.
- **Appendix D** presents a management guide, detailing recommendations for maintaining and updating the SFRA to ensure it remains relevant.
- **Appendix E** summarises the known historical flooding records across the Borough
- **Appendix F** contains the outputs of refined site-specific surface water modelling undertaken for the local areas of Herne Hill, Camberwell and Peckham Rye.
- **Appendix G** provides a concise summary of key development control and spatial planning recommendations for the Borough.
- **Appendix H** contains the LBS Developers' Guide for Surface Water Management.
- **Appendix I** contains the LBS Basements and Flooding – Guide for Developers.

While it is generally recommended that the SFRA be considered holistically, the key sections deemed to be most relevant to various parties are summarised below.

1.2.1 Development Control

A key objective of the SFRA is to collate, assess and map all forms of flood risk, using this as evidence to steer new development towards areas of lowest flood risk, through the Sequential Test process. The spatial distribution of different sources of flood risk across the Borough is illustrated in the mapping contained in Appendix A, and further described in Chapter 3. These sections will provide a broad indication of the sources of flood risk impacting on any potential development sites, and the flood zone in which they are situated.

Following this, Chapter 4 summarises the Sequential Test process, which can be used to determine the compatibility of various development types within each flood zone; describing how the mapping and information should be used to assess planning applications.

1.2.2 Strategic Planning

The maps contained within Appendix A illustrate the spatial distribution of flood risk across Southwark, and are intended to inform strategic land use planning and development allocation. Greater detail on each source of flood risk is contained in Chapter 3.

Chapter 4 provides an overview of the NPPF risk based approach to sequential planning, which should inform development planning and site allocations. This is followed by specific recommendations for the Borough, intended to inform planning policy, development control and emergency planning.

1.2.3 Guidance for Developers

When considering proposed development, it is recommended that developers refer to the mapping contained in Appendix A to obtain an overall understanding of the different sources and levels of flood risk which may affect their site. Further detail on any relevant sources of flooding can be found in Chapter 3.

Chapter 5 provides detailed guidance in undertaking site-specific flood risk assessments, depending on the Flood Zone of the development and whether it is located within a defined Critical Drainage Area (CDA). This further describes common measures which are available for appropriately managing and mitigating flood risk. Further detail on the applicability and use of different types of SuDS is provided in Appendix B.

Developers should also refer to Chapter 4 in order to understand the compatibility between different types of development and levels of flood risk, and how the Sequential Test will be used by the Borough to assess planning applications.

1.3 Study Area

1.3.1 Location

The study area is defined by the administrative boundary of LBS, illustrated in Map A1. The Borough is located in central London, extending from the River Thames in the north, to Dulwich in the south, covering an area of approximately 29km². The Borough is bordered to the North by the east-flowing River Thames, with the London Borough of Lambeth bordering to the west, the London Boroughs of Croydon and Bromley to the south and the London Borough of Lewisham to the east. The study area falls within the Thames River Basin District (RBD) and is located in the EA Thames Region. The water utility provider is Thames Water Utilities Ltd.

1.3.2 Land Use

As a large inner city Borough, Southwark comprises many distinct districts including Bermondsey, Borough and Bankside, Camberwell, Dulwich, Nunhead and Peckham Rye, Peckham, Rotherhithe and Walworth. The Borough is heavily urbanised, with a population of 288,283 residents, distributed across 124,167 households¹.

A strong tourism economy is present in the north of Southwark, while the southern region is predominately suburban. There are numerous parks within Southwark including Southwark Park, Dulwich Park, Burgess Park, Peckham Rye Common, Belair Park and numerous sports grounds and squares.

Strategic road and rail networks, managed by TfL and rail operators, traverse the Borough. This include thirteen major road routes, the Jubilee, Northern and Bakerloo underground lines, London Overground lines and National Rail routes, in addition to a range of stations and supporting infrastructure.

¹ 2011 Census <http://www.ons.gov.uk/ons/guide-method/census/2011/index.html>

1.3.3 Topography

With respect to topography, Southwark can be broadly divided into two general areas by the 5m AOD contour, which is approximated by the west to east orientated A202. The land is relatively undulating, rising away from the River Thames and reaching around 100 m AOD near the southern tip of the Borough at Crystal Palace. To the north of the A202, in the Bermondsey and Camberwell areas, the Borough is characterised by a ‘basin’ of low lying land. Ground elevations in the centre of this basin, to the east of Walworth, are close to 0 m AOD. However, they rise to around 4 to 5 m AOD adjacent to the River Thames.

The general topography of the Borough is illustrated in Map A12.

1.3.4 River Network

The northern boundary of the Borough is bounded by the River Thames for approximately 7 km. There are no other Main Rivers within the Borough, with all other drainage catchments having historically been incorporated into the sewer network.

The Detailed River Network has been provided by the EA and identifies three ordinary watercourses to the northeast of the Borough in the Rotherhithe area (tributaries of the River Thames). The location of these watercourses is illustrated in Map A1.

Although the dataset does not identify any further ordinary watercourses in the Borough, it is thought there are several hidden watercourses present, which have been culverted or routed underground. This includes the Rivers Neckinger, Peck and Effra. The approximate location of these watercourses has been estimated, and is also indicated on Map A1, although it should be noted that this positioning is unconfirmed.

1.3.5 Geology

1.3.5.1 Bedrock Geology

The bedrock geology of the Borough comprises Chalk Formation, which is overlain by Thanet Sand Formation (fine grained sand), Lambeth Group (clay with beds of sand), London Clay Formation (clay and silt) and Claygate Member (sand, fine grained silt and clay).

London Clay dominates the surface bedrock geology in much of the south and north west of the Borough. However, in the Bermondsey area to the east, the Lambeth Group, Thanet Sand Formation and Chalk Formation are exposed. These units outcrop beneath the superficial deposits in much of the central and north eastern areas of the Borough. In the south eastern area of Southwark, near Dulwich and Crystal Palace, the Claygate Member overlies the London Clay Formation on higher ground.

1.3.5.2 Superficial Geology

The superficial geology of the area consists of various River Terrace Deposits, Alluvium, Peat, Head, Langley Silt Member, Interglacial Lacustrine Deposits and Sand and Gravel of Uncertain Age. These blanket much of the northern half of the study area where ground levels are less, but are largely absent in the southern half at higher elevations.

1.3.5.3 Infiltration

Due to the dominance of London Clay within the bedrock geology, there are likely to be constraints on the applicability of SuDS techniques reliant on subsurface infiltration. Map A11 summarises the infiltration constraints present within Southwark. This indicates that across the majority of the Borough the subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions (requiring bespoke approaches). Further detail on this map is contained within Section 5.3.

1.4 Methodology and Approach

This SFRA is a desk-based study, using available information and data to enable the assessment of flood risk across the Borough. All of the datasets used in this SFRA update have been requested and obtained from stakeholders specifically for this study. Each of these datasets has been analysed and discussed with key stakeholders to ensure the latest and most relevant information is included in the SFRA.

This data is interrogated and then presented in a suitable graphical and tabular format to facilitate the decision making process by LBS. The SFRA will also be used to inform the application of the Sequential Test to development sites and to identify if any of them require the application of the Exception Test. The key steps followed in the preparation of this SFRA are summarised below:

- Arrange an inception meeting between LBS and all key stakeholder organisations to establish the main objectives of the study (from each perspective), aid collaborative working and discuss available information and datasets.
- Liaise with stakeholders to request relevant datasets and information.
- Interrogate received data and review against the objectives of the SFRA to identify any gaps in the required information.
- Consult with key stakeholders to agree the approach, and define datasets to be included within the SFRA.
- Assess the risk of flooding from all sources, including flooding from the sea, rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources.
- Produce strategic flood risk maps, GIS deliverables and a technical report.

Further detail regarding the SFRA methodology and key datasets selected for inclusion is provided in Appendix C.

1.4.1 Consultation

The following stakeholders were engaged to provide data and information during this SFRA.

- **London Borough of Southwark** – LBS is the LPA, with responsibility for strategic planning of future development within the Borough, determination of planning applications and emergency planning. Additionally, LBS has a role as the Lead Local Flood Authority (LLFA), responsible for leading the management of flood risk from surface water, groundwater and ordinary watercourses. Given the range of roles and responsibilities across LBS related to flood risk, officers from the following departments were involved in the preparation of this SFRA:
 - Emergency Planning
 - Planning Policy
 - Development Control
 - Flood Risk and Drainage
- **Environment Agency** – The EA takes a strategic overview of the management of all sources of flooding and erosion. The study area falls within the EA Kent, South London and East Sussex region. The Agency also has operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea, as well as being a coastal erosion risk management authority..
- **Thames Water** – Thames Water is responsible for management of the sewer system across the study area. This includes managing the risks of flooding from water mains and foul or combined sewer systems providing drainage from buildings and yards. In addition, private individuals may be responsible for drainage systems that operate prior to discharge either into a watercourse or into a public sewer.

There are a number of other stakeholders with responsibility for strategic planning and flood risk management within Southwark. These include The Greater London Authority, neighbouring London Boroughs, The Canal and Rivers Trust, the London Fire Brigade, the British Geological Society, Network Rail, London Underground, Transport for London, the Highways Agency and Natural England, among others.

2 Legislative and Planning Policy Framework

This section provides a brief overview of the legislative and national, regional and local planning policy context relevant to the Borough and referenced in the preparation of this SFRA. Hyperlinks providing further detail on each of the described documents are contained in the footnotes where possible.

2.1 National Policy

2.1.1 Flood and Water Management Act (2010)

The Flood and Water Management Act (FWMA)² was enacted in 2010, with the intention of enabling the provision of more comprehensive and effective flood risk management. The act formalises flood risk management responsibilities across a range of organisations including the EA, water companies and highway authorities, and requires cooperation across all groups. Unitary authorities, including LBS, are designated as Lead Local Flood Authorities (LLFA), with responsibility to lead and co-ordinate local flood risk management. As such LBS's responsibilities include the following:

- Coordinate management of flooding from surface water, ground water and ordinary watercourses;
- Develop, maintain and implement Flood Risk Management Strategies;
- Investigate and record local flood events; and
- Establish and maintain a Flood Risk Asset Register.

The Act also gives LLFAs the role of approving drainage strategies for large planning applications.

The Act further required the preparation of a number of other studies and strategies, as are further described in the following sections.

2.1.2 National Strategy for Flood and Coastal Erosion Risk Management

In accordance with the Act, the EA has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England³. Developed around the notion of understanding risks, empowering communities and building resilience, this Strategy provides a framework for the work of all FCERM authorities.

2.1.3 Flood Risk Regulations

As well as the duties under the FWMA, LBS have legal obligations under the EU Floods Directive, which was transposed into UK Law through the Flood Risk Regulations 2009 ('the Regulations').⁴

The regulations set out duties for the EA and LLFAs in the preparation of a range of studies and mapping outputs. As such, LBS was required to produce a Preliminary Flood Risk Assessment (PFRA), Flood Risk Maps showing the extents and hazards of flooding in their area and Flood Risk Management Plans. These studies are summarised in the following sections.

2.1.4 National Planning Policy Framework

The NPPF⁵ was published in March 2012, and presents a structure and context for planning within England, providing a framework for local authorities and residents to produce local and neighbourhood plans that reflect the needs and priorities of their communities.

² Flood and Water Management Act (2010) <http://www.legislation.gov.uk/ukpga/2010/29/contents>

³ National Flood and Coastal Erosion Risk Management Strategy for England <https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england>

⁴ Flood Risk Regulations (2009) <http://www.legislation.gov.uk/uksi/2009/3042/contents/made>

⁵ The NPPF (2012) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf Technical Guidance https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf

Within the core principles of NPPF, set out in Paragraph 17, it is stated that planning should: "Support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change."

Section 10 titled Meeting the Challenge of Climate Change, Flooding and Coastal Change, establishes the principles for assessing and managing flood risk through the planning and development process, which is supported by the Technical Guidance document.

The overall approach of the NPPF to flood risk is broadly summarised below (from Paragraph 103 in the NPPF).

"When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of SuDS."

Each LPA within the study area is responsible for preparing an SFRA to inform the allocation of development sites within their administrative areas in accordance with their established Sustainability Appraisal. The policy levels of this process in the context of flood risk and the position of the SFRA within the planning framework are shown in Figure 2-1 below:

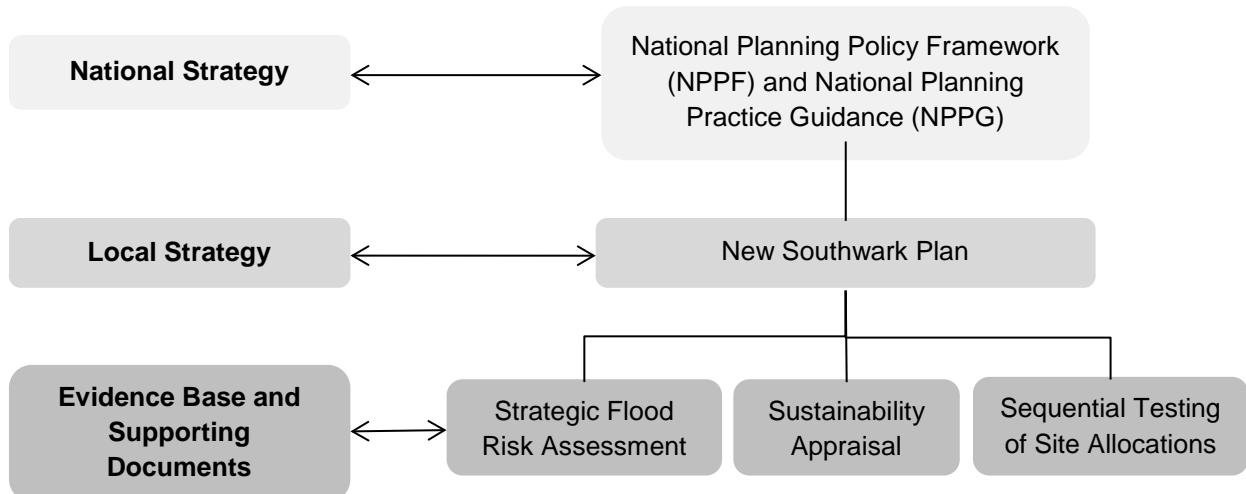


Figure 2-1: Overview of Policy Levels and Documents in the context of Flood Risk

The NPPF is supported by Technical Guidance⁶, which provides additional guidance to ensure the effective implementation of the planning policy, with particular relation to managing flood risk.

Further detail regarding the application of the Sequential and Exception Tests is included in Section 4.1.

2.2 Regional Flood Risk Policy

2.2.1 London Plan

The London Plan⁷, updated in March 2015, is the core planning and development guidance document for all of Greater London. Flood risk is considered in the London Plan under the section dealing with response to climate change. Policy statements 5.12 and 5.13 require developers to follow the guidance of NPPF, TE2100 and the SFRA in undertaking a site specific flood risk assessment. It also requires developers to follow the

⁶ NPPF Technical Guidance (2012) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf

⁷ The London Plan (March 2015) and London Regional Flood Risk Appraisal <http://www.london.gov.uk/priorities/planning/london-plan>

SuDS hierarchy when devising surface water management strategies, ensuring surface water is attenuated and stored at source wherever possible. A key recommendation is that all developments should aim to achieve Greenfield runoff rates where possible.

Supplementary Planning Guidance (SPG) has additionally been published to provide further guidance on policies within the London Plan, which cannot be addressed in sufficient detail within the main Plan. The SPG for Sustainable Design and Construction⁸ was published in April 2014, and provides further practical detail on flood risk and sustainable drainage.

2.2.2 London Regional Flood Risk Appraisal

The first review of the London Regional Flood Risk Appraisal (RFRA) was released for public consultation in January 2014, providing underpinning evidence to the London Plan. The RFRA provides a broad overview of the different types of flood risk in London and provides a spatial analysis of tidal, fluvial and surface water flood risk against major development locations, key infrastructure assets and services. The RFRA contains 14 recommendations to be implemented by the EA and other agencies.

2.2.3 Thames Catchment Flood Management Plan

The Thames Catchment Flood Management Plan (CFMP)⁹, was published by the EA in December 2009, and is the overarching flood risk management policy document for the Thames River Basin. It provides an overview of flood risk within the catchment and presents the EA's key strategic policy for sustainable flood risk management over the next 50 to 100 years.

Under the Thames CFMP, Southwark falls into Policy option 4, as "Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change". In particular, this policy references the need to adapt the urban environment to make space for water, through appropriate location, layout and design of redevelopment.

2.2.4 Thames Estuary 2100 Plan

The EA's Thames Estuary 2100 Plan (TE2100) was updated in 2016¹⁰ and covers the Thames estuary from Teddington in the west to the mouth of the estuary at Shoeburyness and Sheerness. It provides a plan for improving the tidal flood defence system for the period to 2100 so that current standards of flood protection are maintained or improved taking account of sea level rise. This plan is of particular relevance to Southwark, due to the significant level of dependence on the Thames Defences for flood protection.

This study indicates that the present system of flood risk management for tidal flooding can continue to provide an acceptable level of risk management up to 2030 without major alterations. However, beyond 2030 more actions will be needed, and the plan sets out recommendations and a timeline for these.

Southwark contains part of the TE2100 Wandsworth to Deptford policy unit, which has been designated TE2100 policy 5, "to take further action to reduce the risk of flooding (now or in the future)". This advocates an increase in the level of flood protection from the current 1 in 1000 year level to 1 in 10,000; justified by the unique commercial, economic and historic value of London, as well as the potential for loss of life in the unlikely event of an extreme flood event.

Specific actions in the TE2100 Plan that refer to the Borough are as follows:

- To maintain, enhance or replace the existing river defence walls/banks and flood control structures;
- To implement a programme of defence raising through central London in about 2065;
- To incorporate the Riverside Strategy concept into local plans, strategies and guidance documents;
- To agree a programme of managing flooding from other sources in the defended tidal floodplain;

⁸ Supplementary Planning Guidance for Sustainable Design and Construction <https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/supplementary-planning-guidance/sustainable-design-and>

⁹ Thames Catchment Flood Management Plan <https://www.gov.uk/government/publications/thames-catchment-flood-management-plan>

¹⁰ TE2100 Plan <https://www.gov.uk/government/publications/thames-estuary-2100-te2100>

- To inform the development and revision of local council SFRAs and flood plans;
- To agree partnership arrangements and principles to ensure that new development in the tidal flood risk area is safe and where possible applies the NPPF to reduce the consequences of flooding;
- To agree partnership arrangements for floodplain management; and
- To agree a programme of floodplain management.

2.2.5 Thames River Basin District Draft Flood Risk Management Plan

Under the EU Floods Directive and UK Flood Risk Regulations, the EA is required to prepare FRMPs for all of England covering flooding from main rivers, the sea and reservoirs. The draft Thames River Basin District FRMP¹¹ was published for consultation by the EA in 2014, setting out the proposed measures to manage flood risk within the District from 2015 to 2021 and beyond.

2.2.6 Thames River Basin District Management Plan

The Thames River Basin District Management Plan has been prepared under the European Water Framework Directive, and represents the first of a series of six-year planning cycles. The plan describes the river basin district, the pressures impacting the state of the water environment, and proposed actions to address these.

Southwark falls within the Thames Estuary catchment area as described in the plan. The plan highlights the heavily urbanised nature of this catchment. Water quality is noted as a particular concern, due to the impact of storm and effluent discharges, resulting in drops in dissolved oxygen, and increases in aesthetic pollution, risk to health and fish kills.

The plan further identifies a series of actions to assist in improving water body status, with particular opportunities highlighted through improvements to sewage treatment works along the tidal River Thames and the construction of the London Tideway Tunnel.

2.3 Local Planning Policy and Flood Risk Strategies

2.3.1 Draft New Southwark Plan

LBS is currently in the consultation stage of the New Southwark Plan¹², as a revision of the previous Southwark Plan and Core Strategy. This plan will set out the regeneration strategy for the next 10-15 years and will be used to make decisions on planning applications.

The plan has now reached the Preferred Option (2015), presenting the policies and visions proposed for inclusion in the plan. This includes support for the provision of 30,000 new homes, including 11,000 new Council homes. Additionally, the plan promotes attraction of new businesses and protection of social infrastructure, including schools and community facilities. Under the plan, growth will be directed particularly to the north of the Borough, including the areas of Elephant and Castle, Aylesbury, Peckham, Nunhead, Canada Water and Old Kent Road.

The plan re-establishes the council's roles as LLFA in managing local flood risk, including flooding from surface run-off, ordinary watercourses and groundwater. Key Policy DM63 within the plan deals specifically with reducing flood risk, particularly emphasising risk from the River Thames and surface water sources. The sub-policies within DM63 state that development must:

- Be safe and resilient to flooding, when located within an area of flood risk, and meet the Exception test, where located within Flood Zones 2 or 3.
- Reduce surface water run-off rates through the application of SuDS.

¹¹ Thames River Basin District Draft Flood Risk Management Plan https://consult.environment-agency.gov.uk/portal/h0/flood/draft_frmp/consult?pointId=3063510

¹² New Southwark Plan http://www.southwark.gov.uk/info/856/planning_policy/3315/the_new_southwark_plan

- Utilise permeable surfacing for all front garden areas.

2.3.2 Local Flood Risk Management Strategy

As a LLFA, LBS has a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management. The Southwark Local Flood Risk Management Strategy¹³ was adopted in August 2015, outlining the general approach to managing flood risk across the Borough. The primary purpose of this strategy is to ensure that, as far as is reasonably practicable, the risk of flooding to human health and life, the environment, economic activity, infrastructure and cultural heritage arising from surface water, groundwater and ordinary watercourses is minimised.

The strategy sets out LBS's role as a LLFA and also clarifies responsibilities of other organisations for managing flooding from various sources. The strategy details the potential sources of flooding within the Borough and the general approach to managing flood risk. A review of the strategy will be undertaken every 6 years.

2.4 Other Local Studies

2.4.1 Southwark Surface Water Management Plan

A Surface Water Management Plan (SWMP)¹⁴ was prepared as part of the Drain London Study. This study undertook an assessment of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall. The plan outlines the preferred surface water management strategy for the Borough and includes an Action Plan that has been developed in conjunction with both LBS and relevant other Risk Management Authorities.

The SWMP used probabilistic two dimensional modelling to analyse surface water flood risk and identified 5 Critical Drainage Areas (CDAs) within, or crossing, the Borough. These are defined as discrete geographic areas (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more areas during severe weather, thereby affecting people, property or local infrastructure. The Borough's CDAs include Herne Hill, Camberwell, Peckham, Dulwich and a small pocket in the north, in the vicinity of London Bridge Rail Station.

As a result of this study, detailed flood investigation and mitigation schemes have been pursued in the areas of Peckham Rye, Herne Hill and Camberwell (as further described in Section 3.3.2.1).

The main outputs of the Southwark SWMP have been considered in the preparation of this SFRA.

2.4.2 Preliminary Flood Risk Assessment

Under the Flood Risk Regulations (2009), all LLFAs were required to prepare a PFRA. This study provides a high level summary of significant flood risk, describing both the probability and harmful consequences of past and future flooding.

The Southwark Preliminary Flood Risk Assessment¹⁵ was produced in June 2011 as part of the Drain London study. The assessment gives an overview of all local sources of flood risk. Boroughs must review the PFRA every six years and therefore the next update of this document is due in 2017.

2.4.3 Developers' Guide for Surface Water Management

As a LLFA, LBS is responsible for managing flood risk from surface water, groundwater and ordinary watercourses. In order to effectively reduce flood risk, LBS is committed to reducing the surface water runoff entering drainage systems throughout the Borough, by requiring the use of SuDS in all developments. This

¹³ Southwark Local Flood Risk Management Strategy

http://www.southwark.gov.uk/info/200448/flood_risk_management/3643/local_flood_risk_management_strategy

¹⁴ Southwark Surface Water Management Plan

http://www.southwark.gov.uk/downloads/download/2956/surface_water_management_plan

¹⁵ Southwark Preliminary Flood Risk Assessment

http://www.southwark.gov.uk/downloads/download/4298/preliminary_flood_risk_assessment_pfra

document is intended to inform developers on the requirements to deal with surface water and how that will be appraised as part of development planning applications. The guidance sets out how these submissions should be prepared and the criteria which should be met.

This document is contained within Appendix H of this SFRA.

2.4.4 Basements and Flooding – Guide for Developers

As a part of their role as a LLFA, LBS undertakes reviews of planning applications from a flood risk and drainage perspective. This includes development proposals for new or extended basement areas. This guidance has been developed to inform developers of the requirements for planning submissions, with regards to new or extended basements, from a flood risk perspective.

This document is contained within Appendix I of this SFRA.

3 Flood Risk in Southwark

3.1 Overview

The Borough is bounded to the north by the River Thames. Whilst the Thames poses a potential risk of flooding to properties within the Borough, all properties are currently protected from combined tidal and fluvial flooding by the Thames Tidal Defences (TTD) up to the 1 in 1000 year event. This protection is effective provided the Thames Barrier is operated to protect against storm surges from the North Sea and that there is sufficient storage behind the barrier to accommodate the River Thames when it is shut during extreme fluvial events at high tides. Besides the River Thames, there are no other known watercourses within the Borough that pose a potential risk of fluvial flooding.

A potential risk of flooding from other (non-river related) sources exists throughout the Borough. In particular, sewer surcharge and surface water flooding as a result of heavy rainfall and / or blocked gullies is known to be a particular risk within certain CDAs.

Areas of the Borough are also thought to be susceptible to elevated groundwater levels, which may additionally interact with and exacerbate these sources of flood risk. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within the Borough.

The various sources of flooding with the potential to affect the Borough have been analysed below.

3.2 Historic Flooding

Information on historic flooding events within the Borough has been compiled and is shown in Map A2 and broadly summarised below. It should be noted that some of these historical events might have been as a result of issues that have now been addressed and, therefore, an indication of historical flooding affecting a particular location does not necessarily mean that it remains prone to flooding. A site specific FRA will be required to confirm whether any historical issues have been addressed and development in previously flooded sites can take place.

3.2.1 Historic Flooding from the River Thames

The Borough has previously experienced flooding in 1928, 1937 and 1968 as a result of fluvial / tidal flooding of the River Thames. The northern boundary of the Borough was also flooded in December 2005 when the Thames Barrier, which normally protects the Borough from tidal flooding, was not shut, and sufficient warning was not provided to local residents close to the floodgates prior to the onset of flooding.

3.2.2 Historic Flooding from Surface Water

There are several records of historic surface water flooding which has impacted the Borough. The first recorded flooding event occurred in 1915 in the Dulwich area, followed by an event in the 1960s and in 1984. A particularly severe event occurred on the 27th April 2004, when intense rainfall caused extensive surface water flooding in the Dulwich and Herne Hill areas. This caused extensive damage to residential and commercial properties, schools and severely disrupted transport, resulting in substantial economic damage. The flooding was attributed to particularly intense rainfall accumulating in low lying areas. Other notable surface water flooding events have occurred in June 2006 and July 2007, impacting upon transport networks in the region. Severe flooding additionally occurred on the 14th of August 2014 in the Peckham area, as a result of heavy rainfall generated by Hurricane Bertha. The most recent surface water flooding incident occurred on the 23rd of June, 2016, impacting several areas across the Borough.

3.2.3 Historic Groundwater Flooding

Map A2 indicates the locations of a number of groundwater flooding incidents between 2000 and 2010 within the Borough that have been reported by the EA and LBS. It should be noted that there has not been a statutory obligation to record incidences of groundwater flooding in the past, and it is therefore likely that this list is not exhaustive.

3.2.4 Historic Sewer Flooding

General information on sewer flooding history has been provided by Thames Water, and is contained within Map A2. This data indicates the total number of properties which have been impacted by sewer flooding (both externally and internally), per postcode area, over the previous decade.

It should be noted that the flood records provided by Thames Water may not be a complete and accurate record of flood events in the Borough over the last 10 years. Some minor flooding incidents may go unreported, particularly if no property is affected by such flooding.

3.2.5 Historic Flooding from Artificial Sources

It is understood that several historical flooding incidents within the Borough have occurred as a result of major water main bursts, including an event in August 2013 when a burst water main, managed by Thames Water, caused flooding of Half Moon Lane in Herne Hill. There is no further known flood history from artificial sources within the Borough.

3.3 Flood Risk from all Sources

3.3.1 Tidal and Fluvial

The northern extent of the Borough is bounded by the lower reaches of the River Thames, draining a catchment of 5,000 square miles. Historically, the River Thames floodplain was substantially wider than it is today, with the dense urban area of London particularly constraining the downstream reaches of the river corridor. The River Thames is also tidally influenced in this area, with tidal flooding from this source representing the primary risk to people and property within the Borough.

The primary mechanisms associated with flood risk from the River Thames are summarised below:

- Daily tidal fluctuation, occurring when the freshwater Thames is met by the incoming tide from the North Sea.
- Surge tides, which occur due to climactic conditions creating bands of low pressure in the Atlantic and North Sea. This causes a surge of water to move across the Atlantic, travelling southwards into the North Sea and becoming compressed as it travels towards and through the narrow English Channel, between Great Britain and mainland Europe. This causes a rapid rise in sea levels, which can be exacerbated by strong northerly winds.
- Fluvial mechanisms, due to prolonged rainfall within the upper reaches of the Thames catchment.

The greatest overall flood risk from the River Thames occurs when tidal surges coincide with particularly high tide levels or fluvial flooding in the upper reaches of the catchment.

The Thames Tidal Defence system, including the Thames Barrier and Thames River Walls provide the Borough with a significant Standard of Protection (SoP) from combined fluvial and tidal flooding up to the 1 in 1000 year event. The current and future River Thames Defences are described in further detail in Section 3.4.

Whilst these defences provide a significant SoP to the Borough, it is essential to appreciate that they are engineered structures which can only protect to a certain point, may malfunction and have a finite structural life. There will always therefore be a residual risk of flooding from this source, associated with:

- Overtopping of the defences, during a larger event than has been planned for, or
- Breach of the defences, due to structural failure.

The likelihood of such residual risks are very small; however, the scale of consequences from rapid inundation and deep water in heavily urbanised areas mean that these residual risks must be considered, as further expanded below.

Besides the River Thames, there are no other watercourses within the Borough known to present a risk of fluvial flooding. It should be noted that limited information is available on the level of flood risk associated with

any other ordinary watercourses. However, there is no known flood history associated with these sources, and the perceived risk is therefore considered low.

The risk of flooding from rivers and the sea across the Borough is illustrated in Map A3. This map delineates the probability of flooding into three Flood Zones, as defined by the EA. Flood Zone 3 is additionally delineated into Flood Zone 3a (high probability area) and Flood Zone 3b (known as the functional floodplain, where water has to flow or be stored in times of flood). Each of the Flood Zones is described in Table 3-1.

Table 3-1- Flood Zone Definitions (as defined in the NPPF)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	At risk from flood event greater than the 1 in 1000 year event (greater than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	At risk from flood event between the 1 in 200 and 1 in 1000 year event (between 0.5% and 0.1% annual probability of flooding each year)	Medium Probability
Flood Zone 3a	At risk from a tidal flood event less than or equal to the 1 in 200 year event (greater than 0.5% annual probability of flooding each year), or a fluvial flood event less than or equal to the 1 in 100 year event (greater than 1% annual probability of flooding each year).	High Probability
Flood Zone 3b	At risk from a flood event less than or equal to the 1 in 20 year event or otherwise agreed between the LPA and the EA.	Functional Floodplain

Within the Borough, the illustrated flood zones are primarily associated with the risk of tidal flooding from the Thames, as the dominant source of flood risk across this region.

It can be seen from Map A3 that the majority of the northern half of the Borough is located within Flood Zone 3a and therefore classed as at high risk of flooding.

The floodplain areas within Southwark associated with the River Thames do not have a Flood Zone 3b or functional floodplain associated with them, as they are classed as defended and would not flood during a 1 in 20 year event. Therefore, the functional floodplain has been defined as the area situated on the river side of the raised defence line.

3.3.1.1 Overtopping

The TTD provide a 1 in 1000 year level of protection. Overtopping occurs when flow exceeds the capacity of the channel to convey that flow, and water passes over a flood defence. Low levels of overtopping may arise even when the defence crest level is higher than the water level due to the actions of winds, wave and spray. Development proposals adjacent to the River Thames flood defences should include consideration of overtopping risk within the site-specific FRA.

3.3.1.2 Breach Analysis

The floodplain areas within Southwark are associated with the River Thames and classified as defended. Therefore, the associated flood risk with these areas is that of a residual nature, resulting from a failure or breach in the flood defences. To provide further detail on the variation of the residual risk, hydraulic breach modelling was commissioned by the EA along the extent of the Tidal Thames frontage, from Teddington to Dartford Creek.

This modelling was completed in 2014 using TuFlow software, simulating breach of the tidal defences in 113 critical breach locations, focused on those which are likely to result in the most severe flooding, including 9 locations within or impacting upon the Borough. These breach locations are shown in Map A8.1, and further detailed in Table 3-2.

Table 3-2 - Breach locations

Breach Name	Description	Coordinates	
		Eastings	Northings
Berm04	Commercial Pier Wharf	536668.96	179530.3
Berm05	Sunderland Wharf	536493.9	180457
Berm06	Lower Globe & Normandy Wharf	535982.94	180536.5
Berm07	Fishers Sufferance Wharf	535320.27	179974.6
Berm08	Farrands Wharf	534572.9	179753.3
Berm09	Butlers Wharf	533970.27	179919.3
Berm10	Tower Bridge Abutment Upper Pool	533634.19	180132.8
Berm11	Bankside - The Anchor Public House & Restaurant	532446.15	180463.2
Berm12	Nelson's Wharf	531325.4	180525.6

The modelling simulated a breach in the River Defences occurring at the same time as a defined Maximum Likely Water Level. These levels were determined using combinations of flow and tide, consistent with the water levels used in the TE2100, and modelled under present day conditions (2015) in addition to two climate change scenarios (2065 and 2100). The breach locations have been largely defined by previous studies, and have been selected based on floodplain topography behind the flood defences and property density, in order to represent expected worst case scenarios. As such, the modelling did not take into account the conditions of the defences or the expected probability of breach. Similarly, breach width was assumed as a uniform 20 m, across all modelled breaches.

The potential maximum extent of inundation resulting from defence breaching for each of the considered scenarios is shown in Map A8.1. The modelled water depth, velocity and hazard for each breach location, under the present day and future conditions are shown in the series of Maps A8.2 to A8.4.

When considering these maps, it is essential to consider the limitations and assumptions of the modelling. In particular, not all possible breach locations have been considered in this study. As such, the illustrated flood velocity, depth and hazard represent the expected conditions arising from one or more of the specific breach locations and, as such, will vary spatially if the breach location is in a different local area.

All proposed development sites in Flood Zone 2 and Flood Zone 3 would be subject to a Flood Risk Assessment. Therefore, it is recommended that if any proposed development is located within the breach extent of the Thames, consideration should be given to whether a breach assessment should be conducted, unless they are covered by one of the 9 locations modelled or it can be otherwise demonstrated the local conditions, such as topography, condition of flood defences or flow paths would not result in inundation of their site.

3.3.2 Flooding from Surface Water

Pluvial flooding occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas, before the runoff enters any watercourse or sewer. It is usually associated with high intensity rainfall events and can be exacerbated when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with the additional flow.

This source of flooding can be compounded when combined with impermeable sub-soils, significant areas of development with associated hard standing areas or areas of open grassland. As the majority of the Borough is heavily developed, the risk of surface water flooding is increased.

The Southwark SWMP undertook a comprehensive review of pluvial flood risk, including direct rainfall modelling and mapping across the Borough. As part of this study, the surface water flood risk was mapped and analysed. The following primary flooding mechanisms were identified:

- *River Valleys* - Across the study area, the areas particularly susceptible to overland flow are formed by narrow corridors associated with topographical valleys. These largely correspond to the routes of 'hidden' watercourses including the Rivers Peck, Nickinger and Effra, which run across the Borough. This results in large areas of deep surface water ponding in the Herne Hill and Peckham areas;
- *Low Lying Areas* - areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- *Railway Embankments and Cuttings* - discrete surface water flooding locations along the upstream side of the raised network rail embankment (running roughly west to east through the centre of Southwark) and several railway cuttings throughout the Borough including railway lines near to Denmark Hill and Surrey Quays Stations;
- *Borough Central Belt* – the most extensive and deepest areas of surface water flooding in the Borough are located along the central belt of Southwark, north of the A202 (e.g. Camberwell and Old Kent Road); this coincides with the southern extent of the River Thames Flood Zone 3; and,
- *Sewer Flood Risk* – areas where extensive and deep surface water flooding or historical flood records indicate that surface water flooding is likely to be influenced by sewer flooding mechanisms alongside pluvial and groundwater sources (e.g. Herne Hill and Dulwich).

The results of this modelling and analysis suggests that 30,280 residential properties and 2,530 non-residential properties in the Borough could be at risk of surface water flooding of greater than 0.03m depth during the 1% AEP rainfall event¹⁶. Of those, 230 residential properties and 45 non-residential properties could be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event.

The SWMP further identified Local Flood Risk Zones (LFRZs) where flooding may affect houses, businesses or infrastructure. Those areas identified to be at more significant risk were further delineated into CDAs representing one or several LFRZs as well as the contributing catchment area and features that influence the predicted flood extent. Within Southwark, the five CDAs identified, are located in Herne Hill, Central Southwark, East Southwark, Camberwell and London Bridge.

Two of these CDAs, Herne Hill and Camberwell, cross the boundary with the London Borough of Lambeth and one CDA, East Southwark, crosses the boundary with the London Borough of Lewisham. Significant predicted flooding along Borough borders requires close cooperation between LBS and its neighbouring boroughs with respect to flood risk mitigation.

The surface water flood risk and CDAs across the Borough are shown in the Surface Water Flood Map, on Map A4.

3.3.2.1 Site Specific Modelling and Flood Alleviation Schemes

Following and building on the recommendations of the SWMP, detailed site-specific modelling has been undertaken for the areas of Herne Hill, Camberwell and Peckham Rye. This modelling has been undertaken for the purpose of several ongoing and completed flood alleviation schemes, to reduce the surface water flood risk in these areas.

Within Herne Hill, the completed flood alleviation scheme includes bunds and barriers to temporarily contain and redirect surface water, increased capacity of existing water bodies and additional underground water

¹⁶ Southwark Surface Water Management Plan (2011)
http://www.southwark.gov.uk/downloads/download/2956/surface_water_management_plan

storage. The low impact and sustainable approach has led to a reduction in surface water and sewer flood risk, while additionally contributing to local habitats, biodiversity and amenity.

A surface water storage scheme is currently being developed in Peckham, while a combination of storage and property level protection is proposed in East Camberwell.

The latest available outcomes of the site specific modelling undertaken to inform these schemes are shown in Appendix F. These outputs provide a greater refinement on the strategic level surface water flood maps provided in Appendix A.

3.3.3 Flooding from Groundwater

Groundwater flooding occurs as a result of water rising up from an underlying aquifer or flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is likely to be at shallow depth. Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. Groundwater flooding can also interact with other flood sources, exacerbating the risk of pluvial, fluvial or sewer flooding by reducing rainfall permeation or infiltrating to sewers.

As a part of the Southwark SWMP, a detailed analysis into groundwater flood risk was undertaken. This study identified key groundwater flooding mechanisms within Southwark, and the potential for this to interact with other forms of flood risk. The key findings are summarised below.

Much of the Borough is underlain by the London Clay Formation, which is an aquiclude, hydraulically separating the underlying Chalk principal aquifer and Basal Sands (Thanet Sand Formation and Lambeth Group) secondary aquifers from the overlying superficial deposits across the majority of the southern half and northwest area of the borough. However, in the Camberwell and Bermondsey areas, the London Clay Formation is absent and hydraulic continuity between bedrock and superficial deposit aquifers may exist. Additionally, it is thought that a perched water table(s) may exist within the Claygate Member in the south east (near to Crystal Palace).

Considering the underlying hydrogeology, the primary groundwater flooding mechanisms within the Borough are associated with:

- Elevated groundwater levels in the Chalk and Thanet Sand Formation aquifers (in the Bermondsey and Camberwell areas) and hydraulic interactions with the superficial deposits
- Superficial aquifers not in hydraulic continuity with surface watercourses or bedrock aquifers
- Superficial aquifers in hydraulic continuity with the River Thames.

The areas deemed to be at greater susceptibility to flooding from groundwater are illustrated in Map A5.

It can be seen that there are substantial areas, particularly to the north of the Borough where geological indicators suggest there is higher potential for groundwater flooding to occur at surface level. It should be noted that, within the areas delineated, the local rise of groundwater will additionally be heavily controlled by local geological features and artificial influences (e.g. structures or conduits).

3.3.4 Flooding from Reservoirs, Canals and Other Artificial Sources

Historically, many flood events within the Borough are understood to have occurred due to major water main bursts. Responsibility for maintenance and repair of water mains lies with Thames Water, as the network operator.

Reservoirs, water retention ponds and canals may also have a potential flood risk associated with them. Under normal circumstances, the flood risk posed is low; however, if a breach occurs, extensive flooding could be experienced.

Reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. The EA is the enforcement authority for the Reservoirs Act 1975 in England, responsible for ensuring regular inspection and maintenance.

A number of reservoirs and open water bodies have been identified within Southwark, including:

- Honor Oak Reservoir (covered water supply reservoir);
- Nunhead Reservoir (covered water supply reservoir);
- Belair Park Lake;
- Dulwich Park Lake;
- Canada Water (historical dock);
- Greenland Dock (historical dock); and
- South Dock (historical dock).

Areas at residual risk of flooding from reservoirs (during a breach event) within the Borough are illustrated within Map A7. This includes substantial areas around Peckham and Nunhead.

Numerous small local ponds and water features are also present across the Borough; however, very limited information exists with regards to their capacity and connectivity and therefore an assessment of the flood risk posed by them will need to be made at a site specific level.

3.3.5 Flooding from Sewers

Southwark is served by a combined sewer system, managed by Thames Water. Flooding can occur along the route of sewers when the flow entering a sewer exceeds its hydraulic capacity and the system becomes surcharged. Under these conditions water will overflow from the pipe network at manholes and storm overflows, often causing flooding in the vicinity.

Under current Thames Water standards, sewer systems are typically designed and constructed to accommodate a 1 in 30 year rainfall event. Therefore, during rainfall events of greater than a 1 in 30 year return period, the sewer system may be susceptible to surcharge and flooding. Additionally, drainage systems across London are of varying age and capacity, with many parts of the system thought to be designed to accommodate a 1 in 15 year return period rainfall event or less.

In addition to capacity issues, sewer flooding can be caused or exacerbated by blockage by debris or sediment. A further contributing factor to system surcharge is high water levels in receiving watercourses. Within the Borough there is potential for sewer outfalls to rivers to become submerged during high water levels (either fluvial or tidal). When this happens, water is unable to escape into the river and flows back along the sewer. Once storage capacity within the sewer itself is exceeded, the water will overflow into streets and houses.

Limited information on sewer capacity and flood risk is available for the Borough. The data provided by Thames Water (as described in Section 3.2.4) and shown within Map A2, is restricted to the postcode for the wider area where there is a history of flooding from sewers. This data is provided as a four-digit postcode area and only covers the previous ten years, resulting in the representation of relatively large areas by limited and isolated recorded flood events thus making it difficult to determine precisely where sewer flooding risk is greatest. In addition, Thames Water focuses their efforts on removing properties from the DG5 register. Therefore this dataset may no longer accurately represent those properties which are currently at risk, particularly in areas where flood alleviation schemes have been implemented.

3.4 Flood Defences

3.4.1 Condition and Standard of Protection

There are two main categories of flood defences across Southwark, formal and informal (de facto). Formal defences are specifically constructed to control floodwater, and are often maintained by the owner. Informal defences include structures that have not necessarily been constructed for this purpose but do have an impact on retaining flood water, such as railway and road embankments or other linear infrastructure such as boundary walls and buildings.

The primary flood defences within the Borough are the TTD, including the Thames Barrier and secondary tidal flood defences along the Thames frontage. The Thames Barrier, located in Woolwich Reach lies approximately 7km downstream of the Borough boundary and is the main structure of the TTD system. When closed, the barrier prevents extreme storm surges from flowing up the estuary and flooding central London. Additionally, the Barrier has also been used to control the risks of fluvial flooding to the upper stretches of the Thames, by closing during low tides to increase the storage capacity in the river channel to safely store fluvial floodwaters that are travelling downstream from the upper catchment in extreme events.

Within the Borough, the TTD consist of fixed defences on the Thames and a flood gate on the entrance to the South Dock Marina. There are also some drainage outfalls with tidal flap gates to prevent flow from the Thames into drainage systems.

Overall, the TTD are designed to provide protection up to a 1 in 1,000 year flood event.

The location of these defences within the Borough is shown on Map A7, along with the area of the Borough benefiting from their protection.

These defences, consisting of masonry, concrete or sheet piled walls are categorised as 'hard defences'. Such defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Erosion of the river bed is understood to be occurring within the Borough, which may require defence improvement to avoid damage.

The EA regularly monitors the condition of their flood defences and has a 5 year maintenance programme for them. During these inspections, defects are noted and maintenance is usually carried out following a priority scale.

Other informal flood defences have been identified within Southwark, consisting of raised earth and railway embankments, which act to retain overland flow. The location of these structures is additionally shown on Map A7.

3.4.2 Future Policy

The EA has recently completed a comprehensive programme of study referred to as TE2100, to establish the best approaches to manage flood risk in the estuary throughout the 21th century, taking into consideration various Climate Change scenarios.

For the geographical area encompassing the Borough, the study indicates that further action is required in order to keep up with climate change and further manage and reduce both the likelihood and consequence of flooding. This advocates an increase in the level of flood protection from the current 1 in 1,000 year level to 1 in 10,000; justified by the unique commercial, economic and historic value of London, as well as the potential for loss of life in the unlikely event of a flood.

Under the TE2100 plan, the recommended measures for defences within Southwark include:

- An ongoing programme of inspection, maintenance, repair and replacement of defences;
- Raising of all defences by up to 0.5 m by 2065; and
- Raising of all defences by an additional 0.5 m by 2100. This allows for projected increases in sea level to 2135.

The actual dates of defence raising will depend on the rate of sea level rise and may be revised with ongoing updates of the TE2100 Plan. The drainage outfalls into the Thames may also require improvement as the sea level rises and storm rainfall increases. These may additionally be impacted by works associated with the proposed Thames Tideway Tunnel.

The TE2100 plan further highlights the requirement for safeguarding land corridors along the River and setting back development where possible, to allow for defence maintenance, repair and wider riverside enhancement. A recommended width of 10 metres is specified.

It should be noted that, in the future, climate change is anticipated to increase the frequency of closure of the Thames Barrier. Operational constraints, and the needs of the river and its users, may place restrictions on this. Consequently other means of reducing the risk of fluvial flooding from the River Thames may have to be sought in future years.

3.5 Impact of Climate Change

Climate change is anticipated to have a significant impact on temperature, rainfall and seasonal changes within London. The latest predictions are for warmer and drier summers, and wetter winters, with appreciable changes anticipated by the 2020s¹⁷. Within London the following impacts are anticipated:

- *By the 2020s* - increase in summer mean temperature of 1.5°C, decrease in mean summer rainfall of 6% and increase in mean winter rainfall of 6% (from a 1961–1990 baseline)
- *By the 2050s*- increase in mean summer temperature of 2.7°C, increase in mean winter rainfall of 15% and decrease in mean summer rainfall of 18%
- *By the 2080s* - increase in mean summer temperature of 3.9°C, an increase of 20% in mean winter rainfall and decrease in mean summer rainfall of 22%

The expected impacts of Climate Change on various sources of flooding across the Borough are broadly described in Table 3-3 below.

Table 3-3 - Anticipated Impact of Climate Change on Flood Risk within the Borough

Flood Source	Anticipated Impact within Southwark
Groundwater Flooding	Increased frequency and intensity of rainfall events is anticipated, which could lead to further groundwater flooding in the Borough due to increased perched groundwater levels and associated spring flows
Surface Water and Sewer Flooding	Increased storm intensity, frequency and duration is anticipated to increase the pressure on existing drainage and sewer systems, potentially leading to more frequent localised flooding incidents.
Tidal Flooding	Thermal expansion of the oceans and polar ice melt is anticipated to lead to rises in mean sea level, storm surge height and frequency, and wave heights, exacerbating the tidal flood risk to the Borough from the Thames.
Fluvial Flooding	Changing rainfall patterns are likely to increase peak river flows, thereby increasing levels of fluvial flood risk across the Borough. While fluvial flooding from the Thames is considered unlikely to be a problem (because fluvial flood levels are unlikely to overtop the defences), this may act to exacerbate levels of tidal flood risk.

The impact of climate change has been taken into account as a part of the hydraulic modelling work undertaken for the Borough, and is reflected in the flood outlines for the 2065 and 2100 year scenarios, illustrated within the breach mapping. The Maximum Likely Water Levels utilised in each of these scenarios were formulated to be consistent with the levels used within the TE2100 study, considering the interaction of anticipated flow, tide and the operational philosophy of the Thames Barrier.

¹⁷ UK Climate Projections (2009) <http://ukclimateprojections.metoffice.gov.uk/>

3.5.1 Climate Change Allowances

The EA have recently updated national climate change allowances, to be used in the assessment of future flood risk, to support the NPPF in minimising vulnerability and providing resilience to the impacts of climate change. This includes predictions of anticipated change for:

- Peak river flow by river basin district;
- Peak rainfall intensity;
- Sea level rise; and
- Offshore wind speed and extreme wave height.

The range of allowances provided for river flow, rainfall intensity and sea levels are based on statistical percentiles, representing the range of possible climate change scenarios, which give rise to the central (50th percentile), higher central (70th percentile) and upper end (90th percentile) estimates of impacts.

The allowances provided are additionally based on a range of time periods, representing the anticipated impact over the next 100 years. The percentile and time period to be used is dependent on the proposed development location, vulnerability and design life.

It should be noted that, unless otherwise stated, residential development is assumed to have a design life of 100 years and commercial development is assumed to have a design life of 60 years.

The updated peak rainfall intensity allowances for small and urban catchments are presented in **Table 3-4** below.

Table 3-4 – Peak rainfall intensity allowances for small and urban catchments (adapted from EA guidance)

	Upper End	Central
Percentage change anticipated for 2015 - 2039	10%	5%
Percentage change anticipated for 2040 to 2069	20%	10%
Percentage change anticipated for 2072 - 20115	40%	20%

It is recommended that both the central and upper end allowances are considered in assessment of flood risk, in order to understand the potential range of climate change impact. The EA has provided detailed online guidance¹⁸ on the use of these allowances for flood risk assessment and it is recommended that reference is made to this source for the most up to date guidance.

Given the tidally influenced nature of the River Thames, adjacent to the Borough, anticipated rises in sea level and offshore wind and wave height will largely influence the maximum expected water levels over the next century. The maximum anticipated water levels (during tidal surge events) will be influenced by a complex interaction of sea levels, fluvial flows and operation of the Thames Barrier, investigated in detail during the TE2100 project¹⁹.

¹⁸ Climate change allowances for Flood Risk Assessment <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

¹⁹ Thames Estuary 2100 Plan <https://www.gov.uk/government/publications/thames-estuary-2100-te2100>

4 Managing Flood Risk

4.1 Risk Based Approach to Planning

The NPPF approach aims to ensure that flood risk is considered at all stages of the planning process and to avoid inappropriate development in areas of greatest flood risk; steering development towards areas of lower risk.

Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, the sustainability benefits of that development outweigh the risks from flooding and, the development will be safe for its lifetime without increasing flood risk elsewhere. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur.

Building on these principles, the NPPF and Technical Guidance have established a process for the assessment of flood risk, with each stage building upon the previous assessment with a refinement of the evidence base. Utilising a Source – Pathway – Receptor approach, the source of flooding, the spatial distribution of flood risk and the vulnerability of development types are assessed to inform decision making through each of the key stages of the Flood Risk Management Hierarchy, as outlined in the NPPG and shown in Table 4-1 below.

Table 4-1: Flood Risk Management Hierarchy and the SFRA Process



Stage	Approach
Level 1 SFRA	Assessment (broad scale and comprehensive)
Sequential Test Across Planning Area	Avoidance
Level 2 SFRA (if required)	Detailed Assessment (Growth Area or Site Specific)
Sequential Approach at Site	Avoidance
Control and Improvement	Through Design (e.g. SuDS)
Mitigate Remaining Risks	Flood Resilient Design and Construction

4.1.1 Applying the Sequential Test

As described in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. As such, development should not be permitted in areas of flood risk, where there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Sequential Test should be carried out on all development sites and can be applied at all levels and scales of the planning process, both between and within Flood Zones.

The approach seeks to prevent the allocation of sites that are inappropriate on flood risk grounds by considering the vulnerability of the type of development proposed and how compatible the intended use is with the level of flood risk at the site. Five vulnerability classifications are defined; these are listed below and further defined in Table 4-2.

- Essential Infrastructure;
- Highly Vulnerable;
- More Vulnerable;
- Less Vulnerable, and
- Water Compatible.

Table 4-2: Flood Risk Vulnerability Classifications (from Table 2 in the NPPG)

Appropriate Use Classification	Examples of Classification
Essential Infrastructure	<ul style="list-style-type: none"> • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons and needs to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	<ul style="list-style-type: none"> • Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • 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, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	<ul style="list-style-type: none"> • Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non-residential institutions not included in "more vulnerable", 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 working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water Compatible Development	<ul style="list-style-type: none"> • Flood control infrastructure. • Water and Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence, 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 ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

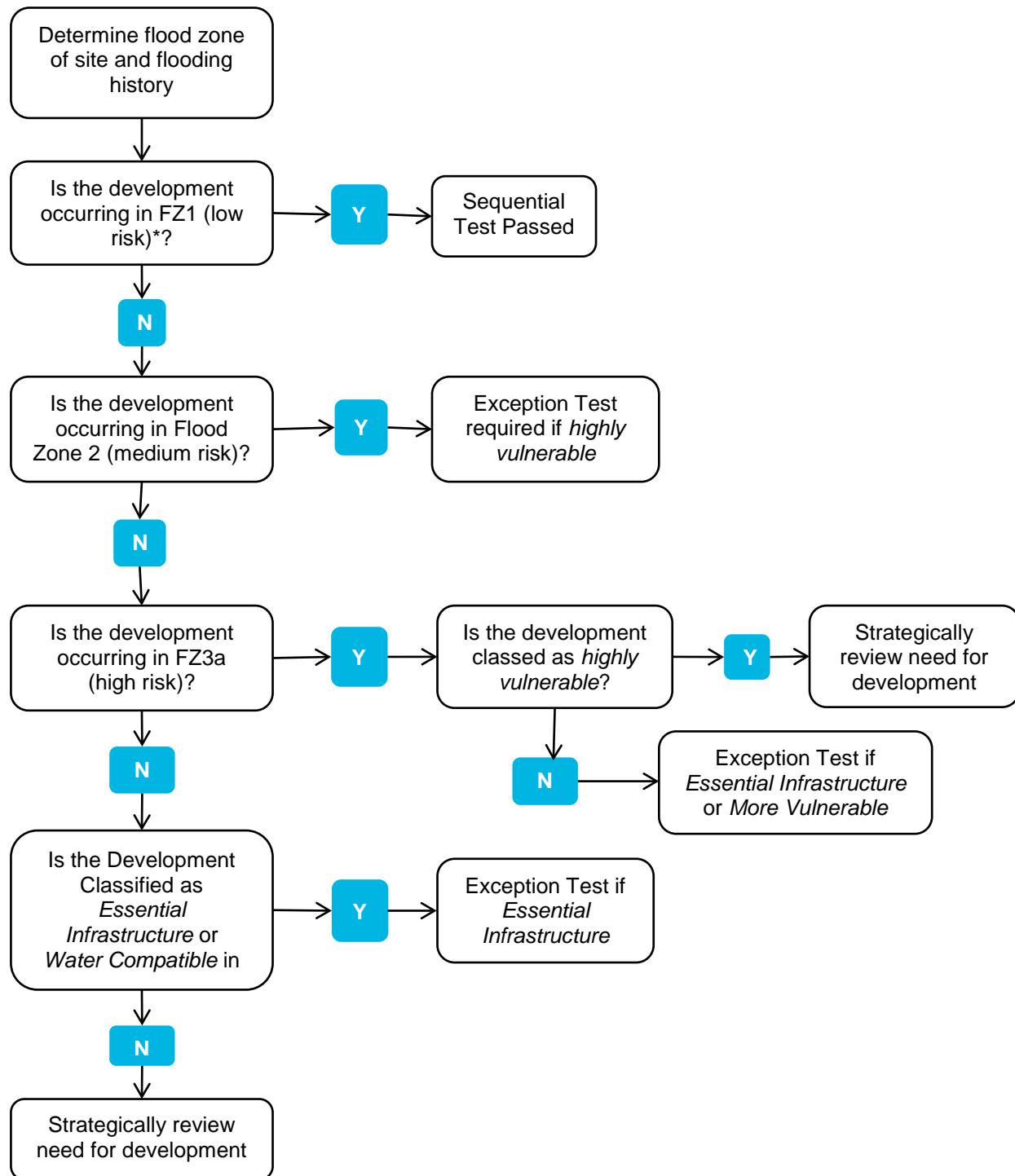
Table 4-3 illustrates the types of development that are considered as suitable within areas of varying perceived flood risk. This utilises the Flood Zones defined earlier, and delineated for the Borough in Map A3.

Table 4-3: Flood Zones and Development Compatibility (from Table 3 in the NPPG)

Flood Zone	Description	Annual probability of river or sea flooding	Appropriate uses
Zone 1	Low Probability	1 in 1,000 (<0.1%)	<ul style="list-style-type: none"> • All uses
Zone 2	Medium Probability	1 in 100 – 1 in 1,000 (river) (1-0.1%) 1 in 200 – 1 in 1,000 (sea) (0.5-0.1%)	<ul style="list-style-type: none"> • Water Compatible • Less Vulnerable • More Vulnerable • Essential Infrastructure • Highly Vulnerable*
Zone 3a	High Probability	1 in 100 or greater (river) (>1%) 1 in 200 or greater (sea) (>0.5%)	<ul style="list-style-type: none"> • Water Compatible • Less Vulnerable • More Vulnerable* • Essential Infrastructure*
Zone 3b	The Functional Floodplain	1 in 20 or greater (5%) or land which is designed to flood in an extreme (0.1%) flood.	<ul style="list-style-type: none"> • Water Compatible • Essential Infrastructure*

Notes: *only if Exception Test passed

This SFRA provides the tools to undertake the Sequential Test by presenting information to identify the variation in flood risk across the Borough, allowing an area-wide comparison of future development sites with respect to flood risk considerations. The following flow diagram (Figure 4-1) illustrates how the Sequential Test process should be applied to identify the suitability of a site for allocation, in relation to the flood risk classification.



* Other sources of flooding also need to be considered

Figure 4-1: Sequential Test Process - Schematic

If, following the application of the Sequential Test, a proposed site allocation does not meet the criteria of acceptability, that site might qualify for the application of an Exception Test. This test considers both the development safety and the benefit of the site to the wider sustainability objectives of the Borough in order to establish whether the development can be deemed acceptable. This test is further described below.

It should be noted that, while the focus of the Sequential Test is on tidal and fluvial flood risk (through use of the NPPF Flood Zones), some areas of the Borough will be at risk of flooding from other sources. Consequently all sources of flooding must be considered in the location of new development. If the development is not deemed water compatible, and the site is found to be impacted by a recurrent flood source

(other than fluvial), the site and flood sources should be investigated further irrespective of a requirement for the Exception Test.

4.1.2 Exception Test

The Exception Test is an additional test to be applied by decision-makers following application of the Sequential Test. The Exception Test has two elements as shown below, both of which must be satisfied for development in a flood risk area to be considered acceptable.

The Exception Test provides a method of managing flood risk while still allowing necessary sustainable development to occur. The test is only appropriate for use when there are large areas in Flood Zones 2, 3a and 3b, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons. The flow chart presented in Figure 4-1 and Table 4-3 demonstrates the methodology to determine whether an Exception Test is required for proposed site allocations.

In order to pass the Exception Test, the NPPG identifies the following considerations that need to be demonstrated/fulfilled to the satisfaction of the LPA:

- That the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and
- A site-specific flood risk assessment (FRA) must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

Satisfying the Exception Test involves consideration of the reasons behind the selection of the site for development, from the sustainability appraisal, as well as consideration in planning and design, such that the site will remain safe and operational in the event of flooding. This may involve demonstrating:

- A sequential approach is taken to development site layout, such that within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- Buildings are designed to be appropriately flood resilient and resistant, with essential services remaining functional in the event of flooding, and quick recovery following a flood;
- Provision of safe means of access and egress during a flood event;
- Emergency evacuation procedures are developed, to be utilised following receipt of a flood warning; and
- Priority is given to the use of SuDS.

Further detail on undertaking site specific flood risk assessments, including measures to safely mitigate and manage flood risk, are provided in Chapter 5.

Both parts of the Exception test must be satisfied in order for the development to be considered acceptable in terms of flood risk. There must be robust evidence in support of every part of the test.

A significant proportion of Southwark is located within Flood Zone 3a of the River Thames; therefore it is likely that the requirements of the Exception Test will need to be satisfied for 'more vulnerable' e.g. residential, development in this area.

For this reason, the breach modelling has been considered during this Level 1 SFRA to enable LBS to take into account the variation in flood depth and hazard within Flood Zone 3a when allocating development sites. The breach modelling information should be used at this early stage to determine whether more appropriate locations are available within Flood Zone 3a, with a lower hazard rating.

4.2 Recommendations for Policy and Practice

To ensure a holistic approach to flood risk management and ensure that flooding is taken into account at all stages of the planning process, the findings of this report should be incorporated into the new Southwark Plan. This will help to ensure that flood risk is taken into account at all levels of the planning process.

Given the location of Southwark adjacent to the River Thames, the Borough is highly reliant on flood defences. Nevertheless, it is recommended that policy options are expanded to include greater emphasis on floodplain management, in addition to flood defence. This may include more appropriate use of the floodplain (Flood Zone 3), making space for water, improved flood preparedness and enhanced emergency planning and response measures.

Specific recommendations for the Borough are detailed in the following sections. An overview table summarising key spatial planning and development control recommendations is additionally contained in Appendix G.

4.2.1 Strategic Planning

When considering strategic spatial planning across the Borough, flood risk should be an early and primary consideration. A sequential approach should be taken to allocating strategic development areas in regions of lowest flood risk, taking into account vulnerability of land use. Consideration should also be given to strategic allocation of open space and preserving and expanding river corridors to create space for flooding to be managed effectively.

In particular, the following specific recommendations are made:

- Ensure the Sequential Test is undertaken for all strategic land allocations to reduce flood risk to the allocation and ensure that the vulnerability classification of the proposed land use is appropriate to the Flood Zone classification.
- Pursue potential opportunities to move existing development from within the floodplain to areas with a lower risk of flooding. This should include consideration of the vulnerability of existing developments and whether there is potential for land swap with lower vulnerability uses.
- Identify opportunities to create space for water and flooding through appropriate location, layout and design of development, in order to accommodate climate change and assist in managing future flood risk. This can be achieved by restoring floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for storage.
- Safeguard existing corridors of land along the River Thames and tributaries and promote the setting back of development to enable sustainable and cost effective flood risk management, including upgrading of river walls and embankments.
- Consider opportunities to realign or set back defences and improve the riverside frontage to provide amenity space and environmental enhancement. A combination of defence realignment and floodplain management could reduce the impact of flooding to existing properties and other assets located in the floodable areas on the river side of realigned defences (similar to the approach used around the Tate Modern at Bankside).
- The consultation and initial investigation associated with detailed site specific flood risk assessments should be undertaken at an early stage for major development locations to ensure opportunities to reduce flood risk are identified early and maximised wherever possible.
- Ensure that developments at residual risk of flooding are designed to be flood compatible and/or flood resilient and maximise the use of open spaces within these developments to make space for water during times of flooding. Opportunities should be sought to identify a safe route for any exceedance flow of floodwaters and a suitable storage or discharge location, to avoid any risk to people.
- A number of Opportunity Areas have been identified within Southwark, targeted to deliver strategic growth and development. Consideration should be given to undertaking Integrated Water Management Strategies within these areas, in order to holistically assess flood risk, water supply and drainage requirements and constraints for these areas.

- The London Borough of Southwark look at opportunities to undertake integrated water management strategies for different parts of the Borough as a way of dealing with issues including limited capacity of drainage infrastructure, flood risk and water scarcity. These strategies seek to find a balance between excess and lack of water across an area by considering a mixture of sustainable and innovative solutions at site, neighbourhood and area level.

4.2.2 Development Control

In consulting on and determining development applications, LBS will ensure that all new developments have considered flood risk management from the planning stage. In general, this means that:

- Development is located in the lowest risk area where possible;
- New development is flood-proofed to a satisfactory level/standard and does not increase flood risk elsewhere; and
- Surface water is managed effectively on site.

When a proposed development is located within an area perceived to be at risk of flooding, then a FRA should determine the actual level of risk to the development and identify options to mitigate the flood risk to the development, site users and surrounding area. The requirements for site specific flood risk assessments and their contents are further detailed in Chapter 5.

Planning applications should be considered and assessed in line with the sequential approach detailed in Section 4.1. Further, more specific recommendations and considerations for development planning are provided below:

- If development is to be constructed with less vulnerable uses on the ground level, covenants need to be put in place to prevent future alteration of these areas to 'more vulnerable' uses without further consideration of the associated flood risk.
- Single storey residential development should not be considered in high flood risk areas as they offer no opportunity for safe refuge.
- NPPF does not permit basement dwellings to be located within Flood Zone 3a, and as such these should not be permitted in any areas at risk of flooding. This would include the excavation of basements under existing dwellings.
- Residual flood risk should be managed through emergency planning, site design and protection measures. The key residual flood risks within Southwark are overtopping or breach of the River Thames.
- Where development within flood risk areas is necessary due to wider sustainability/regeneration objectives, flood resistance and resilience practices should be followed in the construction and operation of the buildings to minimise the impact of flooding.
- All residential floor levels should be situated a minimum of 300 mm above the 2100 Maximum Likely Water Level, anticipated through a breach of the River Thames defences. Potential access and egress routes should also be considered and recommendations made for appropriate actions of future occupants in the event of a breach occurring.
- Flood risk from all sources should be considered when identifying the perceived level of flood risk affecting a site.
- Opportunities should be taken to identify sites where developer contributions could be used to fund future flood risk management schemes, improvements to surface water drainage systems or flood defences in adjacent areas. However, it should be noted that developer installed defences should not wholly justify development in locations with inappropriate levels of flood risk;
- If Greenfield runoff rates cannot be achieved due to site constraints, contribution to off-site solutions to reduce surface water flooding in the local areas could be taken into consideration.
- An 8 m and 16 m buffer strip must be maintained along fluvial and tidal river corridors respectively, to ensure maintenance of the channel can be undertaken. Additionally, opportunities should be pursued

- for small scale set back of existing development from river walls to enable these structures to be modified, raised and maintained in a sustainable, aesthetically acceptable and cost effective way
- For developments adjacent to the River Thames, particular consideration should be given to facilitating the recommendations of the TE2100 plan in maintaining, enhancing and replacing flood defences, and safeguarding riverside land.

4.2.3 Flood Defences

The SFRA has highlighted the importance of flood defences to the Borough. As such, future policy should seek to ensure that the current high level of protection is retained (and improved where possible) by those responsible for maintaining flood defences in the area (e.g. riparian land owners, EA, others, etc.).

In particular, the future sustainability of the Borough (and London as a whole) is dependent to a large degree upon the retention and ongoing maintenance of the TTD in the longer term. However, decisions surrounding investment of this nature in future years cannot be predicted with any certainty. Additionally, the exact impact of climate change, and the interaction of the resulting hydrological effects with operational and wider issues is still uncertain. It is therefore imperative that planning decisions are taken with a clear understanding of the potential risks posed to property and life should things ultimately go wrong. As such, redevelopment must ensure that residual flood risk is reduced in areas benefiting from flood defence measures through effective mitigation.

As discussed, management of the TTD within the Borough will include routine activities of inspection, maintenance, repair and replacement of defences, in addition to eventual raising of levels to allow for the impact of climate change. However, raising the level of defences on the current footprint would introduce a visual barrier to the river and will not achieve any wider sustainability objectives. Therefore, opportunities should be pursued for subsequent improvement of the riverside through integrated design, considering public access and connectivity, amenity, landscaping and environmental enhancement. Where new development is proposed adjacent to the TTD, consideration should be given to the specific recommendations of the TE2100 plan, in requiring reduction of current and future flood risk through:

- Raising existing flood defences to the required levels in preparation for future climate change impacts or otherwise demonstrate how tidal flood defences can be raised in the future, through submission of plans and cross-sections of the proposed raising;
- Demonstrating the provision of improved access to existing flood defences and safeguarding land for future flood defence raising and landscape, amenity and habitat improvements;
- Maintaining, enhancing or replacing flood defences to provide adequate protection for the lifetime of development;
- Where opportunities exist, re-aligning or setting back flood defence walls and improving the river frontage to provide amenity space, habitat, access and environmental enhancements; and
- Securing financial contributions towards the anticipated costs of FRMI required to protect the proposed development over its lifetime.

In more general consideration of FRMI, local policy should continue to maintain and expand assets that are effective in managing current and future flood risk and promote wider sustainability.

4.2.4 Sustainable Drainage Systems

SuDS must be included in new developments as a way to manage surface water flood risk, improve water quality and increase amenity and biodiversity. Runoff rates from new development on greenfield sites should be restricted to greenfield runoff rates, as required by the London Plan. Development on Brownfield sites should also aim to achieve greenfield runoff rates wherever possible.

SuDS should be delivered in accordance with the Sustainable Drainage Hierarchy set out in Policy 5.13 of the London Plan, the emerging Sustainable Design and Construction SPG, the emerging London Sustainable Drainage Action Plan and CIRIA guidance C753. A preference should be given to the installation of blue-green surface infrastructure wherever possible, as opposed to hardscape or underground solutions, due to the wider benefits for biodiversity, amenity and microclimate.

The underlying geology within Southwark is likely to impose constraints on the implementation of infiltration SuDS in many areas across the Borough. This is likely to necessitate the installation of lined systems to provide attenuation and reduction of runoff rates, requiring reuse of runoff or discharge to local surface water bodies or drainage systems.

Greater detail and recommendations for SuDS within the Borough are contained in Section 5.3.

4.2.5 Emergency Planning

It is strongly recommended that emergency planning strategies are put in place in areas deemed at actual and/or residual risk of flooding to ensure adequate preparation and response is in place during flood events. Where a new development or change of land use is proposed, flood evacuation plans should be developed through liaison with the emergency planners and the emergency services.

Additionally, following production of this SFRA, it is recommended that emergency planning strategies should be reviewed to determine the suitability of refuge centres and evacuation routes based on the updated flood risk mapping produced.

Emergency Planning can be broadly split into three phases, all of which should be considered in managing flood risk across the Borough:

- *Before a flood* – raising flood awareness, ensuring no inappropriate use of the floodplain/flow paths, preparing suitable flood emergency plans and communicating them to the wider community;
- *During a flood* – Flood alerts and communication, rescuing occupants, providing safe refuge and alternative accommodation;
- *After the flood* – providing support to help people recover and return to their homes and businesses.

Consideration of emergency planning is even more critical when it relates to vulnerable sites and essential infrastructure, as further described below. The Map A10 series within this SFRA indicates the location of vulnerable sites within the Borough, in relation to the various sources of flood risk.

4.2.5.1 Vulnerable Sites

Emergency service authorities responsible for hospitals, ambulance, fire and police stations should ensure that emergency plans, in particular for facilities in flood risk areas, are in place and regularly reviewed so that they can cope in the event of a major flood. These plans should be put in place to cover arrangements through other suitable facilities.

The NPPF classifies police stations, ambulance stations, fire stations and command centres as Highly Vulnerable buildings. It is essential that all establishments related to these services are located in the lowest flood risk zones to ensure that in the event of an emergency those services vital to the rescue operation are not impacted by flood water. Furthermore, development control policies should seek to locate more vulnerable uses such as schools and care homes in areas at the lowest risk of flooding to minimise the impact of a flood on their vulnerable users.

Allied to this, nominated rest and reception centres should also be identified within the study area and compared with the outputs of this SFRA to ensure that these centres are not at risk of flooding, so that evacuees will be safe during a flood event. Developments that would be suitable for such uses would include leisure centres, churches, schools and community centres.

4.2.5.2 Critical Infrastructure

In the event of a flood incident, it is essential that the evacuation and rescue routes to and from any proposed development remain safe. Floodplain management and emergency response activities must have a focus on key infrastructure such as the London Underground network and any properties that are below sea level. Essential infrastructure located in Flood Zone 3a must be operational during a flood event to assist in the emergency evacuation process.

Relevant transport authorities and operators should examine and regularly review their infrastructure including their networks, stations, and depots, for potential flooding locations and to identify the need for any flood risk

reduction measures. For large stations and depots, solutions should be sought to store or disperse rainwater from heavy storms in a sustainable manner.

4.2.6 Basements

Basement dwellings are classified as highly vulnerable development and should not be permitted within Flood Zone 3. Basement access threshold levels should be raised above the 1 in 100 year flood level with climate change, and all basements must include provision of internal staircases to upper floors. Flood resilient construction techniques should be employed and consideration given to all forms of flood risk.

It is recommended that basement impact assessments are a requirement for all proposed basement developments, in order to demonstrate that the proposals are safe from a flood risk perspective, and will not have any adverse impacts on local hydrogeology.

4.2.7 Integrated Water Management

It is recommended that a holistic approach to flood risk management is adopted across the Borough within the wider context of the water cycle and local environment. In particular, it is anticipated that growing population numbers and changing climate patterns will place increased pressure on already stressed water resources within London. New development can assist in alleviating this water scarcity by incorporating water efficiency measures such as grey water recycling, rainwater harvesting and water use minimisation technologies. This will also have a substantial benefit on the sewer system which will receive less wastewater from properties, potentially freeing up capacity during flood events.

Similarly, consideration should be given to maximising the benefits of surface water management infrastructure to enhance the urban environment for the benefit of communities and biodiversity. Through high quality design and installation, such infrastructure can contribute to multi-functional benefit in the following areas:

- *Provision of habitat and biodiversity* - when adequately planned, the delivery of diverse, high quality green spaces can provide valuable habitat to a range of flora and fauna, including birds and invertebrates, while contributing to green corridors, allowing the movement of species through urbanised spaces.
- *Recreation and community* - provision of space for recreation and contribution to community health, wellbeing and social cohesion.
- *Microclimate adaptation* - Reducing the impact of the urban heat island effect by providing shading to protect against radiations, reducing local temperatures through evapotranspiration and reducing heat absorbed and then released by surfaces.
- *Public realm* - street greening and the delivery of effectively landscaped open spaces can substantially improve the amenity value of neighborhoods

4.2.8 Consultation and Coordination

In order for future flood risk management within the Borough to be successful, it is essential that relevant partners and stakeholders, who share responsibility for flood risk management assets work collaboratively to reduce flood risk in the Borough.

In particular, LBS will continue to work with the EA and others to ensure ongoing maintenance and improvement of the River Thames Defences. This will include ensuring that the recommendations of the TE2100 Plan are implemented in new and existing developments, to keep communities safe from flooding in a changing climate and improving the local environment.

Similarly, opportunities will be sought to reduce the risk of flooding from surface water and sewer surcharge through consultation with Thames Water, to determine key areas for maintenance and locations that would benefit from flood alleviation schemes.

5 Guidance for Developers

5.1 Site Specific Flood Risk Assessment

The aim of a site specific FRA is to assess the flood risk to and from a proposed development, and demonstrate that it will not be at risk of flooding during the design event. This includes assessment of mitigation measures required to safely manage flood risk and demonstration that the proposed development will not increase flood risk elsewhere. All sources of flood risk will need to be considered.

This section presents the recommendations for site specific FRAs prepared for submission with planning applications to LBS, following the approach recommended by:

- The EA, particularly its Flood risk standing advice²⁰
- NPPF and NPPG²¹;
- CIRIA C753 The SuDS Manual²²;
- CIRIA report 624, Development and Flood Risk: Guidance for the construction industry
- LBS's Developers' Guide for Surface Water Management (contained in Appendix H)
- LBS's Basements and Flooding – Guidance for Developers (contained in Appendix I)

FRA reports are usually undertaken by the developer and submitted as part of the planning application process, however, there are instances where a LPA might wish to commission a detailed, site-specific FRA to further understand the level of risk associated with a strategic site, and to inform decision making. An example of this would be where new flood defences or improved SoP to existing defences is considered for a site, and the resultant flood reduction benefits, loss of floodplain storage and downstream implications need to be understood.

A site specific FRA is required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1;
- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
- Proposals for new development (including minor development and change of use) in any CDAs (as designated by either the Borough or the EA); and
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

A FRA should demonstrate that the proposed development is safe from flooding from all sources, including the provision of safe access and egress, and that the development does not increase flood risk elsewhere. Proposals for the sustainable management of surface water should also be presented through a drainage strategy, demonstrating betterment in terms of runoff rates, amenity and biodiversity, as further described in Section 4.2.4.

If a detailed FRA is required, it must be undertaken by a suitably qualified professional. Assessments should be on a site by site basis making use of local knowledge. However, an initial assessment of flood risk can be made by consulting the mapping section of this SFRA.

FRAs should also be appropriate to the scale, nature and location of the development. Table 5-1 presents the different levels of site-specific FRA (as defined in CIRIA publication C624) and identifies typical sources of information that can be used.

²⁰ Environment Agency Flood Risk Standing Advice <https://www.gov.uk/guidance/flood-risk-assessment-standing-advice>

²¹ National Planning Policy Framework <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

²² The SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

Table 5-1 - Levels of Site Specific FRA (CIRIA C624)

Level	Requirements	Typical Sources of Information
Level 1 Screening Study	<p>The Level 1 FRA should identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information.</p>	<p>Typical sources of information include:</p> <ul style="list-style-type: none"> • LBS SFRA, SWMP and PFRA; • Flood Map for Planning (Rivers and Sea); • Local flood risk policy documentation (such as Flood Risk Management Plan, Catchment Flood Risk Management Plan and Local Flood Risk Management Strategy); • EA Standing Advice; and • NPPF Tables 1, 2 and 3.
Level 2 Scoping study	<p>The Level 2 FRA should be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include:</p> <ul style="list-style-type: none"> • An appraisal of the availability and adequacy of existing information; • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. <p>The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.</p>	<p>Typical sources of information include those listed above, plus:</p> <ul style="list-style-type: none"> • Local policy statements or guidance, Local Flood Risk Management Strategy; • Catchment Flood Management Plan; • Data request from the EA to obtain results of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity; • Consultation with EA/LBS/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding; • Historic maps; • Interviews with local people and community groups; • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition; and • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.
Level 3 Detailed study	<p>To be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include:</p> <ul style="list-style-type: none"> • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and • Quantitative demonstration of the effectiveness of any proposed mitigations measures. 	<p>Typical sources of information include those listed above, plus:</p> <ul style="list-style-type: none"> • Detailed topographical survey; • Detailed hydrographic survey; • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development; • Monitoring to assist with model calibration/verification; and • Continued consultation with the LPA, EA and other flood risk consultees.

5.1.1 Flood Risk Assessments for Flood Zone 1

Site specific flood risk assessments are required in Flood Zone 1, if a proposed development is:

- 1 hectare or greater;
- Within a defined CDA as designated by either the Borough or the EA (and shown on Map A4); or
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

The following recommendations are made for site specific FRA's in Flood Zone 1.

- The developer should check whether the site has been identified as at risk from other (non-river related) flood sources by referring to the relevant maps within this SFRA. If so, a more detailed assessment of this risk over the lifetime of the development must be made.
- Assess the flood risk from all sources, including an assessment of the effects of climate change over the lifetime of the development.
- A drainage impact assessment must be carried out by a suitable professional to identify the impact of the proposed development on surface water drainage and recommend the approach to controlling runoff to the required discharge rates, through the use of SuDS. Where possible, runoff should be reduced to Greenfield Rates, in accordance with the recommendations of the London Plan.
- If the development is adjacent to a river, it must be set back an appropriate distance from the watercourse and development must enhance the river form and habitat. If culverted, the development should not build over the culvert and the developer should seek opportunities to de-culvert the watercourse as part of the development.
- The FRA must show that flood risk will be reduced overall.

NPPG (Table 3) confirms that all types of development are deemed suitable in Flood Zone 1.

If the site is on a 'dry island', surrounded by Flood Zone 2 or 3, the developer must also show that safe access and egress will be possible during a flood event.

5.1.2 Flood Risk Assessments for Flood Zones 2 and 3

A FRA must be undertaken for any proposed developments in flood zones 2 and 3. It is strongly recommended that the Sequential Test, and, depending on the vulnerability of the development (refer to Table 4-2), the first two parts of the Exception Test, be satisfied before the FRA is commenced.

If the development is within Flood Zone 2 or 3, the flood risk will be greater, and therefore the following recommendations and comments are made in addition to those that apply to sites in Flood Zone 1.

- The Sequential Test should demonstrate that there are no other suitable alternative sites in Flood Zone 1 for development.
- Show that flood risk will be reduced, and that suitable methods of mitigation will protect the development against fluvial or tidal flooding. Within Southwark, the TTD provide mitigation of tidal and fluvial flooding from the River Thames up to a SoP of 1 in 1,000 years. However, developers must demonstrate mitigation of residual flood risk due to breach of the River Thames defences, by considering the Maximum Likely Water Level, including climate change, over the lifetime of the development.
- Show that safe access can be provided to an appropriate level for the type of development.
- Show that flow routes are preserved and floodplain storage capacity is not reduced.
- The residents and occupiers of commercial buildings should be made aware their home / business is located in an area of flood risk, and should be encouraged to sign up to the EA Floodline Warnings Direct service (if available in this location).

It should be noted that, unless otherwise stated, residential development is assumed to have a design life of 100 years and commercial development is assumed to have a design life of 60 years. If in Flood Zone 3, the

FRA must also confirm whether the development is located in Flood Zone 3a or 3b. It should be noted that only planning applications for essential infrastructure or water compatible development will be considered in Flood Zone 3b. Within Flood Zone 3b it must additionally be demonstrated that the development will:

- Remain operational and safe for users in times of flood;
- Result in no net loss of floodplain storage;
- Not impede water flows; and
- Not exacerbate flood risk elsewhere.

It should be noted Flood Zone 3b within Southwark is restricted to areas in front of the Thames defence line.

5.2 Reducing Residual Flood Risk

Within Southwark, the TTD provide mitigation of flooding from the River Thames with a SoP of 1 in 1,000 years. However, there remains a residual flood risk of flooding due to breach or overtopping of these defences. Developers should protect against residual flood risk, to the Maximum Likely Water Level, with allowance for climate change over the lifetime of the development. Flood risk from all sources should additionally be considered. The measures chosen will depend on the nature of the flood risk. Some of the more common measures are broadly outlined in this section.

5.2.1 Reducing Flood Risk through Site Layout and Design

Flood risk should be considered at an early stage in deciding the layout and design of a development to provide an opportunity to reduce flood risk within the site. NPPF and NPPG state that a sequential, risk-based approach should be applied to try to locate more vulnerable land (such as residential use) use to higher ground, while more flood-compatible development (e.g. parking, recreational space) can be located in areas at the highest risk of flooding within the site.

Low-lying waterside areas, or areas along known surface water flow routes, can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, while avoiding the creation of isolated islands as water levels rise.

5.2.2 Modification of Ground Levels

Modifying ground levels to raise the land above the required flood levels may be a potential means of reducing flood risk at certain sites, particularly where the risk is entirely from tidal flooding and the land does not provide conveyance for flood waters. However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced by raising land above the floodplain, thus adversely impacting on flood risk downstream. As such, compensatory flood storage must be provided to account for land raises in the floodplain. Where the site is entirely within the floodplain it is not possible to provide compensatory storage at the maximum flood level and this will not be a viable mitigation option.

For proposed sites shown to be at actual risk of flooding from the 1 in 100 year plus Climate Change event, localised topography raising must be balanced with suitable floodplain compensation storage at a location (to be agreed with the EA). Such locations need to be sited in areas that currently do not flood (i.e. not part of the floodplain) and ideally within the redline application boundary.

Hydraulic modelling is likely to be needed to demonstrate that the floodplain compensation design is technically robust, that there is no increase in flood risk off-site and that flood flow paths are not altered in such a way that could cause increase of flooding elsewhere. Consideration should also be given to surface water ponding, which may be increased due to changes in local topography.

5.2.3 Raised Defences

Construction of raised floodwalls or embankments can relocate floodwaters away from new development or reduce the rate of flood inundation following a residual event. However, this should not be regarded as a preferred option for new development, as a residual risk of flooding will remain. Additionally, it is essential to ensure that diversion of flood water does not increase flood risk to other people and properties in other areas. Compensatory storage must be provided where raised defences remove storage from the floodplain. Temporary or demountable defences are not acceptable flood protection for new development unless flood risk is residual only.

5.2.4 Upstream Flood Storage

Flood storage areas can be an effective way of attenuating floodwater for management of flood risk in surrounding areas. The basic function of these techniques is increased flood storage, through installation of features including pools, ponds, ditches and river restoration schemes. These features can provide habitat for local wildlife, contributing to local ecology and biodiversity, while additionally providing open space for recreational and amenity benefit.

5.2.5 Developer Contributions to Flood Defences and Risk Management Infrastructure

Riparian developments are required to have flood defences renewed or otherwise made good for the life of the development, accounting for the effects of climate change. In some cases, it may be necessary for the developer to make a contribution to the improvement of flood defences, or other flood alleviation schemes that would benefit both the development in question and the local community. Developers should also assess other existing assets (e.g. bridges, culverts, embankments) and renew them to last at least the lifetime of the development.

Proposed developments which are adjacent to main rivers should show that sufficient access is provided to existing defences for their maintenance, and where appropriate improvement has been considered. Where possible, development should be set back from the edge of the Thames and waterways to enable future sustainable and cost effective flood risk management, including upgrade of river walls and embankments.

5.2.6 Building Design and Finished Floor Levels

Where developing in flood risk areas is unavoidable, the most common method of mitigating flood risk to occupants is to ensure habitable floor levels are raised above the maximum flood water level. This significantly minimises the risk of damage to the building interior, furnishings and electrical installations during flood events. Floor levels should ideally be raised by the following recommended amounts, as a minimum:

- In areas at fluvial flood risk:
 - 300 mm above the 1% AEP event plus climate change water level;
- In areas at risk of tidal flooding due to breach in the TTD:
 - 300 mm above the maximum water level caused by a defence breach, including consideration of climate change.

This additional height that the floor level is raised is referred to as the ‘freeboard’. The climate change scenario considered should be based on the anticipated design life of the development. Unless otherwise stated, residential development is assumed to have a design life of 100 years, and commercial development is assumed to have a design life of 60 years.

Making the ground floor use of a building water compatible (for example a garage), may also be an effective way of raising living space above likely flood levels.

Constructing a building on stilts is not considered an acceptable means of flood mitigation for new development. However, it may be allowed in special circumstances if it replaces an existing solid building, as it can improve flow routes. In these cases safe access and egress must be provided and covenants established to ensure the ground floor use is not changed at a later stage.

5.2.7 Flood Resistance and Resilience

There may be special circumstances under which flood risk to a development remains. For example where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 0.1% AEP. In such cases (and for existing development in the floodplain), additional measures can be put in place to reduce damage during a flood and increase the speed of recovery. These measures should not be relied on as the only mitigation method.

Flood resistance measures aim to prevent floodwaters from entering a property and damaging its fabric. Such measures may be temporary, such as demountable flood barriers and door flood guards for individual properties. If installed correctly, in advance of a flood event these measures can work effectively. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water. However complications can arise regarding transportation of defences and installation time, therefore a reasonable time period between flood warning and the onset of flooding is required.

The use of temporary resistance measures is considered appropriate for existing properties, however they are not recommended for new development. This is because the temporary measures require intervention to function plus continued maintenance procedures which cannot be guaranteed. Permanent flood resistance measures such as use of low permeability materials to prevent water ingress are therefore recommended for new development.

Flood resilience measures aim to reduce the consequences of flooding and ensure that buildings can be swiftly returned to normal use following a flood event. This includes interior design to reduce damage caused by flooding by for example:

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

Resilience measures will be specific to the nature of flood risk and the type of development proposed and as such will be informed and determined by the FRA. Further detailed guidance on flood resilient construction techniques are provided in the publication *Improving the Flood Performance of New Buildings* (DCLG, 2007)²³.

5.2.8 Basements

Basement dwellings are classified as highly vulnerable development and should not be permitted within Flood Zone 3. Basement access threshold levels should be raised above the 1 in 100 year flood level with climate change, and all basements must include provision of internal staircases to upper floors. Flood resilient construction techniques should be employed and consideration given to all forms of flood risk.

Basement impact assessments should be undertaken for all proposed basement developments, in order to demonstrate that the proposals are safe from a flood risk perspective, and will not have any adverse impacts on local hydrogeology. Developers should refer to LBS's *Basements and Flooding – Guide for Developers* for further detail of requirements for basement proposals (contained in Appendix I).

5.3 Sustainable Drainage Systems (SuDS)

Implementing SuDS aims to recreate more natural drainage systems within the urban environment. These features celebrate the presence of water, enriching the urban environment, while providing valuable function for flood alleviation and biodiversity enhancement. Within developments, SuDS measures look to maximise permeable surfaces in an effort to increase the amount of water that is attenuated, treated and processed within the natural hydrological cycle.

²³ Improving the Flood Performance of New Buildings - Flood Resilient Construction (2002)

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

Incorporating SuDS features will assist in absorbing runoff generated within development sites, reducing flooding, improving water quality, providing irrigation for vegetation and improving amenity. Such features can also contribute to a range of wider benefits, including provision of habitat for biodiversity, recreational opportunities, improved air quality and amelioration of the urban heat effect.

All new developments within the Borough must incorporate SuDS to provide attenuation and management of rainfall runoff unless there is a valid reason to justify that they are not suitable. Sustainable drainage should be delivered in accordance with the Sustainable Drainage Hierarchy set out in Policy 5.13 of the London Plan, the emerging Sustainable Design and Construction SPG, the emerging London Sustainable Drainage Action Plan and CIRIA guidance C753.

The SuDS hierarchy demonstrates a preference for surface water to be controlled at source where possible, either with rainwater storage or natural infiltration, as set out below:

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

Runoff rates from new development on greenfield sites should be restricted to greenfield runoff rates, as required by the London Plan. Redevelopment sites should also aim to achieve greenfield runoff rates wherever possible. Where this is not achievable, robust justification will be required, and an alternative reduction in runoff agreed through consultation with LBS.

Developers should refer to LBS's Developers' Guide for Surface Water Management, contained in Appendix H.

Appendix B provides a brief summary of the main SuDS techniques that could be suitable for implementation within LBS. Detailed guidance on the selection, design, construction and maintenance of SuDS is provided in the CIRIA SuDS Manual²⁴.

The selected SuDS measures will be dependent on various factors 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. Maintenance is of particular importance if the intention is for future adoption of the SuDS measures by the Council or others. These requirements should be agreed with Southwark at the planning stage.

Many SuDS measures are designed to promote infiltration into the ground beneath, promoting recharge of the water table and reducing runoff. The majority of the Borough has been identified as potentially unsuitable for infiltration SuDS owing to the impermeable London Clay Formation. Where the London Clay Formation is absent or where River Terrace Deposits exist, enhanced site investigation is required to confirm that infiltration SuDS are suitable. Groundwater source protection zones are present across the Borough and can be viewed on the EA website. Where sites fall within these further restrictions may apply and guidance should be sought from the EA.

Map A10 contains information on the likely suitability of infiltration SuDS across the Borough. This map delineates four subsurface categories, in which infiltration is likely to be of varying suitability, based upon a range of hydrogeological indicators. Further detail on the four categories is included in Table 5-2:

²⁴ The SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

Table 5-2 - SuDS Infiltration Suitability category descriptors

Category	Description
Highly suitable	The underlying geology is likely to be suitable for free-draining infiltration SuDS.
Probably suitable	The underlying geology is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
Potentially suitable for bespoke designs	The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions
Unlikely to be suitable	There is a very significant potential for one or more geo-hazards associated with infiltration.

As illustrated, the subsurface conditions across the majority of the Borough are of limited compatibility with respect to infiltration SuDS. Given these likely infiltration constraints, selected SuDS features will need to be focused on surface water storage and attenuation, and appropriately lined so as to transport water to an area for safe disposal.

5.4 Managing Flood Risk from Other Sources

5.4.1 Surface Water and Sewer Flooding

New development should seek to improve on-site drainage infrastructure to reduce levels of flood risk. The site specific FRA and drainage strategy should demonstrate that the development will not increase flood risk elsewhere, and that LBS's requirements for runoff rates and SuDS are met. SuDS are a highly effective way of managing surface water flood risk, as described in Section 5.3 and Appendix B, and should be incorporated on all development sites. Areas of higher pluvial flood risk within the Borough are highlighted in Map A4.

When redeveloping existing buildings, the installation of flood-proofing and resilience measures can be used to protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. These valves can be installed within gravity sewers or drains, within the property's private sewer, upstream of the public sewer system. These need to be carefully installed and must be regularly maintained.

5.4.2 Groundwater

Groundwater flooding has a very different flood mechanism to any other, as it may emerge from below ground level and for this reason many conventional flood defence and mitigation methods are not suitable. Flood risk may be reduced through building design, by ensuring that floor levels are raised sufficiently above the water table. Site design would also need to preserve any flow routes followed by the groundwater overland and make sure flood risk is not increased downstream. Proposed basement areas are likely to be particularly susceptible to groundwater flooding in certain areas. This may be mitigated through waterproof construction; however, consideration should be given to the potential impact on subterranean flow or water tables.

Developers should considerer the strategic level groundwater flood risk mapping contained in Map A5. Site specific ground investigation is likely to be required in locations where below ground development is proposed or there is known groundwater flood risk. Consideration should additionally be given to the requirements for basement impact assessments, as detailed in Section 5.2.8.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is unlikely to be considered an acceptable solution.

5.4.3 Artificial Sources

The flooding mechanism associated with flood risk from artificial sources is primarily related to breach or failure of structures (reservoir, lake, flood storage areas). Due to the nature of this mechanism, it is often difficult to foresee the location or extent of these problems and therefore it is important that the site specific FRA takes into consideration the integrity and history of any adjacent artificial structures and makes recommendations/provisions aimed at reducing the level of risk from these sources where applicable. The reservoir residual flood risk areas contained in Map A6 should additionally be considered.

5.5 Making Development Safe

5.5.1 Safe Access and Egress

Emergency access and egress is required for developments during times of flooding to enable the safe evacuation of occupants, provide access for emergency services and enable flood defence authorities to carry out any necessary duties. An emergency access and egress route is a path that is 'safe' for use by occupiers without the intervention of emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times.

The *FD2320/21 Defra/EA Flood Risks to People Report* provides requirements for maximum flood depth and velocity to quantify whether an evacuation route should be deemed safe, where the requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles;
- Safe, dry route for people;
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity) is low and should not cause risk to people; and
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity) is low to permit access for emergency vehicles.

Provision of safe access and egress may involve raising access routes to a suitable level above flood levels. As with land raising, it is imperative that any assessment takes into consideration the volume of floodwater potentially displaced.

5.5.2 Flood Warning and Evacuation

Emergency and evacuation plans should be in place for all properties 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 LBS Emergency Planning and Resilience Team when producing an emergency evacuation plan for developments as part of a FRA. Those preparing detailed emergency evacuation plans for vulnerable 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 EA operates a flood warning service in certain areas at risk of both fluvial and tidal flooding. The Flood warning system helps residents in flood warning areas to prepare for flooding, through means such as obtaining sand bags (or similar), moving valuables upstairs and where necessary evacuating the property to minimise the potential consequences of flooding.

All homes and businesses within Flood Zones 2 and 3 are eligible for the EA's Floodline Warnings Direct service, and should be encouraged to sign up to it. It is recommended that the developers make new owners of the property aware of this so they can sign up to FWD.

Areas of the Borough which are subject to flood warnings and alerts are illustrated in Map A9.

5.6 Making Space for Water

5.6.1 Opportunities for River Restoration and Enhancement

All new development close to watercourses should consider the opportunity to improve and enhance the water environment. Developments should look at particular opportunities for river restoration and enhancement. Restoration can take place on various scales, from small enhancement measures to full river restoration. Options include backwater creation, de-silting, in-channel habitat enhancement, removal of in-stream structures (e.g. weirs), and restoration of banks among others. These measures have the potential of reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

River restoration is of particular relevance when considering that there are several 'lost' and culverted rivers traversing the Borough. There should be a presumption against further culverting of watercourses or constructing over culverts. All new developments with culverts running through their site should seek opportunities to de-culvert, for flood risk management and conservation benefit.

These measures are supported by the European Water Framework Directive (WFD), a comprehensive river basin management planning system to help protect and improve the ecological health of waterbodies across Europe. In the UK, the EA is the authority charged with implementation of the Directive, and must meet certain targets aiming towards restoring water bodies towards good condition. In line with the objectives of the directive, opportunities for waterbody improvement must be considered across all development proposals incorporating watercourses.

5.6.2 Buffer Strips

Developers must aim to set back development from the edge of adjacent waterways, in order to provide a buffer strip to 'make space for water' and allow additional capacity to accommodate the effects of climate change. This is necessary in areas where flood defences or other engineered structures are present in order to provide a corridor for maintenance and improvement works, and particularly relevant in areas adjacent to the TTD.

As a minimum, development should be set back:

- 5 meters from ordinary watercourses;
- 8 meters from fluvial main rivers; and
- 16 meters in tidal areas.

An Environmental Permit (previously known as Flood Defence Consent) will be required from the EA for all works within 16 metres of the TTD.

5.6.3 Designing for Exceedance

The capacity of existing drainage systems is limited, and can be overwhelmed by rainfall events of intensity above the design capacity, possibly leading to surcharge and flooding. In order to manage and minimise the impacts of such events, developers should seek opportunities to identify a safe route for any exceedance flow and suitable storage or discharge location, so that this does not put people or property at risk.

As exceedance is expected to occur infrequently, such measures should ideally provide other benefits. An example of this is blue-green urban corridors, which provide ecological and recreational functionality under the smaller and design rainfall events, while additionally providing effective and safe means of managing extreme events when these do occur.

6 Summary

6.1 Overview

The NPPF and accompanying Guidance emphasise the responsibility of LPAs to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. This SFRA aims to facilitate this process by identifying the spatial variation in flood risk across the Borough, allowing an area-wide comparison of future development sites with respect to flood risk considerations.

The greatest risk to property and life from flooding within the Borough is as a result of tidal activity within the River Thames. However, the Borough is currently protected from combined tidal and fluvial flooding by the TTD up to the 1 in 1000 year event. This risk is therefore of a residual nature, associated with overtopping or breaching of defences. Aside from the River Thames, there are no other watercourses within the Borough known to present a risk of fluvial flooding.

A potential risk of flooding from other (non-river related) sources exists throughout the Borough, including sewer surcharge and surface water flooding as a result of heavy rainfall or blocked drainage systems. Southwark plays a key role in managing this risk as a LLFA, under the FWMA.

Areas of the Borough are also thought to be susceptible to elevated groundwater levels, which may additionally interact with and exacerbate these sources of flood risk. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within Southwark. This SFRA identifies the tidal floodplains associated with the River Thames and presents Flood Zone Maps that delineate the flood zones outlined in the NPPF. Breach modelling has additionally been undertaken, allowing greater understanding of the residual risk associated with this source. The resulting hazard, depth and velocity mapping contained within this SFRA provide further definition of the spatial variations of flood risk within Flood Zone 3.

These maps provide the necessary understanding to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and either the Exception Test or a site-specific FRA which clearly demonstrate that the site can be safely developed from a flood risk perspective.

6.2 Key Recommendations

To facilitate a holistic approach to flood risk management and ensure that flooding is taken into account at all stages of the planning process, the findings of this report should be incorporated into the New Southwark Plan. This will help to ensure that flood risk is taken into account at all levels of the planning process.

Given the location of the Borough adjacent to the River Thames, it is likely to always be highly reliant on flood defences. However, in general, it is recommended that policy options are expanded to include greater emphasis on floodplain management, in addition to flood defence. This may include more appropriate use of the floodplain, making space for water, improved flood awareness and flood-readiness and enhanced emergency planning and response measures.

In the future, climate change is anticipated to have an impact on all sources of flood risk within the Borough. It is important that planning decisions recognise the potential risk that increased runoff poses to property and plan development accordingly so that future sustainability can be assured.

This Level 1 SFRA report will be complemented by further detailed assessment of the allocated development sites within the Borough, during the Level 2 SFRA.

6.3 Maintenance of this SFRA

In order for this SFRA to serve as a practical planning tool now and in the future, it is imperative that the SFRA is adopted as a 'living draft' and is reviewed periodically in light of emerging policy directives and an improving understanding of flood risk within the Borough.

Appendix D lists a series of recommendations ensuring that the SFRA is kept up-to-date and maintained. This will allow the SFRA to follow emerging best practice and developments in policy and climate change predictions.

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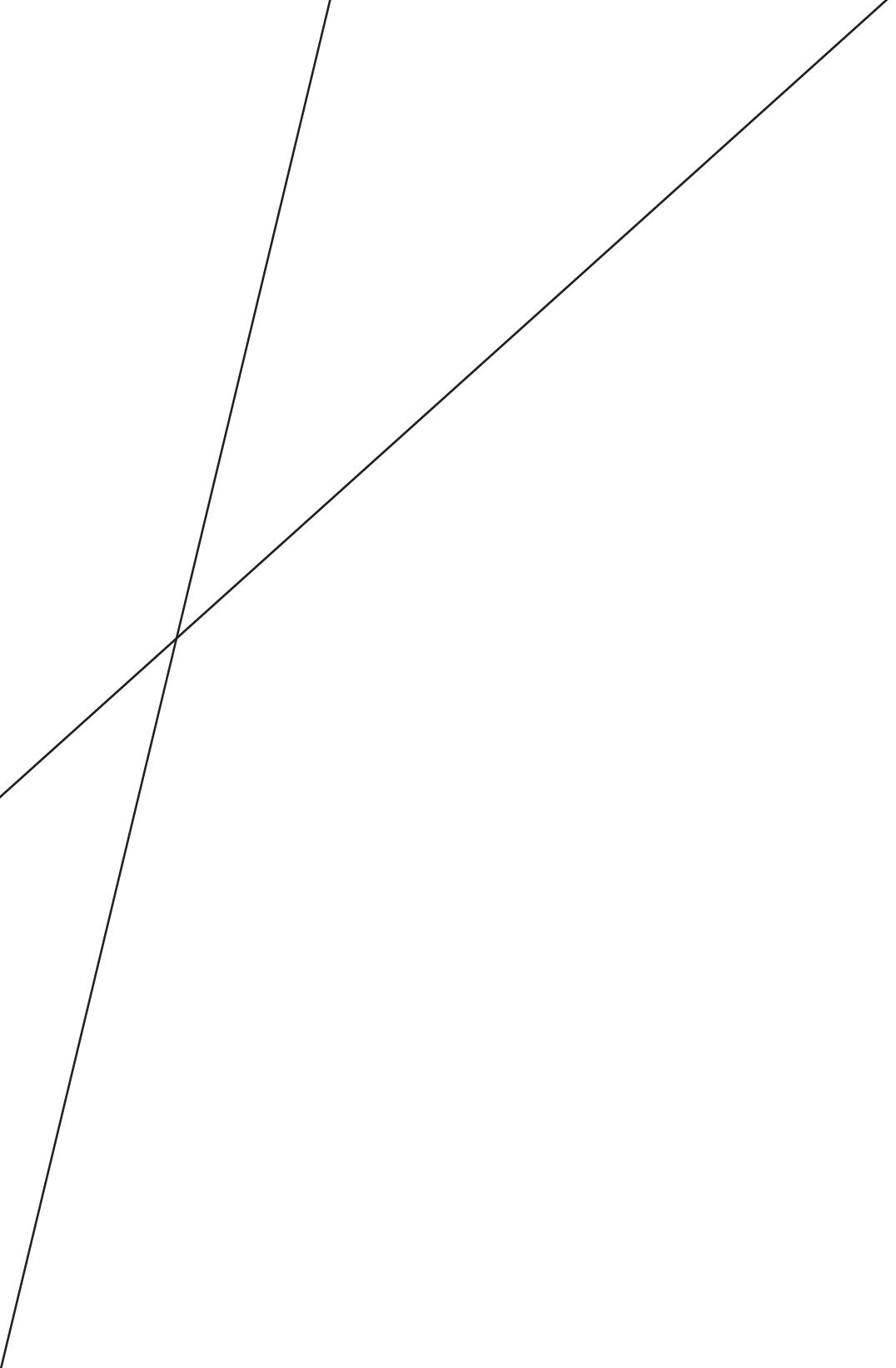
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