London Borough of Newham Level 1 & 2 Strategic Flood Risk Assessment

Final Report

Project Number: 60527164

25 September 2017

Advisory Note

The London Borough of Newham is preparing for Local Plan review. The Council is required to '*ensure that the Local Plan is based on adequate, up-to-date and relevant evidence about the economic, social and environmental prospects of the area' (NPPF paragraph 158).* Since publication of the Newham 2010 Strategic Flood Risk Assessment, a number of key policy and guidance changes have been introduced which has led to the production of this updated Strategic Flood Risk Assessment.

The Council has worked closely with partners including the Environment Agency who have reviewed and provided comments on this updated SFRA during its production.

It is important to note that hydraulic modelling data is updated on a rolling programme by the Environment Agency. Data used within this SFRA is the best available at the time of writing and includes the most recently published Environment Agency tidal breach modelling (May 2017) for upstream of the Thames Barrier.

As per agreement with the Environment Agency due to the current programme for Local Plan review, additional updated River Thames modelling for downstream of the Thames Barrier and updated River Roding model have not been included. Both are planned for release late 2017 and will supersede older modelling of these areas.

In accordance with Paragraph 102 of the National Planning Policy Framework and current Planning Practice Guidance, any site-specific FRA for future development should be based on the best available data, which should be confirmed with the Environment Agency and London Borough of Newham at the time of preparation.

Quality information

Prepared by	Checked by	Approved by
Hannah Booth Sarah Betts	Emily Craven	Jon Robinson

Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	Feb 2017	Draft for Client Comment	EC	Emily Craven	Associate
2	May 2017	2nd Draft including EA and LLFA comments	EC	Emily Craven	Associate
3	August 2017	Final Report	EC	Emily Craven	Associate
4	September 2017	Final Report	EC	Emily Craven	Associate

AECOM Infrastructure & Environment UK Limited
Midpoint
Alencon Link
Basingstoke
Hampshire RG21 7PP
UK

T: +44(0)1256 310200
aecom.com

Prepared in association with:

London Borough of Newham

Table of Contents

Contents

Abbreviations

ACRONYM	DEFINITION
AOD	Above Ordnance Datum
AIMS	Asset Information Management System
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
Defra	Department for Environment, Flood and Rural Affairs
DCLG	Department for Communities and Local Government
FRA	Flood Risk Assessment
FWMA	Flood and Water Management Act 2010
GIS	Geographical Information System
GLA	Greater London Authority
LBN	London Borough of Newham
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
MLWL	Maximum Likely Water Level
PPG	Planning Practice Guidance
NPPF	National Planning Policy Framework
SA	Sustainability Appraisal
SFRA	Strategic Flood Risk Assessment
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
TWUL	Thames Water Utilities Limited
uFMfSW	Updated Flood Map for Surface Water

Glossary of Terms

GLOSSARY	DEFINITION
1D Hydraulic Model	Hydraulic model which computes flow in a single dimension, suitable for representing systems with a defined flow direction such as river channels, pipes and culverts
2D Hydraulic Model	Hydraulic model which computes flow in multiple dimensions, suitable for representing systems without a defined flow direction including topographic surfaces such as floodplains
Asset Information Management System (AIMS)	Environment Agency database of assets associated with Main Rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level plan through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the NPPF and Planning Practice Guidance as at 3rd February 2017.
Critical Drainage Area	Within the SWMP – A discrete geographic area (usually hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zone during severe weather thereby affecting people, property or local infrastructure. By the Environment Agency - discrete geographical area where multiple and interlinked sources of flood risk cause flooding during severe weather.
Crest Level	Within this report, meaning ‘the highest point’. Typically referring to a flood defence height.
Culvert	A structure, often a channel or pipe that carries water below the level of the ground
Design flood	This is a flood event of a given annual flood probability, which is generally taken as: • fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or; • tidal flooding with a 0.5% annual probability (1 in 200 chance each year), The suitability of a proposed development is assessed and mitigation measures, if any, are designed against the design flood. Both should contain a suitable allowance for climate change. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances .
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are ‘at risk’ of sewer flooding more frequently than once in 20 years. Refer to map 9a and 9b included in Appendix A.
Evapotranspiration	The sum of evaporation and plant transpiration from the land and ocean surface to the atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and waterbodies.

GLOSSARY	DEFINITION
Exception Test	The exception test should be applied following the application of the sequential test. The exception test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. Conditions need to be met before the exception test can be applied.
Flood Defence	Infrastructure used to protect an area against floods, such as floodwalls and embankments; they are designed to a specific standard of protection (design flood) which is the largest flood that a given project is designed to safely accommodate.
Flood Resilience	Measures that minimise water ingress (e.g. to buildings) and promotes fast drying and easy cleaning, to prevent permanent damage.
Flood Resistant	Measures that prevent flood water entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Zone	Flood Zones refer to the probability of river and sea flooding ignoring the presence of existing flood defences (i.e. the natural floodplain). It should be noted that Flood Zones on the Environment Agency Flood Map for Planning do not take account of the potential impact of climate change. See Section 2.4 and 2.5 for further information on Flood Zones and breach modelling and Map 4 Appendix A https://flood-map-for-planning.service.gov.uk/
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	A freeboard is used to account for residual uncertainty within design, often an extra 300mm added to finished floor level above the design flood level to account for any uncertainty in flood levels. A safety factor. Refer to section 5.4 for further guidance.
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Impounded Reservoir	A reservoir with outlets controlled by gates that release stored surface water as needed in dry months; may also store water for domestic or industrial use or for flood control. Also known as storage reservoir.
ISIS	A commonly-used 1D hydraulic modelling software package.
Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, London Borough of Newham as LLFA are responsible for developing, maintaining and applying a strategy for local flood risk management (flooding from surface water, groundwater and ordinary watercourses) in their areas and for maintaining a register of flood risk assets.
Light Detection and Ranging (LiDAR)	Airborne ground survey mapping technique, which uses a laser to measure the distance between the aircraft and the ground. Within this report, LiDAR has been used to map topography across the borough as illustrated in Map 1.
Local Flood Risk Zone	Discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location.
Local Planning Authority (LPA)	The public authority that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and

GLOSSARY	DEFINITION
	operational activities for Main Rivers only.
Maximum Likely Water Level	Highest water levels permitted upstream of the Thames Barrier, i.e. the water levels are controlled by the closure of the Thames Barrier.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Ordnance Datum	In the British Isles, an ordnance datum is a vertical datum used by an ordnance survey as the basis for deriving altitudes on maps. A spot height may be expressed as AOD (Above Ordnance Datum), in this instance meaning above mean sea level at Newlyn in Cornwall.
Ordinary Watercourse	A watercourse that does not form part of a Main River. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act 1991.
Pluvial	Pluvial refers to flood events occurring through the direct action of rain – i.e. surface water flooding. Rather than water overflowing the banks of a river which is considered fluvial flooding.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account. An example of residual flood risk include the failure of flood management infrastructure (e.g. River Thames Flood Walls), or a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defences, or an intense rainfall event which the drainage system cannot cope with.
Return Period	Also known as a recurrence interval is an estimate of the likelihood of an event, such as a flood to occur.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Source Protection Zone (SPZ)	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Surface Water	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Tidal Flooding	Temporary inundation of low lying areas during exceptionally high tide events.
Topographic survey	A survey of ground levels.
TUFLOW	A modelling package for simulating depth averaged 2D free-surface flows that is in widespread use in the UK and elsewhere for 2D inundation modelling.

Executive Summary

The National Planning Policy Framework (NPPF) Flood Risk and Coastal Change[1] emphasise the responsibilities for LPAs to ensure that flood risk is understood and managed effectively through all stages of the planning process.
This Level 1 & Level 2 Strategic Flood Risk Assessment (SFRA) aims to facilitate this by identifying the spatial variation in flood risk across the London Borough of Newham (LB Newham) allowing a borough-wide comparison of future development sites with respect to flood risk considerations.

The Environment Agency identifies the tidal and *fluvial* floodplains associated with *main rivers* across the Borough, presented in Flood Zone Maps included in Appendix A. In addition, this SFRA has mapped the impact of *climate change* which is not included within published Environment Agency Mapping. These should be used for planning purposes when determining the suitability of development.

The Borough is bounded to the south by the River Thames, to the east by the River Roding and to the west by the River Lee. Whilst each of these rivers pose a potential risk of flooding to properties within the Borough, all property is currently protected from *fluvial* and *tidal flooding* from *main rivers* by the presence of formal flood defences. The River Thames Tidal Defences (TTD) provide protection up to the 1 in 1000 year (0.1% AEP) event, the River Lee up to a 1 in 50 year return period (2% Annual Exceedance Probability (AEP)) and the River Roding up to the 1 in 1000 year (0.1% AEP) for the lower 7km of the watercourse (downstream of Highbridge Road, IG11).

Given the level of protection provided by *fluvial* and tidal flood defences within the borough, there are deemed to be no areas located within Flood Zone 3b, function floodplain. The majority of rivers within the borough are *main rivers* and the requirement for future maintenance and improvement of these defences is managed by the Environment Agency in collaboration with local stakeholders.

The *residual flood risk*, should existing flood defences fail has been illustrated through reference to Environment Agency Thames Tidal Breach Modelling[2] which includes breach locations on the River Lee, River Thames, River Roding and the Royal Docks. This data is presented within Appendix A and should be used when applying the Sequential approach to development location within Flood Zones.

Potential risk of flooding from other sources exists throughout the Borough, including sewer surcharge, and surface water flooding as a result of heavy rainfall and limited capacity of drainage infrastructure. Thirteen surface water 'flood risk hotpots' were identified in the LB Newham SWMP spread across the borough.

There are no areas with critical drainage problems as notified by the Environment Agency located in the LB Newham.

The SFRA provides an overview of the risk of flooding from all sources across LB Newham and should be used to assist in the development of policy formulation, strategic planning, development control and flood risk management.

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 to ensure that development is appropriately flood resilient and resistant, safe for its users for the development's lifetime and will not increase flood risk overall.

[1] National Planning Policy Framework, Published 8th May 2012 https://www.gov.uk/government/publications/national-planning-policy-framework--3
[2] Thames Tidal Breach Modelling Study, Atkins, May 2017. FRAs submitted as part of planning applications should look to latest EA modelling data available at time of preparation of site specific studies.

1. Introduction

1.1.1 In its role as the *Local Planning Authority* (LPA), the London Borough of Newham (LBN) is currently preparing documents that will form part of the new Local Plan and set out a vision and framework for development in the Borough.

1.1.2 The National Planning Policy Framework[3] (NPPF) and accompanying Planning Practice Guidance (PPG)[2] emphasise the responsibilities for LPAs to ensure that flood risk is understood and managed effectively using a risk-based approach through all stages of the planning process. As such, LPAs are required to undertake a Strategic Flood Risk Assessment (SFRA) to support the preparation of their Local Plan.

1.1.3 AECOM has been commissioned by the LB Newham to review and revise their existing SFRA which was completed in May 2010. The methodology followed in this study complies with the NPPF[2] as well as guidelines from the Environment Agency and forms a combined Level 1 / Level 2 SFRA. The SFRA has been completed in collaboration with the LB Newham, the Environment Agency and Thames Water. The results of this SFRA are intended to inform strategic land use planning and decision making from a flood risk perspective.

1.2 Approach to Flood Risk Management

1.2.1 The NPPF[2] and associated PPG[21] for Flood Risk and Coastal Change[4] emphasise the active role LPAs such as LB Newham should take to ensure that flood risk is assessed, avoided, and managed effectively and sustainably throughout all stages of the planning process. The overall approach for the consideration of flood risk set out in Section 1 of the PPG[21] can be summarised as follows:

1.2.2 This has implications for LPAs and developers as described below.

Assess flood risk

1.2.3 Local Plans should be supported by an SFRA and LPAs should use the findings to inform strategic land use planning. SFRA Aims and Objectives

1.2.4 The aim of this SFRA is to collate and present the most up to date flood risk information from all sources for use by LB Newham to inform the preparation of the Newham Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.2.5 In order to achieve this, the SFRA will:

- Refine information on the areas that may flood taking into account all sources of flooding and the impacts of *climate change*;
- Inform the Sustainability Appraisal process, so that flood risk is fully taken into account;

[3] Communities and Local Government. 2012. *National Planning Policy Framework*. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

[4] Communities and Local Government. 6th March 2014. *Planning Practice Guidance: Flood Risk and Coastal Change.* Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

- Inform the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF2, and planning application process;
- Identify the requirements for site-specific Flood Risk Assessments;
- Inform the preparation of flood risk policy and guidance;
- Provide information for use by LLFA emergency planning teams to help plan an effective response to flood risk; and,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

1.2.6 The 2017 SFRA report will be used by LB Newham to inform the allocation of sites within the Local Plan. Reference to Environment Agency Flood Zone mapping (Map 4 Appendix A) and the location of the Borough within Central London adjacent to the River Thames has identified that land outside of flood risk areas cannot appropriately accommodate all necessary development required within the LB Newham. Therefore, this report constitutes both a Level 1 and Level 2 SFRA. The Level 2 element of the report builds upon the Level 1 report to consider the detailed nature of flood risk within each Flood Zone to support the application of the Exception Test.

1.2.7 Figure 1-1The aim of this SFRA is to collate and present the most up to date flood risk information from all sources for use by LB Newham to inform the preparation of the Newham Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.2.8 In order to achieve this, the SFRA will:

- Refine information on the areas that may flood taking into account all sources of flooding and the impacts of climate change;
- Inform the Sustainability Appraisal process, so that flood risk is fully taken into account;
- Inform the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF2, and planning application process;
- Identify the requirements for site-specific Flood Risk Assessments;
- Inform the preparation of flood risk policy and guidance;
- Provide information for use by LLFA emergency planning teams to help plan an effective response to flood risk; and,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

1.2.9 The 2017 SFRA report will be used by LB Newham to inform the allocation of sites within the Local Plan. Reference to Environment Agency Flood Zone mapping (Map 4 Appendix A) and the location of the Borough within Central London adjacent to the River Thames has identified that land outside of flood risk areas cannot appropriately accommodate all necessary development required within the LB Newham. Therefore, this report constitutes both a Level 1 and Level 2 SFRA. The Level 2 element of the report builds upon the Level 1 report to consider the detailed nature of flood risk within each Flood Zone to support the application of the Exception Test.

1.2.10 Figure 1-1, reproduced from the PPG[21], illustrates how flood risk should be taken into account in the preparation of the Local Plan by LB Newham.

1.2.11 For sites in areas at risk of flooding (typically Flood Zone 2 or 3, Refer to Section 2.4, Section 6 and Map 4 Appendix A), or with an area of 1 hectare or greater, developers must undertake a site-specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development).

Avoid flood risk

1.2.12 LB Newham should apply the sequential approach to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of *climate change* and the vulnerability of future users to flood risk.

1.2.13 In plan-making this involves applying the Sequential Test, and where necessary the Exception Test to Local Plan allocations, as described in SFRA Aims and Objectives

1.2.14 The aim of this SFRA is to collate and present the most up to date flood risk information from all sources for use by LB Newham to inform the preparation of the Newham Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.2.15 In order to achieve this, the SFRA will:

- Refine information on the areas that may flood taking into account all sources of flooding and the impacts of *climate change*;
- Inform the Sustainability Appraisal process, so that flood risk is fully taken into account;
- Inform the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF2, and planning application process;
- Identify the requirements for site-specific Flood Risk Assessments;
- Inform the preparation of flood risk policy and guidance;
- Provide information for use by LLFA emergency planning teams to help plan an effective response to flood risk; and,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

1.2.16 The 2017 SFRA report will be used by LB Newham to inform the allocation of sites within the Local Plan. Reference to Environment Agency Flood Zone mapping (Map 4 Appendix A) and the location of the Borough within Central London adjacent to the River Thames has identified that land outside of flood risk areas cannot appropriately accommodate all necessary development required within the LB Newham. Therefore, this report constitutes both a Level 1 and Level 2 SFRA. The Level 2 element of the report builds upon the Level 1 report to consider the detailed nature of flood risk within each Flood Zone to support the application of the Exception Test.

1.2.17 Figure 1-1In decision-making this involves applying the *Sequential Test* and if necessary the Exception Test for specific development proposals (ensuring that even within sites, vulnerable uses are directed to areas of lowest risk). Detail of when applicants will need to evidence passing of the tests is provided in Section 4.

Manage and mitigate flood risk

1.2.18 Where alternative sites in areas at lower risk of flooding are not available, it may be necessary to locate development in areas at risk of flooding. In these cases, LB Newham and

developers must ensure that development is appropriately flood resilient and resistant, safe for its users for the lifetime of the development, and will not increase flood risk overall.

1.2.19 LB Newham and developers should seek flood risk management opportunities to reduce the level of flood risk in the area e.g. safeguarding land for flood risk management or where appropriate through designing off-site works required to protect and support development in ways that benefit the area more generally.

1.3 SFRA Aims and Objectives

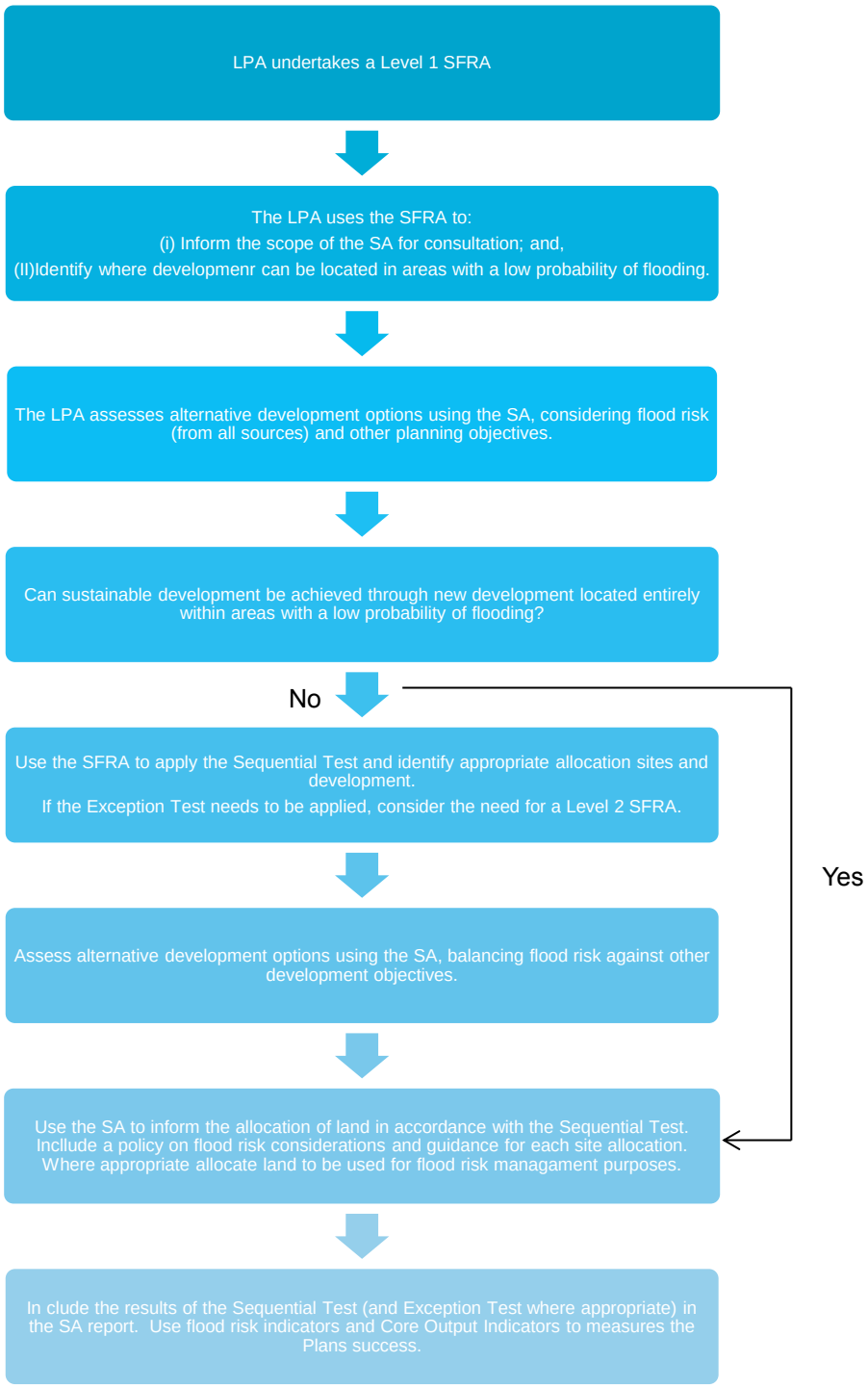
1.3.1 The aim of this SFRA is to collate and present the most up to date flood risk information from all sources for use by LB Newham to inform the preparation of the Newham Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.3.2 In order to achieve this, the SFRA will:

- Refine information on the areas that may flood taking into account all sources of flooding and the impacts of *climate change*;
- Inform the Sustainability Appraisal process, so that flood risk is fully taken into account;
- Inform the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF[2], and planning application process;
- Identify the requirements for site-specific Flood Risk Assessments;
- Inform the preparation of flood risk policy and guidance;
- Provide information for use by LLFA emergency planning teams to help plan an effective response to flood risk; and,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

1.3.3 The 2017 SFRA report will be used by LB Newham to inform the allocation of sites within the Local Plan. Reference to Environment Agency Flood Zone mapping (Map 4 Appendix A) and the location of the Borough within Central London adjacent to the River Thames has identified that land outside of flood risk areas cannot appropriately accommodate all necessary development required within the LB Newham. Therefore, this report constitutes both a Level 1 and Level 2 SFRA. The Level 2 element of the report builds upon the Level 1 report to consider the detailed nature of flood risk within each Flood Zone to support the application of the Exception Test.

Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (PPG[21] for Flood Risk and Coastal Change, p6)



1.4 Flood Risk Policy and Guidance

1.4.1 There is an established body of policy and guidance documents which are of particular importance when considering development and flood risk. These are identified in Table 1-1 along with links for where these documents can be found for further detail.

Table 1-1 Flood Risk Policy and Guidance Documents

National Policy Documents		
National Planning Policy Framework (para. 99-104)	The NPPF[2] was published by the UK's DCLG in March 2012, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG[21]) for use in England.	https://www.gov.uk/government/publications/national-planning-policy-framework--2
Flood and Water Management Act (2010)	Provides for a more comprehensive management of flood risk.	http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf
Flood Risk Regulations (2009)	The Flood Risk Regulations transpose the EU Floods Directive into law in England. It aims to provide a consistent approach to flood risk across Europe.	http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf
Regional Flood Risk Policy		
London Plan	The London Plan is the statutory spatial development strategy for the Greater London area that is published by the GLA. To ensure clarity for stakeholders, it is important that LB Newham local policy is aligned with the minimum recommendations of the London Plan.	https://www.london.gov.uk/what-we-do/planning/london-plan
Thames *Catchment Flood Management Plan*	Role of the CFMP is to establish flood risk management policies which will deliver sustainable flood risk management for the long term (an Environment Agency Document).	https://www.gov.uk/government/collections/catchment-flood-management-plans
Thames Estuary 2100 Plan	How the Environment Agency is planning to manage tidal flood risk in the Thames estuary until the year 2100.	https://www.gov.uk/government/publications/thames-estuary-2100-te2100
Managing Flood Risk in the Lower Lee Catchment, today and into the future.	The Environment Agency has developed a detailed strategy for the Lower Lee catchment and provides a basis for implementing wider CFMP strategies within the Lower Lee catchment. E.g. ongoing maintenance and improvement of River Lee Flood Relief Channel and associated hydraulic control structures.	https://www.gov.uk/government/publications/managing-flood-risk-lower-lee-catchment
Guidance Documents		
Planning Policy Guidance – Flood Risk and Coastal Change	Describes the planning approach to development within areas at risk of flooding from all sources	http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
Environment Agency Standing Advice	Guidance on information to be included within robust site specific FRAs	https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
London Sustainable Drainage Action Plan, GLA October 2015	A plan to inspire, facilitate and co-ordinate a change in how we manage rainwater in London. It seeks to replace impermeable surfaces with green, sustainable drainage systems.	https://www.london.gov.uk/sites/default/files/lsdap_final.pdf
Sustainable Design and Construction SPG, GLA, April 2014	Guidance on greenfield runoff rates, Sustainable Drainage Systems, flood resilience / resistance and flood risk management linking back to policies contained within the London Plan.	https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Sustainable%20Design%20%26%20Construction%20SPG.pdf
Local Documents and Strategies		
LBN Core Strategy Policy SC 3:Flood Risk and Detailed Sites & Policies DPD policy SC5	Core strategy sets out the Boroughs plans for development within the Borough over the next 15 year including policy guidance on flood risk.	https://www.newham.gov.uk/Documents/Environment%20and%20planning/CoreStrategy2004-13.pdf

LBN draft Local Flood Risk Management Strategy (LFRMS)	As LLFA, LB Newham has created the LFRMS to understand and manage flood risk within the borough.	https://www.newham.gov.uk/Documents/Environment%20and%20planning/FloodRiskManagementStrategy.pdf
LBN Surface Water Management Plan	A SWMP was produced for LB Newham as part of the Drain London (GLA) study. This study included an assessment of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.	https://www.newham.gov.uk/Documents/Environment%20and%20planning/SurfaceWaterManagementPlan.pdf
LBN Multi-Agency Flood Plan	Describes the management structures and actions of local responders in response to a flooding event in LB Newham.	LBN internal document.
LBN Preliminary Flood Risk Assessment (PFRA)	In accordance with the Flood Risk Regulations 2009, LBN provided a PFRA to provide a high level overview of flood risk from local sources for provision to the Environment Agency, ultimately reporting to Europe. The 2011 report is currently under review – June 2017.	https://www.newham.gov.uk/Documents/Environment%20and%20planning/PreliminaryFloodRiskAssessment.pdf

2. Assessing Flood Risk in Newham

2.1 Study Area

2.1.1 The study area is defined by the administrative boundary of the LB Newham, located on the north side of the River Thames approximately 3 miles to the east of the City of London. LB Newham borders the LB of Barking and Dagenham to the east, Redbridge and Waltham Forest to the north and Hackney and Tower Hamlets to the west.

2.1.2 The borough boundary encompasses an area of 3,600ha and is bound on three sides by watercourses. The River Thames forms the southern borough boundary, the River Lee flows from north to south along the extent of the western borough boundary before discharging into the River Thames and the River Roding flows from north to south along the extent of the eastern borough boundary before discharging into the River Thames. The River Thames is tidally influenced adjacent to Newham. The Royal Docks are located in the south of the Borough on historical River Thames riverside marshes and collectively form the largest enclosed docks in the world and form a major feature of the Borough.

2.1.3 Newham is made up of traditional Victorian terraces (in the 'Urban Newham' portion of the Borough, the north and east) and, increasingly, a mix of modern, high density mixed-use development replacing disused or underused industrial land in the south and west (the 'Arc of Opportunity') as well as a number of post-war housing estates (predominately in the Canning Town area) . There are some notable areas of open space including West Ham Park, Beckton District Park and Thames Barrier Park, but the majority of the Borough is developed.

2.1.4 There are significant targets for new homes and jobs in Newham to meet both local and strategic needs. In the 2012 Local Plan Core Strategy, LBN projected a total of 37,000 new homes and 24,000 jobs to be generated by 2027, demonstrating a significant growth projection across the Borough.

2.2 Topography

2.2.1 The River Thames flows eastwards along the southern borough boundary where the land is low lying at levels of approximately 1m to 4m Above *Ordnance Datum* (AOD). Lower topography is also located on the eastern and western borough boundaries, associated with the River Lea and River Roding catchments where ground levels fluctuate around 2m to 4m AOD. To the north of the A13, Newham Way towards Forest Gate, ground levels rise from 4m up to approximately 12m to 14m AOD at the northern borough boundary.

2.2.2 Map 1 included in Appendix A shows *Light Detection and Ranging* (LiDAR) data. This is an airborne mapping technique, which uses a laser to measure the distance between the aircraft and the ground. Up to 100,000 measurements per second are made of the ground, allowing highly detailed terrain models to be generated at spatial resolutions of between 25cm and 2 metres. The data used in this study covering LB Newham has a spatial resolution of 1m. The Environment Agency's LiDAR data archive contains digital elevation data derived from surveys carried out since 1998.

Appendix A, Map 1 Topography

2.3 River Network

2.3.1 All watercourses in England and Wales are classified as either '*Main River*s' or '*Ordinary Watercourses*'. The difference between the two classifications is based largely on the

perceived 'importance' of the watercourse with particular reference to its potential to cause significant and widespread flooding. However, it is not always the case the watercourses classed as *ordinary watercourses* cannot cause localised flooding.

2.3.2 The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e. *Main River* or Ordinary Watercourse). The Environment Agency have duties and powers in relation to *Main River*s and the LLFA (LB Newham) have duties and powers in relation to *ordinary watercourses* including ditches, dykes, rivers, streams and drains (not public sewers).

2.3.3 There are three *Main River*s present within the Borough (Thames, Lee and Roding) as described below.

River Thames

2.3.4 The River Thames drains a catchment area of 5,000 square miles as it flows towards the sea. It is tidally influenced for approximately 90km of its length up to Teddington in Middlesex. The southern boundary of the LB Newham is formed by the River Thames which has been heavily modified over time to include the construction of raised defences along much of its length.

River Lee Navigation (Lower)

2.3.5 The River Lea is located along the western boundary of the Borough. The River originates near Luton and flows through Bedfordshire, Hertfordshire and London. The river drains an area of approximately 1400km^2 before meeting the River Thames at Bow Creek.

2.3.6 The Lower River Lee is largely an artificial watercourse containing multiple channels. As the River Lee enters the north western corner of the Borough, it is contained within two channels being The River Lee Navigation and the Old River Lee. As the watercourse reaches the Olympic park, the watercourse includes The Lee, the Lee Flood Relief Channel (FRC), the City Mill River, Waterworks River, Bow Back River and Channelsea River. These watercourses all converge to form one channel (River Lee) adjacent to Twelvetrees Business Park before flowing south to its confluence with the River Thames at Bow Creek.

2.3.7 The River Lee FRC is a largely artificial watercourse designed to carry flood water to reduce the likelihood of flooding in the valley. Water levels in the FRC, Navigation and the River Lee itself are controlled by a system of weirs, gates and sluices.

2.3.8 In addition to being designated a *Main River*, the Lee Navigation is also part of the Canals and River Trust network including the Bow Back (Pudding Mill, Three Mills Wall and Waterworks) rivers. Locks are administered by British Waterways.

2.3.9 The tidal reach of the River Lea (also known as the Bow Creek) extends upstream to the Bow Lock link to the River Lee Navigation and the Prescott Lock link into the Prescott Canal / River Lea at Three Mills.

Figure 2.1 Bow Locks at Bromley by Bow – the tidal extent of the River Lee

Source: Wikipedia https://en.wikipedia.org/wiki/Bow_Locks#/media/File:Bow_Locks3.jpg

River Roding

2.3.10 The River Roding flows south from its source near Stanstead airport (Essex) in a south westerly direction through Epping, Uttlesford and Redbridge prior to flowing along the boundary between LBs Newham and Barking and Dagenham. The lower tidal reach of the River Roding is called the Barking Creek and extends from the River Thames upstream to the Barking Barrage. The Barking Creek tidal barrier is located at the confluence with the River Thames and provides tidal flood protection to the River Roding and adjacent low lying areas.

Ordinary Watercourses

2.3.11 *Ordinary Watercourses* include smaller streams, ditches and drainage channels which are not designated as *Main River*.

2.3.12 Mapping included in Appendix A (map 4) shows a number of short reach *ordinary watercourses* that discharge to the River Roding along the eastern side of the borough.

2.3.13 The Royal Docks, located in the south of the borough are classified as ordinary watercourse but are managed by the Royal Docks Management Authority. The dock gates themselves form part of the Thames Defences and therefore fall under the responsibility of the Environment Agency.

2.4 Fluvial Flood Risk

2.4.1 Flooding from rivers occurs when water levels rise higher than bank levels causing floodwater to spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- Intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet conditions and where there is significant *groundwater* base flow.
- Constrictions in the river channel causing flood water to back up; and
- Constrictions preventing discharge at the outlet of the river e.g. locked flood gates, or tide locking.

Flood Map for Planning (Rivers and Sea) (Flood Zone 1, 2 & 3)

2.4.2 The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF[2] seeks to assess the

probability of flooding from rivers by categorising areas within the *fluvial* floodplain into zones of low, medium and high probability, as defined in Table 2.1 and presented on the Flood Map for Planning (Rivers and Sea) available on the Environment Agency website. These Flood Zones have been presented in Map 4 (Page 1 to 4) included in Appendix A.

Table 2-1 Fluvial Flood Zones (extracted from the PPG[21], 2014)

Flood Zone	Flood Zone Definition for River Flooding	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1,000 chance of river flooding each year (0.1% annual probability). Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	**Low**
Flood Zone 2	Land having between a 1 in 100 and 1 in 1,000 chance of river flooding each year (between 1% and 0.1% annual probabilities).	**Medium**
Flood Zone 3a	Land having a 1 in 100 or greater chance of river flooding each year (greater than 1% annual probability).	**High**
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (flood storage area). Flood Zone 3b is defined by the LPA, in this instance the 1 in 20 annual probabilities have been used to define Flood Zone 3b. Not separately distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea).	**Functional Floodplain**

2.4.3 The Environment Agency 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain. The 'Flood Map for Planning (Rivers and Sea)' dataset is available on the Environment Agency website[5] and is the main reference for planning purposes as it contains the Flood Zones which are referred to in the NPPF[2].

2.4.4 The Environment Agency dataset has been used to define and illustrate Flood Zone 1, 2 and 3 on Map 4 contained within Appendix A of this SFRA. However, it should be noted that the Flood Zones shown on the Environment Agency Flood Map for Planning do not take account of the possible impacts of *climate change.* In the absence of this information, *climate change* mapped outlines have been derived from the following sources:

- River Roding – 1 in 1000 year flood outline (in the absence of updated hydraulic modelling)
- River Lee – 1 in 100 year + 70% modelled flood outline derived from updated hydraulic modelling completed as part of a separate Environment Agency scheme (Hertfordshire and North London (HNL) Package 1 modelling)

2.4.5 Further information on *climate change* can be found in section 3 of this report.

2.4.6 The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling (JFLOW) and is routinely updated and revised using results from the Environment Agency's ongoing programme of river catchment studies. The studies can include topographic surveys and hydrological and/or hydraulic modelling as well as incorporating information from recorded flood events.

[5] Environment Agency Flood Map for Planning (Rivers and Sea) http://apps.environment-agency.gov.uk/wiyby/37837.aspx

Appendix A, Map 4 Pages 1 to 4 Flood Zone Mapping

2.4.7 It should be noted that a separate map is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[6]. This map takes into account the presence of flood defences and so describes the actual chance of flooding, rather than the chance if there were no defences present. While flood defences reduce the level of risk they do not completely remove it as they can be overtopped or fail (breach) in extreme weather conditions, or if they are in poor condition.

2.4.8 The residual risk of flooding or the risk should existing defences fail, is discussed further in Section 2.5 of this SFRA. However for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Hydraulic Modelling Studies

2.4.9 Table 2-1 provides a summary of the hydraulic modelling studies that have been undertaken for the *Main Rivers* in LB Newham and used to inform the Environment Agency's Flood Map for Planning (Rivers and Sea). The type of model (1D or 2D) is also specified, along with the corresponding available outputs for each model.

2.4.10 The scope of these modelling studies typically covers flooding associated with *Main Rivers*, and therefore *Ordinary Watercourses* that form tributaries to the *Main Rivers* may not always be included in the model. Modelling of *Ordinary Watercourses* available on the Flood Map for Planning (Rivers and Sea) may be the result of the national generalised JFLOW modelling carried out by the Environment Agency and may need to be refined when determining the probability of flooding for an individual site and preparing a site-specific FRA.

[6] Environment Agency 'Risk of Flooding from Rivers and Sea' http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=floodmap#x=237038&y=161974&scale=1

Table 2-2 Hydraulic models for Main Rivers in LB Newham (fluvial flood risk)

Watercourse	Catchment Description	Modelling Study
Lower Lea	The catchment of the Lower Lea is approximately 370km^2. The Lower Lea flows through a heavily urbanised area for 34km from Feildes Weir in a southerly direction through North London entering the River Thames at Canning Town, just upstream of the Thames Barrier at the boundary between LB Tower Hamlets and LB Newham. The River Lea is tidally influenced to the Lea Bridge sluices. Further detail with regard to the River Lea and the hydraulic model used to inform this SFRA can be found from the Environment Agency.	CH2MHill, 2014 River Lee 2 D Modelling and Mapping Technical Report. Existing Environment Agency baseline model re-run in 2017 by AECOM using new inflow data to illustrate new *climate change* allowances (1 in 100 year(1% AEP) + 10%, 15%, 25%, 35% & 70%). Note for the purposes of mapping, Appendix A map 4 illustrates the 1% AEP +70% *climate change* event. Updated modelling is also used to delineate Flood Zone 3b (1 in 20 year (5%) flood outline).
River Roding	The catchment of the River Roding is approximately 380km^2 with its source near to Stanstead Airport. The river flows through Epping, Uttlesford and Redbridge prior to flowing along the boundaries of LB Barking and Dagenham and LB Newham. The lower catchment of the Roding within LB Newham is highly urbanised with a 'flashy' response to rainfall. The Roding is tidally influenced to the A12 at Redbridge (approximately).	Environment Agency 1D-2D linked Lower Roding Tuflow Model. September 2009. This model is currently being reviewed by the Environment Agency to include latest *climate change* allowances. Updated model results were not available at the time of writing this SFRA.

Functional Floodplain (Flood Zone 3b)

2.4.11 The Functional Floodplain is defined in the NPPF[2] as *'land where water has to flow or be stored in times of flood'.* The Functional Floodplain (also referred to as Flood Zone 3b), is not separately distinguished from Flood Zone 3a on the Flood Map for Planning. Rather the SFRA is the place where LPAs should identify areas of Functional Floodplain in discussion with the Environment Agency.

2.4.12 For the purposes of this SFRA, existing hydraulic modelling data has been interrogated to identify areas with an annual probability of 1 in 20 (5%) or greater flood extents to be delineated as Flood Zone 3b. Results have found:

- There is no Flood Zone 3b associated with the River Thames due to the presence of formal flood defences providing protection to 1 in 1000 year (0.1% AEP);
- There is no Flood Zone 3b associated with the River Lee as existing flood defences retain water in bank typically to the 1 in 50 year (2%) AEP;
- There is no Flood Zone 3b associated with the River Roding due to the presence of formal flood defences providing protection up to the 1 in 1000 year (0.1% AEP)

2.5 Tidal Flood Risk

2.5.1 The Borough of Newham is bounded to the south by the River Thames. The primary flood mechanisms associated with the River Thames are:

- Daily tidal fluctuation, occurring when the freshwater Thames is met by the incoming tide from the North Sea;

- Surge tides, which occur due to climatic 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; and

- *Fluvial* mechanisms, due to prolonged rainfall within the upper reaches of the Thames catchment during times of high tide.

2.5.2 The greatest overall flood risk from the River Thames occurs when tidal surges coincide with particularly high tide levels and/or *fluvial* flooding in the upper reaches of the catchment. As the flood risk associated with *fluvial* mechanisms is relatively minor, compared to the tidal influence, the risk from this source is defined as tidal and addressed as such within this SFRA. *Fluvial* influences on this tidal risk have, however, been considered within this analysis.

Thames Tidal Breach Modelling

2.5.3 The Thames Tidal Defence system, including the Thames Barrier and Thames River Walls provide the Borough with a significant Standard of Protection (SoP) against *tidal flooding*, up to the 1 in 1000 year event (0.1% AEP).

2.5.4 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 design 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/operational failure.

2.5.5 The likelihood of such residual risks is 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.

2.5.6 As described above, the 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas of LB Newham that would flood if there were no flood defences or buildings i.e. this depicts the "natural" floodplain. There are two main areas at risk of *tidal flooding* in Newham, as indicated by the mapped Flood Zones. This includes North Woolwich and Silvertown, extending into Beckton and Plaistow. All of these areas are located within Flood Zone 3, with smaller, adjacent areas located in Flood Zone 2. It is important to recognise that this flood risk is a residual risk, should flood defences fail.

2.5.7 In order to better understand the *residual flood risk*, reference has been made to Environment Agency Thames Tidal Breach Modelling 2015[7]. This modelling simulates tidal breaches along the River Thames at a series of pre-determined breach locations. Breach locations were chosen by the Environment Agency using a risk-based approach by examining critical locations based on low floodplain topography. For hard defences as found across the majority of LB Newham, a breach width of 20m was applied.

2.5.8 The London Thames Barrier is located in the south western half of the Newham river frontage. This means that there are two methods used in the River Thames Environment Agency breach modelling:

- Downstream of the Thames Barrier – i.e. North Woolwich and eastwards towards the River Roding; the Environment Agency has 1 in 1000 year (0.1% AEP) and 1 in 200 year

[7] Thames Tidal Breach Modelling, Environment Agency, 2015. Note that this modelling is due to be updated in 2017. The EA will include any revisions to the Flood Map for Planning as part of their quarterly updates. Any site specific FRAs should look to the latest EA breach modelling data.

(0.5% AEP) hydraulic modelling data. This applies to breach locations Dok03, Dok04, Dok05, Dok06, Dok07, Dok08.

- Upstream of the Thames Barrier – i.e. Silvertown and west towards the River Lee; there is no *return period* data for modelled levels as the water levels are controlled by barrier closures. The water levels here are referred to as *Maximum Likely Water Levels* (MLWLs) and are modelled for the 2065 and 2100 scenario. This applies to breach locations Dok01,Dok02, Dok 09 and Doc10.

2.5.9 Reference to Environment Agency data has identified that there are 11 breach locations within the LB Newham boundary. A composite map to show the maximum depth and extent of flood water should a breach occur has been mapped for the 1 in 200 year (0.5% AEP) and 1 in 1000 year (0.1% scenarios). Mapping included in Appendix A, Map 8 illustrates the following:

- Map 8a – Downstream of the Thames Barrier – 1 in 1000 year (0.1% AEP) breach modelling flood extents, combined with the 2100 maximum likely water level results upstream of the Thames Barrier.

- Map 8b – Downstream of the Thames Barrier – 1 in 200 year (0.5% AEP) breach modelling flood extents combined with the 2065 maximum likely water level results Upstream of the Thames Barrier.

Appendix A, Figure 8a & 8b Breach Modelling Data

2.6 Surface water flood risk 'Updated Flood Map for Surface Water'

2.6.1 Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

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

2.6.3 The LB Newham Surface Water Management Plan (SWMP) undertook a comprehensive review of *pluvial* flood risk and identified *Local Flood Risk Zones* where surface water flooding may affect homes, businesses or infrastructure. In addition, 13 *critical drainage area*s were identified, defined within the SWMP as the *'wider hydrological catchment areas causing flooding in one or more Local Flood Risk Zones'.* This information was used to create a long-term action plan for the LB Newham to assist in their role as LLFA and is not directly linked to the need to provide a Flood Risk Assessment at the site level.

2.6.4 In addition, the NPPF[2] also refers to areas with 'critical drainage problems' as notified by the Environment Agency. These are not the same and at the time of writing, the Environment Agency has confirmed that there are no 'areas with critical drainage problems' for the purposes of planning located within the LB Newham.

2.6.5 More recently than completion of the 2010 SWMP, the Environment Agency has undertaken further detailed modelling of surface water flood risk at a national scale and produced mapping identifying and classifying those areas at risk of surface water flooding:

- 3.33% annual probability (1 in 30 year), 'high'
- 1% annual probability (1 in 100 year), 'medium' and
- 0.1% annual probability (1 in 1,000 year) 'low'.

2.6.6 The latest version of the mapping is referred to as the 'Risk of Flooding from Surface Water Map (RoFfSW) and the extents have been made available to LB Newham as GIS layers. This dataset is also available nationally on the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'[8].

Appendix A, Map 5 Pages 1 to 4 Surface Water Flood Risk

2.7 Geology and Groundwater flood risk

Groundwater Flooding

2.7.1 *Groundwater* flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow *groundwater* to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to *groundwater* flooding because the water table is usually at a much shallower depth and *groundwater* paths tend to travel from high to low ground.

2.7.2 There are many mechanisms associated with *groundwater* flooding which are linked to high *groundwater* levels and can be broadly classified as:

- Direct contribution to channel flow – where the river channel intersects the water table and *groundwater* enters the streambed increasing water levels and causing flooding.
- Springs erupting at the surface
- Inundation of drainage infrastructure – potentially where drainage infrastructure has eroded over time.
- Inundation of low lying property (basements)

2.7.3 The main impacts of *groundwater* flooding are:

- Flooding of basements of buildings below ground level – in the mildest case this may involve seepage of small volumes of water through walls, temporary loss of services etc. In more extreme cases larger volumes may lead to the catastrophic loss of stored items and failure of structural integrity;
- Overflowing of sewers and drains – surcharging of drainage networks can lead to overland flows causing significant but localised damage to property. Sewer surcharging can lead to inundation of property by polluted water. Note: it is complex to separate this flooding from other sources, notably surface water or *sewer flooding*;
- Flooding of buried services or other assets below ground level – prolonged inundation of buried services can lead to interruption and disruption of supply;

[8] Environment Agency Risk of Flooding from Surface Water Map https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=406157&northing=270632&address=100121267048&map=SurfaceWater

- Inundation of roads, commercial, residential and amenity areas – inundation of grassed areas can be inconvenient; however the inundation of hard-standing areas can lead to structural damage and the disruption of commercial activity. Inundation of agricultural land for long durations can have financial consequences; and
- Flooding of ground floors of buildings above ground level – can be disruptive, and may result in structural damage. In addition, typically a *groundwater* flood event will have a long duration (when compared to other flood sources) which adds to the disruptive nature of the flood event.

2.7.4 Reference to the BGS dataset 'Susceptibility to *Groundwater* Flooding' included in Appendix A Map 6a, identifies that the western perimeter of the borough and land to the north of the docks are not considered to be prone to *groundwater* flooding. The risk increases to the north east of the borough in sections of Forest Gate, Manor Park and East Ham where areas with potential for *groundwater* flooding below ground and at the surface are identified.

2.7.5 For more information on the BGS geology datasets please refer to the BGS website.

Appendix A, Map 2 and 6 Geology and Groundwater Flood Risk

2.8 Sewer Flood Risk

2.8.1 The majority of the drainage in the LB Newham is provided through a combined network operated by Thames Water i.e. the sewer network contains both surface water and foul water flow.

2.8.2 The western half of the boroughs drainage infrastructure consists almost exclusively of a combined sewerage system which is transferred via the 'Northern Outfall Sewer' to the south eastern boundary of Newham to Becton Sewer Treatment Works before being discharged to the River Tames.

2.8.3 Pumping stations along this network including the Abbey Mills pumping station are key to the network and whose failure could have a major impact in terms of sewer and surface water flooding.

2.8.4 In addition, the combined sewers can create water pollution issues during combined sewer overflow events when wet weather flows exceed the sewage treatment plant capacity and outfall directly to the River Thames. The Thames Tideway Tunnel is being designed /built to improve pollution within the River Thames by providing a new 25 kilometre interception, storage and transfer tunnel running. The tunnel starts in west London and generally follows the route of the River Thames to Limehouse, where it then continues north-east to Abbey Mills Pumping Station near Stratford. There it will be connected to the Lee Tunnel, which will transfer the sewage to Beckton Sewage Treatment Works.

2.8.5 During heavy rainfall, flooding from the sewer system may occur if:

2.8.6 1) The rainfall event exceeds the capacity of the sewer system/drainage system:

2.8.7 Sewer systems are typically designed and constructed to accommodate rainfall events with an annual probability of 3.3% (1 in 30 chance each year) or greater. Therefore, rainfall events with an annual probability less than 3.3% would be expected to result in surcharging of some of the sewer system.

2.8.8 While TWUL, as the sewerage undertaker recognise the impact that more extreme rainfall events may have, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event.

2.8.9 2) The system becomes blocked by debris or sediment:

2.8.10 Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

2.8.11 3) The system surcharges due to high water levels in receiving watercourses:

2.8.12 Within the study area there is potential for surface water outlets to become submerged due to high river levels. This could potentially occur along any river frontage including the River Lee, Roding and/or River Thames when in flood. When this happens, water is unable to discharge.

2.8.13 Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers (the majority of the LB Newham) if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

2.8.14 Water companies are required to maintain a register of properties which are *at risk* of flooding due to hydraulic overloading of the sewers (the sewer pipe is too small, or at too shallow a gradient). This is called the DG5 risk register.

2.8.15 Appendix A Figures 9a and 9b show the internal and external sewer flood incident records from the DG5 Risk Register that has been supplied by Thames Water. It should be noted that these are flooding incidents that have been reported to TWUL by the home owners. There are obviously incidents that don't get reported and therefore will not show on the database. Incidents of *sewer flooding* can be retrospectively reported to TWUL via their website – http://thameswater.co.uk/help-and-advice/9782.htm.

2.8.16 This dataset has identified that greater incidents of *sewer flooding* have occurred in the north of the borough, in the areas of Stratford, Upton and West Ham (post codes E15, E7 8 and E7 9). The high number of sewer incidents could be a result of a shallow gradient drainage network as the topography in the area is observed to be relatively flat.

2.8.17 An isolated area with a greater number of sewer incidents is observed in East Ham, post code E6 3. The higher number of *sewer flooding* incidents in this location may be a result of overloading of the combined surface water and foul water drainage system.

Appendix A, Figure 9 Sewer Flooding Incidents

2.9 Risk of Flooding from Reservoirs

2.9.1 The Environment Agency dataset 'Risk of Flooding from Reservoirs' identifies areas that could be flooded if a large[9] reservoir were to fail and release the water it holds. EA data shows the west of the borough along the Lee Valley being at risk of reservoir flooding if reservoirs to the north of the borough (including King George V and William Girling reservoirs in Enfield and the Basin and Perch Pond reservoirs in Wanstead) were to fail.

[9] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

2.9.2 The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any *impounded reservoir*s (there are none in Newham) and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and/or whether emergency draw-down (release of water to reduce the water level within the reservoir and therefore reduce flood risk) of the reservoir will add to the extent of flooding.

2.9.3 Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a minimal risk.

2.9.4 The LB Newham is responsible for working with members of the Local Resilience Forum (LRF, in this case the London Resilience Forum, convened by the GLA to develop emergency plans for reservoir flooding and ensure communities are well prepared.

Appendix A, Map 11 Flood Risk from Reservoirs

2.10 Risk of Flooding from the Royal Docks

2.10.1 The Royal Docks comprise three docks; the Royal Albert Dock the Royal Victoria Dock and the King George V Dock. The three docks collectively form the largest enclosed docks in the world with a water area of nearly 250 acres. The management of the Royal Docks is undertaken by the Royal Docks Management Authority Limited (RODMA). The Docks were originally constructed to provide berths for large vessels; however, they are now largely used for recreational purposes.

2.10.2 The water levels in the Docks are controlled by a series of lock gates and are independent of water levels within the Thames, i.e. the water level does not rise and fall with the tide level.

2.10.3 There is a residual risk of a breach or failure of the lock gates during a tidal surge which could result in overtopping of the dock walls and flooding of the surrounding area. This risk has been assessed by the Environment Agency as part of the Thames Tidal Breach Modelling Study 2015, breach reference DOK 7.

Appendix A, Map 8 Breach Extents

2.11 Historic Flood Events

2.11.1 The Environment Agency and LB Newham have provided their Flood History dataset for use in this SFRA. This has been mapped on Map 3 included within Appendix A of this report. Data shows a limited record of flooding from the River Roding in the east of the borough, while flooding has occurred to the west associated with the River Lee. There are flood defences in place on this watercourse, however they offer varying levels of protection and any development within areas shown to have a flood history should investigate this risk further as part of a site specific flood risk assessment.

Appendix A, Map 3 Flood History

2.12 Flood Risk Management Infrastructure

2.12.1 There are two main categories of flood defences, formal and informal (de facto). Formal defences are specifically constructed to control floodwater. 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.

Thames Tidal Defences (River Walls)

2.12.2 The primary flood defences within the Borough are the River Thames defences, including the Thames Barrier and secondary tidal flood defences along the Thames frontage.

2.12.3 The Thames Barrier, located in Woolwich Reach downstream of the Borough, 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 (and thus not allowing tidal waters back into the river channel) in order to increase the storage capacity of the river channel to safely store *fluvial* floodwaters that are travelling downstream from the upper catchment in extreme events.

Figure 2.2 Thames Barrier

Source: The Environment Agency https://www.gov.uk/guidance/the-thames-barrier

2.12.4 Overall, the TTD are designed to provide protection up to a 1 in 1000 year flood event (0.1%AEP) and the design has an allowance for sea level rise built into it to the year 2030 to account for the effects of global warming.

2.12.5 The height of the River Thames defences (along the southern boundary of the borough) is set by an Act of Parliament[10]. These were raised in the mid-1970s as an interim protection measure in conjunction with the construction of the Thames Barrier. With the completion of the barrier, the river walls were built to a height of 7m AOD.

2.12.6 The strategy for managing tidal risk in the Thames Estuary is described in the TE2100 plan. The Environment Agency *AIMS* database contains details of flood defence *crest levels* and the standard of defence which they offer.

River Lee

2.12.7 The River Lee is protected by hard defences along the watercourse frontage, and is further influenced by a complex range of other hydraulic structures and assets. Notably this includes the River Lea Flood Relief Channel (RLFRC), which flows parallel to the River Lee Navigation Canal. Several associated sluice gates, radial gates, weirs and other control structures maintain constant water levels, with water discharged in times of flood. The channel was

[10] Thames River Prevention of Floods Acts (1879 – 1962)

completed in 1976, with capacity for a 1 in 70 year event (1.43% AEP) and was running almost full during the storms of October 1987, 1993 and 2000. The River Lee has a number of tributaries and each has flood defences to a varying standard of protection.

River Roding - Barking Barrier

2.12.8 The Barking Barrier is located at Creekmouth where the Barking Creek (this is the lower, tidally-dominated reaches of the River Roding area) meets the River Thames. The barrier was built alongside the Thames Barrier and is operated and maintained by the Environment Agency under the same conditions. When the barrier is closed, it impounds flows from the River Roding in the Barking Creek however; the linear flood walls on the River Roding are designed to provide sufficient storage to contain upstream *fluvial* flows while the Barking Barrier is closed due to high tidal levels. *AIMS* data identifies flood defence *crest levels* on the River Roding to be between 5.3m AOD and 6.5m AOD.

Figure 2.3 Barking Barrier at Creekmouth

Source: Canoe London[11] *http://canoelondon.com/river-roding/*

King George V Dock Gate

2.12.9 The King George V (KGV) Gate provides protection to the Royal Docks and low lying land in Newham from extreme tidal events in the River Thames that exceed the retained water level in the Docks. The lock gates at the dock entrance are approximately 30m wide and the impounded water level in the dock is 4.26m AOD, with a depth of 14.26m.

2.12.10 The KGV gate is owned and operated by the Environment Agency and is closed according to the Thames Barrier closure rule.

Maintenance

2.12.11 The responsibility for the management of river defences and assets within LB Newham is divided between The Environment Agency, LB Newham and private owners bordering *main rivers*. The Environment Agency has a supervisory duty over all defences under the Environment Act 1995 and is responsible for the management and maintenance of the Thames Barrier, Barking Barrier and KGV Gate. The Environment Agency carries out annual inspections of flood defence assets and updates the *AIMS* database.

Appendix A, Map 4 pages 1 to 4 Flood Defence Infrastructure

[11] http://canoelondon.com/river-roding/

2.13 Flood Defence Policy

Future Policy - Environment Agency TE2100

2.13.1 The EA has recently completed a comprehensive study referred to as Thames Estuary 2100 (TE2100), to establish the best approach to manage flood risk in the estuary throughout the 21st century, taking into consideration various *Climate Change* scenarios.

2.13.2 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 1in 1000 year level (0.1% AEP) to 1 in 10,000 (0.01% AEP); 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.

2.13.3 Under the TE2100 plan, the recommended measures for defences on the River Thames and Lee within LB Newham include:

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

2.13.4 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. Similarly, the requirement and configuration of raised defences and upgraded dock gates will be dependent on ongoing consultation and exploration of options. The TE2100 plan further highlights the requirement for safeguarding land corridors adjacent to the River Thames and its tributaries) and setting back development where possible, to allow for defence maintenance, repair and wider riverside enhancement. A recommended width of 10 metres is specified.

2.13.5 It should be noted that, in the future, *climate change* is anticipated to increase the frequency of closure of the Thames Barrier. However, 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.

2.13.6 For further information, reference should be made to the TE2100 Plan which can be found at https://www.gov.uk/government/publications/thames-estuary-2100-te2100.

Flood Alleviation Schemes

2.13.7 In addition to *fluvial* and tidal flood defences, a number of flood alleviation schemes have been implemented and are planned to manage the flood risk from other sources across the Borough, particularly surface water and *sewer flooding*. These range from localised SuDS schemes, to more strategic regional infrastructure solutions.

2.13.8 The West Ham Flood Alleviation Scheme is a project completed by Thames Water in 2010 with a target to protect 800 homes from *sewer flooding*. It is designed to reduce the risk of *sewer flooding* in Newham in areas where there is limited capacity within the local combined sewer system. The West Ham Flood Alleviation Scheme consists of a main tunnel of 2800mm with storage capacity running from a new built Abbey Mills Pumping Station linking drainage networks in Stratford, West Ham and Forest Gate. The main tunnel is connected to the existing local combined sewer network providing flood alleviation during heavy rainfall events.

2.13.9 The Thames Tideway Tunnel, a significant new combined sewage storage and transfer system that will help reduce pollution within the River Thames by alleviating the problem of overflows from London's Victorian sewers. Currently, many low level interceptor sewers overflow directly into the River, with a detrimental impact on the aquatic environment. The main Tideway Tunnel will run from Acton in west London to Abbey Mills Pumping Station in east London, controlling the most polluting combined sewer overflows (CSOs) by intercepting, storing and conveying the discharges which currently flow into the river. While the Thames Tideway Tunnel does not directly alleviate flooding, it is a replacement for the CSOs which are controlling water levels within the local combined sewerage system.

2.13.10 Further information on the Thames Tideway Tunnel can be found here: https://www.tideway.london/

3. Impact of Climate Change

3.1.1 The NPPF[2] and supporting practice guide sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of *climate change*. This includes demonstrating how flood risk will be managed now and over the lifetime of development, taking *climate change* into account.

3.1.2 In previous SFRAs and site specific Flood Risk Assessments an allowance of 20% was added to the 1 in 100 year (1% AEP) *return period* to account for increases in flood risk due to *climate change*. In February 2016, the Environment Agency published revised guidance on *climate change* allowances[12] including predictions of anticipated change for:

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

3.1.3 The guidance reflects an assessment completed by the Environment Agency between 2013 and 2015 using United Kingdom Climate Projections 2009 (UKCP09) data to produce more representative *climate change* allowances across England. The full guidance can be found using the following link to the .gov.uk website and is discussed further below. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

3.2 Peak River Flow

Strategic Planning

3.2.1 For the purposes of strategic planning and completion of the *sequential test*, LB Newham are advised to use the '2070 to 2115' 100 year development lifetime outlined in Table 3-2 below. For more vulnerable, residential development this correlates to a *climate change* range of impacts of between + 25% and + 70% on the 1 in 100 year (1%) AEP.

3.2.2 **River Thames -** Hydraulic modelling for the River Thames has been provided by the Environment Agency. Flood outlines are based on the 2008 TE2100 in-channel water levels for the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) annual probability of exceedance. These were modelled for a range of water levels including present day 2014, 2065, 2100. Each modelled event includes an allowance for *climate change*.

3.2.3 **River Lee -** Hydraulic modelling is available from the Environment Agency for the River Lee, therefore, for the purposes of mapping *climate change* flood outlines within this SFRA and

[12] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

sequential testing, *climate change* mapping is based on the 1 in 100 year (1%) AEP + 70% *climate change* as a conservative approach.

3.2.4 **River Roding -** The Environment Agency is currently undertaking new hydraulic modelling for the River Roding which will include allowances for the new *climate change* guidance. However, in the absence of model outputs for the updated *climate change* allowances on the River Roding, the 1 in 1000 year (0.1%) AEP has been used as a proxy for the 1 in 100 year plus *climate change* for use when mapping *climate change* flood outlines and completing Sequential Testing. This approach has been agreed with the Environment Agency.

Site Specific Flood Risk Assessments

3.2.5 When considering peak river allowances the NPPF[2] flood zone and flood risk vulnerability classification needs to be considered to confirm which range of *climate change* allowances should be assessed. This is set out in

3.2.6 Table 3-1 below.

Table 3-1 NPPF[2] Flood Zone and Vulnerability

Flood Zone (Table 2-1)	Vulnerability (Table 4-1)	River Flow Allowances (Table 3-2)
Flood Zone 2	Essential Infrastructure	Higher Central and Upper End
	Highly Vulnerable	Higher Central and Upper End
	More Vulnerable	Central and Higher Central
	Less Vulnerable	Central
	Water Compatible	None of the allowances
Flood Zone 3a	Essential Infrastructure	Upper End
	Highly Vulnerable	Development should not be permitted
	More Vulnerable	Higher Central and Upper End
	Less Vulnerable	Central and Higher Central
	Water Compatible	Central
Flood Zone 3b	Essential Infrastructure	Upper End
	Highly Vulnerable	Development should not be permitted
	More Vulnerable	Development should not be permitted
	Less Vulnerable	Development should not be permitted
	Water Compatible	Central

3.2.7 In order to determine which allowance category to use, the development lifetime should be considered. This should be judged based on the characteristics of development and applicants should be able to justify the chosen lifetime. Typically:

- Residential developments should apply a minimum lifetime of 100 years, unless there is specific justification for considering a shorter period;
- Non- Residential developments should apply a 75 year lifetime.

3.2.8 Therefore, in this locality, if a **residential** (more vulnerable/100 year lifetime) development were proposed within **Flood Zone 3a** an allowance of between **35% and 70% should be applied** typically to the 1 in 100 year (1%) AEP to account for the potential impacts of *climate change* on Peak River flows (as the development would still be in place in the 2080s).

3.2.9 *Climate change* allowances applicable to LB Newham (Thames River Basin District) are set out in Table 3-2 below.

Table 3-2 Peak River Flow Allowances* for Thames River Basin District

River Basin District	Allowance Category	Total potential change anticipated for the '2020's (2015 to 2039)	Total potential change anticipated for the '2050's (2040 to 2069))	Total potential change anticipated for the '2080's (2070 to 2115)
Thames	Upper End	25%	35%	70%
	Higher Central	15%	25%	35%
	Central	10%	15%	25%

**'Allowances' in this context is the amount as a % that is added to estimated peak river flows to account for climate change increases.*

River Roding

3.2.10 As noted above, currently there is no hydraulic modelling available for the River Roding that includes allowances for *climate change*. Until a time when this data is available, there will be greater emphasis on site specific FRAs to include additional hydraulic modelling to determine future flood risk to development sites. Reference should be made to Environment Agency Technical Note *'Flood Risk Assessments: Climate Change Allowances Hertfordshire and North London'* (available from the Environment Agency) for further guidance.

4. Avoiding Flood Risk – Risk Based Approach to Planning

4.1.1 The NPPF[2] 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.

4.1.2 Development is only permissible in areas at risk of flooding (see Table 4-3 below) in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, the sustainability benefits outweigh flood risks 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.

4.1.3 Building on these principles, the NPPF[2] 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 Technical Guidance and shown in Table 4-1 below.

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

Hierarchy

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

4.2 Sequential Approach

4.2.1 This Section guides the application of the *Sequential Test* and Exception Test in the Plan-making and planning application processes. Not all development will be required to undergo these tests, as described below, but may still be required to undertake a site specific FRA, guidance about which is included in Section 6.

4.2.2 The sequential approach is a decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test where required will ensure that new developments in flood risk areas will only occur where flood risk is clearly outweighed by other sustainability drivers.

4.2.3 The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones (e.g. within LB Newham, there is a large frontage onto the River Thames within Flood Zone 3. However, sites located further from the flood defence walls may be at a reduced flood risk than sites adjacent to the flood defence walls. In this instance breach modelling can be used to provide a greater understanding of the risk within the Flood Zone. See 4.3.7 point 11). All opportunities to locate new developments (except

Water Compatible (Table 4-2)) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

4.3 Applying Sequential Test – Plan-Making

4.3.1 Regarding the allocation of sites through the Local Plan, it should be demonstrated that a range of possible sites were considered in conjunction with the Flood Zone and vulnerability information provided by the SFRA, and the *Sequential Test*, and where necessary, the Exception Test applied. Figure 4.1 illustrates the approach for applying the *Sequential Test* that LB Newham should adopt in the allocation of sites as part of the preparation of the Newham Local Plan (note that the process for planning applications is examined in 4.4). The *Sequential Test* should be undertaken by LB Newham and accurately documented to ensure decision processes are consistent and transparent

4.3.2 The *Sequential Test* requires an understanding of the Flood Zones in the study area and the vulnerability classification of the proposed developments. Flood Zone definitions are provided in Table 2-1 and mapped in the figures in Appendix A (and the Environment Agency's *Flood Map for Planning (Rivers and Sea)*). Flood risk vulnerability classifications, as defined in the NPPG are presented in Table 4-2.

4.3.3 NPPF[2] acknowledges that some areas will (also) be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including: flooding from land or surface water runoff; groundwater; sewers; and artificial Sources.

4.3.4 If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the *Sequential Test*.

4.3.5 The flow diagram presented in 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.

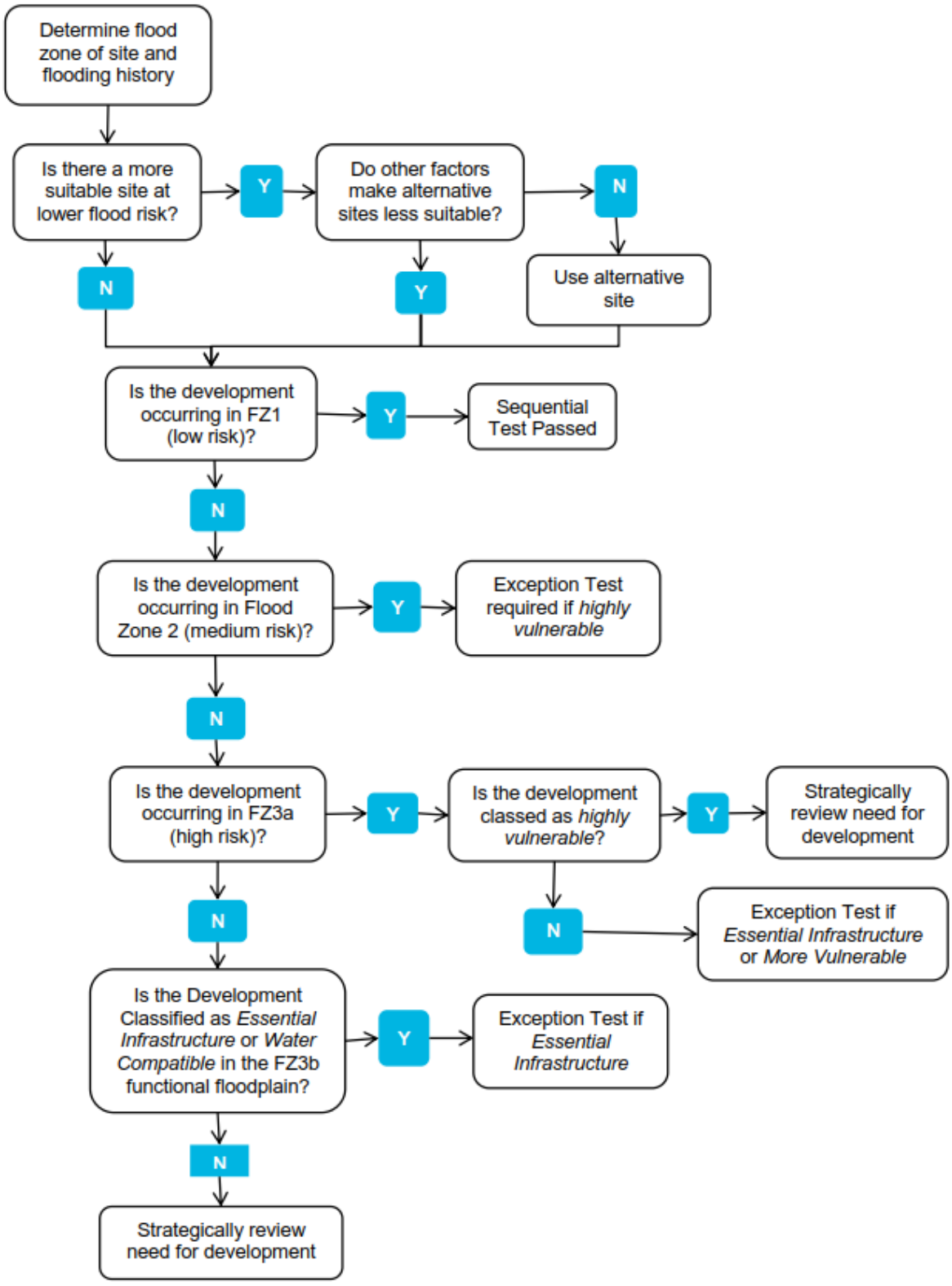


Figure 4-1 Application of the Sequential Test for the Plan Making Process *(after Diagram 2 Application of the Sequential Test for Local Plan Preparation NPPF[2])*

Table 4-2 Flood Risk Vulnerability Classification *(after Table 2 NPPF[2] March 2014)*

Vulnerability Classification	Development Uses
Essential Infrastructure	• 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, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• 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. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• 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	• 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	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • 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 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG[21], 2014)

Flood Risk Vulnerability Classification		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	Exception test Required	✓	✓	✓
	3a	Exception Test Required	×	Exception Test Required	✓	✓
	3b *[1]	Exception Test Required*	×	×	×	✓*

✓ - Development is appropriate × - Development should not be permitted

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:
- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

4.3.6 The recommended steps in undertaking the *Sequential Test* are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability and is summarised in Table 4-3.

Recommended stages for LPA application of the Sequential Test in Plan-Making

4.3.7 The information required to address many of these steps is provided in the accompanying maps presented in Appendix A.

1. Assign potential developments with a vulnerability classification (Table 4-2). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.
2. The location and identification of potential development should be recorded.
3. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these span more than one Flood Zone, all zones should be noted, preferably using percentages.
4. The design life of the development should be considered in accordance with NPPF[2] guidelines with respect to *climate change*, being:
   - **Residential development** should be considered for a minimum of **100 years**, unless there is specific justification for considering a shorter period.
   - The lifetime of non-residential development depends on the characteristics of that development. Planners should use their experience within their locality to assess how long they anticipate the development being present for. Developers would be expected to justify why they have adopted a given lifetime for the development, for example when they are preparing a site-specific flood risk assessment. Typically a timeframe of **75 years** is applied to **commercial / industrial** developments.
5. Identify existing flood defences serving the potential development sites to outline areas at *residual flood risk*. However, it should be noted that for the purposes of the *Sequential Test*, Flood Zones ignoring defences should be used.
6. Highly Vulnerable developments to be accommodated within the Borough should be located on those sites identified as being within Flood Zone 1. If these cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are

insufficient sites in Flood Zone 1, sites in Flood Zone 2 can then be considered. If sites in Flood Zone 2 are inadequate then additional sites in Flood Zones 1 or 2 may need to be identified to accommodate development or opportunities sought to locate the development outside the Borough.

7. Once all Highly Vulnerable developments have been allocated to a development site, consideration can be given to those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located on sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test.
8. Once all More Vulnerable developments have been allocated to a development site, consideration can be given to those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located on sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.
9. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.
10. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.
11. Where required, the more detailed Level 2 SFRA should consider the nature of flood risk and hazard to allow a sequential approach to site allocation within a Flood Zone. Consideration of flood hazard within a flood zone would include:
    - flood risk management measures,
    - the rate of flooding,
    - flood water depth,
    - flood water velocity.

    The Level 2 SFRA will provide enough information for the exception test to be applied.

Windfall Sites

4.3.8 Windfall sites are those that have not been specifically identified as available in the Local Plan process. Given the patterns of development in Newham it's likely that most windfall sites would be within the 'Urban Newham' area where flood risk is lower and, as such, development is inherently preferable. Such sites should be assessed at application stage as required.

4.4 Applying Sequential Test – Planning Applications

4.4.1 It is necessary to undertake a *sequential test* for a planning application if both of the following apply (also refer to 4.1 above):

- The proposed development is in Flood Zone 2 or 3.
- A *sequential test* hasn't already been completed for a development of the type you plan to carry out on your proposed site (check with LB Newham).

Sequential Test Exemptions[13]

4.4.2 It should be noted that the *Sequential Test* does not need to be applied in the following circumstances:

[13] Refer to NPPF for guidance https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants

- Individual developments proposed on sites which have been allocated in development plans through the *Sequential Test*.
- Minor development, which is defined in the NPPF[2] as:
  - Minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2.
  - Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
  - Householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in additional to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site. However, such sites still need to meet the requirements for site-specific flood risk assessments[14].
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of *climate change*).
- Redevelopment of existing properties (e.g. replacement dwellings), provided they do not increase the number of dwellings in an area of flood risk (i.e. replacing a single dwelling within an apartment block).

Applying the Sequential Test to planning applications

4.4.3 The Environment Agency publication 'Demonstrating the flood risk *Sequential Test* for Planning Applications[15]' sets out the procedure for applying the *sequential test* to individual applications as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning, the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources.
- Apply the *Sequential Test*; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 4-3, apply the Exception Test.
- Apply the Sequential approach to locating development within the site.

4.4.4 Ultimately, after applying the *Sequential Test*, LB Newham (taking advice from the Environment Agency) needs to be satisfied in all cases that the proposed development would

[14] Note that while the sequential test is not required, a site specific FRA is required for all proposals for new development including minor development and change of use in Flood Zone 2 and 3. NPPF Footnote 20 referring to paragraph 103
[15] Environment Agency, April 2012, 'Demonstrating the flood risk Sequential Test for Planning Applications', Version 3.1

be safe and not lead to increased flood risk elsewhere. This needs to be demonstrated within a FRA and is necessary regardless of whether the Exception Test is required.

4.5 Exception Test

4.5.1 The purpose of the Exception Test is to ensure that, following the application of the *Sequential Test*, new development is only permitted in Flood Zone 2 and 3 where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering *climate change*.

4.5.2 The Exception Test provides a method of managing flood risk while still allowing necessary sustainable development to occur. The test is used when there are large areas in Flood Zones 2 and 3a (consistent with LB Newham Appendix A Map 4) 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 demonstrates the methodology to determine whether an Exception Test is required for proposed site allocations.

4.5.3 In order to pass the Exception Test, the NPPF[2] paragraph 102 identifies two elements that need to be demonstrated/fulfilled to the satisfaction of the LPA:

1. The development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and
2. 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.

4.5.4 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 that:

- 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;
- there is a safe means of access and egress during a flood event;
- Emergency evacuation procedures are developed, to be utilised following receipt of a flood warning;
- Priority is given to the use of sustainable drainage systems

4.5.5 A significant proportion of LB Newham is located within Flood Zone 3a of the River Thames (Appendix A Map 4); 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.

4.5.6 With reference to point 4.5.5, breach modelling results for the River Thames[16] should be taken into account to determine the variation in flood depth and hazard within Flood Zones. This will confirm whether more appropriate locations may be available within Flood Zones, with a lower hazard rating.

[16] TE2100 Environment Agency 2015

5. Managing and Mitigating Flood Risk through Spatial Planning and Development Control

5.1 Overview

5.1.1 The NPPF[2] appreciates that it may not always be possible to avoid locating development in areas at risk of flooding. This section builds on the findings of the SFRA to provide guidance on the range of measures that could be considered on site in order to manage and mitigate flood risk. These measures should be considered when preparing a site-specific FRA as described in Section 6. Appendix B outlines the approach that LB Newham is adopting in relation to flood risk planning policy and development management decisions.

5.2 Design Flood Level

5.2.1 Where a development is identified as being located within an area at risk of tidal or *fluvial* flooding, the *design flood* is an important part of the flood risk planning process which needs to be defined in a site specific Flood Risk Assessment to support the planning application process. The *design flood* event is the largest flood that a given project is designed to safely accommodate. The 1 in 100 year *fluvial* (1% AEP) or 1 in 200 year (0.5%) AEP tidal including a suitable allowance for *climate change*17 are typically used.

5.3 Development Layout and Sequential Approach

A sequential approach to site planning should be applied within new development sites

5.3.1 Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding. Reference should be made to Environment Agency breach modelling to provide further detail of *fluvial* and tidal flood risk within Flood Zones.

5.4 Finished Floor Levels

For the purposes of informing a site specific FRA, all More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an appropriate allowance for *climate change*. To improve resilience in areas at risk during a breach in the tidal flood defence, the Environment Agency recommend that, where feasible floor levels are set above the modelled 2100 breach levels.

5.4.1 Where developing in Flood Zone 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly

[17] Climate change guidance is periodically updated – reference should be made to the Environment Agency via https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Latest climate change guidance was published on 19th Feb 2016 and updated 3rd Feb 2017.

Vulnerable land uses, is to ensure internal floor levels are raised a *freeboard* level above the *design flood* level[18].

5.4.2 With reference to British Standards[19] for the 1 in 100 year *return period* event (1% AEP) including a suitable allowance for *climate change*, flood levels associated with surface water drainage and flood risk should be not less than 300mm below the finished ground floor level and the level of any opening into any basement of the proposed buildings on site.

5.4.3 In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the Environment Agency and/or LB Newham should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood resistance measures are implemented up to an agreed level.

5.4.4 There are also circumstances where *flood resilience* measures should be considered first. These are described further below. For both Less and More Vulnerable developments where internal access to higher floors is required, the associated plans showing the access routes and floor levels should be included within any site-specific FRA.

5.5 Safe Access/ Egress

5.5.1 Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

5.5.2 A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1) using public rights of way without the intervention of emergency services or others during design flood[12] conditions, including *climate change* allowances.

For developments located in areas at risk of *fluvial* flooding safe access / egress must be provided for new development 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 of flooding) is low and should not cause risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.

5.5.3 In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for *climate change*.

18 The design flood level is generally taken as; fluvial flooding likely to occur with a 1% annual probability (1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year). Both should include a suitable allowance for climate change.

19 BSI Standards Publication Code of Practice for surface water management for development sites, BSI 2013

5.6 Safe Refuge

5.6.1 In exceptional circumstances, dry access above the 1% annual probability (1 in 100 year) flood level including *climate change* may not be achievable. In these circumstances the Environment Agency and LB Newham should be consulted to ensure that the safety of the site occupants can be satisfactorily managed; this will be informed by the type of development, the number of occupants and their vulnerability and the flood hazard along the proposed egress route. For example, this may entail the designation of a safe place of refuge on an upper floor of a building, from which the occupants can be rescued by emergency services. It should be noted that sole reliance on a safe place of refuge is a last resort, and all other possible means to evacuate the site should be considered first. Provision of a safe place of refuge will not guarantee that an application will be granted.

5.7 Flood Warning Areas

5.7.1 The Environment Agency provides a free flood warning service for many areas at risk of flooding from rivers and the sea. In some parts of England, the Environment Agency may be able to provide warnings where flooding from groundwater is possible. This free warning service can provide advance notice of flooding can provide time to prepare.

5.7.2 The Environment Agency issue flood warnings to homes and businesses when flooding is expected. Upon receipt of a warning, occupants should take immediate action.

5.7.3 To sign up to get warnings in England by phone, email or text message if your home or business is at risk of flooding visit the GOV.UK website.

5.8 Surface Water Management

All major developments and other development should not result in an increase in surface water runoff, and where possible, should demonstrate betterment in terms of rate and volumes of surface water runoff.

5.8.1 Sustainable Drainage Systems (SuDS) should be used to reduce and manage surface water run-off to and from proposed developments as near to source as possible in accordance with the requirements of the Technical Standards and supporting guidance published by DCLG and Department for the Environment, Food and Rural Affairs (DEFRA)[20]. In line with the LB Newham Core Strategy, SuDS must be implemented for sites in Flood Zone 2 and 3. SuDS must be considered for sites in Flood Zone 1.

5.9 Recommendations for Policy and Practice

5.9.1 Further recommendations for policy and practice across LB Newham are contained within Appendix B of this report including:

- Strategic planning;
- Development control;
- Emergency planning;
- Flood Defences, and;
- SuDS.

[20] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards; PPG Flood Risk and Coastal Change – 23rd March 2015 http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/

6. Guidance for Developers

6.1 What is a Flood Risk Assessment?

6.1.1 A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 100 of the NPPF[2] and PPG[21]. A FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow LB Newham to satisfy itself that policy requirements have been met.

6.2 When is a Flood Risk Assessment required?

The NPPF states that a site-specific FRA is required in the following circumstances:

- Proposals for new development (including minor development[21] and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)[22].
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

6.3 How detailed should a FRA be?

6.3.1 The PPG[21] states that site-specific FRAs should be proportionate to the degree of flood risk, the scale and nature of the development, its vulnerability classification and the status of the site in relation to the Sequential and Exception Tests. Site-specific FRAs should also make optimum use of readily available information, for example the mapping presented within this SFRA and available on the Environment Agency website, although in some cases additional modelling or detailed calculations will need to be undertaken.

6.3.2 Table 6-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C62423 and identifies typical sources of information that can be used.

[21] According to the PPG Flood Risk and Coastal Change, 6th March 2014 https://www.gov.uk/guidance/flood-risk-and-coastal-change#minor-development-to-flood-risk minor development means:
minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2.
alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats
[22] There are no critical drainage areas / problems as notified by the Environment Agency within LB Newham
[23] CIRIA, 2004, Development and flood risk – guidance for the construction industry C624.

Table 6-1 Levels of Site-Specific Flood Risk Assessment

Description
Level 1 Screening study to 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. The screening study will ascertain whether a FRA Level 2 or 3 is required. Typical **sources of information** include: • LB Newham SFRA • Flood Map for Planning (Rivers and Sea) • Environment Agency Standing Advice • NPPF Tables 1, 2 and 3
Level 2 Scoping study to 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: • 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. 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. Typical **sources of information** include those listed above, plus: • Local policy statements or guidance. • Thames *Catchment Flood Management Plan.* • Data request from the EA to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity. • Consultation with EA/LB Newham/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. • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition. • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences
Level 3 Detailed study 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: • 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. Typical **sources of information** include those listed above, plus: • 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. • Continued consultation with the LPA, Environment Agency and other flood risk consultees.

6.4 What needs to be addressed in a Flood Risk Assessment?

6.4.1 The PPG[21] states that the objectives of a site-specific flood risk assessment are to establish:

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

- Whether the development will be safe and pass the Exception Test, if applicable.

6.5 Flood Risk Assessment Checklist

6.5.1 Table 6-2 provides a checklist for site-specific FRAs listing the information that will likely need to be provided along with references to sources of relevant information. As described in Section 6.3, the exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk.

Table 6-2 Site-Specific Flood Risk Assessment Checklist (building on guidance in PPG[21])

What to Include in the FRA		*Source(s) of Information*
1.Site Description		
Site address	*-*	*-*
Site description	*-*	*-*
Location plan	*Including geographical features, street names, catchment areas, watercourses and other bodies of water*	*SFRA Appendix A*
Site plan	*Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel*	*OS Mapping* *Site Survey*
Topography	*Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum).* *Plans showing existing and proposed levels.*	*SFRA Appendix A,* *Site Survey*
Geology	*General description of geology local to the site.*	*SFRA Appendix A* *Ground Investigation Report*
Watercourses	*Identify Main Rivers and Ordinary Watercourses local to the site.*	*SFRA Appendix A*
Status	*Is the development in accordance with the Council's Spatial Strategy?*	*Seek advice from LB Newham if necessary*
2. Assessing Flood Risk		
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 6-1 regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.		
Flooding from Rivers	*Provide a plan of the site and Flood Zones.* *Identify any historic flooding that has affected the site, including dates and depths where possible.* *How is the site likely to be affected by climate change?* *Determine flood levels on the site for the 1% annual probability (1 in 100 chance each year) flood event including an allowance for climate change.* *Determine flood hazard on the site (in terms of flood depth and velocity).* *Determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.*	*SFRA Appendix A* *Environment Agency Flood Map for Planning (Rivers and Sea).* *Environment Agency Products 1-7.* *New hydraulic model (where EA data not available)*
Flooding from Land	*Identify any historic flooding that has affected the site.* *Review the local topography and conduce a site walkover to*	*SFRA Appendix A* *Topographic survey.*

	determine low points at risk of surface water flooding. *Review the Risk of Flooding from Surface Water mapping & SWMP report.*	*Site walkover.* *Risk of Flooding from Surface Water mapping (EA website).*
Flooding from Groundwater	*Desk based assessment based on high level BGS mapping in the SFRA.* *Ground survey investigations.* *Identify any historic flooding that has affected the site.*	*SFRA Appendix A* *Ground Investigation Report*
Flooding from Sewers	*Identify any historic flooding that has affected the site.*	*SFRA Appendix A.* *Where appropriate an asset location survey can be provided by Thames Water Utilities Ltd http://www.thameswater-propertysearches.co.uk/*
Reservoirs, Docks, canals and other artificial sources	*Identify any historic flooding that has affected the site.* *Review the Risk of Flooding from Reservoirs mapping & EA breach modelling for the Docks*	*Risk of Flooding from Reservoirs mapping (EA website).*
3. Proposed Development		
Current use	*Identify the current use of the site.*	-
Proposed use	*Will the proposals increase the number of occupants / site users on the site such that it may affect the degree of flood risk to these people?*	-
Vulnerability Classification	*Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?*	*SFRA Table 4-2* *SFRA Table 4-3*
4. Avoiding Flood Risk		
Sequential Test	*Determine whether the Sequential Test is required.* *Consult LB Newham to determine if the site has been included in the Sequential Test.* *If required, present the relevant information to LB Newham to enable their determination of the Sequential Test for the site on an individual basis.*	*SFRA 4.4*
Exception Test	*Determine whether the Exception Test is necessary.* *Where the Exception Test is necessary, present details of:* *Part 1) how the proposed development contributes to the achievement of wider sustainability objectives as set out in the LB Newham Sustainability Appraisal Scoping Report.* *(Details of how part 2) can be satisfied are addressed in the following part 5 'Managing and Mitigating Flood Risk'.)*	*SFRA Table 4-3* *Refer to LB Newham sustainability objectives*
5. Managing and Mitigating Flood Risk		
Section 5 of the SFRA presents measures to manage and mitigate flood risk and when they should be implemented. Where appropriate, the following should be demonstrated within the FRA to address the following questions: *How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime?* *How will you ensure that the proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?* *Are there any opportunities offered by the development to reduce flood risk elsewhere?*		

What flood-related risks will remain after you have implemented the measures to protect the site from flooding (i.e. residual risk) and how and by whom will these be managed over the lifetime of the development (e.g. flood warning and evacuation procedures)?		
Development Layout and Sequential Approach	*Plan showing how sensitive land uses have been placed in areas within the site that are at least risk of flooding.*	*SFRA Section 5.2*
Finished Floor Levels	*Plans showing finished floor levels in the proposed development in relation to Ordnance Datum taking account of indicated flood depths.*	*SFRA Section 5.3*
Flood Resistance	*Details of flood resistance measures that have been incorporated into the design. Include design drawings where appropriate.*	
Flood Resilience	*Details of flood resilience measures that have been incorporated into the design. Include design drawings where appropriate.*	
Safe Access / Egress	*Provide a figure showing proposed safe route of escape away from the site and/or details of safe refuge. Include details of signage that will be included on site.* *Where necessary this will involve mapping of flood hazard associated with river flooding. This may be available from Environment Agency modelling, or may need to be prepared as part of hydraulic modelling specific for the proposed development site.*	*SFRA Section 5.4*
Flow Routing	*Provide evidence that proposed development will not impact flood flows to the extent that the risk to surrounding areas is increased. Where necessary this may require modelling.*	
Riverside Development Buffer Zone	*Provide plans showing how a buffer zone of relevant width will be retained adjacent to any Main River or Ordinary Watercourse in accordance with requirements of the Environment Agency LB Newham*	
Surface Water Management	*Details of the following within FRA for all other developments located within Flood Zones 2 and 3:* *Calculations (and plans) showing areas of the site that are permeable and impermeable pre and post-development.* *Calculations of pre and post-development runoff rates and volumes including consideration of climate change over the lifetime of the development.* *Details of the methods that will be used to manage surface water (e.g. permeable paving, swales, wetlands, rainwater harvesting).* *Where appropriate, reference the supporting Outline or Detailed Drainage Strategy for the site.* *Information on proposed management arrangements*	*SFRA Appendix B*
Flood Warning and Evacuation Plan	*Where appropriate reference the Flood Warning and Evacuation Plan or Personal Flood Plan that has been prepared for the proposed development (or will be prepared by site owners).*	

6.6 Pre-application Advice

6.6.1 At all stages, LB Newham, and where necessary the Environment Agency and/or the Statutory Water Undertaker may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

6.6.2 The Environment Agency and LB Newham each offer pre-application advice services which should be used to discuss particular requirements for specific applications.

- Environment Agency http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/research/planning/33580.aspx
- LB Newham

  https://www.newham.gov.uk/Pages/Services/Planning-Pre-application-service.aspx

6.6.3 The following government guidance sets out when LPAs should consult with the Environment Agency on planning applications https://www.gov.uk/flood-risk-assessment-local-planning-authorities.

7. Level 2 SFRA Methodology

7.1.1 A large area of LB Newham is located within Flood Zone 2 or 3 including parts of Canning Town & Custom House, Royal Docks and Beckton where many strategic sites outlined within the LB Newham Core Strategy, and proposed in the February 2017 Local Plan Review document, are located. The majority of flood risk posed to these areas is a residual risk in the unlikely event that the River Thames Tidal Defences fail. Further detail with regard to flood risk within Flood Zones is therefore required in order to apply the sequential approach to development within Flood Zones.

7.1.2 LB Newham has provided 10 strategic sites for detailed assessment as part of this level 2 SFRA. For each site, a 'site assessment pro-forma' has been completed to determine the potential for a site to pass the Exception Test and to provide recommendations for the issues that would need to be considered by the LPA and potential developers as the sites come forward for development.

7.2 Level 2 SFRA Data

Maximum Flood Depth

7.2.1 The Environment Agency has provided the flood zone outlines for LB Newham (Flood Map for Planning, Rivers and Sea) as described in Section 2.4 and illustrated in Appendix A. These flood zones show the probability of river and sea flooding (not including defences).

7.2.2 In addition for the purposes of the Level 2 assessment, reference has been made to Thames Tidal Breach Modelling (described in Section 2.5). There are 11 breach locations along the LB Newham frontage which have been simulated for the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) annual probability of exceedance tidal events including an allowance for *climate change*.

7.2.3 During a flood event, the water depth can vary considerably across a flooded area. It is important to identify areas of a site that are more likely to experience greater depths of water and to try to locate high vulnerability developments in areas with a lower flood depth. In addition flood depth is required to inform finished floor levels and to identify access and egress routes during a flood event.

7.2.4 For the purposes of this SFRA, maximum flood depth data has been extracted from existing Environment Agency hydraulic models. For the purposes of the SFRA, the flood depths experienced during each breach event have been mapped together, using the maximum values at each point in the floodplain.

Hazard Rating

7.2.5 Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain. Each element within the model is assigned one of four hazard categories as described in Defra guidance[24].

[24] http://randd.defra.gov.uk/Document.aspx?Document=FD2321_7400_PR.pdf

Table 7-1 Key to Depth Hazard

Depth of Flooding At Risk	Hazard Rating
Less than 0.75	Very Low Hazard - Caution
0.75m -1.25m	Danger for Some
1.25m – 2.0m	Danger for Most
>2.0m	Danger for All

7.3 Surface Water Runoff

7.3.1 Although the Exception Test is primarily concerned with the definitions of Flood Zones and thereby the risk from *fluvial* and tidal sources, it is important that surface water management is considered at an early stage in the assessment of the potential development sites identified by LB Newham.

7.3.2 In order to support this, the following information has been provided as part of the site assessments presented in Appendix C.

- A high level assessment of potential surface water flow paths has been made, using the Environment Agency Risk of Flooding from Surface Water mapping (RoFSW).
- Estimated Greenfield runoff rates have been provided for each site based on the Institute of Hydrology IH124 Methodology[25]. A tool on the HR Wallingford UK Sustainable Drainage website[26] has been used to provide these rates for a range of *return periods*. (It is noted that this tool applies a minimum flow of 5l/s to any site[27]. In order to provide more accurate Greenfield Runoff Rates, the growth factors have been applied to the QBAR runoff rate to provide runoff rates for the 1 in 1 year, 1 in 30 year and 1 in 100 year runoff rates).
- A high level identification of where surface water could be discharged with reference to Ordnance Survey (OS) mapping and a strategic understanding of the underlying geology[28]. Generally the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable (in accordance with London Plan policy 5.13). A Red (no potential), Amber (maybe possible with further site investigation), Green (existing data confirms suitability) assessment has been provided to determine the potential for each at a particular development site:
  - Discharge into the ground (shallow infiltration);
  - To a surface water body e.g. watercourse;
  - To a surface water sewer, highway drain, or another drainage system;
  - To a combined sewer.
- This information provides a starting point for developers when identifying the issues that will need to be considered when developing a surface water drainage strategy for a particular site.

[25] The Institute of Hydrology carried out a number of studies on revising the runoff equations produced in the original Flood Studies Report (1975). IH124 was specifically produced to address the runoff from small catchments (Institute of Hydrology, 1994). Although shown to be slightly less accurate than more recent FEH based methods, it is still considered to be an acceptable approach for assessing greenfield runoff rates. The IH124 estimates greenfield runoff based on the mean annual flood flow from a rural catchment, the area of the catchment, the standard average annual rainfall and a runoff coefficient based on the SOIL category. Further information can be found here: http://www.uksuds.com/surfacewaterstorage_js.htm

[26] http://www.uksuds.com/greenfieldrunoff_js.htm

[27] Historically 5l/s was applied to an outlet where Qbar was lower than 5l/s, as most devices would require an outlet orifice size smaller than 50mm,which would increase the susceptibility of blockage and failure. There are now vortex flow control devices which can be designed to a lower discharge rate, with 600mm shallow design head and still provide a more than 50mm orifice diameter. Furthermore it is expected by Essex CC that development should incorporate an appropriately designed SuDs system which should remove materials which are likely to cause blockages before water reaches any flow control devices.

[28] With reference to strategic BGS geological mapping accessed via http://mapapps.bgs.ac.uk/geologyofbritain/home.html

7.4 Level 2 Site Assessments

7.4.1 Appendix C provides the Level 2 assessments for each of the potential development sites identified by LB Newham. For each potential development site, the datasets described in Section 6 have been used to assess the flood risk to the site; any further information that would be required as part of a site specific FRA for the site has been identified; and, recommendations for measures to avoid, manage and mitigate flood risk have been provided in accordance with the guidance presented in Section 5 of the Level 1 SFRA Report.

7.4.2 The potential development sites are presented in the order set out in Table 7-2.

Table 7-2 Level 2 SFRA potential development sites for assessment

Settlement	Site Name	Area (ha)
Beckton & Royal Docks	Alpine Way	5.38
	Beckton Riverside	76
	North Woolwich Gateway	5
	Connaught Riverside	12
	Silvertown Landing	5.62
	Lyle Park West	7
Custom House & Canning Town	Canning Town Riverside	2
	Coolfin North	7.9
East Ham	East Ham Northern Gateway	1
	East Ham Western Gateway	1

8. Summary

8.1 Overview

8.1.1 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. In addition to the SFRA report, planners and developers should use supporting mapping to inform borough wide and site specific flood risk assessments.

8.1.2 The Borough is bounded to the South by the River Thames and to the East by the River Roding and to the West by the River Lee. Whilst the tidal Thames poses a potential risk of flooding to the Borough, the TTD provide a substantial standard of protection, up to the 1 in 1000 year event (1% AEP). 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. The River Lee and Roding are also defended; however, small areas of the Borough are at actual risk of *fluvial* flooding from the River Lee for events above a 1 in 50 year *return period* (2% AEP). See Map 4 page 1 for further detail, additional hydraulic modelling information for the River Lee should it be required can be sought from the Environment Agency.

8.1.3 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 limited capacity of drainage infrastructure. Geological indicators also suggest that certain areas of the Borough may be susceptible to elevated *groundwater* levels (map X?), 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.

8.1.4 This SFRA identifies the floodplain areas associated with the River Thames, River Lee and River Roding and presents Flood Zone Maps that delineate the flood zones outlined in the NPPF. These maps provide the necessary information 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 the Exception Test when required

8.1.5 Given the position of the Borough adjacent to the River Thames, River Lee and River Roding, it is highly reliant on flood defences. Ongoing maintenance of these defences is critical, and priority should be given to safeguarding the standard of protection provided by defences over the lifetime of any development.

8.1.6 However, it is further recommended that policy options are expanded to include greater emphasis on floodplain management to complement flood defence infrastructure, by promoting appropriate use of the floodplain and making space for water. Existing corridors of land along the river frontage should be safeguarded and opportunities taken to set back development to enable sustainable and cost effective flood risk management, including upgrading of river walls and embankments. Flood awareness and robust emergency planning and response will additionally be critical to sustainable ongoing flood risk management.

Appendix A Mapping