London Borough of Richmond upon Thames
Strategic Flood Risk Assessment (SFRA) Update

March 2016

London Borough of Richmond upon Thames
Civic Centre
44 York Street
Twickenham
TW1 3BZ

Document title	London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA)
Document short title	SFRA (Update)
Status	Final Report
Date	March 2016

Issue and Revision Record

Revision:	**Final**
Date:	**March 2016**
Originator:	Michael Arthur, Mark Jwaideh and Tom Whitworth (Metis Consultants) – Update of 2010 version of SFRA
Approved by:	Andrea Kitzberger-Smith - Planning Policy Manager - London Borough of Richmond upon Thames

LBRuT does not accept any responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it is intended. This report is based on information supplied by other parties, therefore LBRuT accepts no liability for any loss or damage suffered by clients, planning applicants and developers stemming from any conclusions based on data contained within this report.

Note that the datasets presented in the SFRA should not be interpreted at an individual property scale – they are provided as an indicator for residents / developers to seek further detailed information on their individual property flood risks and should not be the only source of flood risk information used. If there is any uncertainty regarding the flood risk (for example if a property is on the edge of a flood zone), then further information should be requested from the Environment Agency by the individual to confirm the level of risk.

UPDATE OF THE LONDON BOROUGH OF RICHMOND UPON THAMES STRATEGIC FLOOD RISK ASSESSMENT SUMMARY OF MAIN CHANGES

Background

In June 2008, Jacobs completed the London Borough of Richmond upon Thames (LBRuT) (Level 1) Strategic Flood Risk Assessment (SFRA). The 2008 SFRA provided a robust assessment of flood risk across the Borough. The main outputs from the study were a set of maps and GIS data delineating fluvial and tidal flood zones to meet the requirements of the then prevailing Planning Policy Statement 25: Development and Flood Risk.

The London Borough of Richmond upon Thames updated the 2008 SFRA in August 2010, referred to hereafter as the 2010 SFRA, to reflect the changes in national, regional and local planning policies and guidance as well as the changes in legislation (including Flood Risk Regulations 2009 and Flood and Water Management Act 2010). The update also took account of new flood risk related plans/documents and maps, such as the Thames Estuary 2100 Plan and the Areas Susceptible to Surface Water Flooding maps.

Main changes to the 2010 SFRA

The London Borough of Richmond upon Thames updated the 2010 SFRA between May and November 2015. The update was necessary for the following reasons:

- The PPS25 has been superseded by the National Planning Policy Framework (NPPF). This document was published in March 2012.
- The PPS25 Practice Guide Companion initially ran alongside the NPPF document, but this has been replaced by the National Planning Practice Guidance (NPPG) which was published in March 2014.
- The Environment Agency has commissioned a number of new modelling studies that supersede those used for the original SFRA.
- The Environment Agency published Risk of Flooding from Surface Water maps in December 2013.
- The Environment Agency published revised Tidal Breach Hazard Mapping in October 2015.
- The Environment Agency has published the Thames Catchment Flood Management Plan summary report in December 2009 and the Thames Estuary 2100 Plan in November 2012
- The Borough adopted the Development Management DPD in November 2011.
- The Mayor of London published the updated version of the London Plan in March 2015.
- The Flood and Water Management Act 2010 has been enacted.
- The River Thames Scheme: reducing flood risk from Datchet to Teddington was developed in November 2010 to meet the recommendations set out in the Lower Thames Flood Risk Management Strategy.
- The update of this SFRA also removes any reference to the 'Rapid Inundation Zones'. The reference of this spatial process was removed to simplify the overall interpretation of the hazard mapping. The Rapid Inundation Zones are superseded by the most up to date breach modelling available.

The update reflects the intention stated in the original version of the SFRA (June 2008) to review and update the SFRA on a regular basis as it is a 'Living Document'. This updated version reflects new knowledge of flood risk within the Borough and amendments to national, regional and local guidance and policy.

The updates made as part of this revision to the SFRA are summarised below. Many of the amendments made are of relatively minor nature and it would not be appropriate or helpful to list every single change. Attention is drawn to the following more substantial changes made to the June 2010 version:

Chapter 2 – Introduction: Updated in line with published revisions to Thames Catchment Flood Management Plan, Lower Thames Strategy, Thames Estuary 2100 and adopted Core Strategy.

Chapter 4 – Policy Framework:

- Update to National Planning Policy Framework and associated Practice Guidance
- Update in line with current London Plan (2015)
- Update to the Sustainable Design and Construction – Supplementary Planning Guidance (2014)
- Update in line with adopted Regional Flood Risk Appraisal (2014)
- Update to the Flood and Water Management Act (2010)
- Update to the Regional Flood Risk Appraisal
- Update to the Thames Estuary 2100 Flood Risk Management Plan
- Update to the Thames Scheme: Reducing flood risk from Datchet to Teddington
- Update to the River Basin Management Plan: Thames River Basin District
- Update to the Mayor's Climate Change Adaption Strategy
- Update to the Adopted Development Management Plan (2011)
- Update to the Mayor's Water Strategy
- Update to the Local Flood Risk Management Strategy (2015)
- Update to the Surface Water Management Plan
- Update to the Preliminary Flood Risk Assessment

Chapter 5 – Data Collection:

- New section on the Environment Agency Updated Flood Map for Surface Water dataset
- New section on the Aquifer Designation dataset provide by the British Geological Survey

Chapter 6 – Flood Risk in Richmond:

- Clarification on redevelopment in Flood Zone 3b Functional Floodplain (requirement to reduce risk)
- Sub-chapter on Environment Agency Updated flood map for surface water flooding
- Sub-chapter on sewer flooding
- Update on Climate Change section with regard to UK Climate Projections (2009)
- Update on Life of Development, in line with NPPF Practice Guide
- Sub –chapter on Residual Risk of Flooding updated

Chapter 7 – Sustainable Management of Flood Risk:

- Update on Lead Local Flood Authority
- Update to Thames Catchment Flood Management Plan
- Updated information regarding Lower Thames Strategy
- Update to Thames Estuary 2100 Strategy
- Update to Planning & Development Control, in particular regarding Sequential Test, requirements for Flood Risk Assessment in Flood Zone 1, and Spatial Planning & Development Control Recommendations (table)
- Update to sub chapter planning recommendations for other sources of flooding
- Update to Character Areas, particularly regarding Eel Pie Island and Teddington area, in line with updated flood maps, including update on localised drainage issues
- Update on requirements for detailed Flood Risk Assessments
- Update to Basements
- Update of Sustainable Drainage Systems section, particularly with regard to drainage hierarchy
- Update of Local Community Actions to Reduce Flood Damage, particularly with regard to designing for flood risk, including flood resistance and resilience and Flood Warning and Evacuation Plans

- Update to Emergency Planning section
- Update on Insurance

Appendix C – Adapted to describe how flood hazard is assessed

Appendix F – Removal of Delineation of Function Floodplain Zone 3b for Beverley Brook Catchment and insert UK Climate Projections 2009

Appendix G – Insert town centre boundaries and sequential test maps

All Mapping – All mapping updated with most recent national and local datasets (Please note the Environment Agency UFMfSW maps is not suitable be viewed at a scale greater than 1:10,000 or at an individual property level scale).

The next stage is the Level 2 SFRA, which is a more detailed assessment of flood risk. This detailed assessment will be done in places that are at risk of flooding (as shown in the SFRA Level 1) and where there are pressures for new development (see Conclusion & Recommendations for further information on the Level 2 SFRA).

EXECUTIVE SUMMARY

Introduction

1. A large proportion of Richmond Borough is situated in proximity to the River Thames and its tributaries; it is the only Borough to span both sides of the River Thames. Therefore, a relatively large number of properties within the Borough are potentially at risk of flooding from rivers.

2. The River Thames within this Borough extends from Barnes to Hampton Court (upstream of Teddington Weir). Teddington Weir represents the upper tidal extent of the River Thames, and the Borough is at risk from both fluvial (river) and tidal (sea) flooding.

3. Downstream of Teddington Weir, the Borough is protected against flooding from the River Thames by the Thames Tidal Defence (TTD) system. The TTD system provides protection against tidal flooding through a combination of raised flood defences, flood proofing to riverside properties and the Thames Barrier. A 'combined' event can be observed when an unusually high tide happens to coincide with particularly high river levels due to prolonged rainfall in the upper catchment.

4. The probability of *fluvial* flooding (alone) from the River Thames within the Borough upstream of Teddington is somewhat higher than from tidal flooding. In simple terms, this means that river levels as a result of prolonged heavy rainfall within the upper catchment (including Oxfordshire and Gloucestershire as seen during the summer 2007 event) will be higher, and occur more frequently, than the combined tidal and fluvial event described above. For this reason, the standard of protection provided to property upstream of Teddington is closer to 1% chance in any one year event.

5. It should be remembered that the risk of fluvial and tidal flooding can be expected to increase as a result of climate change. Within the London Borough of Richmond upon Thames, the current understanding of the flooding regime appears to indicate that the increase in the number of properties potentially at risk of flooding in 2010 as a result of climate change is relatively small. Rather, those properties that are currently at risk can expect to be affected by flooding more frequently and to a greater severity. It is therefore important that the Borough has a clear policy in place to deal with the potential impacts of climate change, both for those properties that are currently affected by flooding and where the severity may increase in the future, and for those that are currently not at risk but may be at risk in future years. The Environment Agency published new guidance on 19th February 2016 on how climate change could affect flood risk to new developments. Note that the new allowances do not apply the Tidal River Thames. Development should continue to follow the actions within the Thames Estuary 2100 plan (TE2100 plan). Clear recommendations have been provided accordingly, highlighting the importance of sustainable design techniques to mitigate the potential risk of flooding, not only within Zone 3a (High Probability), but also within Zone 2 (Medium Probability); Zone 2 encompasses those areas that are likely to be at higher risk in the future.

6. It is important to highlight that river and tidal flooding are not the only sources of flood risk within the Borough. LBRuT is very susceptible to surface water flooding, as recent events showed, such as the summer 2007 flooding. In addition, the Borough, in conjunction with the Environment Agency, has identified a series of localised flooding issues, partly through consultation with the community when producing the Borough's Preliminary Flood Risk Assessment (2011), Local Flood Risk Management Strategy (2015) and Surface Water Management Plan (2011). The majority of the localised flooding incidents were typically as a result of blocked gullies and/or culverts, sewer flooding or surface water flooding. The latter is known to be a concern within the Borough, as the topography results in some steep slopes, especially in Richmond town centre which can form flow paths for surface water runoff and subsequently pluvial flooding at lower elevations. During heavy rains, runoff can flow very quickly along these paths and the local drainage system is unable to cope.

7. The NPPF outlines the aim of the sequential test to steer new developments to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The SFRA will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding. This is based heavily upon the NPPF flood zones and these are defined largely on the basis of tidal and fluvial (river) flood risk. It is essential that the Borough does not disregard the potential risk of flooding from other sources, and that local policy advocates the importance of sustainable design techniques to minimise the potential impact that these may have upon future development. Conversely, future development may exacerbate localised problems of this nature. Careful design through, for example, the incorporation of sustainable drainage systems (SuDS), can ensure that this does not happen, and may provide other benefits (e.g. a reduction in on site water demand).

8. Approximately 6,500 of the Borough's 100,000 properties are located within Flood Zone 2, approximately 13,300 properties within Flood Zone 3 and around 600 properties in the functional floodplain[1]. Flooding represents a risk to both property and life. It is essential therefore that planning decisions are informed, and take due consideration of the risk posed to (and by) future development by flooding. It is worth noting that 95% of the damages sustained by a residential property as a result of flooding occurs within the first 9 inches of water.

Outcomes of the LBRuT SFRA

9. The London Borough of Richmond upon Thames has been delineated into zones of low, medium and high probability of flooding, based upon existing available information provided by the Environment Agency. Detailed flood risk mapping has been made available for the River Thames (both tidal and fluvial), the River Crane, the Duke of Northumberland River and the Beverley Brook. The Environment Agency's latest available flood zone map, which has been renamed as "Flood Map for Planning (Rivers and Sea)" in December 2013, has been adopted as the basis for this SFRA. In addition, the Environment Agency has provided the Borough with tidal and fluvial flood hazard mapping information where available.

Zone 3b The Functional Floodplain

10. This zone comprises land where water has to flow or be stored in times of flood. In accordance with the principles set out in the NPPG these areas have been sub-delineated on the basis of current land use, i.e. open space as 'Zone 3b Functional Floodplain' versus areas that are currently developed.

11. The latter areas are subject to relatively frequent flooding and maybe fast flowing and/or deep water. Notwithstanding this however, the NPPF recognises the importance of pragmatic planning solutions that will not unnecessarily 'blight' areas of existing urban development. To this end, whilst it may be impractical to refuse all future development within existing urban areas falling within Zone 3b, careful consideration must be given to future sustainability. A suite of dedicated planning policies has been developed accordingly. These areas have been designated as Zone 3b (Developed Land).

Zone 3a High Probability

12. This zone comprises land assessed as having a >1% chance in any one year of river flooding, or a >0.5% chance in any one year of flooding from the sea. 'Highly vulnerable' development should not be permitted in this zone. 'More vulnerable' uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. All developments in this zone should be accompanied by a flood risk assessment.

[1] Analysis by overlaying Borough's LLPG records with EA flood maps (June 2015).

13. The SFRA has outlined specific development control recommendations that should be placed upon development within Zone 3a High Probability to minimise both the damage to property, and the risk to life in case of flooding. It is essential that the developer carries out a detailed Flood Risk Assessment to consider the site-based constraints that flooding may place upon the proposed development.

Zone 2 Medium Probability

14. This zone comprises land assessed as having between a 1% and a 0.1% chance in any one year of river flooding or between a 0.5% and a 0.1% chance in any one year of sea flooding. The 'Highly vulnerable' uses are only appropriate in this zone if the Exception Test is passed. There are generally no other restrictions placed upon land use within these areas, however it is important to ensure that the developer takes account of possible climate change impacts to avoid a possible increase in the risk of flooding in future years (achieved through completion of a Flood Risk Assessment). Revised guidance on the new climate change allowances developed by the EA and published in February 2016. All developments in this zone should be accompanied by a flood risk assessment. Developers and local authorities should also seek opportunities to reduce the overall level of flood risk in the area and beyond by the layout and form of any developments, along with the appropriate application of SuDS.

Zone 1 Low Probability

15. This zone comprises land assessed as having a less than 0.1% chance in any one year of river or sea flooding. All uses of land are appropriate in this zone. Consideration must be given to the potential risk of flooding from other sources (outlined in 'Surface Water Flooding' and 'Localised Flooding Issues' sections below), ensuring that future development is not inadvertently placed at risk. It is also essential to ensure that future development does not exacerbate the current risk posed to existing homes and businesses. Developers and local authorities should also seek opportunities to reduce the overall level of flood risk in the area and beyond by the layout and form of any developments, along with the appropriate application of SuDS.

Surface Water Flooding

16. In addition to fluvial and tidal flooding, properties and infrastructure within the London Borough of Richmond upon Thames are also at risk of flooding from other, more localised, sources caused by surface water. Surface water flooding is caused where the existing drainage systems are unable to deal with demand, where the topography has changed affecting the flow paths or due to blockages of culverts and gullies.

17. Evidence of historical flooding of this nature has been captured through discussions with the Environment Agency, the Borough and local residents. Note that not every occasion would have been reported and documented and the information displayed may not incorporate all occurrences of surface water flooding.

18. Work has been done within the Borough to keep a better record of blocked gullies and problematic locations which are repeatedly flagged up. This is partly in conjunction with the requirement of a Lead Local Flood Authority to develop an Asset Register (Flood and Water Management Act, 2010) and partly as a method to prioritise and repair problem locations.

19. Some parts of the London Borough of Richmond upon Thames are susceptible to surface water flooding and have been identified via the Updated Flood Map for Surface Water datasets provided by the Environment Agency.

Localised Flooding Issues

20. Along with surface water flooding, other localised flooding issues include groundwater flooding and the surcharging of the underground sewer system (which results in overland flow). Evidence of historical flooding of this nature has been captured through discussions with the Environment Agency, the Borough and local residents.

21. The NPPF does not address localised drainage issues within its delineation of flood zones and what development is acceptable within them. It is difficult to predict the likelihood and anticipated severity of localised flooding. Local drainage related problems are generally very localised, and relate to historical incidents, the source of which is often uncertain. Incidents of this nature will often be as a result of 'on the ground' conditions on any particular day (e.g. litter or leaves on the road may exacerbate a problem). Observed flooding can certainly be captured, however not surprisingly these are generally within areas of existing development. Within other areas of the Borough, topography and geology can be interrogated in an effort to highlight areas that may be most susceptible to groundwater flooding and/or flash flooding following periods of particularly intense rainfall.

22. From a spatial planning perspective therefore, local drainage issues should not affect decision making with respect to the allocation (or otherwise) of sites within LBRuT and it is considered unreasonable to restrict future development within areas that may have suffered a localised flooding incident in years past. It is essential however not to overlook the potential risk of localised flooding during the design process. Whilst the incidents that have been identified will typically not result in widespread damage or disruption, a proactive approach to risk reduction through design can mitigate the potential for damage, both to the development itself and elsewhere. Specific development control recommendations have been provided accordingly.

23. The implementation of sustainable drainage systems (SuDS) must be ensured and careful consideration to overland flow routes (and avoidance of their obstruction), as part of the site design, should be encouraged.

24. Thames Water was approached for information regarding flooding arising from the surcharging and blockage of surface and foul water sewers. This data, known as DG5 flooding data, is subject to confidentially issues and specific incidences where individual properties were affected cannot be divulged. However, Thames Water is allowed to detail how many properties have been subject to DG5 flooding per postcode area (the first four digits of the postcode are provided only).

The Way Forward

25. A considerable proportion of the London Borough of Richmond upon Thames is at risk of flooding. The risk of flooding posed to properties within the Borough arises from a number of sources including river flooding, localised runoff, sewer and groundwater flooding.

26. A planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the

27. NPPF Sequential Test. Specific planning recommendations have been provided for all urban centres within the Borough.

28. Following application of the Sequential Test, and the decision to proceed with development in areas at risk of flooding due to other planning constraints (that outweigh flood risk), it will be necessary for the Exception Test to be applied. Specific recommendations have been provided to assist the Borough and the developer to meet the Exception Test. These could be applied as development control recommendations for all future development.

29. Council policy is essential to ensure that the recommended development control recommendations can be imposed consistently at the planning application stage. This is essential to achieve future sustainability within the Borough with respect to flood risk management. Current policy has been reviewed in light of the findings and recommendations of the 2010 LBRuT SFRA.

30. Emergency planning is imperative to minimise the risk to life posed by flooding within the Borough. It is recommended that the Borough advises the Local Resilience Forum of the risks raised in light of the LBRuT SFRA, ensuring that the planning for future emergency response can be reviewed accordingly.

Table of Contents

Appendices

Figures

Glossary and Acronyms

AEP	Annual Exceedance Probability e.g. 1% AEP is equivalent to 1% probability of occurring in any one year (or, on average, once in every 100 years)
Attenuation	Reducing the rate of flow by storing and releasing it at a controlled rate.
Aquifer	Underground layer of water-bearing permeable rock from which groundwater can be extracted using a water well or from which groundwater flooding can occur
BREEAM	Building Research Establishment Environmental Assessment Methodology
CDA	Critical Drainage Area, is an area that has critical drainage problems and which has been notified to the local planning authority as such by the Environment Agency.
Core Strategy	The Development Plan Document within the Borough's Local Development Framework, which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.
CFMP	Catchment flood management plans, this considers all types of inland flooding, from rivers, groundwater, surface water and tidal flooding.
Culvert	This is a pipe that allows water to flow under a road, railway line, buildings or similar obstruction from one side to the other side.
DCLG	Department of Community and Local Government
Defra	Department of Environment, Food and Rural Affairs
Development	The carrying out of building, engineering, mining or other operations, in, on, over or under land, or the making of any material change in the use of a building or other land.
Development Plan Document (DPD)	A spatial planning document within the Borough's Local Development Framework, which set out policies for development and the use of land. Together with the Regional Spatial Strategy (in this instance The London Plan), they form the development plan for the area. They are subject to independent examination.
Drainage Hierarchy	A hierarchy setting out a preferred method of selecting which Sustainable Drainage System should be used, from most to least sustainable.
EA	Environment Agency
Exception test	Applied in line with Sequential test in the case where there are no reasonably available sites for a proposed development in flood zones 1 or 2 and should the suitability of sites in flood zone 3 (areas with a high probability of river or sea flooding) be considered.
FWMA '10	Flood and Water Management Act (2010)
FRA	Flood Risk Assessment
FFL	Finished floor level
Flood Hazard	Rates and considers the potential risk to life of a flood. This is a measure of the flood depth and flow velocity. A flood hazard can be Tidal or Fluvial influenced or both.
Flood Map	Nationally consistent delineation of 'high', 'medium' and 'low' flood risk.
Fluvial	Flooding caused by rivers
Formal Flood Defence	A structure built and maintained specifically for flood defence purposes
Freeboard	The difference between the flood defence level and the design flood level; it is also an allowance for uncertainty in estimating flood levels, and for potential wave action as a result of for example vehicles driving through flood water
Greenfield land	Land that has not been previously developed (also see Previously Developed land definition)
Greenfield runoff rate	The surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites.
GIS	Geographical Information: Is a system designed to capture, store, manipulate, analyse, manage, and present all types of spatial or geographical data.
GLA	Greater London Authority
Habitable Room	A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.
Informal Flood Defence	A structure that provides a flood defence function, however has not been built and/or maintained for this purpose (e.g. boundary wall)
Local Development Framework (LDF)	See definition for "Local Plan"
LFRMS	Local Flood Risk Management Strategy

LIDAR	Light Detection and Ranging, remote sensing technique which measures distance by illuminating a target and reflecting light.
Local Plan	Consists of a number of statutory planning documents, such as the Core Strategy and Development Management Plan, which together form the framework for development and the use of land in the Borough
Major development	A major development is: a) where the number of dwellings to be provided is ten or more, or the site areas is 0.5ha or more, ore b) non-residential development, where the floor space to be provided is 1000m2 or more, or the site area is 1ha or more
LDF	Local Development Framework, is the spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004.
NPPF	National Planning Policy Framework (NPPF) for England, published by the Development for Communities and Local Government. This sets the government's planning policies for England and how these are expected to be applied.
NPPG	National Planning Policy Guide (NPPG) is the guidance document which exists alongside the NPPF.
PFRA	Preliminary Flood Risk Assessment
Planning Policy Guidance (PPG)	A series of notes issued by the Government, setting out policy guidance on different aspects of planning. They will be replaced by Planning Policy Statements.
Planning Policy Statement (PPS)	A series of statements issued by central Government, setting out policy guidance on different aspects of planning. They replace Planning Policy Guidance Notes They have been replaced by the National Planning Policy.
Pluvial	Flooding caused by rain
PPG25	Planning Policy Guidance 25: Development and Flood Risk. Office of the Deputy Prime Minister (ODPM), 2001
PPS25	Planning Policy Statement 25: Development and Flood Risk Department of Community & Local Government, 2006. This has been superseded by the NPPF
Previously Developed (Brownfield) Land	Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example, a house and its garden would be considered to be previously developed land (also see Greenfield Land definition)
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Appraisal
Residual Risk	The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.
Resilience	Constructing the building in such a way that although flood water may enter the building, its impact is minimised, structural integrity is maintained and repair, drying and cleaning are facilitated.
Resistance	Construction the building in such a way as to prevent flood water entering the building or damaging its fabric. This has the same meaning as flood proof.
RMA	Risk Management Authority
Run-off	The flow of water from an area caused by rainfall
SAB	SuDS Approval Board
SEA	Strategic Environmental Assessment: European Community Directive on the assessment of the effects of certain plans and programmes on the environment
Sequential test	The test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. Detailed in the PPG.
SFRA	Strategic Flood Risk Assessment
Standard of Protection (SOP)	The design event or standard to which a building, asset or area is protected against flooding, generally expressed as an annual exceedance probability.
SuDS	Sustainable Drainage System: A sequence of management practices and control structures, often referred to as SuDS, designed to drain water in a more sustainable manner than some conventional techniques.
Supplementary Planning Document (SPD)	Provides supplementary guidance to policies and proposals contained within Development Plan Documents. They are not subject to independent examination but to rigorous procedures of community involvement and Sustainability Appraisal. SPDs form part of the LDF and the planning framework.
Sustainability Appraisal (SA)	An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987)

SWMP	Surface water Management Plan
TE2100	Thames Estuary 2100 (Aug 2011) (Guide on how the EA plans to manage flood risk in the Thames Estuary until 2100)
TTD	Thames Tidal Defences
Tidal	Flooding caused by the sea
Tributaries	This is a stream or river that flows into a larger stream, river or water body such as a lake. (Not into the sea).
UFMfSW	Update Flood Map for Surface Water (Environment Agency UFMfSW maps is not suitable be viewed at a scale greater than 1:10,000 or at a property level scale).
Flood risk vulnerability and flood zone 'compatibility' classes	The NPPG provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone
Windfall sites	Sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan
WFD	Water Framework Directive.
Zone 1 Low Probability	NPPF Flood Zone, defined as land assessed as having a less than 0.1% chance in any one year of river or sea flooding
Zone 2 Medium Probability	NPPF Flood Zone, defined as land assessed as having between a 1% and 0.1% chance in any one year of river flooding or between a 0.5% and 0.1% chance in any one year of sea flooding
Zone 3a High Probability	NPPF Flood Zone, defined as land assessed as having a >1% chance in any one year of river flooding or a >0.5% chance in any one year of flooding from the sea.
Zone 3b The Functional Floodplain	NPPF Flood Zone, to be identified in the SFRA with EA agreement, taking account of local circumstances rather than on rigid probability parameters. Land which would flood with an annual probability of >5% chance in any one year, or is designed to flood in an extreme 0.1% chance in any one year flood, is a starting point for consideration.

1 Why and how this update was prepared

1. This update (2015) of the SFRA replaces the SFRA version that was published in August 2010. The update reflects the intention stated in earlier SFRAs (2008, 2010) to review and update the SFRA on a regular basis as it is a 'Living Document'. Therefore, this updated version reflects new existing knowledge of flood risk within the Borough and amendments to national, regional and local guidance and policy.

2. Chapter 8 of the August 2010 SFRA states that a periodic review of the Richmond SFRA is imperative as the SFRA has been developed building heavily upon existing flood risk knowledge and a rolling programme of detailed flood risk mapping within the Thames region. Further modelling of both the fluvial and tidal River Thames, Beverley Brook, River Crane (including Duke of Northumberland's River) and Borough wide surface water mapping has occurred since 2010. These have significantly improved the current understanding of flood risk within the Borough and have altered predicted flood extents within the Borough. Contact the Environment Agency for further updates on the Beverley Brook model as it is currently being reviewed (March 2016).

3. As part of the SFRA review process, the Questions outlined in Chapter 7 of the original version have been addressed. A summary of the answers to the questions is provided below:
    - Question 1: No major flooding has occurred, but the Borough has some records of localised flooding issues which will be added to the SFRA.
    - Question 2: Yes, the PPS25 has been superseded by the National Planning Policy Framework (NPPF) which has a Technical Guidance document. The PPS25 Practice Guidance has been superseded by the National Planning Policy Guidance (NPPG).
    - Question 3: Yes, new EA modelling and mapping for the Borough; (Risk of Flooding from Surface Water, the TE2100 model and new EA Flood Risk Standing Advice)
    - Question 4: Yes, the SFRA will need to take account of the Borough's published Flood Emergency guidance.

4. This update of the SFRA reflects current, and as far as it is possible to do so, emerging national, regional and local policy. It also takes into account any relevant legislation enacted since the SFRA was updated and published in August 2010. Any further legislation changes, which may have a bearing on the matters covered in the SFRA, will be reflected in future updates.

5. The update of this SFRA also draws on feedback from the Borough's Development Control Section on the application of the SFRA and its recommendations when determining planning applications and in identifying whether further clarification of any of the wording in the SFRA would be of benefit. The update also draws on feedback and input from staff at the Environment Agency.

   The update of this SFRA also removes reference to 'Rapid Inundation Zones'. The Rapid Inundation Zones have been superseded by the most up to date tidal defence breach modelling available. *Contact the Environment Agency for the best available information on breach modelling.*

6. Many of the amendments made are of relatively minor nature and it would not be appropriate or helpful to list every single change. The substantial changes from the August 2010 version are listed on page ii and iii.

2 Introduction

2.1 Overview

7. A large proportion of the London Borough of Richmond upon Thames is situated in close proximity to the River Thames and its tributaries. The River Thames, River Crane and Beverley Brook are all key features of the Borough, and all pose a potential risk of flooding (to some degree) to local homes and businesses. It is highlighted that the upstream extent of tidal influence within the River Thames is Teddington Weir and properties within the Borough are subject to not only fluvial flooding, but also tidal flooding. Groundwater flooding and surface water flooding are also known to pose a risk to property and livelihood within the Borough, and the Borough takes the potential risk of flooding very seriously.

8. Approximately 6,500 of the Borough's 100,000 properties are located within flood zone 2, approximately 13,300 properties within flood zone 3 and around 600 properties in the functional floodplain[2]. Flooding represents a risk to both property and life, and it is essential that planning decisions are informed, and take due consideration of the risk posed to (and by) future development by flooding.

9. The Environment Agency has developed strategic studies relating more widely to the River Thames, in particular the Thames Catchment Flood Management Plan (CFMP) and the Thames Estuary 2100 (TE2100) Strategy. The EA updated the previous TE2100 in June 2014 and published the Thames CFMP summary report in December 2009. These set out the Environment Agency's preferred plan for sustainable flood risk management over the next 50 to 100 years and covers the fluvial and non-tidal part of the Thames region. See Section 7.3.2 for further details.

10. The River Thames Scheme reducing flood risk from Datchet to Teddington[5] is proposed to reduce flood risk to over 15,000 properties in communities near Heathrow, including Datchet, Wraysbury, Egham, Staines and Chertsey. It sets out the Environment Agency's preferred options for managing the risk of flooding for the area. Recommendations of the draft strategy include large scale flood diversion channels, improvements to weir structures and implementation of floodplain management options. See Section 7.3.3 for further details.

11. Whilst the Thames CFMP focuses on the fluvial and non-tidal part of the Thames, the Thames Estuary 2100 (TE2100) Plan covers the long-term flood management policies for the tidal part of the River Thames. The TE2100 Plan demonstrates how flood risk can be managed in the Thames Estuary over this century. See Section 7.3.4 for further details.

12. An ever increasing 'squeeze' is evident through competing needs for government funding for flood defence, and an increasing potential risk of flooding due to pressure for future development and climate change. For this reason, a key focus of the Environment Agency's strategies is the need to proactively deliver a reduction in flood risk through the planning process – in simple terms, guiding vulnerable development away from areas that are most at risk, and adopting sustainable design techniques. The Borough embraces these core principles of sustainability and the key messages of the Thames CFMP and the TE2100 Plan have underpinned the development of the LBRuT SFRA and are also reflected within the LBRuT Local Development Framework, particularly in the adopted Core Strategy and the Development Management DPD.

13. The National Planning Policy Framework (NPPF) requires that local planning authorities prepare a SFRA in consultation with the Environment Agency. The primary purpose of the SFRA is to determine the variations in flood risk across the Borough. Robust information on flood risk is essential to inform and support the Borough's revised flooding policies in its emerging Local Development Framework (LDF).

[2] Analysis by overlaying Borough's LLPG records with EA flood maps (May 2015)

[5] Previously referred to as the Lower Thames Strategy

14. This SFRA forms part of the Borough's evidence base for its Local Plan. It is a technical document published in November 2015. This SFRA will be developed and refined over time and will feed into the Borough's preferred policies and site allocations within the Borough.

2.2 Future Development in Richmond

15. The London Borough of Richmond upon Thames Core Strategy was adopted in April 2009. It sets out the LDF vision, which has three inter-related themes of 'A Sustainable Future', 'Protecting Local Character' and 'Meeting People's Needs'.

16. The London Borough of Richmond upon Thames is characterised by a large number of parks, open land and greenspace areas, providing an important asset to not only the local community, but also the wider Greater London region. The protection of these areas is considered a paramount objective of the Core Strategy. Other key policy drivers are the Borough's responsibility towards global sustainability by constructing new buildings in a sustainable way, minimising energy use and maximising renewable energy, the need to protect the local environment, particularly the outstanding natural and historic environment and range of biodiversity as well as the requirement to accommodate housing needs.

17. Due to the close proximity to London and the historical character retained by many of the key community centres within the Borough, Richmond upon Thames is a sought after location for housing. Challenging housing targets have been placed upon Richmond upon Thames, contributing to the anticipated population growth within the wider greater London region. The Borough adopts a policy approach that focuses on the concept of 'sustainability', seeking the local provision of supporting infrastructure (e.g. employment and shops) to sustain local residents, thereby reducing the need for movement into neighbouring Boroughs to meet these demands.

18. The protection of the core greenspace areas within the Borough means that future housing targets can only be satisfied through the allocation of sites within brownfield (i.e. previously developed) areas. It is recognised that many brownfield areas within the Borough are situated adjacent to river corridors, and may potentially be at risk of flooding. Redevelopment in areas at risk of flooding will be unavoidable as some already developed areas and town centres are in areas at risk of flooding. Redevelopment and/or intensification within flood affected areas may increase the number of residents at risk, and therefore careful consideration is required as an integral part of the planning process. However, redevelopment in flood risk areas also provides opportunities to achieve a net reduction in flood risk and to manage the flood risk and its consequences in a better way. A Flood Risk Assessment will need to be produced to aid the decision making processes on development proposals in areas at risk of flooding.

2.3 Why carry out a Strategic Flood Risk Assessment (SFRA)?

19. Flooding can result not only in costly damage to property, but can also pose a risk to life and livelihood. It is essential that future development is planned carefully, steering it away from areas that are most at risk from flooding, and ensuring that it does not exacerbate existing known flooding problems.

20. The National Planning Policy Framework (NPPF) has been developed to include a chapter on meeting the challenge of climate change, flooding and coastal change, to underpin decisions relating to future development (including urban regeneration) within areas that are subject to flood risk. In simple terms, the NPPF requires local planning authorities to review the variation in flood risk across their district, and to steer vulnerable development (e.g. housing) towards areas of lowest risk. Where this cannot be achieved and development is to be permitted in areas that may be subject to some degree of flood risk, the NPPF requires the Local Planning Authorities to demonstrate that there are sustainable mitigation solutions available that will ensure that the risk to property and life is minimised (throughout the lifetime of the development) should flooding occur.

21. The National Planning Policy Guidance (NPPG) states that a SFRA is a study carried out by planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change and to assess the impact that

changes or development in an area will have on flood risk. The SFRA will be used to refine information on the Environment Agency's Flood Map for Planning (Rivers and Seas). Local planning authorities should use the assessment to determine the variations in risk from all sources of flooding across their areas, and also the risks to and from surrounding areas in the same flood catchment. Local planning authorities should also use the assessment to inform the sustainability appraisal of the Local Plan, so that flood risk is fully taken into account when considering allocation options and in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased.

22. The SFRA should be used to apply the Sequential Test, and, where necessary, the Exception Test when determining land use allocations. The requirements for site-specific flood risk assessments in particular locations, including those at risk from sources other than river and sea flooding can be determined as well as the acceptability of flood risk in relation to emergency planning capability. Finally, the SFRA can be used to consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for flood water.

2.4 What is a Strategic Flood Risk Assessment (SFRA)?

23. The London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA) has been carried out to meet the following key objectives:
    - To collate all known sources of flooding, including river (tidal and fluvial), surface water, sewers and groundwater, that may affect existing and/or future development within the Borough;
    - To delineate areas that are considered functional floodplain or which have a 'low', 'medium' and 'high' probability of flooding within the Borough, in accordance with the National Planning Policy Framework (NPPF), and to map these:
        - Areas that are considered 'functional floodplain' are defined as being zones comprised of land where water *has* to flow or be stored in times of flood. The identification of these areas should take account of local circumstances and not be defined solely on rigid probability parameters. Land which would flood with an annual probability of >5% chance in any one year, or is designed to flood in an extreme 0.1% chance in any one year flood, should provide a starting point for consideration and discussions to identify the functional floodplain.
        - Areas of 'high' probability of flooding are assessed as having a >1% chance in any one year of river flooding, or >0.5% chance of flooding from the sea, and are referred to as Zone 3a - High Probability;
        - Areas of 'medium' probability of flooding are assessed as having between a 1% and 0.1% chance in any one year of river flooding, or between a 0.5% and 0.1% chance in any one year annual probability of sea flooding, and are referred to as Zone 2 - Medium Probability;
        - Areas of 'low' probability of flooding are assessed as having a less than 0.1% chance in any one year of river or sea flooding and are referred to as Zone 1 - Low Probability.
    - Within flood affected areas, to recommend appropriate land uses (in accordance with the NPPF *Sequential Test*) that will not unduly place people or property at risk of flooding
    - Where flood risk has been identified as a potential constraint to future development, recommend possible flood mitigation solutions that may be integrated into the design (by the developer) to minimise the risk to property and life should a flood occur (in accordance with the NPPF *Exception Test*).

<u>The Sequential Test</u>

24. The primary objective of the NPPF is to plan to help achieve sustainable development. The NPPF advocates a sequential approach which aims to manage flood risk principally by avoidance of the risk. This prevents the allocation of sites that are inappropriate on flood risk grounds (see table below). When determining planning applications, the Borough will ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where informed by a site-specific flood risk assessment following the

Sequential Test. In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the initial instance. **Only if it can be demonstrated that there are no suitable sites within these areas should alternative sites (i.e. within areas that may potentially be at risk of flooding) be contemplated**. This is referred to as the Sequential Test.

Flood Zone	Description	Annual probability of river or sea flooding	Summary of appropriate uses
Zone 1	Low probability	<0.1% chance in any one year	• All uses
Zone 2	Medium probability	1% - 0.1% chance in any one year **(river)** 0.5% - 0.1% chance in any one year **(sea)**	• Water Compatible • Less Vulnerable • More Vulnerable • Essential Infrastructure • Highly Vulnerable only if Exception Test passed
Zone 3a	High probability	>1% chance in any one year **(river)** >0.5% chance in any one year **(sea)**	• Water Compatible • Less Vulnerable • More Vulnerable only if Exception Test passed • Essential Infrastructure only if Exception Test passed
Zone 3b	The functional floodplain. This zone comprises land where water has to flow or be stored in times of flood.	>5% chance in any one year or land which is designed to flood in an extreme (0.1%) flood; exception is Eel Pie Island.	• Water Compatible • Essential Infrastructure only if Exception Test passed

25. As seen in the above table, an integral part of the sequential approach outlined in the NPPF and in particular the NPPG stipulates permissible development types. This considers both the degree of flood risk posed to the site, and the likely vulnerability of the proposed development to damage (and indeed the risk to the lives of the site tenants) should a flood occur.

26. The NPPF Sequential Test is summarised in Diagram 2 of the NPPG. The London Borough of Richmond upon Thames has adopted its own Sequential Test approach for properties in and around town centres.

The Exception Test

27. Many towns within England are situated adjacent to rivers and are at risk of flooding. The future sustainability of these communities relies heavily upon their ability to grow and prosper. The NPPF recognises that in some Boroughs, including the London Borough of Richmond upon Thames, restricting residential development from areas designated as Zone 3a High Probability may compromise the viability of existing communities within the Borough.

28. For this reason, the NPPF provides an Exception Test. The Exception Test provides a method of managing flood risk while still allowing necessary sustainable development to occur. In line with the NPPF, if, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate.

29. For the Exception Test, in line with the NPPF (paragraph 102), both of the following elements must be passed for the development to be allocated or permitted:

- *'it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and.*
- *a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*

2.5 A Living Document

30. The LBRuT SFRA has been developed in accordance with the NPPF. The SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the Borough. The Environment Agency regularly review and update their Flood Map for Planning (Rivers and Sea) (on a quarterly basis) and has a rolling programme of detailed flood risk mapping. This will improve the current knowledge of flood risk within the Borough, and may marginally alter predicted flood extents. This may influence future development control decisions within these areas.

31. National datasets are continuously reviewed and updated. Hence, to ensure the Richmond SFRA remains a living document, the maps and figures should be regularly updated with the most recent data files available.

32. It is recommended that the LBRuT SFRA is reviewed on a regular basis. A series of key questions to be challenged as part of the SFRA review process are set out in Section 8 of this document, providing the basis by which the need for a detailed review of the document should be triggered.

3 SFRA Approach

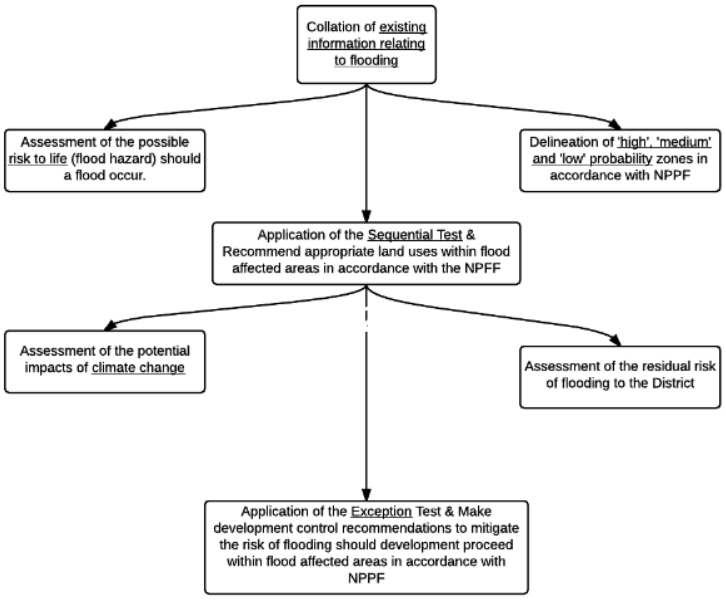
33. The primary objective of the LBRuT SFRA is to inform the revision of flooding policies, including the allocation of land for future development, within the Local Plan. More specifically, the SFRA seeks to inform the identification of sustainability objectives, test policy options, allocate land for housing and employment, 'shape' flood risk related policies within the Development Management Plan[3] (DMP) and inform planning application decisions. The SFRA has a broader purpose however, and in providing a robust depiction of flood risk across the Borough, it can:

- Assist the development control process by providing a more informed response to development proposals affected by flooding, influencing the design of future development within the Borough[6];
- Help to identify and implement strategic solutions to flood risk, providing the basis for possible future flood attenuation works;
- Support and inform the Borough's emergency planning response to flooding.

34. The Government provides no specific methodology for the SFRA process, however, guidance for preparing SFRAs can be found in the NPPG. To meet these broader objectives, the SFRA has been developed in a pragmatic manner in close consultation with both the Borough and the Environment Agency.

35. A considerable amount of knowledge exists with respect to flood risk within the Borough, including information relating both to historical flooding, and the predicted extent of flooding under extreme weather conditions (i.e. as an outcome of detailed flood risk modelling carried out by the Environment Agency). The London Borough of Richmond upon Thames SFRA has built heavily upon this existing knowledge, underpinning the delineation of the Borough into 'high', 'medium' and 'low' flood risk zones, in accordance with NPPF. These zones have then been used to provide a robust and transparent evidence base for the development of flooding related policy, and the allocation of sites.

36. A summary of the adopted SFRA process is provided in the figure below, outlining the specific tasks undertaken and the corresponding structure of the SFRA report.



[3] London Borough of Richmond upon Thames (2011) Development Management Plan

37. It is important to recognise that all of the rivers that affect the Borough flow into, or from, adjoining authorities within the Thames Valley. Future development within the Borough, if not carefully managed, can influence the risk of flooding posed to residents within neighbouring areas. Conversely, careless planning decisions within adjacent districts can also impact adversely upon flooding within the Borough.

38. Consistency in adopted approach and decision making with respect to the effective management of flood risk throughout the Thames system is therefore imperative. Regular discussions with the Environment Agency have been carried out throughout the SFRA process to this end, seeking clarity and consistency where needed.

4 Policy Framework

4.1 Introduction

39. This section provides an overview of the strategy and policy context relevant to flood risk in the London Borough of Richmond upon Thames (LBRuT).

40. The success of the SFRA is heavily dependent upon the Borough's ability to implement the recommendations put forward for future sustainable flood risk management, both with respect to planning decisions and development control recommendations (see Section 7.4). A framework of national and regional policy directive is in place, providing guidance and direction to local planning authorities. Ultimately, it is the responsibility of the Borough to establish robust policies that will ensure future sustainability with respect to flood risk.

4.2 National Policy

4.2.1 National Planning Policy Framework[4]

41. The National Planning Policy Framework (NPPF) was published in March 2012 and replaces most of the Planning Policy Statements (PPS) including *PPS25: Development and Flood Risk*. The NPPF sets out the Government's planning policies for England and provides a framework within which local people and their accountable Councils can produce their own distinctive local and neighbourhood plans, which reflect the need and priorities of their communities. The flood risk policy can now be found in chapter 10 of the NPPF: *Meeting the challenge of climate change, flooding and coastal change*. It states that planning plays a key role in helping shape places to provide resilience to the impacts of climate change, which gives much weight to the issue of flooding. The aim of chapter 10 in the NPPF is to ensure that flood risk is taken into account at all stages of the planning process in order to prevent inappropriate development in 'at risk' areas.

42. The NPPF sets out the Government's requirements for the planning system only to the extent that is relevant, proportionate and necessary to do so. The purpose of the planning system is to contribute to the achievement of sustainable development. The NPPF retains the principles of PPS25 in seeking to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. To guide local planning policy, Local Planning Authorities continue to be required to produce a SFRA which will inform the sustainability appraisal of the Local Plan and identify the requirements for site-specific flood risk assessments in particular locations. This is done firstly by determining the variations in risk from all sources of flooding across the area and then using the sequential approach which comprises of the Sequential Test and the Exception Test to locate future developments.

43. A partnership approach is stressed in the NPPF to ensure that Local Planning Authorities work with partners such as the Environment Agency. The Environment Agency can provide both information and advice relating to flood risk, and should always be consulted when preparing policy or making decisions which will have an impact on flood risk.

44. The future impacts of climate change are highlighted, as climate change will lead to increased flood risk in many places in the years ahead. When developing planning policy, LPAs need to consider if it is necessary to encourage the relocation of existing development to locations at less of a risk from flooding in order to prevent future impacts of flooding.

[4] Communities and Local Government (2012) National Planning Policy Framework

4.2.2 National Planning Practice Guidance[5]

45. The National Planning Practice Guidance (NPPG) was published in March 2014 and accompanies the NPPF. Rather than being a static document, the NPPG is an online website, created by the Government with the aim of making planning guidance more accessible and easier to keep up to date.

46. The section entitled *Flood Risk and Coastal Change* advises on how planning can take account of the risks associated with flooding and coastal change in plan-making and the application process. It defines flood risk and details how it should be taken into account when developing Local Plans. The NPPG explains how a SFRA should be prepared and address various sources of flood risk. Within the NPPG, the sequential, risk-based approach to the location of development is outlined along with details on how the Sequential and Exception Tests should be applied. The NPPG contains tables detailing the Flood Zones, Flood Risk Vulnerability Classification and Flood Zone development 'compatibility'.

4.2.3 Flood Risk Regulations 2009[6]

47. The Flood Risk Regulations (FRR) were enacted on 10 December 2009. They implement the requirements of the European Union Floods Directive which aims to provide a consistent approach to managing flood risk across Europe. The FRR places duties on the Environment Agency and Lead Local Flood Authorities (refer next section) to prepare preliminary flood risk assessments, flood risk maps and flood risk management plans.

4.2.4 Flood and Water Management Act 2010[7]

48. Following a review of the 2007 flooding, Sir Michael Pitt published his report, *Learning Lessons from the 2007 Floods*, more commonly called *The Pitt Review*. Within this report, Sir Michael Pitt recommended a change in the way that flood risk was managed. He stated that "the role of Local Authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas". In response to this, the government published The Flood and Water Management Act (FWMA) which came into effect on Monday 12th April 2010. The Act takes forward a number of recommendations from the Pitt Review and places new responsibilities on Local Authorities and the Environment Agency (and others) to manage the risk of flooding.

49. The Environment Agency has been given an overview role of Flood and Coastal Erosion Risk Management. Unitary Authorities and County Councils are required to take the lead in managing local flood risk, designating them as the Lead Local Flood Authority (LLFA). LBRuT is the LLFA for Richmond Borough. Local flood risk includes flooding from ordinary watercourses, surface water and groundwater. The FWMA also defines the Environment Agency, a LLFA, a district Council for an area for which there is no unitary authority, an internal drainage board, a water company and a highway authority as Risk Management Authorities (RMA).

50. As a LLFA and a RMA, the London Borough of Richmond upon Thames have a number of key responsibilities under the FWMA which include:
    - Developing a local strategy for flood risk management
    - Investigating flood incidents
    - Maintain a register of assets
    - Leadership and partnership
    - Designation powers
    - Statutory consultee to the planning process for surface water management
    - Sharing of information about flood risk

[5] Communities and Local Government (2014) National Planning Policy Guidance
[6] Communities and Local Government (2009) Flood Risk Regulations 2009
[7] Communities and Local Government (2010) Flood and Water Management Act 2010

4.3 Regional Planning Policy

4.3.1 The London Plan [8]

51. The London Plan (the Plan) is the adopted regional spatial strategy relevant to the London Borough of Richmond upon Thames. It was produced by the Greater London Authority (GLA) in 2011 and is a strategic overview of development across London for the next 20 years. It includes frameworks relating to economic, environmental, social and transport factors. One of the objectives of the Plan is to make London a world leader in tackling climate change, which includes as key policy direction the management of flood risk and water resource issues at an early stage. The Plan seeks to ensure that all future development minimises the risk of flooding within London. The London Plan is regularly updated, with the latest version, *The London Plan, The Spatial Development Strategy for London Consolidated with Alterations since 2011* being adopted on the 10th March 2015.

52. The following key policies are of particular relevance within the context of the Richmond SFRA:

- **Policy 5.3** ***'****Sustainable design and construction'* sets out sustainable design principles, which includes avoiding impacts from natural hazards such as flooding.
- **Policy 5.11** *'Green roofs and development site environs'* defines how properties should be designed to include roof, wall and site planting, especially green roofs and walls where feasible, to deliver many objectives, which in terms of flood risk, include sustainable urban drainage.
- **Policy 5.12** *'Flood risk management'* states that The Mayor will work with all the relevant agencies including the Environment Agency to address current and future flood issues and minimise risk in a sustainable and cost effective way. Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated technical Guidance on flood risk over the lifetime of the development and have regard to measures proposed in key evidence documents such as TE2100 and CFMPs. This policy explains the ways in which a development must demonstrate that it can pass the Exception Test set out in the NPPF and the Technical Guidance. The policy also states that a SFRA should be utilised when preparing LDF's to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding and identifying specific opportunities for flood risk management measures.
- **Policy 5.13** *'Sustainable drainage'* describes how developments should utilise sustainable drainage systems (SUDS) unless there are practical reasons for not doing so, should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. This policy makes reference to the Flood and Water Management Act (2010) in terms of utilising Surface Water Management Plans to identify areas where there are particular surface water management issues and develop actions and policy approaches aimed at reducing these risks.

53. The policies mentioned above will need to be considered when the Borough is considering how to allocate land, in particular, in order to meet development pressures such as the need for additional housing.

4.3.2 Sustainable Design and Construction – Supplementary Planning Guidance[9]

54. The Sustainable Design and Construction Supplementary Planning Guidance (SPG) was produced by the GLA in April 2014 to provide guidance on the implementation of London Plan Policy 5.3 – *Sustainable Design and Construction*, as well as a range of policies (primarily in chapters 5 and 7) that deal with matters relating to environmental sustainability.

[8] Greater London Authority (2015) The London Plan
[9] Greater London Authority (2014) Sustainable Design and Construction SPG

55. Chapter 3 of the SPG, *Adapting to Climate Change* (Note that new guidance on climate change allowances was published by the EA in February 2016) *and Greening the City* contains a section on flooding and provides guidance on the following key areas:

- Surface water flooding
- Sustainable drainage
- Flooding and the resilience and resistance of buildings
- Safety
- Consideration of all sources of flooding in basement development
- Flood defences
- Flood risk management from tidal and fluvial flooding
- Other sources of flooding.

56. The Mayors priorities outline that through their Local Flood Risk Management Strategies, Boroughs should identify areas where there are particular surface water management issues and develop policies to address these. They also state that developers should maximise all opportunities to achieve greenfield runoff rates in their developments and should design sustainable drainage systems (SuDS) into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits.

4.3.3 Regional Flood Risk Appraisal[10]

57. The Regional Flood Risk Appraisal (RFRA) was originally produced in October 2009 alongside an earlier version of the London Plan. It has since been updated in August 2014. It investigates flood risk in more detail and identifies that London is at risk from tidal, fluvial, surface water, sewer and groundwater sources of flooding. This document was recently reviewed alongside the Further Alterations to the London Plan (FALP) with the updated document published in August 2014. At the centre of the RFRA is the spatial analysis of tidal, fluvial and surface water flood risk against a number of different receptors of flood risk, including major development locations, key infrastructure assets and services.

58. The RFRA provides an overview of all sources of flooding in London and addresses its probability and consequences. The RFRA, represents important evidence to underpin the FALP. The reviewed RFRA includes a revised set of monitoring recommendations, which will be used to keep the information up-to-date and to ensure regular checks on broad mitigation measures. The recommendations of specific relevance to the Borough of Richmond are outlined below:

Recommendation 1: All Thames-side planning authorities should consider in their SFRAs and put in place Local Plan policies to promote the setting back of development from the edge of the Thames and tidal tributaries to enable sustainable and cost effective upgrade of river walls/embankments, in line with Policy 5.12 of the FALP, CFMPs, TE2100 and advice from the Environment Agency.

Recommendation 2: The London Boroughs of Richmond upon Thames, Kingston, Hounslow and Wandsworth should put in place policies to ensure alternative responses to managing fluvial risk such as flood resilience measures or potentially safeguarding land for future flood storage or, on the fluvial tributaries, setting back local defences or any resilience measures between Teddington Lock and Hammersmith Bridge in line with TE2100 findings.

Recommendation 4: Boroughs at confluences of tributary rivers with the River Thames should ensure Flood Risk Assessments (FRAs) include an assessment of the interaction of all forms of flooding, but fluvial and tidal flood risks in particular.

Recommendation 5: Regeneration and redevelopment of London's fluvial river corridors offer a crucial opportunity to reduce flood risk. SFRAs and policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in the Thames CFMP. In particular opportunities should be sought to:

- Set back of development from the river edge to enable sustainable and cost effective flood risk management options

[10] Greater London Authority (2014) Regional Flood Risk Appraisal

- Ensure that developments at residual flood risk are designed to be flood compatible and/or flood resilient

- Maximise the use open spaces within developments which have a residual flood risk to make space for flood water;

Recommendation 6: Developments all across London should reduce surface water discharge in line with the Sustainable Drainage Hierarchy set out in Policy 5.13 of the London Plan, the emerging Sustainable Design and Construction SPG and the emerging London Sustainable Drainage Action Plan.

Recommendation 7: Thames Water should continue its programme of addressing foul sewer flooding.

Recommendation 8: The groundwater flood risk in identified locations should be considered in FRAs and SFRAs to ensure that its impacts do not increase.

Recommendation 9: The reservoir flood risk in identified locations (see reservoir flood maps) should be considered in FRAs and SFRAs to ensure its impacts do not increase.

Recommendation 10: Detailed flood risk assessments should be undertaken at an early stage at the level of individual major development locations and town centre development sites, and opportunities to reduce flood risk should be maximised where possible.

59. Further recommendations are provided to help to focus attention on the strategic issues relating to flood risk in London and it has also highlighted the range and scale of infrastructure which is at risk of flooding. This will be useful to emergency planners in considering the wider context of their activities and in focusing the minds of spatial planners in relation to the location of new facilities.

4.3.4 Thames Catchment Flood Management Plan[11]

60. The Thames Catchment Flood Management Plan (CFMP) was published in 2009 and is one of 77 CFMPs introduced by the Environment Agency for England and Wales. The objectives behind the CFMP are to give an overview of the flood risk within the catchment and to set out the preferred plan for sustainable flood risk management over the next 50 to 100 years. The Plan focuses on the risks from fluvial (river) flooding. The future management of tidal flooding in London is being addressed through the Thames Estuary 2100 Flood Risk Management Plan (see Section 4.3.5).

61. The CFMPs consider the impacts of climate change by assuming that mild, wetter winters will result in increases in peak river flows of 20% and more frequent, short duration intense storms in the summer will cause more regular, widespread 'flash flooding' from overwhelmed drainage systems and some rivers.

62. The Thames CFMP suggests that the London Borough of Richmond upon Thames has between 1,000-2,000 properties at risk from a 1% annual exceedance probability fluvial flood. To help understand the diverse nature of flood risk across the Thames CFMP area, it has been divided into sub-areas which generally follow river catchment or urban area boundaries. There are then 6 policy options for the management of flood risk and one of these have been applied to each sub-area. The London Borough of Richmond upon Thames lies within sub area 9 – London Catchments, which has the vision and preferred policy of policy option 4:

Policy 4 - Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change (Note that new guidance on climate change allowances was published by the EA in February 2016).

[11] Environment Agency (2009) Thames Catchment Flood Management Plan

4.3.5 Thames Estuary 2100 Flood Risk Management Plan[12]

63. The Thames Estuary 2100 (TE2100) Project Flood Risk Management Plan has been developed to direct the multi-agency actions that are needed to manage and reduce tidal flood risk over the next 100 years. It is adaptable to a changing climate to ensure that the actions that are taken are the right ones, taken at the right time and will not waste money on over-engineered solutions.

64. The TE2100 action plan sets out recommendations estuary-wide and in each of the TE2100 policy units. There are 23 policy units, so to avoid repetition, those with similar characteristics and requiring a similar type and range of actions have been grouped together. There are eight local action zones and an estuary-wide zone. The flood risk management recommendations are split into short term (the first 25 years), medium term (the following 15 years) and long term (the end of the century) and could be implemented by different parties.

65. The London Borough of Richmond upon Thames would be impacted by any work carried out due to the recommendations set out in Action Zone 0 – estuary-wide, and Action Zone 1 – west London. Within Action Zone 1, individual policy units include Richmond, Twickenham and Barnes & Kew. Please refer to the TE2100 action plan for the detailed recommendations.

4.3.6 River Thames Scheme: reducing flood risk from Datchet to Teddington[13]

66. The River Thames Scheme is a flood risk management strategy developed by the Environment Agency and published in November 2010 to meet the recommendations set out in the Lower Thames Flood Risk Management Strategy. The Scheme consists of a new flood channel, improvements to three of the existing Thames weirs (including Teddington weir), installations of property level protection measures for up to 1,200 homes and improved flood incident response plans. The proposed scheme will protect 9,500 properties to a 1.33% chance of occurring in any year event. In total, around 15,000 properties, local infrastructure and many businesses will be better protected from flooding.

67. All communities between Datchet and Teddington will benefit from the scheme. The Environment Agency is working on the scheme with seven Local Authorities, including the London Borough of Richmond upon Thames. Subject to funding, construction work could begin in the summer of 2018 on the modifications to the first Thames weir and construction of the flood channel is expected to start in 2020 and take approximately 5 years to complete.

4.3.7 River Basin Management Plan: Thames River Basin District[14]

68. The Thames River Basin Management Plan (RBMP) was produced by the Environment Agency in 2009 and is about the pressures facing the water environment in the Thames river basin district and the actions that will address them. It was prepared under the Water Framework Directive (WFD) Regulations, which was passed into UK law in 2003, and is the first of a series of six-year planning cycles. The WFD aims to:
    - Prevent deterioration in water quality
    - Improve and protect inland waters and groundwater
    - Encourage more sustainable use of water as a natural resource
    - Create better habitats for wildlife that live in and around water
    - Help reduce the effects of floods and droughts

69. The Thames RBMP is a statutory plan which summarises a 'programme of measures' required in order to meet the objectives of the WFD. The London Borough of Richmond upon

[12] Environment Agency (2012) Thames Estuary 2100 Plan
[13] Environment Agency (2014) River Thames Scheme
[14] Environment Agency (2009) Thames River Basin Management Plan

Thames it situated within the London catchment (non-tidal urban tributaries of the Thames Tideway) and the Estuaries and water bodies. The London catchment is highly urbanised and the majority of rivers are designated heavily modified and there is a distinct lack of natural river processes throughout the catchment.

70. The river modifications have led to a loss of habitat diversity. Water quality also remains a significant issue due to the highly urbanised nature and the subsequent increase in surface water runoff and storm sewer overflows. The estuaries and coastal water bodies has water quality concerns due to the impacts of storm discharges from the five major sewage works which serve London and from the combined sewer network. The Thames River Basin District has also been the subject of physical modification over the years which represents further pressures on the water environment. For each of the two catchments, there are key actions which work towards improving the status of the watercourses:

London Catchment key actions:

- The Environment Agency will undertake pollution prevention projects on Pymmes Brook, Brimsdown Ditch and the River Wandle.
- The Environment Agency will investigate the cause of urban diffuse pollution on the Ravensbourne.
- Thames Water have planned improvements at their Deephams waste water treatment works.
- The Environment Agency will work with partners at Cranebank to put the river back on its original meandering course and improve fish populations.
- The Environment Agency and Natural England will work together to continue to develop and implement the London Rivers Action Plan to improve ecology through habitat creation and enhancement.
- Physical habitat pressures will be considered through the delivery proposed flood risk management work, for example at Ashlone Wharf and Worcester Park on the Beverley Brook.

Estuaries and Coastal Water Bodies:

- Improvements to the London sewerage network to reduce the impact of storm sewage on water quality in the Thames Tideway – Thames and Lee Tunnels.
- Contribute to achievement of favourable condition on West Thurrock Lagoon & Marshes Site of Special Scientific Interest by implementing flood management programme.
- Develop national guidance framework on dredging to inform Programme of Measures to meet WFD objectives.
- Flood/Coastal Erosion Risk Management Measure – Managed realignment of flood defence.
- Environment Agency to provide tailored advice to key bodies – Regional Development Agencies/ Government Offices for Regional Spatial Strategy and local authorities for Local Development Frameworks.

71. An update on the Thames RBMP was recently consulted on, ending on the 10th April 2015. The updated RBMPs will direct considerable investment and action from 2016 onwards.

4.3.8 The Mayor's Climate Change Adaption Strategy[15]

72. Managing Risks and Increasing Resilience: The Mayor's Climate Change Adaptation Strategy is part of a series of strategies that together set out actions and policies to make London the best big city in the world. It was published in 2011 by the Greater London Authority and it

[15] Greater London Authority (2011) The Mayor's Climate Change Adaption Strategy

focuses on the issues climate change may have in the form of floods, droughts, heatwaves and very cold weather, in the future. The aim of the Strategy is to assess the consequences of climate change on London and to prepare for the impacts of climate change and extreme weather to protect and enhance the quality of life of Londoners. The Mayor proposes that this will be met through achieving a number of objectives.

73. Chapter 3 of the Strategy focuses on flooding and highlights the Drain London Forum progress and the importance of not increasing the risk of surface water flooding through greater urbanisation. This is to be reflected in this document with sections on SuDS and flood mitigation.

4.3.9 The Mayor's Water Strategy[16]

74. The Mayors Water Strategy was developed by the Greater London Authority in 2011 to present a London-specific view of water management. It draws on the other plans and strategies but also seeks to influence their future development. Its goal is to improve water management, both in terms of the water we want (such as drinking water) and the water we do not want (such as sewage and floodwater in the wrong place). The Strategy lists 18 actions which cover managing water use, paying for water services, managing rainwater and disposal of wastewater. Action 18 is relevant to the SFRA as it focuses on surface water flood risk.

4.4 Local Planning Policy

Note that PPS25 and its Practice Guide have now been superseded by the NPPF and the Planning Practice Guidance. The key elements and approaches to flood risk as set out in PPS25 were retained in the NPPF. The local policies from previous SFRA versions are considered to be in line with the NPPF.

4.4.1 London Borough of Richmond upon Thames LDF Core Strategy (Adopted April 2009)

75. The London Borough of Richmond upon Thames adopted its LDF Core Strategy in April 2009. One strategic, high level policy sets out that development will need to be designed to take account of the impacts of climate change over its lifetime, including flood risk (Note that new guidance on climate change allowances was published by the EA in February 2016)

76. Policy CP3 Climate Change – Adapting to the Effects states:

"3.A Development will need to be designed to take account of the impacts of climate change over its lifetime, including:

- *Water conservation and drainage*
- *The need for Summer cooling*
- *Risk of subsidence*
- *Flood risk from the River Thames and its tributaries*

3.B Development in areas of high flood risk will be restricted, in accordance with PPS25, and using the Environment Agency's Catchment Flood Management Plan, Borough's Strategic Flood Risk Assessment and site level assessments to determine risk."

4.4.2 London Borough of Richmond upon Thames Adopted Development Management Plan (November 2011)

77. The London Borough of Richmond upon Thames has adopted its Development Management Plan. This has been built on the Core Strategy and includes more detailed policies on the management of development. This Development Plan Document (DPD) has superseded the

[16] Greater London Authority (2011) The Mayor's Water Strategy

policies of the UDP. A number of specific policies guide future developments within the Borough that may be affected by flooding.

Policy DM SD 6 Flood Risk

78. "Development will be guided to areas of lower risk by applying the Sequential Test. Unacceptable developments and land uses will be restricted in line with PPS25 and as outlined in the table below. Developments and Flood Risk Assessments must consider all sources of flooding and the likely impacts of climate change (Note that new guidance on climate change allowances was published by the EA in February 2016)

79. Where a Flood Risk Assessment is required and in addition to the Environment Agency's normal floodplain compensation requirement, attenuation areas to alleviate fluvial and/or surface water flooding must be considered where there is an opportunity. The onus is on the applicant/developer for proposals on sites of 10 dwellings or 1000sqm of non-residential development or more to provide evidence and justification if attenuation areas cannot be used.

80. In areas at risk of flooding, all proposals on sites of 10 dwellings or 1000sqm of non-residential development or more are required to submit a Flood Warning and Evacuation Plan".

Table 1: Application of the NPPF within the various flood zones within Richmond (from Policy DM SD 6)

Flood Zone	Land uses and developments – restrictions	Sequential Test	Exception Test	Flood Risk Assessment
Zone 3b	The functional floodplain as identified in the Borough's Strategic Flood Risk Assessment will be protected by not permitting any form of development on undeveloped sites unless it: - is for water-compatible development - is for essential utility infrastructure which has to be located in a flood risk area and no alternative locations are available and it can be demonstrated that the development would be safe, without increasing flood risk elsewhere and where possible would reduce flood risk overall Redevelopment of existing developed sites will only be supported if there is no land use intensification and a net flood risk reduction; the restoration of the functional floodplain to its original function will be supported. Proposals for the change of use or conversion to a use with a higher vulnerability classification will not be permitted Basements, basement extensions, conversions of basements to a higher vulnerability classification or self-contained units will not be permitted*	Required for essential utility infrastructure	Required for essential utility infrastructure	Required for all development proposals
Zone 3a	Land uses are restricted to water compatible, less and more vulnerable development. Highly vulnerable developments will not be permitted Self-contained residential basements and bedrooms at basement level will not be permitted. All basements, basement extensions and basement conversions must have internal access to a higher floor and flood resistant and resilient design techniques must be adopted*	Required for all developments unless exceptions outlined in the justification apply	Required for more vulnerable development	Required for all development proposals
Zone 2	No land use restrictions Self-contained residential basements and bedrooms at basement level will not be permitted. All basements, basement extensions and basement conversions must have internal access to a higher floor and flood resistant and resilient design techniques must be adopted*	Required for all developments unless exceptions outlined in the justification apply	Required for highly vulnerable development	Required for all development proposals unless for change of use from water compatible to less vulnerable
Zone 1	No land use restrictions	Not applicable	Not applicable	Required for sites greater than 1 ha Required for all other development proposals where there is evidence of

				a risk from other sources of flooding, including surface water, ground water and sewer flooding.

**** Further guidance on development of basement properties within Flood Zones 2 and 3 is provided in this SFRA in Section 7.4.6.***

Policy DM SD 7 Sustainable Drainage

81. "All development proposals are required to follow the drainage hierarchy when disposing of surface water and must utilise Sustainable Drainage Systems wherever practical. Any discharge should be reduced to greenfield run-off rates wherever feasible.

82. When discharging surface water to a public sewer, developers will be required to provide evidence that capacity exists in the public sewerage network to serve their development."

Policy DM SD 8 Flood Defences

83. "The effectiveness, stability and integrity of the flood defences, river banks and other formal and informal flood defence infrastructure within the Borough will be retained and provision for maintenance and upgrading will be ensured. Setting back developments from river banks and existing flood defence infrastructure, where there are opportunities, will be encouraged. The removal of formal or informal flood defences is only acceptable if this is part of an agreed flood risk management strategy by the Environment Agency.

84. The Environment Agency must be consulted for any development that could affect a flood defence infrastructure."

Policy DM SD 9 Protecting Water Resources and Infrastructure

85. "The Borough's water resources and supplies will be protected by resisting development proposals that would pose an unacceptable threat to surface water and groundwater quantity and quality. This includes pollution caused by water run-off from developments into nearby waterways.

86. New developments must achieve a high standard of water efficiency by:

    1. Meeting the minimum mandatory target for water consumption as set out in the Code for Sustainable Homes, or
    2. Meeting a minimum of 2 credits on water consumption for other types of developments (BREEAM "excellent"), or
    3. Meeting a minimum of 3 credits on water consumption for conversions (EcoHomes "excellent"), and
    4. Utilising rainwater harvesting for all external water uses to reduce the consumption of potable water wherever possible.

87. The above requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure that these standards are met or exceeded.

88. New developments should also consider the following:

    1. Utilising rainwater harvesting and greywater recycling for all non-potable uses to reduce the consumption of potable water wherever possible, and
    2. Designing of landscaping to minimise water demand.

89. Proposals that seek to increase water availability or protect and improve the quality of rivers and groundwater will be encouraged.

90. The development or expansion of water supply or waste water facilities will normally be permitted, either where needed to serve existing or proposed new development, or in the interest of long term water supply and waste water management, provided that the need for such facilities outweighs any adverse land use or environmental impact.

91. The Borough will support in principle the implementation of the Thames Tunnel project.

92. Where rivers have been classified by the Environment Agency as having 'poor' status (currently the River Crane, the Beverley Brook and the River Thames, upstream of Teddington), any development affecting such rivers is encouraged to improve the water quality in these areas".

Policy DM SD 10 Water and Sewerage Provision

93. "New development will need to ensure that there is adequate water supply, surface water, foul drainage and sewerage treatment capacity to serve the development.

94. Planning permission will only be granted for developments which increase the demand for off-site service infrastructure where:

    1. Sufficient capacity already exists, or
    2. Extra capacity can be provided in time to serve the development, which will ensure that the environment and the amenities of local residents are not adversely affected.

95. Developers will be required to provide evidence that capacity exists in the public sewerage and water supply network to serve their development.

96. Any new water supply, sewerage or waste water treatment infrastructure must be in place prior to occupation of the development. Financial contributions may be required for new developments towards the provision of, or improvements to such infrastructure".

4.4.3 Local Flood Risk Management Strategy[17]

97. Under the FWMA 2010, the London Borough of Richmond upon Thames, as a LLFA, has the duty to develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS).

98. The LFRMS has five key objectives:
    - Encourage direct involvement in decision making through the establishment of and maintain partnerships with key organisations, including the Environment Agency and Thames Water.
    - Improve our knowledge and understanding of the interactions between different sources of flooding in LBRuT.
    - Encourage residents, businesses and local landowners to take action and contribute to the management and reduction of flood risk

[17] London Borough of Richmond upon Thames (2015) Local Flood Risk Management Strategy

- Target resources where they have the greatest effect by adopting a risk-based approach
- Contribute to wider social, economic and environmental outcomes by encouraging sustainable multi-benefit solutions for the management of local flood risk

99. The LFRMS is currently in a draft format, having under gone consultation which ended on 16th March 2015. Reponses from views by residents, groups and businesses provided from the consultation will help shape the final Strategy document, which will be implemented to manage flood risk across the Borough.

4.4.4 Surface Water Management Plan[18]

100. The Surface Water Management Plan (SWMP) was released in September 2011 and was delivered as part of the Tier 2 package of works of the Drain London Project. The document outlines the preferred surface water management strategy for the London Borough of Richmond upon Thames. It includes consideration of flooding from sewers, drains, groundwater and runoff from land, small water courses and ditches that occur as a result of heavy rainfall.

101. Pluvial modelling was undertaken across the entire Borough for five specified annual exceedance probabilities. The results were used to identify Local Flood Risk Zones (LFRZs) within the Borough, where flooding was predicted to affect houses, businesses or infrastructure. Those areas identified to be at more significant risk have been delineated into Critical Drainage Areas (CDAs). A total of seven CDAs had been identified in Richmond.

102. Opportunistic measures to be implemented across the Borough to tackle surface water flood risk were also reviewed. This included ongoing maintenance of the drainage network, community awareness, wide spread water conservation measures and sit-specific measures within CDAs.

4.4.5 Preliminary Flood Risk Assessment[19]

103. The Preliminary Flood Risk Assessment (PFRA) report was published June 2011 following the requirements set out by the Flood Risk Regulations 2009. The PFRA provides a high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The scope of the PFRA is to consider flooding from the following sources; surface runoff, groundwater, sewers and ordinary watercourses and any interaction these have with main rivers and the sea.

4.4.6 Planning Guidance Document Delivering SuDS in Richmond[20]

104. Delivering SuDS in Richmond was published in February 2015 and provides advice on how to incorporate SuDS in a range of developments, from single dwellings to large scale developments. It supports applicants and developers in implementing the requirements of the adopted Development Management Plan (2011) Policy DM SD 7 Sustainable Drainage.

[18] London Borough of Richmond upon Thames (2011) Surface Water Management Plan
[19] London Borough of Richmond upon Thames (2011) Preliminary Flood Risk Assessment
[20] London Borough of Richmond upon Thames (205) Delivering SuDS in Richmond

5 Data Collection

5.1 Overview

105. A considerable amount of knowledge exists with respect to flood risk within the London Borough of Richmond upon Thames (LBRuT), including (but not limited to):

- Historical river flooding information;
- Information relating to localised flooding issues (surface water, groundwater and/or sewer related), collated in consultation with the Borough, Thames Water and the Environment Agency;
- Detailed flood risk mapping;
- Environment Agency Flood Zone Maps;
- Topography (LiDAR).

106. All of this data has been sourced from the Borough and the Environment Agency, forming the core dataset that has informed the SFRA process. The application of this data in the delineation of the 'high', 'medium' and 'low' risk flood zones, and the formulation of planning and development control recommendations, is explained in Section 7.4 below. An overview of the core datasets, including their source and their applicability to the SFRA process, is outlined below.

5.2 Environment Agency Flood Zone Maps

107. The Environment Agency's 'Flood Map for Planning' (from here on referred to as the Flood Map) shows the natural floodplain, ignoring the presence of defences, and therefore areas potentially at risk of flooding from rivers or the sea. The Flood Map shows Flood Zone 3 (high risk), which is the area that is susceptible to a 1% chance in any one year probability of flooding from rivers, and / or a 0.5% chance in any one yearof flooding from the sea.. It also shows Flood Zone 2 (medium risk), which indicates the area that has between a 1.0% - 0.1% chance in any one year of flooding from rivers and / or 0.5% - 0.1%chance in any one year of flooding from the sea..

108. The Flood Map outlines have been produced from a combination of a national generalised computer model, more detailed local modelling (if available), and some historic flood event outlines (historic outlines are only included in Flood Zone 2). The availability of detailed modelling for the Richmond area is further discussed in Section 5.4.

109. The Environment Agency's knowledge of the floodplain is continuously being improved by a variety of studies, detailed models, data from river flow and level monitoring stations, and actual flooding information. They have an ongoing programme of improvement, and updates are made on a quarterly basis where improved information is made available.

110. The Flood Map in the London Borough of Richmond upon Thames is provided in Figures 1 to 11, showing a considerable proportion of the area being at risk from river flooding. This is generally due to the relatively low lying topography of much of the Borough, particularly adjoining the River Thames and its tributaries.

5.3 Historical Flooding

111. The River Thames has a considerable history of flooding with significant events (resulting in property flooding) occurring no less than ten times within the past 100 years. The most recent River Thames flood occurred in January 2014 in which a number of areas to the west of London were severely affected, resulting in damage to homes and businesses within low lying Boroughs (including Spelthorne, Windsor and Maidenhead) along the Thames corridor. Several Thames gauges showed record levels since they were installed in the 1980s and 90s.

112. The flood extents for previous river and tidal flooding events within the London Borough

of Richmond upon Thames were provided by the Environment Agency and the Borough. These outlines have been used to review the delineation of the adopted flood risk zones. Known areas of localised drainage issues within the Borough have been collated in Figures 1 to 11. Collectively, this information will also be useful when considering the susceptibility to flooding of specific sites when carrying out a detailed site based Flood Risk Assessment (FRA).

5.4 Detailed Hydraulic Modelling

113. A number of detailed flooding investigations have been carried out by the Environment Agency throughout the London Borough of Richmond upon Thames, including the lower reaches of the River Thames (upstream of Teddington Weir) and new modelling for the tidal Thames. Detailed hydraulic modelling downstream of Teddington Weir has also been carried out.

114. A detailed study and modelling of the River Crane (incorporating the Duke of Northumberland River) to predict flood extents has been carried out. The Environment Agency has also carried out a full review of the Beverley Brook model. The above studies incorporate the development of a detailed hydraulic model, providing a robust understanding of the localised flooding regime in line with Section 105 (2) of the Water Resources Act for the delineation of the NPPF flood zones (contact the Environment Agency for further updates on the Beverley Brook model as it is being reviewed as at March 2016).

115. It should be noted that the detailed hydraulic models developed on behalf of the Environment Agency assume 'typical' conditions within the respective river systems that are being analysed. The predicted water levels may change if the operating regimes of the rivers involved are altered (e.g. engineering works which may be implemented in the future), or the condition of the river channel is allowed to deteriorate.

5.5 Flood Defences

116. Flood defences are typically raised structures that alter natural flow patterns and prevent floodwater from entering property in times of flooding. They are generally categorised as either 'formal' or 'informal' defences. A 'formal' flood defence is a structure constructed specifically to redirect the flow of floodwater, and that is maintained for this purpose by its respective owner, regardless of ownership. An 'informal' flood defence is a structure that has not been specifically built to redirect floodwater, and is not maintained for this specific purpose. It may however afford some protection against flooding. These may include boundary walls, industrial buildings, railway embankments and road embankments situated adjacent to rivers.

117. Formal raised flood defences within the Borough have been identified in consultation with the Environment Agency, providing protection against tidal and fluvial flooding from the River Thames. These are indicated in Figures 1 to 11. The construction of these raised flood defences commenced in the late 1970s (completed in the early 1980s) and no defence raising has occurred since this time. With completion of the Thames Barrier, the walls at their original heights provide the following standard of protection within the London Borough of Richmond upon Thames:

- A 0.1% chance in any one year standard of protection (SoP) against a *combined* tidal and fluvial flooding event from Richmond downstream (i.e. towards the City of London) (with the exception of Eel Pie Island).
- A progressively decreasing SoP against a *combined* tidal and fluvial flooding event from Richmond upstream (i.e. towards Teddington). The new tidal modelling carried out by the Environment Agency suggests the SoP currently decreases to somewhat less than 1% chance in any one year at Teddington, and that this will likely decrease with time to between 5% and 2% chance in any one year by the end of the century.
- A 0.1% chance in any one year SoP against tidal flooding *only* between Richmond and Teddington.

It is noted that a 'combined' event would be observed when an unusually high tide happens to coincide with particularly high river levels due to prolonged rainfall in the upper catchment.

118. It is important to recognise however that the probability of *fluvial* flooding (alone) from the River Thames within the Borough upstream of Teddington is somewhat higher than from tidal flooding. In simple terms, this means that river levels as a result of prolonged heavy rainfall within the upper catchment (including Oxfordshire and Gloucestershire as seen during the summer 2007 event) will be higher, and occur more frequently, than the combined tidal and fluvial event described above. For this reason, the standard of protection provided to property upstream of Teddington is closer to 1% chance in any one year .

119. A small number of *informal* defences have been identified that may alter the path of floodwaters, including the embankment adjoining Beverley Brook at the Palewell Playing Fields, and the railway embankments near Barnes Common. It is important to recognise that local roads and / or rail lines that have been constructed on raised embankments may alter overland flow routes at any location throughout the Borough, and as such may have a localised effect upon the risk of flooding. This should be carefully reviewed in a local context as part of the detailed site based Flood Risk Assessment.

120. Sites close to flood defences are important because even minor developments can affect their structural integrity and / or the Environment Agency's ability to access them for inspection and maintenance purposes. Therefore, the Environment Agency will be consulted on all proposals, including minor developments, that fall within 20 metres of the landward side of the flood defence, if present, or the bank of the river, if not. Refer to Figures 1-11 and Figure D for the location of the tidal flood defences.

121. It is important to reiterate that the risk of flooding can never be fully addressed. There will always be a residual risk of flooding, due to (for example) a more extreme event, changing climatic conditions, and/or a structural failure of the constructed flood defence system. It is incumbent on both Borough and developers to ensure that the level and integrity of defence provided within developing areas can be assured for the lifetime of the development.

5.6 Environment Agency Surface Water Flood Map

122. The Updated Flood Map for Surface Water (uFMfSW) assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year (annual probability of flooding is shown in brackets):

- 3.3% chance in any one year
- 1% chance in any one year
- 0.1% chance in any one year

123. The uFMfSW provides the following data for each scenario:

- Extent of flooding
- Depth
- Velocity (including magnitude and flow direction at maximum velocity)
- Flood Hazard (as a function of depth and velocity)

124. The current version of the mapping is referred to as the "updated Flood Map for Surface Water" on the Environment Agency Website[21]. The extents have been made available to Richmond as a GIS layer.

125. The uFMfSW improves upon previous nationally produced surface water flood mapping

[21] Environment Agency (2015) updated Flood Map for Surface Water

as it incorporates significant improvements in modelling techniques and is more representative of flow routes. Furthermore, it provides digital terrain information at the 2m resolution or finer for over 90% of urban areas in England and Wales.

126. The data set has a number of strengths associated with it. Firstly the 2m model grid used allows multiple small ground features to be accounted for. Secondly, the high quality ground level information in urban areas enhances features representing buildings, roads and flyovers. Thirdly, the influence of land use and soil type and integrated within the modelling. Lastly, the incorporation of locally produced LLFA surface water flood mapping increases the accuracy of the dataset where this is available.

127. Although the dataset provides a number of strengths. There are limitations associated with the uFMfSW. It assumes a single drainage rate for all urban areas within national produced modelling unless stated otherwise by LLFAs. Modelled flood extents are particularly sensitive to drainage rates. Omitting subsurface drainage elements such as flood relief culverts and flood storage can significantly affect model outcomes. The national scale dataset also assumes free outfall and so does not take into consideration tide locking or high river levels which may prevent surface water from draining away freely. Lastly, there are limited surface water records for LLFAs, so in many areas LLFAs have not been able to validate predicted extents.

128. The SFRA utilises the extent of flooding at the 1% chance in any one year of flooding due to its realistic extent of local flooding which could be managed and regulated by the local planning authority. Although the 3.3% chance in any one year of rainfall is the common design standard for urban drainage design, using this within flood risk mapping is not sufficiently conservative and the 1% chance in any one year is considered a good representation of current conditions with an allowance for climate change.

129. The surface water depth between 0 – 0.15m has been removed from the mapping (Figure G) as building standards typically require proofing courses at a height of 0.15m, resulting in flows below this height to be generally located in carriageways and within curb heights.

5.7 Consultation

130. Consultation has formed a key part of the data collation phase for the 2015 London Borough of Richmond upon Thames SFRA. The following key stakeholders have been comprehensively consulted to inform its investigation:

London Borough of Richmond upon Thames

Planning
Consulted to identify areas under pressure from development and/or regeneration. The update of the SFRA also draws on feedback from the Development Control section on the application of the SFRA and its recommendations.

Drainage
Consulted to identify areas potentially at risk from river flooding and / or urban drainage

Environment Agency

The Environment Agency has been consulted to source specific flood risk information to inform the development of the SFRA. In addition, the Environment Agency is a statutory consultee under NPPF and therefore must be satisfied with the findings and recommendations for sustainable flood risk management into the future. For this reason, the Environment Agency has been consulted during the development of the 2008, 2010 and 2015 SFRAs to discuss potential flood risk mitigation measures and planning recommendations.

Thames Water

Thames Water is responsible for the management of urban drainage (surface water and sewerage) within the Borough. The underground drainage systems in many towns and cities of England are being progressively upgraded from the Victorian sewers. However, they often remain under capacity and subject to relatively frequent 'overload' (i.e. resulting in flooding on the surface).

Thames Water was consulted for the 2015 SFRA to discuss the risk of localised flooding associated with the existing drainage/sewer system. The feedback provided was very general in nature, providing simply a summary of the number of recorded incidents per post code.

It is therefore not possible for the SFRA to pinpoint known capacity problems and/or infrastructure at risk of structural failure. Thames Water cannot provide more specific information on sewer flooding as it identified individual properties and is restricted by the Data Protection Act. They have provided comments on sewer flooding, amongst other issues, and will work with the local authority to understand impacts of developments on their network and identify infrastructure needs.

5.8 Topography & Geology

Topography

131. Detailed topographic information has been provided by the Environment Agency (2007) for the Borough in the form of LiDAR. LiDAR enables a detailed Digital Elevation Model (DEM) to be developed that, in simple terms, provides a three dimensional representation of the Borough. This is presented in Figure A.

132. The topography of the London Borough of Richmond upon Thames is relatively undulating throughout much of the Borough, falling gradually from the upper reaches of the River Crane and Beverley Brook catchments towards the River Thames. The north bank of the River Thames generally features well defined river valleys, demonstrated by the relatively limited extent of floodplain along the river corridors. To the south of the Thames however, the Borough topography varies much more considerably. Steep slopes are evident to the south and east of Richmond, and runoff from these slopes drains rapidly towards the low lying floodplains of the River Thames and Beverley Brook.

Geology

133. Geological information has been retrieved from the British Geological Survey (BGS), providing an overview of soils and substrate, as presented in Figure B. The geology of the London Borough of Richmond upon Thames is characterised to a very large degree by London Clay. The impermeable nature of the soils can increase the susceptibility of the area to surface water (or flash) flooding following periods of heavy rainfall.

134. Immediately adjoining the River Thames, deposits of gravel overlay the London Clay, and this can lead to localised incidents of groundwater flooding. The geology of the Borough will heavily influence the functionality of Sustainable Drainage (SuDS) techniques, and should be carefully considered as part of the design process.

Aquifer Designation

135. Provided by the British Geological Survey and the Environment Agency, the dataset identifies the different types of aquifers in England and Wales at a 1:50 000 scale. An aquifer is the underground layers of water-bearing permeable rock or drift deposits through which abstraction of groundwater can incur. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their supporting role to surface water flows and wetland ecosystems. The maps, presented in Figure H, are split into two different types of aquifer designation:

- Superficial - permeable unconsolidated (loose deposits e.g. sands and gravels)
- Bedrock – solid permeable formations (e.g. sandstone, chalk and limestone)

6 Flood Risk in Richmond

6.1 Overview

136. The River Thames, Beverley Brook and the River Crane are major topographical features of the London Borough of Richmond upon Thames (LBRuT). A considerable proportion of the urban area of the Borough is situated on relatively low lying ground adjacent to the river systems, and a considerable proportion of the borough is potentially affected by flooding. Analysis[22] shows that approximately 600 properties are within the functional floodplain zone 3b (greater than a 5% chance in any one given year). A further 13,500 properties are at "high" risk of flooding (greater than a 1% chance in any one year). Around 6,500 properties are at "medium" risk of flooding (between a 1% and 0.1% chance in any one year of fluvial flooding or between a 0.5% and 0.1% chance in any one year of tidal flooding.

River Thames

137. River Thames flooding has affected the Borough numerous times in the past, however these flood events do not always affect residential property. It is important to recognise that flooding may also affect transportation links, resulting in severe disruption to communities and business. The London Borough of Richmond upon Thames is currently protected to some degree against flooding from the River Thames by the Thames Tidal Defences (TTD). Whilst the current government is committing funds for flood defences within London, the planning process must make decisions that will influence generations well into the future. Investment some 100 years from today can clearly not be predicted with certainty, and there is always a residual risk that an engineered structure may fail.

138. The findings of the TE2100 Plan also show that over the next 25 years, the use of the Thames Barrier for fluvial flood risk management will be reduced. Therefore, it is imperative that the decisions of today are informed by the *residual* risk, taking into account climate change, and should the current defence systems deteriorate over time. The TE2100 study includes an assessment of the potential breach of defences during extreme tidal conditions. The tidal breach modelling represents the residual risk that remains should any of the defences fail. Tidal breach locations and resulting potential tidal breach hazards generated in 2014 / 2015 as part of the TE2100 study are shown in Figure C *(Note: Please contact the Environment Agency for potential further updates on breach modelling).*

River Crane & Beverley Brook

139. The River Crane and Beverley Brook are key features of the London Borough of Richmond upon Thames, situated to the north and the south of the River Thames respectively. Both systems pose a potential risk of fluvial flooding to property within the Borough, as is evident in Figures 1 to 11.

140. The River Crane and Beverley Brook catchment areas are much smaller than the Thames catchment, and they are subsequently 'flashier' systems that will respond to a rainfall event faster than the River Thames. Flood warnings are more difficult to issue accurately and/or with long lead times. This means that often the community may be caught by surprise, resulting in damages being sustained on a more frequent basis.

Other (Localised) Sources of Flooding

141. It is essential to recognise that flood risk within the Borough is not limited solely to flooding of main rivers. There is a risk to properties as a result of surface water and groundwater flooding, exacerbated by high river levels. Localised flooding as a result of local catchment runoff and/or sewer system failure following heavy rainfall is a known risk to properties.

[22] Spatial analyses: overlaying Local Land and Property Gazetteer with the flood zones (May 2015)

142. It is important that planning decisions recognise the potential risk that these additional sources of flooding may pose to property, and that development is planned accordingly to ensure future sustainability. In addition to property damage, flooding can affect lives and livelihoods. It is essential that future development (particularly residential development) is not placed within areas of the Borough within which the safety of residents cannot be assured in times of flood.

A Sustainable Approach

143. As highlighted throughout the SFRA, the potential risk of flooding is increasing due to pressure for future development and climate change. Future investment in flood defence cannot be assured, and for this reason, it is imperative that local government works to proactively deliver a reduction in flood risk through the planning process. The NPPF, regional planning policy, and the Environment Agency require planners to guide vulnerable development away from areas that are most at risk. Sustainable design techniques are also important to ensure that, where a degree of flood risk is inevitable, the risk to property and life is minimised. The core recommendations of the LBRuT SFRA have been developed accordingly.

6.2 Fluvial and Tidal Flooding - Delineation of the NPPF Flood Zones

144. It is emphasised that the **risk** of an event (in this instance a flood event) is a function of both the **probability** that the flood will occur, and the **consequence** to the community as a direct result of the flood. The NPPF endeavours to assess the likelihood (or probability) of flooding, categorising the Borough into zones of low, medium and high probability. It then provides recommendations to assist the Borough to manage the consequence of flooding in a sustainable manner, for example through the restriction of vulnerable development in areas of highest flood risk.

145. To this end, a key outcome of the SFRA process is the establishment of the Sequential Test in accordance with (Table 1) of NPPG. To inform the planning process, it is necessary to review flood risk across the area, categorising the area in terms of the likelihood (or probability) that flooding will occur.

146. The Borough has been delineated into the flood zones summarised below.

Zone 3b The Functional Floodplain

This zone comprises land where water has to flow or be stored in times of flood" (NPPF), or land which would flood with an annual probability of a >5% chance in any one year or is designed to flood in an extreme 0.1% chance in any one year flood.

Zone 3a High Probability

Land assessed as having a >1% chance in any one year of fluvial flooding, or a >0.5% chance in any one year of tidal flooding.

Zone 2 Medium Probability

Land assessed as having between a 1% - 0.1% chance in any one year of fluvial flooding or between a 0.5% - 0.1% chance in any one year of tidal flooding.

Zone 1 Low Probability

Land assessed as having a <0.1%.chance in any one year of flooding.

147. The delineation of the NPPF flood zones is presented in Figures 1 to 11.

6.2.1 Delineation of Zone 3b Functional Floodplain

148. Zone 3b Functional Floodplain is defined as those areas in which *"water has to flow or be stored in times of flood"*. The definition of functional floodplain remains somewhat open to subjective interpretation. The NPPG states that *"Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries*

accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 5% or greater chance in any year, or is designed to flood in an extreme 0.1% chance in any one year of flooding event, should provide a starting point for consideration and discussions to identify the functional floodplain." For the purposes of the London Borough of Richmond upon Thames SFRA, Zone 3b has been defined in the following manner:

1. Land where the flow of flood water is not prevented by flood defences or by permanent buildings or other solid barriers from inundation during times of flood;
2. Land which provides a function of flood conveyance (i.e. free flow) or flood storage, either through natural processes, or by design (e.g. washlands and flood storage areas);
3. Land subject to flooding in the 5% chance in any one year flood event (i.e. relatively frequent inundation expected).

149. Within the London Borough of Richmond upon Thames, detailed modelled flood outlines[23] have been provided by the Environment Agency for the River Thames (fluvial and tidal), the River Crane and the Beverley Brook, providing the basis for the delineation of Zone 3b Functional Floodplain. The functional floodplain is shown in the adjoining maps.

150. In summary, Zone 3b Functional Floodplain encompasses primarily those low lying areas immediately adjoining the main river corridors. Any development within these areas is likely to measurably impact upon the existing flooding regime, increasing the severity and frequency of flooding elsewhere. It is noted that existing urban areas adjoining the main river corridors within the Borough are affected by flooding in the 5% chance in any one year flooding event. The NPPG highlights the importance of considering existing land use when delineating areas that are to be treated as 'functional floodplain' for planning purposes.

151. Discussions with the Environment Agency have confirmed that, due to the obstructions to overland flow paths posed by existing development within flood affected areas, existing buildings (that are impermeable to floodwater) fall within the zone 3b 'Developed Land'. The land surrounding existing buildings form important flow paths and flood storage areas. These must be protected, and planning decisions should be taken accordingly. For this reason, a sub-delineation within Zone 3b has been provided, making reference to 'developed' and 'undeveloped' areas as further described in Section 7.4. The London Borough of Richmond upon Thames may consider removing Permitted Development rights for certain types of developments (such as extensions) in the functional floodplain to protect the important flow paths and flood storage areas surrounding existing buildings.

152. In Zone 3b, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and relocate existing development to land with a lower probability of flooding. The redevelopment of existing developed sites should result in a net flood risk reduction. The restoration of the functional floodplain to its original function should be sought.

153. It is important to recognise that all areas within Zone 3b are subject to relatively frequent flooding – on average a 5% chance in any one year. There are clear safety, sustainability and insurance implications associated with future development within these areas, and informed planning decisions must be taken with care. Developers and planners should consider the future insurability of new developments at the earliest stage possible in the planning process.

6.2.2 Delineation of Zone 3a High Probability

154. Zone 3a High Probability is defined as those areas of the Borough that have a 1% or greater change of river flooding in any one year, and / or a 0.5% chance or greater of flooding from the sea in any one year, whichever is greater. It is emphasised that the delineation of

[23] Detailed modelled flood outline for the 5% chance in any one year design event (January 2010)

Zone 3a High Probability does NOT consider the presence of raised defences. This is because defences do not remove the risk of flooding completely. There remains a risk that the constructed defences may fail, resulting in the rapid inundation of areas behind the defences (refer Section 6.3).

155. The detailed modelling outputs[24] developed by the Environment Agency have been adopted for the delineation of Zone 3a High Probability.

156. It is important to recognise that the delineation of Zone 3a encompasses those areas that are protected against flooding through the presence of flood defences (including the Thames Tidal Defences). These are presented clearly by the Environment Agency's "Areas Benefitting from Defence" layer, provided in Figure D.

157. The 'actual' risk of flooding to property is clearly reduced within these defended areas, however where the defences are engineering structures that are raised above ground level, there remains a residual risk of sudden collapse or overtopping of the defences. Spatial planning and development control decisions should be taken accordingly, and to this end Zone 3a High Probability has been sub-delineated into zones of tidal defence breach or fluvial 'hazard' (reviewing the potential risk to life), considering the impact of a failure of the River Thames defences. This is discussed further in Section 6.3.

6.2.3 Delineation of Zone 2 Medium Probability

158. Zone 2 Medium Probability is defined as those areas of the Borough that are situated between the 0.1% and the 1% chance in any one year of flooding from the river and / or 0.5% chance in any one year of flooding from the sea (whichever is greater). In this instance, Zone 2 Medium Probability is defined in accordance with the NPPF and the Environment Agency's Flood Zone Map.

159. It is noted that, given the relatively rapid rise in topography at the periphery of the floodplain, the increase in the predicted flood level (and hence flood extent) between Zone 3a High Probability and Zone 2 Medium Probability is generally marginal.

6.2.4 Delineation of Zone 1 Low Probability

160. Zone 1 Low Probability is defined as those areas of the Borough that are situated above (or outside of) the predicted 0.1% chance in any one year tidal and river flood extent. For SFRA purposes, this incorporates all land that is outside of the shaded Zone 2 and Zone 3 flood risk areas (as defined above).

6.3 Assessment of Risk to Life (Flood Hazard)

161. The SFRA must consider not only the potential damage sustained by property in the case of flooding, but also the risk to life should a flood event be experienced within the Borough. A considerable amount of research is ongoing worldwide to assess the risk that flooding may pose to life. In simple terms, it can be said that the risk to life is largely a function of the depth and velocity of the floodwater as it crosses the floodplain.

162. The risk to life (as a result of flooding) within the London Borough of Richmond upon Thames has been assessed and delineated in accordance with Defra guidance provided in the form of 'Flood Risks to People' (FD2321/TR2), as described in Appendices A and C. 'Flood Risks to People' uses **Flood Hazard** to assess the potential risk to life. Flood Hazard assessment is a defined method to combine predicted depth and velocity into a 'hazard rating' that can be used to define the level of risk to people. A brief summary of the findings is presented below:

- **Tidal and Fluvial Flood Hazard due to River Thames Flooding**

[24] Detailed modelled flood outline for the1% chance in any one year and/or 0.5% chance in any one year or greater design event (January 2010)

The likelihood of a rapid river level rise within the River Thames, resulting in the rapid inundation of urban areas within the Borough posing a risk to life, is considered to be negligible. This is primarily due to the large River Thames system and its substantial upper contributing catchment area which allows the Environment Agency, with its current flood warning system, to provide long lead times in advance of a pending flood event.

- **Fluvial Flood Hazard due to Flooding from Tributaries of the River Thames**
  The likelihood of a rapid river level rise within the tributaries of the River Thames, including (for example) the River Crane and Beverley Brook, has been considered. Whilst these catchment areas are substantially smaller than that of the River Thames, they remain relatively large and unlikely to be subject to 'flashy' response following a rainfall event. Once again therefore the rapid inundation of urban areas within the Borough posing a risk to life is considered very low.

- **Tidal Flood Hazard due to a Breach of the Flood Defences**
  The flood affected areas of Richmond upon Thames are relatively low lying, and in many areas floodwaters can disperse quickly following a breach failure. The Borough is protected against river and tidal flooding through the Thames Tidal Defence (TTD) system. The TTD provides protection through a combination of raised defences, flood proofing, and the Thames Barrier.

  As part of the TE2100 study (Thames Tidal Breach Modelling Study, Halcrow / CH2M Hill, March 2015), hydraulic modelling was carried out for the Tidal Thames downstream of Teddington Locks to consider the velocity, depth and path of flood water should a failure of the defences occur at defined locations along their length. The water level scenario selected for the SFRA is the 'maximum likely water level' (MLWL) under 2100 climate change conditions (as defined by the TE2100 plan). The MLWL is a generated through considering a number of tide levels, river flows and Thames Barrier operational conditions to generate a conservative estimate of water level upstream of the Thames Barrier. The results of this modelling are shown in Figure C along with the breach locations considered. Appendix B provides further background information on how the breach modelling was undertaken *(Note: Please contact the Environment Agency for further updates on breach modelling to ensure the best available information is used)*

- **Tidal Flood Hazard due to the Overtopping of the Flood Defences**
  It is important to recognise that the River Thames flood defences have been constructed to a finite height. Inevitably there will always remain a residual risk that these will be overtopped in a flood that exceeds the event for which they were designed.

6.4 Surface Water Flooding

163. Surface water flooding within LBRuT identifies high variability in location as shown in Figure G. This is typical of areas with small undulations in topographic elevations as shown in Figure A. However, more significant ponding of surface water can be identified within Richmond Park and other topographic low points such as road / rail underpasses.

164. Surface water ponding relating to rainfall occurs due to overland flow. Human influences such as urbanisation increase overland flow by creating impervious surfaces such as pavements and buildings which do not allow percolation of water through the soil to the aquifer. Runoff finds flow paths often along roads as well as parks and other built up areas, collecting at topographic low points.

165. The Environment Agency updated Flood Map for Surface Water (as shown in Figure G) can be accessed via the Environment Agency website to allow detailed review at a larger scale. The surface water flood mapping on the Environment Agency website is currently the best available information on surface water flood risk (it supersedes the surface water flood modelling and mapping completed as part of the 2011 Surface Water Management Plan).

6.5 Local Drainage Issues

166. A number of observed incidents of flooding throughout the London Borough of Richmond upon Thames have been collated through discussions with the EA and the Borough as part of

this investigation, and these are captured (and described) in the adjoining flood maps. Many of these incidents are within relatively densely urbanised parts of the Borough. The date and cause of flooding has been listed on the maps wherever possible, however it is important to recognise that this can often be somewhat subjective. It should also be noted that not all of the incidents within the Borough would have been reported, therefore it should be expected that there are more than that are displayed on the maps. Figure J identifies the number of blocked gullies found within the London Borough of Richmond upon Thames. The surveying of the gullies was conducted by the Borough themselves.

167. The capturing of historical incidents of flooding within the Borough as part of the SFRA is an important trigger to prospective developers to consider what has happened in the past, developing a design that will seek to ensure that similar problems do not reoccur in the future. It is essential to recognise that historical flooding is not a measure of the potential risk of flooding in the future. Localised flooding (including surface water flooding, groundwater flooding, and/or surcharging of the sewer system) may occur anywhere within the Borough. Figure K[25] shows flooding incidents relating to various sources which have been mapped using Borough and EA records.

168. It is important to highlight that, throughout much of England, the drainage (sewer) network is typically designed to cater for no greater than a 3.33% chance in any one year design storm. For this reason, any event that exceeds this probability can be expected to result in overland flow that may pose a risk of flooding to local properties. It is recognised that the risk of flooding from surface water and/or the sewer network is difficult to predict accurately, and is heavily dependent upon local conditions during the passing of a storm. For example, leaves and/or a parked car may be blocking a gully, water levels within the receiving watercourse may be elevated preventing free drainage from (or backing up of) the sewers.

169. It is important to ensure that the potential risk of localised flooding to a property is considered within a local context. This is most appropriate at the development application stage (i.e. as part of the detailed site level Flood Risk Assessment). The topographic and geological maps provided as Figures A and B respectively have been provided to assist in this respect, offering an indication of both localised 'sags' that may be susceptible to ponding, and overland flow routes that will convey water when the capacity of the underground system is exceeded.

6.6 Groundwater Issues

170. A large proportion of the London Borough of Richmond upon Thames overlays London Clay and consequently the risk of groundwater flooding will typically be low. Areas adjoining the River Thames corridor however are often characterised by deposits of gravel above the clay layer. These are referred to as 'Thames Gravels' and there is evidence within adjoining Boroughs of groundwater flooding occurring some distance from the river as a result of water finding a pathway through the gravels during high river levels.

171. Evidence of historic groundwater flooding within the London Borough of Richmond upon Thames is relatively limited, however a number of incidents have been reported (some resulting in relatively deep flooding for extended periods), and these are reflected in the Surface Water Management Plan.

172. It is important to recognise that the risk of groundwater flooding is highly variable and heavily dependent upon local conditions at any particular time. It is not possible to sensibly develop a strategic map of 'groundwater risk' as part of the SFRA process, and it is important to recognise however that historical flooding is *not* a robust measure of the risk of flooding in future years.

173. Due to the high degree of variability when considering groundwater flooding, it is important to ensure that the potential risk of groundwater flooding to a property is considered within a local context. This is most appropriate at the development application stage (i.e. as

[25] Figure K has been taken from the Local Flood Risk Management Strategy (2015)

part of the detailed Flood Risk Assessment). The topographic and geological maps provided as Figures A and B respectively have been provided to assist in this respect, offering an indication of both areas of Thames Gravels, and localised 'sags' that may be susceptible to ponding. The British Geological Survey has also provided a mapping identifying areas which is susceptible to groundwater flooding, provided in Figure E.

174. In addition, the EA advises that the rise in groundwater levels in response to reduced abstraction is no longer a significant issue. Therefore, any groundwater flooding within LBRuT will likely be in response to seasonal rainfall recharge rather than any long-term abstraction influences.

6.7 Sewer flooding

175. Due to the complexities of the sewage and surface water networks and the uncertainty of development options at this point of the planning process, it is not possible to accurately assess areas which will be affected by sewer flooding as a result of future development. Areas where sewer flooding is known to occur should not necessarily be seen as areas to avoid development as new sewerage capacity may be able to provide alleviation to the problem. The reverse is also true in that areas which currently do not encounter sewer flooding should not always be viewed as areas best placed to accommodate new development.

176. It is essential to ensure that infrastructure is in place ahead of development to avoid unacceptable impacts such as sewage flooding of residential and commercial properties. Consequently, development should only take place where the new demand upon existing infrastructure is taken into account. Therefore, developers should provide evidence in the form of written confirmation from the sewerage undertaker (in this instance Thames Water) that adequate capacity exists in the public sewerage network to serve their development

177. To avoid sewer flooding, detailed computer modelling of development may be required in relation to the sewerage network. To do this the exact location and scale of development needs to be known. The Local Planning Authority will work closely with the water company to ensure that development will not be allowed to precede the delivery of essential sewerage infrastructure by refusing unsustainable developments or attaching 'Grampian' style planning conditions on sites where essential infrastructure is required.

178. Water companies are required to report their performance each year against performance indicators called levels of service indicators. *DG5: Flooding from sewers* is one of the performance indicators and has been provided by Thames Water as shown in Figure I. The data identifies TW3, SW15 and SW15 to be the most susceptible areas to both internal and external flooding due to sewer flooding.

6.8 Climate Change

179. A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the frequency and severity of flooding will change measurably within our lifetime.

180. The Environment Agency has recently (February 2016) published revised guidance[26] on climate change allowances for flood risk assessment. The guidance provides allowances for a range of time periods specifically related to river basin districts for river flows, rainfall intensities for urban catchments and sea level rise. Allowances are split into upper end, higher central and central bands. The issued guidance provides detailed direction on how these should be applied to development scenarios.

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

181. The potential impact that climate change may have upon the likelihood of flooding over the life time of a development should be taken into account and this should be addressed in site level Flood Risk Assessments. The revised EA guidance for climate change allowances should be applied for fluvial and surface water flooding, but they do not apply for tidal flooding as they are already accounted for in the model recent Thames Estuary 2100 plan (TE2100 plan).

River Thames downstream of Teddington Weir (tidal flooding)

182. Within the areas adjoining the River Thames downstream of Teddington Lock (i.e. at risk of tidal flooding from the River Thames), the potential impact that climate change may have upon peak design river levels within the Thames is complicated to a large degree by the operation of the Thames Tidal Defences (TTD).

183. As part of the TE2100 Plan, a detailed review of the TTD design and operation into future years was completed by the Environment Agency. The TE2100 Plan develops on four generic estuary-wide options, of which, the recommended option is to provide "a continuation of defence improvements including major improvements to the Thames Barriers" for the first 60 years. Currently it is envisaged that the impacts of climate change can be mitigated by effective operation and improvement of the Thames Barrier although this cannot be guaranteed in the future. From 2070, rising sea levels will require a different approach to be taken which includes the installation of a new downstream barrier at Long Reach.

184. Clearly future investment in the TTD over the coming century cannot be assured today. It is essential that planning policy takes a proactive stance when considering the potential impact of climate change. For this reason, developers working within this area should consult with the EA and Local Planning Authority as part of the design process to seek advice on the appropriate climate change related design levels to use for design purposes. Any development must take into account the best available information at the time of application. Consultation with the EA and LPA must be undertaken to confirm current allowances.

River Thames upstream of Teddington Weir (fluvial flooding)

185. The current detailed modelling of the River Thames (upstream of Teddington Weir) has considered the potential impact of climate change upon river flooding over the next 100 years, assuming a 20% increase in the peak design flow. This has been reflected in the adjoining flood maps. Note that the Thames Barrier's legal purpose is to protect against tidal flooding and therefore it is likely that the availability of the Thames Barrier to alleviate fluvial flooding will decrease over the next 25 years, as the sea level continues to rise.

River Crane & Beverley Brook

186. Detailed modelled outlines for the 1% chance in any one year plus a 20% allowance for climate change event have been made available for the River Crane or Beverley Brook by the Environment Agency (Note that the modelling of the Beverley Brook is currently being revised and the EA should be consulted to obtain the best available information*).*

Impact of Climate Change upon Flood Risk within LBRuT

187. **It is clear that climate change will not markedly increase the extent of river flooding within most areas of the Borough.** Consequently, few areas that are currently situated outside of Zone 3 High Probability will be at substantial risk of flooding in the foreseeable future. This is an important conclusion from a spatial planning perspective.

188. It is important to recognise that **those properties (and areas) that are currently at risk of flooding may be susceptible to more frequent, more severe flooding in future years**. It is essential therefore that the development control process (influencing the design of future development within the Borough) carefully mitigates against the potential impact that climate change may have upon the risk of flooding to the property.

189. For this reason, all of the development control recommendations set out below require all floor levels, access routes, drainage systems and flood mitigation measures to be designed **with an allowance for climate change**. This provides a robust and sustainable approach to the potential impacts that climate change may have upon the Borough over the next 100 years, ensuring that future development is considered in light of the possible increases in flood risk over time.

Lifetime of development

190. It is essential that developers consider the possible change in flood risk over **the lifetime of the development** as a result of climate change. The likely increase in flow and/or tide level over the lifetime of the development should be assessed proportionally to government guidance as outlined above. The lifetime of residential developments should be considered for a minimum of 100 years unless there is specific justification for considering a shorter period. The lifetime of non- residential developments 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.

191. It is important to remember that the potential impacts of climate change will affect not only the risk of flooding posed to property as a result of river and/or tidal flooding, but it will also potentially increase the frequency and intensity of localised storms over the Borough as well as affect groundwater levels. This may exacerbate localised drainage problems, and it is essential therefore that the detailed FRA considers the potential impacts of climate change upon localised flood risks, as well as the risks of river related flooding.

6.9 Residual Risk of Flooding

192. It is essential that the risk of flooding is minimised over the lifetime of the development in all instances. It is important to recognise that flood risk can never be fully mitigated and there will always be a residual risk of flooding.

193. This residual risk is associated with a number of potential risk factors including (but not limited to):

- a flooding event that exceeds that for which the local drainage system has been designed
- the residual danger posed to property and life as a result of flood defence failure or exceedance
- general uncertainties inherent in the prediction of flooding
- reservoir failure

194. **A flooding event that exceeds that for which the local drainage system has been designed**: Local drainage systems within the UK must be designed so that, unless an area is designated to hold/or convey water as part of the design, flooding does not occur on any part of the site for a 3.33% chance in any one year rainfall event. Therefore flooding events occurring from events greater than the 3.33% chance in any one year must be suitably managed and incorporated within the design of development sites.

195. **The residual danger posed to property and life as a result of flood defence failure or exceedance:** Breaching of a defence is where the defence fails and collapses leaving a passage for water to flow to protected zones. Defence breaching is a residual risk that should be considered and assessed wherever possible. Breach modelling has been conducted along the River Thames by the Environment Agency and is presented in Figure C *(Note: Please*

contact the Environment Agency for further updates on breach modelling). An event (tidal or rainfall related) could occur that exceeds the design standard of the defences and overtop them.

196. **General uncertainties inherent in the prediction of flooding:** The modelling of flood flows and flood levels is not an exact science. There are inherent uncertainties in the prediction of flood levels used in the assessment of flood risk. Whilst the NPPF flood zones provide a robust depiction of flood risk for specific conditions, all modelling requires the making of core assumptions and the use of empirical estimations relating to (for example) rainfall distribution and catchment response. Taking a conservative approach for planning purposes, the Environment Agency advises that finished floor levels are raised to at least 300mm above the peak design **fluvial** flood level (including an appropriate allowance for climate change). This allowance only applies to **fluvial** flood levels – the revised TE2100 **tidal** flood levels include an allowance for modelling uncertainty and do not require the freeboard to be added. For areas that experience fluvial and tidal flooding, the more conservative of the two levels should be used and freeboard applied if appropriate.

197. **Reservoir failure:** Flood risk posed by reservoir or dam failure is a lesser known source of flooding which is often overlooked. The catastrophic behaviour of reservoir/dam failure can lead large volumes of water released at high velocities. At present, the Flood and Water Management Act 2010 gives responsibility to the Environment Agency to determine large reservoirs in England and Wales which are 'high risk'. Large reservoirs are those holding 25,000m3 of water, equivalent to 10 Olympic swimming pools. The Environment Agency has mapped the potential flood extent resulting from reservoir failure and this can be found on their website.

7 Sustainable Management of Flood Risk

7.1 Overview

198. An ability to demonstrate 'sustainability' is a primary government objective for future development within the UK. The definition of 'sustainability' encompasses a number of important issues ranging broadly from the environment (minimising the impact upon the natural environment), energy consumption (seeking alternative sources of energy to avoid the depletion of natural resources) and it can also include social and economic concerns. Of particular importance is sustainable development within flood affected areas.

199. Recent history has shown the devastating impacts that flooding can have on lives, homes and businesses. A considerable number of people live and work within areas that are susceptible to flooding, and ideally development should be moved away from these areas over time. It is recognised however that this is often not a practical solution. For this reason, careful consideration must be taken of the measures that can be put into place to minimise the risk to property and life posed by flooding. These should address the flood risk not only in the short term, but throughout the lifetime of the proposed development. This is a requirement of the NPPF.

200. The primary purpose of the SFRA is to inform decision making as part of the planning and development control process, taking due consideration of the scale and nature of flood risk affecting the Borough. Responsibility for flood risk management resides with all tiers of government, and indeed individual landowners, as outlined below.

7.2 Responsibility for Flood Risk Management

201. There is no statutory requirement for the Government to protect property against the risk of flooding. Notwithstanding this however, the Government recognise the importance of safeguarding the wider community, and in doing so the economic and social wellbeing of the nation. An overview of key responsibilities with respect to flood risk management is provided below:

- The Mayor of London, should consider flood risk when reviewing strategic planning decisions including (for example) the provision of future housing and transport infrastructure.

- The Environment Agency has a statutory responsibility for flood management and defence in England. It assists the planning and development control process through the provision of information and advice regarding flood risk and flooding related issues.

- Lead Local Flood Authorities[27], such as the London Borough of Richmond upon Thames, have a duty to manage surface water and ground water flooding, as well as flooding associated with ordinary watercourses (non-Main Rivers).

- The Local Planning Authority is responsible for carrying out a Strategic Flood Risk Assessment. The SFRA should consider the risk of flooding throughout the Borough and should inform the allocation of land for future development, development control policies and sustainability appraisals. Local Planning Authorities have a responsibility to consult with the Environment Agency when making planning decisions.

- Landowners & Developers[28] have the primary responsibility for protecting their land and property against the risk of flooding. They are also responsible for managing the drainage of their land so that they do not adversely impact upon adjoining properties.

[27] Lead Local Flood Authority as defined in "Flood and Water Management Act (2010)"
[28] Referred to also as 'landowners' within NPPF

202. The Environment Agency has developed a guide entitled "Living on the Edge" that provides specific advice regarding the rights and responsibilities of property owners, the Environment Agency and other bodies. The guide is targeted at owners of land situated alongside rivers or other watercourses, and is a useful reference point outlining who is responsible for flood defence, and what this means in practical terms. It also discusses how stakeholders can work collaboratively to protect and enhance the natural environment of our rivers and streams. This guide can be found on the Environment Agency's website at www.environment-agency.gov.uk.

7.3 Strategic Flood Risk Management - The Environment Agency

7.3.1 Overview

203. The Environment Agency (EA) has a strategic approach to flood risk management. The assessment and management of flood risk is carried out on a 'whole of catchment' basis. This enables the Environment Agency to review the impact that proposed defence works at a particular location may have upon flooding at other locations throughout the catchment.

204. A number of flood risk management strategies have either been adopted or are underway within the region, encompassing many of the large river systems that influence flood risk within the London Borough of Richmond upon Thames. A brief overview of these investigations is provided below.

7.3.2 Thames Catchment Flood Management Plan (CFMP)

205. The flood risk regime within the London Borough of Richmond upon Thames is heavily influenced by the River Thames. The Thames system is under careful consideration by the Environment Agency, and resources are currently being targeted at a strategic level to ensuring that the nature and severity of flood risk throughout the wider greater London area is broadly understood. This will enable the Environment Agency, responsible for the future management of flood risk within the area, to target future activities in a cost effective and sustainable manner.

206. The Thames Catchment Flood Management Plan (CFMP) gives an overview of the flood risk across the river catchment. It recommends ways of managing those risks now and over the next 50-100 years. The CFMP considers all types of inland flooding, from rivers, ground water and surface water. It also takes into account the likely impacts of climate change, the effects of how land is used and managed, and how areas could be developed to meet the present day needs without compromising the ability of future generations to meet their own needs. A CFMP is used to help the Environment Agency and its partners plan and agree the most effective way to manage flood risk in the future.

207. The Environment Agency has published in December 2009 the Thames Catchment Flood Management Plan (CFMP), which sets out the Environment Agency's preferred plan for sustainable flood risk management over the next 50 to 100 years and covers the fluvial and non-tidal part of the Thames region.

208. The main regional level findings are that catchment wide storage is not the answer, there are some opportunities for local storage giving local benefit but limited opportunities for the implementation of new defences and development and planning are going to be key in the future. The Thames region is divided into 43 geographical areas called policy units, of which the Lower Thames, Crane and Beverley Brook policy units are of relevance to the London Borough of Richmond upon Thames.

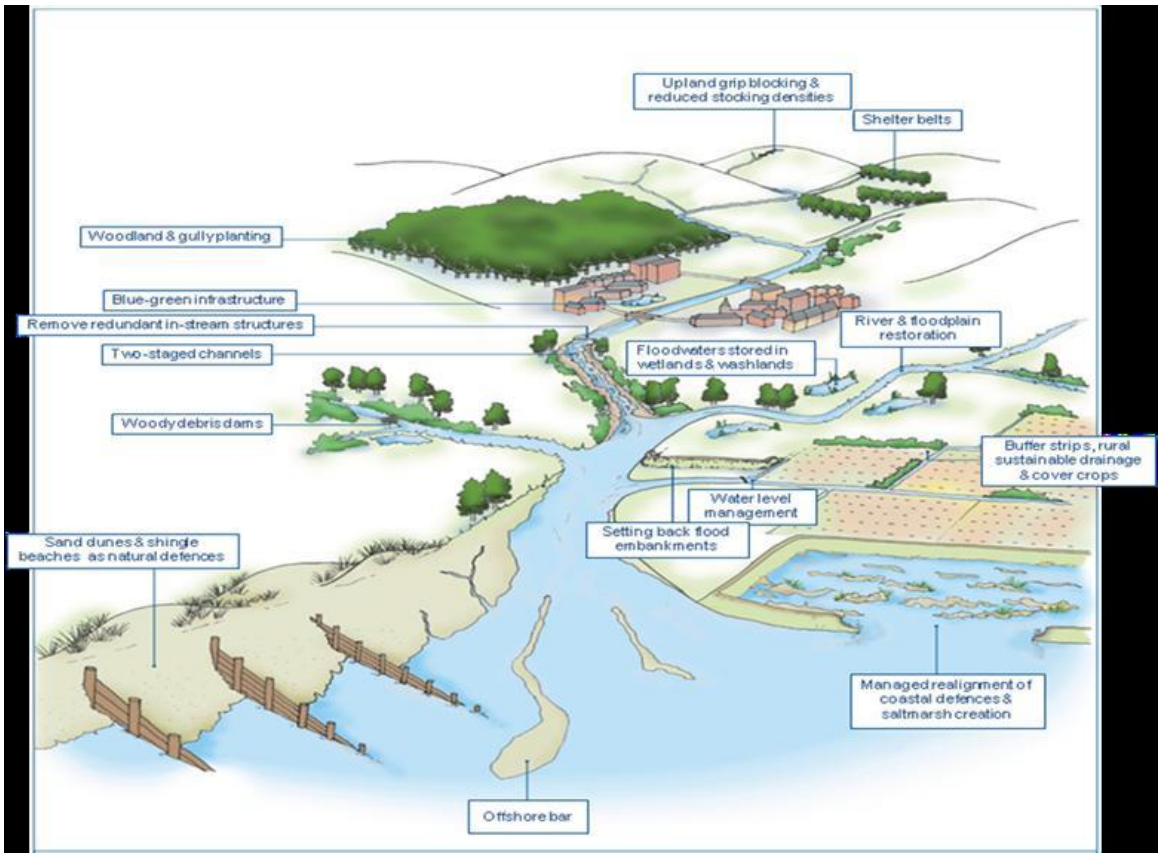
209. The Lower Thames unit is characterised as generally urban areas with no major river flood defences and the main policy for this unit is to reduce the risk - lower the probability of exposure to flooding and/or the magnitude of the consequences of a flood.

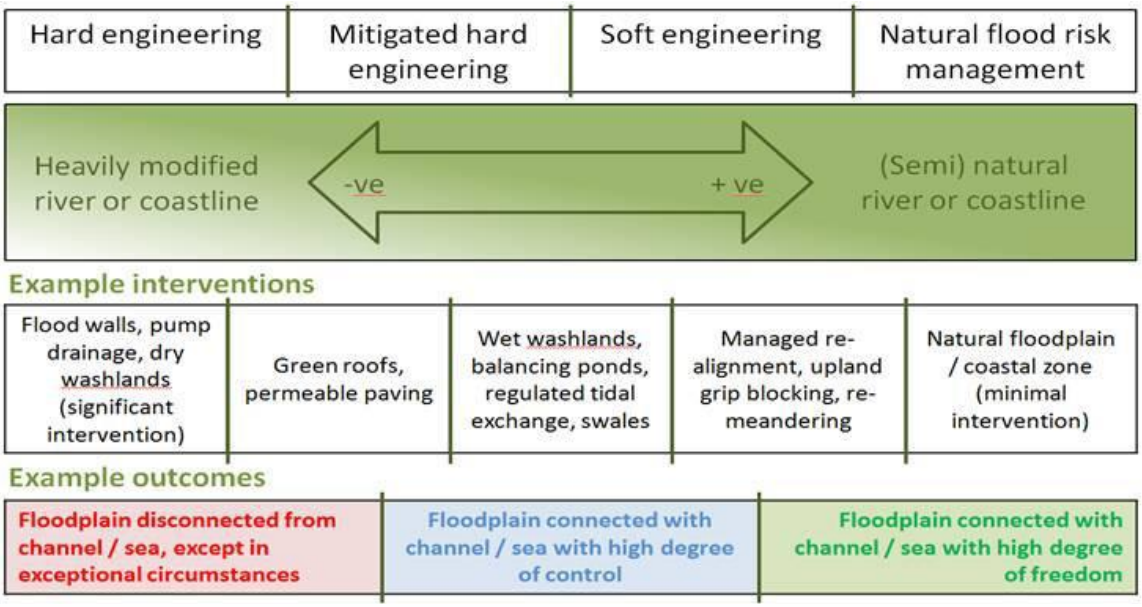
210. The River Crane is characterised as a developed floodplain with little open space and often with concrete channels, where the policy is to accept the risk, but in the longer term take action to ensure that risk does not increase from the current level.

211. The Beverley Brook unit's key characteristic is a highly developed floodplain with little open space and modified river channels, for which the policy is to take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).

212. In summary, the Thames CFMP seeks a sustainable 'planning' led solution to flood risk management within the Greater London area. The CFMP encourages local authorities (and indeed developers) to strive for a positive reduction in flood risk through future development and regeneration. This is striving to ensure that collectively decisions taken not only avoid the creation of a future legacy of new development at risk of flooding, but also progressively reduces the risk of flooding to existing development. This is a key objective of the NPPF. The Borough has endorsed the Thames CFMP in its Core Strategy and the principles and key messages are also reflected in this SFRA.

213. The Environment Agency has produced guidance on the importance of using a mixture of flood risk management techniques and importance of working across boundaries and the catchment to manage flood risk. The diagrams below show a wide range of flood risk management techniques from hard engineering to natural flood risk management. Key techniques relevant to LBRuT include: Green infrastructure, making space for water, river restoration, tidal terracing and set back flood defences.





7.3.3 River Thames Scheme: Datchet to Teddington

214. The River Thames Scheme is a flood risk management strategy for the Lower Thames. It is being actioned as the Environment Agency's preferred option for managing the risk of flooding for the area. Works include large scale flood diversion channels, improvements to weir structures, widening of the Desborough Cut and implementation of floodplain management options. These aim to substantially reduce the risk of flooding from the river for about 5,100 properties within the study area. It will result in 7,200 properties being taken out of the 1% chance in any one year flood risk area. To manage the flood risk most effectively, the study area for the strategy has been divided in two sections: from Datchet to Walton Bridge (Reach 3) and from Walton Bridge to Teddington (Reach 4).

215. The Strategy's recommended approach is:

- Large-scale flood diversion channel works in the Reach 3 area to alleviate flooding
- Improvements to weirs at Sunbury, Molesey and Teddington
- Floodplain management measures in Reach 3 and Reach 4
- Widening of the Desborough Cut to accept higher flood flows

216. Floodplain management in Reach 3 and 4 includes the following:

- Increasing public awareness of flooding, including encouraging the uptake of Floodline Warnings Direct
- Continue to work in partnership with local authorities and other public bodies to improve flood mapping, develop emergency plans, local flood action plans
- Working through policy and planning and encouraging increased flood storage in upstream tributaries
- Community based measures, which may include providing financial support for individual and community based flood prevention initiatives. These would include the use of demountable and temporary defences, and flood resistance schemes for individual and groups of properties. Protection of small groups of properties, particularly between Walton Bridge and Teddington. Protecting individual properties is most suitable in Reach 4
- Floodplain management tools, which consist of interactive flood mapping tools, working with local planning authorities, new procedures to guide and promote sustainable development, and effective community evacuation plans
- Working with local authorities to safeguard flood flow routes. Other approaches would include continuing to control development in areas that are prone to flooding
- The Thames Barrier can be operated to mitigate flood impacts in the downstream parts of Reach 4. The Environment Agency would look to promote its operation to provide benefits whenever this proves to be possible. However, because the Thames Barrier's

legal purpose is to protect against tidal flooding, it is likely that the availability of the Thames Barrier to alleviate for fluvial flooding will get less over the next 25 years, as the sea level continues to rise.

217. Engineering works in Reach 4, which also contains LBRuT:

- The study shows that the Environment Agency would need to do some works to the river through Reach 4 to maintain the flows at their current level to prevent any increase in flooding, and the proposals would also reduce flood risk for most people in Reach 4
- Modifying weirs: this would involve increasing the capacity of Sunbury, Molesey and Teddington weirs to convey water during a flood
- Widening of Desborough Cut
- Local defences: this would protect localised areas such as those around Teddington Studios but this approach is ruled out in visually sensitive locations such as around Hampton Court Palace

218. It is important to emphasise that the intention of the study is not to reduce flood risk in order to make way for future development. It is also unlikely that the physical management measures identified will be in operation within foreseeable planning timeframes.

219. For this reason, the SFRA has not taken the potential flood risk reduction measures in account in this instance. Within future planning horizons however, the revision of the SFRA should review the status of schemes recommended as an outcome of the Lower Thames Strategy, and consider the potential impact that these may have had upon flood risk within the Borough.

7.3.4 Thames 2100 Plan (TE2100)

220. The Environment Agency's Thames Estuary 2100 (TE2100) project has developed a strategic plan for managing flood risk in the River Thames estuary to the year 2100. It covers the areas bordering the River Thames from the estuary upstream to Teddington Lock (Richmond upon Thames) where the tidal influence ends.

221. The Thames Estuary 2100 (TE2100) Plan covers the long-term flood management policies for the tidal part of the River Thames. The TE2100 Plan is a multi-agency action plan that demonstrates how flood risk can be managed in the Thames Estuary over this century in response to a changing climate, a changing Estuary and ageing flood defences.

222. The Plan identified proposals and actions for 8 action zones. Action zone 1 (West London) is divided into 4 policy units, of which 3 are within LBRuT: **(1) Richmond, (2) Twickenham and (3) Barnes & Kew**.

223. The recommended flood risk management policy (P3) for **(1) Richmond and (2) Twickenham** is to continue with existing or alternative actions to manage and maintain flood risk at the current level, accepting that flood risk will increase over time. The key issue in these areas is the risk of fluvial flooding, which is currently mitigated by closing the Thames Barrier. However, the use of the Barrier for this purpose will be significantly reduced in the future to conserve the barrier for tidal flood risk management. This means vulnerable areas such as undefended islands will have to rely upon floodplain management measures such as flood proofing of properties, increased reliance on flood warning and community flood management strategies, special design arrangements for single story and basement properties, safe access and egress routes, with localised defences to protect specific properties where this can be justified. The Thames Landscape Strategy proposal for making space for water through the restoration of the Ham Lands would also play a part in the Plan.

224. For the **(3) Barnes & Kew** policy unit, the recommended flood risk management policy (P5) is to take further action to reduce flood risk beyond that required to keep pace with climate change. The local issue is that defence raising may not be acceptable in all areas and an alternative approach would be a combination of local secondary defences and floodplain management to reduce the impact of flooding to existing properties and other assets.

225. In summary, TE2100 means for LBRuT the following:

- areas of unprotected floodplain in Richmond will flood more frequently as water levels rise
- the Thames Barrier will continue to provide tidal flood protection to the same high standard as the rest of London, but over the next 25 years there needs to be new ways of managing fluvial flooding other than operating the Thames Barrier
- space for water and the shape and space for maintenance and renewal of flood management assets will need to be identified and spatial and emergency planning will have an increasing role in managing and reducing flood risk.

7.4 Planning & Development Control – Richmond upon Thames

7.4.1 Sequential and Exception Tests – Fluvial and Tidal Flooding

226. The risk of flooding is most effectively addressed through *avoidance*, which in very simple terms equates to guiding future development (and regeneration) away from areas at risk. Development that is sustainable for future generations is imperative, and it is widely recognised that the risk of flooding cannot be considered in isolation. There are many tests and measures of 'sustainability' that must be weighed in the balance when locating and designing future development.

227. The NPPG endeavours to guide Local Planning Authorities in this decision making process, and the Sequential and Exception tests underpin the method by which flood risk should be taken into consideration as part of the planning process. The application of these tests within the London Borough of Richmond upon Thames (by the Borough) is outlined below.

The Sequential Test

228. Historically urbanisation has evolved along river corridors, the rivers providing a critical source of water, food and energy. This leaves many areas of England with a legacy of key urban centres that, due largely to their close proximity to rivers, are at risk of flooding.

Applying the Sequential Test at the local planning level

229. The ideal solution to effective and sustainable flood risk management is a planning led one, i.e. steer urban development away from areas that are susceptible to flooding. The NPPF advocates a sequential approach that will guide the planning decision making process (i.e. the allocation of sites). In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the initial instance. **Only if it can be demonstrated that there are no suitable sites within these areas should alternative sites (i.e. within areas that may potentially be at risk of flooding) be contemplated.** This sequential approach is referred to as The Sequential Test, and the application of the Sequential Test at the local level for the Local Plan preparation (i.e. the Site Allocations DPD) is summarised in Diagram 2 of the NPPG.

It is absolutely imperative to highlight that the SFRA does not attempt, and indeed cannot, fully address the requirements of the NPPG Sequential Test. It is necessary for the Borough to demonstrate that sites for future development have been sought within the lowest flood risk zone (i.e. Zone 1 Low Probability). Only if it can be shown that suitable sites are not available within this zone can alternative sites be considered within the areas that are at greater risk of possible flooding (i.e. Zone 2, and finally Zone 3).

Applying the Sequential Test for individual planning applications

230. The Borough must restrict development to the permissible land uses summarised in NPPG Table 2: Flood Risk Vulnerability Classification. This may involve seeking opportunities to 'swap' more vulnerable allocations at risk of flooding with areas of lesser vulnerability that are situated on higher ground.

231. Many properties of the Borough are located in and around town centres. Relocating development from and around these centres (400m is considered to be walking distance from the town centres) is not a realistic option and in order to sustain the continuing role of these centres, development can be used as a way to help manage and reduce flood risk in these areas. Therefore, for the London Borough of Richmond upon Thames, the following local sequential test approach, which has been agreed with the Environment Agency, is applied:

232. Future development in Zone 3a and Zone 2 will only be considered if there has been a Sequential Test applied in accordance with NPPF and guidance contained within any subsequent SPD, however there will be some exceptions to this. The Sequential Test will not be required if it is not a major development[29] and at least one of the following applies:

- It is a LDF proposal site that has already been sequentially tested, unless the use of the site being proposed is not in accordance with the allocations in the LDF
- It is within a town centre boundary[30] as identified within the LDF (Richmond, Twickenham, Teddington, Whitton and East Sheen) (see Annex G for town centre boundaries)
- It is for residential development or a mixed use scheme and within the 400m buffer area identified within the LDF surrounding the town centres referred to above (see Annex G for town centre boundaries including the 400m buffer area)
- It is for the redevelopment of an existing single residential property
- It is for a conversion or change of use

The Sequential Test will be required in all other cases. See Appendix G for a map of the draft town centre boundaries and their 400m buffer area.

233. It is important to recognise that the principles of the sequential approach are applicable throughout the planning cycle, and refer equally to the forward planning process (delivered by the Local Planning Authority as part of the Local Plan), to the determination of applications for development, to the assessment of windfall sites and to locating development within a site. Where windfall sites come forward for consideration, and the above local Sequential Test approach does not apply, it is essential for the developer to consider the planning 'need' for the proposed site (adopting a sequential approach in accordance with NPPG). The Borough will assist where possible with supporting information. The detailed FRA will be required to demonstrate the careful and measured consideration of whether indeed there is an alternative site available within an area of lesser flood risk, in accordance with the NPPG Sequential Test.

The Exception Test

234. It is recognised that a relatively large area of the London Borough of Richmond upon Thames is situated within Zone 3a High Probability and Zone 2 Medium Probability. Prohibiting future residential development in these areas is likely to have a detrimental impact upon the economic and social welfare of the existing community. Within these areas (i.e. areas in which the Sequential Test cannot be met due to other pressing planning considerations), the Borough and potential future developers are required to work through the **Exception Test** (NPPG) where applicable. NPPG Table 3 Flood Risk Vulnerability and Flood Zone 'Compatibility' sets out which types of developments requires the Exception Test.

235. For the Exception Test to be passed:

[29] Major development as defined in NPPF:
"Major development is defined in The Town and Country Planning (Flooding) (England) Direction 2007 as:
(a) in respect of residential development, a development where the number of dwellings to be provided is 10 or more, or the site area is 0.5 hectares or more; or
(b) in respect of non-residential development, a development where the new floor space to be provided is 1,000 square metres or more, or the site area is 1 hectare or more"

[30] Town centre boundaries as identified within the LDF (DM DPD)

a) *"It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared*[31]*.;*

b) *the development should be on developable*[32]*, previously developed land or if it is not on previously developed land*[33]*, that there are no reasonable alternative sites on previously-developed land; and*

c) *a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*

236. The first two points set out in the Exception Test are planning considerations that must be adequately addressed. A planning solution to removing flood risk must be sought at each specific location in the initial instance, seeking to relocate the proposed allocation to an area of lower flood risk (i.e. Zone 1 Low Probability or Zone 2 Medium Probability) wherever feasible.

237. The LBRuT SFRA has been developed to inform the Sequential Test. It will be the responsibility of the Borough to carry out the Sequential Test on the basis of this information, allocating potential sites for future development accordingly (i.e. in the Site Allocations DPD). Furthermore, the developer will be required to demonstrate within the detailed Flood Risk Assessment that the Sequential Test has been applied, and, where applicable, that the risk of flooding has been adequately addressed in accordance with the NPPF.

238. The management of flood risk throughout the Borough must be assured should development be permitted to proceed, addressing the third critical element of the Exception Test. The SFRA has provided specific recommendations that ultimately should be adopted as design features, with evidence provided of how they will be fulfilled prior to permission being granted for all future development. It is the responsibility of the prospective developer to build upon these recommendations as part of a detailed Flood Risk Assessment to ensure that the specific requirements of the NPPF can be met.

239. An overview of flood risk throughout the Borough has been provided in Section 6 and the adjoining flood risk maps. **Future planning decisions should consider the spatial variation in flood risk across the Borough, as defined by the delineated flood zone that applies at the specified site location, and apply the recommendations provided below in 7.4.6 accordingly.** It is reiterated that the NPPF applies equally to allocated sites identified within the LDF, emerging Site Allocations DPD and future windfall sites.

7.4.2 Planning Recommendations - Other Sources of Flooding

240. Other than tidal and fluvial flooding sources, the NPPF identifies reservoirs, surface water, ordinary watercourses, groundwater and sewer flooding as 'other' sources. This section outlines planning recommendations for each of these sources.

Sewer Flooding

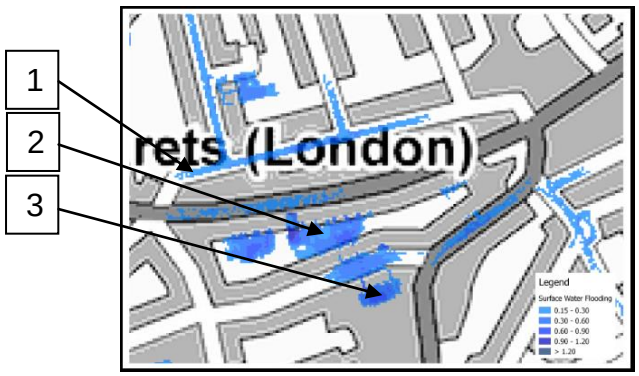
241. Sewer flooding is spatially highly unpredictable, hence there is not enough validation to prevent future developments based on historic artificial flood records. However, planning applications must ensure that the sewer capacity is supportive of any new developments. If not, other sustainable measures must be incorporated into the drainage design of the planning application.

242. *Recommendation:* Developers should liaise with Thames Water to discuss the sewer capacity and request permission to connect to the sewer system.

[31] If the DPD has reached the 'submission' stage, the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal
[32] Developable sites as defined in NPPG (Housing)
[33] Previously-developed land definition (commonly known as Brownfield Land). See NPPG (Housing)

Surface Water and Ordinary Watercourse Flooding

243. The surface water flooding maps (Figure G) show a highly scattered variability of surface water. Due to this LBRuT will request a site-specific Flood Risk Assessment (FRA) from developers on a case by case basis. As a rule of thumb, sites which have been identified within the mapping to show particular risk will require an FRA to be completed. Furthermore, if previous flooding relating to surface water has occurred within the area then an FRA may be requested. Historic flooding records can be found within Richmond's Preliminary Flood Risk Assessment, Surface Water Management Plan and Local Flood Risk Management Strategy. The diagram below identifies examples where an FRA may be required in relation to surface water flood risk:



1: Development surrounding the road would not require a FRA as the predicted surface water flooding is generally confined to the road footprint.

2: Development would require an FRA. The area shows a significant potential for surface water flooding

3: Redevelopment of property within this area would require an FRA to be conducted. The surface water flood map shows potential flooding both on the road surface and the adjacent area. This suggests a topographically lower elevation creating ponding.

244. *Recommendation:* Site specific FRAs will be requested on a case by case basis. However, if the development is located within an area identified at risk of surface water flooding or has had previous surface water flooding the likelihood of an FRA request will increase.

Groundwater Flooding

245. Groundwater flooding susceptibility has been assessed as part of this SFRA and is shown in Figure E. The figure shows that large areas of the Borough are susceptible to groundwater flooding – particularly with regard to basement development.

246. *Recommendation*: All FRAs must consider groundwater flood risk and propose appropriate mitigation measures where there is potential for groundwater flooding.

Reservoir Flooding

247. The failure of a reservoir has the potential to cause large scale damage due to the release of large volumes of water, however, the probability of this occurring is extremely low. The EA's Risk of Flooding from Reservoirs map (http://maps.environment-agency.gov.uk) shows the maximum extent of flooding should a large reservoir fail. The Richmond area is potentially at risk of flooding from more than ten reservoirs in the immediate area.

248. *Recommendation:* Planning applications should consider the risk of reservoir failure where the development location is identified to be potentially at risk of flooding from reservoirs.

7.4.3 Planning Recommendations – Residual Risk

249. Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include failure of flood management infrastructure and severe flood events that exceed a flood management design standard. Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep water flooding, with little or no warning if defences are overtopped or breached.

250. The Environment Agency has provided comments with respect to breach modelling and development within flood zones. There is a low probability that the flood defences supporting the Thames River could be breached assuming the Thames Estuary 2100 strategy is implemented. The Environment Agency has suggested within Flood Zone 3a that the following development recommendations could apply (also refer Figure C for the location of modelled breach locations and associated predicted tidal breach flood hazard extent from each):

- if a developer wishes to build outside of the predicted breach hazard extent within Flood Zone 3a, development may be suitable so long as the development conforms to Policy DM SD 6 Flood Risk within the London Borough of Richmond upon Thames adopted Development Management Plan (see Section 4.4.2). Basement development may be permitted so long as suitable emergency plans and escape routes are implemented.
- if a developer wishes to build within a predicted breach hazard extent and lies within Flood Zone 3a, development may be suitable so long as the development conforms to Policy DM SD 6 Flood Risk within the London Borough of Richmond upon Thames adopted Development Management Plan (see section 4.4.2). Basement building for residential use is generally not allowed due to the increased residual risk brought upon by defence failure.

251. *Recommendation:* Planning applications must accommodate the Spatial Planning and Development Control Recommendations made in Section 7.4.6.

7.4.4 A Proactive Approach – Positive Reduction of Flood Risk through Development

252. It is crucial to reiterate that the NPPF considers not only the risk of flooding posed to new development. It also seeks to positively reduce the risk of flooding posed to existing properties within the Borough. It is strongly recommended that this principle be adopted as the underlying 'goal' for developers and the Borough's development control team within LBRuT.

253. Developers should be encouraged to demonstrate that their proposal will deliver a positive reduction in flood risk to the Borough, whether that be by reducing the frequency or severity of flooding (for example, through the introduction of SuDS), or by reducing the impact that flooding may have on the community (for example, through a reduction in the number of people within the site that may be at risk). This should not be seen as an onerous requirement, and if integrated into the design at the conceptual stage, will place no added demands upon the development and/or planning application process.

254. Possible risk reduction measures for consideration may include the following:

- The integration of SUDS to reduce the runoff rate from the site;
- A change in land use to reduce the vulnerability of the proposed development;
- A reduction in the building footprint;
- The raising of internal floor levels and improving flood resilience (within existing buildings) to reduce potential flood damage;
- The rearrangement of buildings within the site to remove obstructions to overland flow paths;
- The placement of buildings to higher areas within the site to limit the risk of flood damage.

255. It is recommended that a clear statement is requested within each detailed FRA that concisely summarises how a reduction in flood risk has been achieved within the proposed (re)development. This may be specified as (for example) a reduction in flow from the site, a reduction in water levels within (or adjacent to) the site, or a reduction in the consequences of flooding (i.e. reducing vulnerability and number of people at risk).

7.4.5 Localised Flood Risk within the Planning Process

256. The NPPF advocates the application of a sequential approach when allocating land, taking into consideration *all* sources of flooding. The local drainage related problems identified within the LBRuT SFRA are generally localised and relate to historical incidents, the source of which is often somewhat uncertain. It is important to recognise therefore that these are not a measure of 'risk', but rather problems that have occurred due to a particular set of local circumstances in the past. These may or may not reoccur in future years.

257. From a spatial planning perspective, it is considered unreasonable to completely restrict future development within areas that may have suffered a localised flooding incident in years past. Whilst the incidents that have been identified will typically not result in widespread damage or disruption, a proactive approach to risk reduction through design can mitigate the potential for damage, both to the development itself and elsewhere. Therefore, all developments, including extensions, conversions and change of use, should also consider localised flood risk, such as surface water or groundwater flooding. A Flood Risk Assessment is required for smaller development proposals in Flood Zone 1, where there is evidence of a risk from other sources of flooding identified in this SFRA. Specific development control recommendations in Section 7.4.6 have been provided accordingly.

7.4.6 Spatial Planning and Development Control Recommendations

Policy Response	NPPF Flood Zone								
	Zone 3b Functional Floodplain (Tidal & Fluvial)		Zone 3a High Probability *(where combined fluvial / tidal hazard exists, the more conservative recommendations of the two sources should be applied)*						Zone 2 Medium Probability	Zone 1 Low Probability
			TIDAL BREACH FLOOD HAZARD - Defended Only *(Refer Figures C-1 to C-3)*			FLUVIAL FLOOD HAZARD *(Refer Figures C-4 to C-10)*				
	Developed	Undeveloped	Defence Breach 'Extreme & Significant Hazard'	Defence Breach 'Moderate Hazard'	Defence Breach 'Low Hazard' or 'No Hazard'	Undefended 'Extreme & Significant Hazard'	Undefended 'Moderate Hazard'	Defended + Undefended with 'Low Hazard' or 'No Hazard'		
SPATIAL PLANNING RECOMMENDATIONS										
Important Considerations	Within Zone 3b Functional Floodplain, 'developed land' relates solely to existing buildings that are impermeable to flood water. The undeveloped land surrounding these buildings are important flow paths and/or flood storage areas.	The undeveloped Functional Floodplain should be protected by not permitted any form of development unless it is for water-compatible development or essential utility infrastructure. Future development within Zone 3b Functional Floodplain can only be considered following application of the Sequential Test and the Exception Test	Future development within Zone 3a High Probability can only be considered following application of the Sequential Test			Future development within Zone 3a High Probability can only be considered following application of the Sequential Test			Future development within Zone 2 Medium Probability can only be considered following application of the Sequential Test	It is important to recognise that sites within Zone 1 may be susceptible to flooding from other sources. Development may contribute to an increase in flood risk elsewhere if not carefully mitigated
	Property within Zone 3b Functional Floodplain will be subject to frequent flooding with a probability of more than 5% in any year. There are clear sustainability implications to be considered in this regard, and it is highly questionable whether insurance against flooding related damages will be available in the longer term.								Areas of Zone 2 and Zone 1 that may be surrounded by flooding in case of a tidal defence breach must ensure site specific emergency evacuation procedures are in place to ensure that the risk to life is minimised should a flood occur. Coordination with the emergency services will be required in the event of a flooding emergency	
Land Use (refer NPPG Table 2)	Redevelopment should only be supported if there is a net flood risk reduction. Change of use or conversion to a use with a higher vulnerability should not be permitted.	Water Compatible Development and Essential Infrastructure	Land use should be restricted to Water Compatible or Less Vulnerable development. More or Highly Vulnerable development may only be considered if Exception Test can be passed			Land use should be restricted to Water Compatible or Less Vulnerable development. More or Highly Vulnerable development may only be considered if Exception Test can be passed			Land use should be restricted to Water Compatible, Less Vulnerable or More Vulnerable development. Highly Vulnerable development may only be considered if Exception Test can be passed	No restrictions
DEVELOPMENT CONTROL RECOMMENDATIONS										
Detailed Flood Risk Assessment (FRA)	Required	Required	Required			Required			Required	Required for all sites greater than 1ha. Required for all developments if there is evidence of flood risk from other sources.
Ground Floor Level	Ground floor levels should be situated above the 1% chance in any one year plus climate change fluvial flood level plus an appropriate freeboard allowance defined in accordance Section 7.6.2. Ground floor levels should be situated above the Thames 2100 Year 2100 tidal flood level.	N/A	Ground floor levels should be situated above the Thames 2100 Year 2100 tidal flood level.		Flood resiliant design techniques should be adopted to mitigate the potential damage to property in case of flooding. Further guidance is provided in the NPPG	Ground floor levels should be situated above the 1% chance in any one year plus climate change fluvial flood level plus an appropriate freeboard allowance defined in accordance Section 7.6.2.			Flood resiliant design techniques should be adopted to mitigate the potential damage to property in case of flooding. Further guidance is provided in the NPPG	Ground floor levels should be set to ensure no flooding of buildings occurs during the 1 % chance in any one year surface water flood event (generally 100 to 150mm above surrounding ground levels)
Site Access & Egress **(Refer SFRA Appendix E)**	For residential property, dry access is to be provided above the 1% chance in any one year fluvial flood level (including climate change) or year 2100 (from the TE2100 study) tidal flood level (whichever is greater). For non-residential property, access must be 'safe' in accordance with Defra "Flood Risk to People" (FD2320 & FD2321)	N/A	For residential property, dry access is to be provided above the year 2100 (from the TE2100 study) tidal flood level. For non-residential property, access must be 'safe' in accordance with Defra "Flood Risk to People" (FD2320 & FD2321). A dedicated 'safe haven' should be provided above the year 2100 (from the TE2100 study) flood level enable rapid escape should a failure of the defences occur. This may be provided in the form of a sheltered communal space within the building, accessed via internal stairs. It will be necessary to ensure that the safe haven is sufficient in size to safely accomodate all residents / site users.	It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event	For residential property, dry access must be provided above the 1% chance in any one year fluvial (including climate change) flood level. For non-residential property, access must be 'safe' in accordance with Defra "Flood Risk to People" (FD2320 & FD2321). A dedicated 'safe haven' should be provided with appropriate freeboard (Refer Section 7.6.2) above the 1% chance in any year (including climate change) flood level to enable rapid escape should a failure of the defences occur. This may be provided in the form of a sheltered communal space within the building, accessed via internal stairs. It will be necessary to ensure that the safe haven is sufficient in size to safely accomodate all residents / site users.	It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event	It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event	No minimum level stipulated by NPPG
Basements	No basements are permitted within Zone 3b The Functional Floodplain	N/A	New basement development and extensions, conversions or additions to existing basements restricted to Less Vulnerable / Water Compatible uses only. New basement development and extensions, conversions or additions to existing basements will not be permitted for More Vulnerable / Highly Vulnerable uses. Must have internal access that above the year 2100 (from the TE2100 study) tidal flood level assuming a breach of the River Thames defences. Flood resiliant design techniques must be adopted, as stated in the NPPG.	After passing the Exception Test (where applicable) - New basements and extensions, conversions or additions to existing basements may be permitted for residential use where they are not self-contained or used as bedrooms. Must have internal access that above the year 2100 (from the TE2100 study) tidal flood level assuming a breach of the River Thames defences. Flood resiliant design techniques must be adopted, as stated in the NPPG.	New basement development and extensions, conversions or additions to existing basements restricted to Less Vulnerable / Water Compatible uses only. New basement development and extensions, conversions or additions to existing basements will not be permitted for More Vulnerable / Highly Vulnerable uses. Must have internal access with an appropriate allowance for freeboard (refer Section 7.6.2) above the 1% chance in any one year (including climate change) fluvial flood level. Flood resiliant design techniques must be adopted, as stated in the NPPG.	After passing the Exception Test (where applicable) - New basements and extensions, conversions or additions to existing basements may be permitted for residential use where they are not self-contained or used as bedrooms. Must have internal access with an appropriate allowance for freeboad (refer Section 7.6.2) above the 1% chance any one year (including climate change) fluvial flood level. Flood resiliant design techniques must be adopted, as stated in the NPPG.	As for Tidal / Fluvial 'Low Hazard' or 'No Hazard' in Flood Zone 3a - the more conservative tidal / fluvial flood level shall apply for setting the internal access level.	Ground floor and / or access levels should be set to ensure no flooding of basements occur during the 1% chance any one year surface water flood event (generally 100 to 150mm above surrounding ground levels)
Site Runoff	Implement SuDS to ensure that runoff from the site (post redevelopment), as a minimum, is not increased. A reduction in site runoff should be sought, aiming to achieve greenfield run-off rates, or reduce run-off rates by at least 50% over current levels. Any SuDS design must take due account of groundwater and geological conditions. Infiltration techniques (including, for example, soakaways) are unlikely to be effective within areas overlying London Clay.									
Buffer Zone	A minimum buffer zone must be provided to 'top of bank' within sites immediately adjoining the River Thames. A minimum of 16m for the Tidal River Thames and 8m for the Fluvial River Thames. Advice must be sought from the Environment Agency at an early stage.									
Other	Ensure that the proposed development does not result in an increase in the risk of flooding (from all sources) within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased, that overland flow routes are not truncated by buildings and/or infrastructure, or hydraulically linked compensatory flood storage is provided within the site (or upstream)									

7.5 SFRA Interpretation

258. As stated in section '7.4.6: Spatial Planning and Development Control Recommendations' table, a minimum buffer zone must be provided to 'top of bank' within sites immediately adjoining the River Thames. This must be 16m for Tidal River Thames and 8m for Fluvial River Thames. Advice must also be sought from the Environment Agency at an early stage.

259. The spatial variation in flood risk across the Borough is depicted in the adjoining maps, and described below. The LBRuT SFRA should be used by the Borough and prospective developers to meet their obligations under the NPPF throughout the planning cycle. Instructions for use are provided below:

London Borough of Richmond upon Thames (Forward Planning)

260. Figures 1 to 11 provide an overview of the spatial variation in flood risk throughout the Borough. It is necessary to adopt a sequential approach when considering where land should be allocated for future development, and this is described in Section 7.4. These figures should be used to inform this sequential approach. Furthermore, the NPPG provides clear guidance on appropriate land uses within areas potentially at risk from flooding, and this too is discussed in Section 7.4.

261. Whilst there is no particular constraint placed upon land use within areas of Zone 1 Low Probability within the Borough, it is strongly recommended that the Borough takes due consideration of flooding from other sources (such as surface water and groundwater). Areas that have previously flooded from localised sources are depicted in Figures 1 to 11. Many of these localised sources of flooding within LBRuT can be effectively managed through the design process. It is recommended that advice is taken from the Environment Agency for properties at risk of flooding from rivers or the sea to ensure that the severity of the local issue that may affect (or be exacerbated by) the proposed allocation is fully appreciated. The EA have withdrawn the advice they give in terms of surface water flooding and this is now the responsibility of the LLFA within LBRuT as the statutory consultee for surface water management (flood risk and sustainable drainage systems).

London Borough of Richmond upon Thames (Development Management) & Developers

262. It is important that the potential risk of flooding is considered as an integral part of all proposed developments within the Borough. Figures 1 to 11 provide a measure of the severity of flooding within different areas of the borough. These figures should be used to trigger a more detailed assessment of flood risk related issues within any proposed development site in that area, as described in Section 7.4 and Section 7.6.

263. *Policy DM SD 6 Flood Risk* within the London Borough of Richmond upon Thames adopted Development Management Plan (see section 4.4.2) identifies land use and development restrictions relating to the various flood risk zones identified in the character areas.

264. The assessment of localised flooding related issues is imperative for all proposed development, irrespective of its location and/or scale within the Borough, and the SFRA provides some helpful tools to assist in this regard:

- Figures 1 to 11 provide an indication of areas that have been susceptible to localised flooding historically. This is not a comprehensive record of flooding, and relies upon community reports of flooding made to the Borough(s). It is a good indication of areas that may be susceptible however, and reiterates the importance of considering flood risk related issues in areas that are outside of the designated NPPF flood zones.
- Figures 1 to 11 show the Environment Agency Flood Map. This mapping is updated on a quarterly basis and users should consult with the Environment Agency to ensure the best available information is used to inform development.

- Figures A and B provide an overview of the topography and geology of the Borough. The detailed FRA should use this information to assess (in a site based context) the potential risk of localised ponding, flash flooding and/or inundation from groundwater.

265. Finally, to provide meaningful recommendations and for ease of reference, the risk of flooding from rivers and the sea within the Borough have been considered on the basis of 'Character Areas'. These are assessed individually in the following sections.

7.5.1 Character Area R1 – Barnes (Figure 1)

266. A large proportion of the character area of Barnes is within **zone 3a high probability**. The area is subject to tidal and fluvial flooding from the River Thames. Flood zone **3b functional floodplain** has been designated to the areas alongside the River Thames. Flood warnings are provided within the Borough, relating to both fluvial and tidal flooding. The Environment Agency strives to provide as much forewarning as possible of a pending flood event. This provides the Borough, emergency services, residents and businesses with an opportunity to prepare to minimise property damage and risk to life.

267. The southern portion of Character Area R1 is also affected by flooding from the Beverley Brook. The Beverley Brook catchment is relatively steep and underlain by impermeable soils. As a result, the brook is susceptible to flooding of a 'flashy' nature and in addition to placing properties at risk during prolonged widespread rainfall, Beverley Brook may also affect properties during localised high intensity rain storms.

268. In addition to the known fluvial/tidal flooding from the River Thames and Beverley Brook, there are sites where local drainage has been identified by the Borough as a known source of flood risk, namely:

- Lonsdale Road
- The area adjacent to Rocks Lane
- The Terrace[34]

269. These localised problem areas have been highlighted by the Borough following observed flooding at these locations. The precise cause of the flooding problem is generally uncertain. Notwithstanding this however, it is important to ensure that any future development does not exacerbate these issues. It is essential to make certain that future development does not increase the rate runoff that drains towards these areas.

7.5.2 Character Area R2 – East Sheen and Mortlake (Figure 2)

270. The area of Mortlake adjoining the River Thames corridor is within **zone 3b functional floodplain, zone 3a high probability** and **zone 2 medium probability,** subject to both tidal and fluvial flooding from the River Thames. Flood warnings are provided within the Borough, relating to fluvial and tidal flooding. The EA strives to provide as much forewarning as possible of a pending flood event. This provides the Borough, emergency services, residents & businesses with an opportunity to prepare to minimise property damage and risk to life.

271. Whilst the majority of East Sheen is within **zone 1 low probability**, a small proportion of East Sheen is affected by flooding from Beverley Brook (**zone 2 medium probability)**. The Beverley Brook catchment is relatively steep and underlain by impermeable soils. As a result, the Brook is susceptible to flooding of a 'flashy' nature and in addition to placing properties at risk during prolonged widespread rainfall, Beverley Brook may also affect properties during localised high intensity rain storms.

[34] Note that the Environment Agency has identified an observed groundwater flooding event at this location

272. In addition to the known fluvial/tidal flooding from the River Thames and Beverley Brook, there are sites where local drainage has been identified by the Borough as a known source of flood risk, namely:

- Shrewsbury Avenue
- Percival Road
- The Terrace[35]
- Sheen Cemetery
- Observatory Road
- Groundwater flooding at East Sheen

273. These localised problem areas have been highlighted by the Borough following observed flooding at these locations. The precise cause of the flooding problem is generally uncertain. Notwithstanding this however, it is important to ensure that any future development does not exacerbate these issues. It is essential to make certain that future development does not increase the rate runoff that drains towards these areas.

7.5.3 Character Area R3 – Kew & North Sheen (Figure 3)

274. The areas adjoining the River Thames corridor in Character Area R3 are situated within **zone 3b functional floodplain**, **zone 3a high probability** and **zone 2 medium probability.** This area is subject to tidal and fluvial flooding from the River Thames. Flood warnings are provided within the Borough, relating to fluvial and tidal flooding. The Environment Agency strives to provide as much forewarning as possible of a pending flood event. This provides the Borough, emergency services, residents & businesses with an opportunity to prepare to minimise property damage and risk to life.

275. There are no known localised flood risk issues within this area, however it is understood through discussion with the Borough that a perceived flood risk exists within riverfront areas of Kew (within the vicinity of the National Archives). This is due to the erection of raised flood defences to provide protection against River Thames flooding. These defences prevent local runoff from draining into the river, resulting in localised ponding and potential flooding. It is noted that the affected area falls largely within **Zone 3a High Probability** and these localised flooding problems would need to be addressed in a Flood Risk Assessment.

7.5.4 Character Area R4 – Richmond Town (Figure 4)

276. The areas of Character Area R4 that adjoin the River Thames corridor are within **zone 3b functional floodplain** and **zone 3a high probability**, subject to tidal and fluvial flooding from the River Thames. Relatively few properties are affected, however the EA are able to provide forewarning of a pending River Thames flood event, enabling the Borough, emergency services, residents and businesses to prepare to minimise property damage and risk to life. Parts of the Character Area R4 is situated within **zone 2 medium probability**, with the remainder within **zone 1 low probability**.

277. There are a number of localised issues that are known or perceived by the Borough to pose a potential flood risk to surrounding property. These include:

- Ranelagh Drive
- A316 (Twickenham Bridge)
- Haliburton Road

[35] Note that the Environment Agency has identified an observed groundwater flooding event at this location

7.5.5 Character Area R5 – Twickenham, Eel Pie Island & St Margarets (Figure 5)

278. A proportion of St Margarets is situated within **zone 3a high probability** and **zone 2 medium probability**. The area is subject to tidal and fluvial flooding from the River Thames and the River Crane.

279. The areas of Twickenham including Eel Pie Island, which adjoin the River Thames are affected by fluvial and tidal flooding from the Thames, and are within the **zone 3b functional floodplain** and **3a high probability**. A large proportion of Twickenham north of the railway line is within **zone 2 medium probability**, affected by fluvial flooding from the River Crane and Duke of Northumberland's River. Large areas of Twickenham (south of the railway line) are situated within **zone 1 low probability**.

280. The River Thames drains a considerable catchment area and flooding is typically a result of long duration, regional rainfall events. Flood warnings are provided within the Borough, relating to both fluvial (river) and tidal flooding. The Environment Agency strives to provide as much forewarning as possible of a pending flood event. This provides the Borough, emergency services, residents and businesses with an opportunity to prepare to minimise property damage and risk to life.

281. In addition to the fluvial/tidal flooding from the River Thames, River Crane and Duke of Northumberland's River, there are a number of localised issues that are known or perceived by the Borough to pose a potential flood risk to surrounding property. These include:

- Haliburton Road
- Ranelagh Drive
- Twickenham Dip
- Cross Deep
- A316 (Twickenham Bridge)
- Flooding of back gardens adjacent to the River Crane downstream of Chertsey Road

282. Concerns have been raised over the capacity of storm drains in the Mogden Lane area, servicing the large Mogden wastewater treatment facility. It is perceived that subsequent storms in close succession may rapidly overload the system resulting in localised flooding.

283. The Duke of Northumberland River is conveyed in an aqueduct. The future structural integrity of this system has been identified as a possible area for concern.

Eel Pie Island

284. The flood risk designation for Eel Pie Island is **functional floodplain flood zone 3b.**

285. Eel Pie Island has been given this designation due to the access and egress routes to and from the island is via a pedestrian foot bridge, which has its foot on the Twickenham Embankment side, also designated as a functional floodplain zone 3b.

286. "FD 2320/TR2: Flood Risk Assessment Guidance for New Development", provides advice on the assessment of safe access and exit. See Appendix E for further information on Safe Access and Egress Design Requirements.

287. In approximate terms the foot of the bridge floods to depths of 0.6m in a 20% chance in any one year flood event, 1m in a 5% chance in any one year flood event and 1.8m in a 1% chance in any one year flood event. FD 2320/TR2, provides a methodology whereby hazards due to flooding can be estimated by combining the depth and velocity of flood water with a debris factor. Even by ignoring the velocity associated with floodwater the **foot of the bridge would be located in water presenting 'Danger for most'**, a category which includes the general public.

7.5.6 Character Area R6 – Strawberry Hill, Teddington Lock & Trowlock Island (Figure 6)

288. Areas adjoining the River Thames corridor are situated within **zone 3b functional floodplain** and **zone 3a high probability**. The area is subject to tidal and fluvial flooding from the River Thames. Council, emergency services, residents and businesses are issued flood warnings that enable them to prepare for an emergency situation, minimising property damage and risk to life.

289. Flood modelling carried out in the Teddington area shows areas of flooding behind the Thames Tidal Defences (see Figure 6) that are not shown as 'Areas benefiting from flood defenses' (see Figure D). This is because during extreme fluvial flood events flood water is predicted come out of bank some way upstream of Teddington Weir and flow behind the defences that start at that point. Flood Risk Assessments in this area should consider both fluvial dominated events and tidally dominated events (for which a residual risk of breach remains).

290. Existing housing and sports facilities located between the A310 (Manor Road) and the River Thames are affected by flooding, on average, once in every 20 years. This is referred to as **zone 3b functional floodplain**, however giving due consideration to the existing development, a pragmatic approach to future redevelopment is permitted in accordance with Section 7.4. Careful consideration is warranted however, taking due care and attention to the susceptibility of this area to relatively frequent flooding.

291. The area of (and adjoining) Trowlock Island is particularly vulnerable, subject to flooding in a 5% in any one yearevent (**zone 3b functional floodplain**) and it is recommended that these open space areas are preserved for flood storage purposes.

292. Large areas of Ham Lands are located within **zone 2 medium probability** and **zone 3a high probability**. Finally, the remaining proportion of Character Area R6 is situated within **zone 1 low probability**.

293. In addition to the fluvial/tidal flooding from the River Thames, there are a number of localised issues that are known by the Borough to pose a potential flood risk to surrounding property. These include:

- Strawberry Hill Road
- Strawberry Vale[36]
- Manor Road
- Ferry Road
- York Road

294. These localised problem areas have been highlighted by the Borough following observed flooding at these locations. The precise cause of the flooding problem is generally uncertain. Notwithstanding this however, it is important to ensure that any future development does not exacerbate these issues. It is essential to make certain that future development does not increase the rate runoff that drains towards these areas.

7.5.7 Character Area R7 – Teddington South, Hampton Wick and Hampton Court Park (Figure 7)

295. Riverfront areas of Character Area R7 are affected by flood risk, situated largely within **zone 3a high probability** and also within **zone 3b functional floodplain**. The severity of flooding is heavily dependent upon the proximity to the river, and detailed modelling of this reach indicates that the land rises quite steeply away from the river.

296. Additionally, the area dominated by the presence of Hampton Court Palace and its grounds, including the golf course, are envisaged to experience no future development (to the north of the River Thames) within foreseeable planning horizons.

[36] Note that the Environment Agency has identified an observed groundwater flooding event at this location

297. The character area is subject to fluvial flooding from the River Thames. Flood warnings are provided within the Borough, relating to fluvial (river) flooding. The Environment Agency strives to provide as much forewarning as possible of a pending flood event. This provides the Borough, emergency services, residents and businesses with an opportunity to prepare to minimise property damage and risk to life.

298. Some areas of Character Area R7 are situated within **zone 2 medium probability** with the remaining in **zone 1 low probability**.

299. In addition to the fluvial flooding from the River Thames, there is a known localised drainage issue at:

- Hampton Court Road

7.5.8 Character Area R8 – Hampton, Taggs Island & Platt's Eyot (Figure 8)

300. Riverfront areas of Character Area R8 are situated within **zone 3a high probability** and **zone 3b functional floodplain**, subject to fluvial flooding from the River Thames. Riverfront properties adjoining Thames Street and Hampton Court Road, and residents of Taggs Island and Ash Island, are also at risk of fluvial flooding from the River Thames, falling within the 5% chance in any one year predicted flood extents (i.e. **zone 3b functional floodplain**). Careful consideration should be given to the sustainability of future redevelopment within these areas, as outlined in Section 7.4.

301. The Hampton Water Works are also within flood affected areas and it is recognised that this is an essential piece of infrastructure providing water to a substantial proportion of the Greater London region. Failure of this system due to flooding may have a considerable impact.

302. The remaining areas of Character Area R8, including the main areas of Hampton, are situated within **zone 1 low probability**.

303. There is a known localised drainage issue at:
- Burton's Road Ditch

7.5.9 Character Area R9 – Twickenham & Whitton (Figure 9)

304. Character Area R9 is divided by the River Crane. Development along the river corridor has been largely constrained, and a series of park areas and playing fields provide a floodplain function. Notwithstanding this however, small pockets of existing development are situated within **zone 2 medium probability** (surrounding the A306). The majority of Character Area R9 is situated within **zone 1 low probability** (including the Whitton Brook corridor).

305. There is a known localised drainage issue at:

- Mill Road

7.5.10 Character Area R10 – Richmond Park (Figure 10)

306. Character Area R10 encompasses the eastern part of Richmond Park, which is divided by the Beverley Brook. Areas adjoining Beverley Brook are within **zone 2 medium probability**, however, there are no properties located in this area and there will also be no future development in this park. The remaining areas of Richmond Park are situated within **zone 1 low probability**.

307. There are no known localised flood risk issues within Character Area R10.

7.5.11 Character Area R11 – Ham Common and Richmond Park (Figure 11)

308. Character Area R11 is entirely within **zone 1 low probability**, therefore there are no development constraints in place relating to flood risk from the river and sea.

309. There is a known localised drainage issue at:

- Ham Gate Avenue

7.6 Detailed Flood Risk Assessment (FRA) – The Developer

7.6.1 Scope of the Detailed Flood Risk Assessment

310. As highlighted above, the SFRA is a strategic document that provides an overview of flood risk throughout the area. Once the Sequential Test has been applied in accordance with Section 7.4 to determine the allocation of sites for future development, it is imperative that a site-based Flood Risk Assessment (FRA) is carried out by the developer for all proposed developments. This should be submitted as an integral part of the planning application. All development proposals, including extensions, conversions and change of use, should consider the likely impacts of climate change and all sources of flooding.

311. The FRA should be commensurate with the risk of flooding to the proposed development. For example, where the risk of flooding to the site is negligible (e.g. Zone 1 Low Probability), there is little benefit to be gained in assessing the potential risk to life and/or property as a result of flooding. Rather, emphasis should be placed on ensuring that runoff from the site is not impacted by local sources of flooding and does not exacerbate flooding lower in the catchment. The particular requirements for FRAs within each delineated flood zone are outlined below.

It is highlighted that the description of flood risk provided in the Character Area discussions above place emphasis upon the primary source of flood risk (i.e. river flooding). In all areas, a localised risk of flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the Borough. This localised risk of flooding must also be considered as an integral part of the detailed Flood Risk Assessment.

Proposed Development within Zone 3a High Probability & Zone 3b Functional Floodplain

312. All FRAs supporting proposed development within Zone 3b Functional Floodplain and Zone 3a High Probability should include an assessment of the following:

- The vulnerability of the development to flooding from other sources (e.g. surface water, groundwater and sewers) as well as from river / tidal flooding. This will involve discussion with the Borough and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change (Guidance on the new climate change allowances developed by the EA can be found *here*)), i.e. maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.
- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment, to be carried out by a suitably qualified engineer.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed finished ground floor levels. All levels should be stated relevant to Ordnance Datum.
- Details of proposed sustainable drainage systems (SuDS) that will be implemented to ensure that runoff from the site (post redevelopment) does not exceed greenfield runoff rates. Any SUDS design must take due account of groundwater and geological conditions.
- The developer must provide a clear and concise statement summarising how the proposed (re)development has contributed to a positive reduction in flood risk within the Borough.

313. It is reiterated that a proportion of the London Borough of Richmond upon Thames is delineated as Zone 3a High Probability, however the presence of raised defences provides a degree of protection against flooding. It is broadly accepted that these defences reduce the actual risk to properties within lower lying areas of the borough, however recent history has demonstrated the potentially catastrophic consequence of overtopping or a breach failure, often resulting in widespread flooding.

314. Developers should consult the Environment Agency, via the pre-application process, to find out whether they need to complete a breach analysis flood model as part of their Flood Risk Assessment.

315. It is essential that developers situated within close proximity of a raised flood defence[37] thoroughly review the existing and future structural integrity of the defences (i.e. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure.

316. For redevelopment proposals in Zone 3b Functional Floodplain, a net reduction in flood risk is required, and proposals for the change of use or conversion to a use with a higher vulnerability classification are not permitted. Net flood risk reduction includes both on- and off-site measures, including reducing the land use vulnerability, raising of floor levels, reducing site run-off, increasing flood storage capacity, reducing impedance to flood water flow, incorporation of flood resilient and/or resistant measures and others.

Proposed Development within Zone 2 Medium Probability

- For all sites within Zone 2 Medium Probability, a high level FRA should be prepared based upon readily available existing flooding information, sourced from the EA. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed through, for example, the provision of raised floor levels (refer Section 7.6.2) and the provision of a planned evacuation route and / or safe haven.
- The risk of other sources of flooding (e.g. urban drainage and/or groundwater) must be considered, and sustainable urban drainage techniques must be employed to ensure no worsening to existing flooding problems elsewhere within the area.
- As part of the high level FRA, the developer must provide a clear and concise statement summarising how the proposed (re)development has contributed to a positive reduction in flood risk within the Borough.
- Details of proposed sustainable drainage systems (SuDS) that will be implemented to ensure that runoff from the site (post redevelopment) does not exceed greenfield runoff rates. Any SuDS design must take due account of groundwater and geological conditions.

Proposed Development within Zone 1 Low Probability

317. For all sites greater than 1ha in area, a Flood Risk Assessment / Sustainable Drainage Strategy must be prepared. The potential impacts of the development to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff must be considered.

318. Details of proposed sustainable drainage systems (SuDS) that will be implemented to ensure that runoff from the site (post redevelopment) does not exceed greenfield runoff rates. Any SuDS design must take due account of groundwater and geological conditions.

319. The risk of other sources of flooding (e.g. urban drainage and/or groundwater) must be considered.

320. A Flood Risk Assessment is also required for smaller development proposals where there is evidence of a risk from other sources of flooding identified in this SFRA.

[37] The specific requirement for a detailed analysis of defence failure to be carried out should be determined in conjunction with the Borough and the Environment Agency at the FRA scoping stage. It is recommended that all proposed developments situated within 1000m of the defence line confirm the need (or otherwise) to carry out this assessment prior to commencement.

Liaison with the Environment Agency

321. To assist local planning authorities, the Environment Agency has produced standing advice to inform on their requirements regarding the consultation process for planning applications on flood risk matters. Full details of the Environment Agency Flood Risk Standing Advice for applicants / agents can be found here and for Local Planning Authorities can be found here.

322. The Environment Agency is an excellent source of information to inform the development of the detailed FRA. The external relations team should be contacted as early as possible to source information relating to (for example) historical flooding, hydraulic modelling and topography (LiDAR). The Environment Agency has modelled flood levels for various annual exceedance probabilities, including climate change, for most parts of the Borough . Modelled flood levels will be required for Flood Risk Assessments and the levels can be obtained from the Environment Agency's external relations team. It is emphasised that the information provided within the SFRA is the best available at the time of writing. More up to date information may be available, and contact should always be made with the EA at an early stage to ensure that the detailed site based FRA is using the most current datasets, avoiding unnecessary re-work.

323. Early pre-application discussions with the Borough and the Environment Agency are encouraged. The Borough provides pre-application advice for developers as well as householders on its website:
https://www.richmond.gov.uk/pre-applications

324. It is strongly recommended that a draft of the detailed FRA is provided to the EA for review and comment before submitted with the Planning Application, thereby reducing potentially costly delays to the planning process. Developers and applicants can get advice from the Environment Agency free of charge relating to a specific plot of land before submitting a planning application to a Local Planning Authority.

7.6.2 Freeboard - Raised Ground Floor Levels

325. The height that the finished floor level is raised above flood level is referred to as the 'freeboard' and is an allowance to account for uncertainties in the predicted flood levels.

326. The raising of ground floor levels within the highest risk areas of the Borough will ensure that the risk to life, and damage to property, is minimised. Where stipulated within Section 7.4 above, finished ground floor levels should be situated:

- A minimum of 300mm above the 1% chance in any one year event with an allowance for climate change fluvial flood level.
- Above the year 2100 (from the TE2100 study) tidal flood level assuming a breach of the River Thames defences.
- Where tidal and fluvial flooding are possible, then the more conservative of the two allowances should be used. This is determined as an outcome of the site based FRA.

327. A minimum of 600mm above the 1% AEP fluvial flood level should be adopted if no climate change flood level data is available for a specific location.

328. It is noted that the Environment Agency are in the process of revising guidance on freeboard allowances at the time of this SFRA's publication (March 2016). The LBRuT will apply a minimum 300mm freeboard allowance as described above as a default position until new guidance is released. If a developer proposes a freeboard allowance of less than this, then it must be agreed in advance with the Environment Agency and supported by best practice guidance available at the time of planning application submission.

7.6.3 Basements

329. Basements represent a particularly high risk to life within flood affected areas of the Borough, and it is essential that careful consideration is given to their design and use. Basements may be subject to very rapid inundation as floodwater from all sources moves across the floodplain, and it is essential that the minimum design requirements set out in Section 7.4.6 (Page 47) are rigorously adhered to.

330. A summary of the main basement development requirements is provided below:

Flood Zone 3b (Functional Floodplain)	No basement permitted
Flood Zone 3a (Tidal / Fluvial)	**Area of Extreme, Significant and Moderate Breach Hazard**[38] **New Basements:** - Restricted to Less Vulnerable / Water Compatible use only. **Existing Basements:** - No basement extensions, conversions or additions for More Vulnerable / Highly Vulnerable uses. **Area of Low or No Breach Hazard** **New Basements:** - After passing the Exception Test (where applicable), basements are permitted for residential use where they are not self-contained or used for bedrooms. **Existing Basements:** - Basement extensions, conversions or additions maybe permitted for existing developments where they are not self-contained or used for bedrooms. *(Refer Section 7.4.6 (Basements) for criteria)*
Flood Zone 2	**New Basements:** - After passing the Exception Test (where applicable), basements are permitted for residential use where they are not self-contained or used for bedrooms. **Existing Basements:** - Basement extensions, conversions or additions maybe permitted for existing developments where they are not self-contained or used for bedrooms. *(Refer Section 7.4.6 (Basements) for criteria)*
Flood Zone 1	No development restrictions on new or existing basements.

[38] Refer to maps in Appendix C to determine tidal breach hazard rating

331. The development of basements within the various flood zones must conform with *Policy DM SD 6 Flood Risk* within the London Borough of Richmond upon Thames adopted Development Management Plan (DMP) (see section 4.4.2).

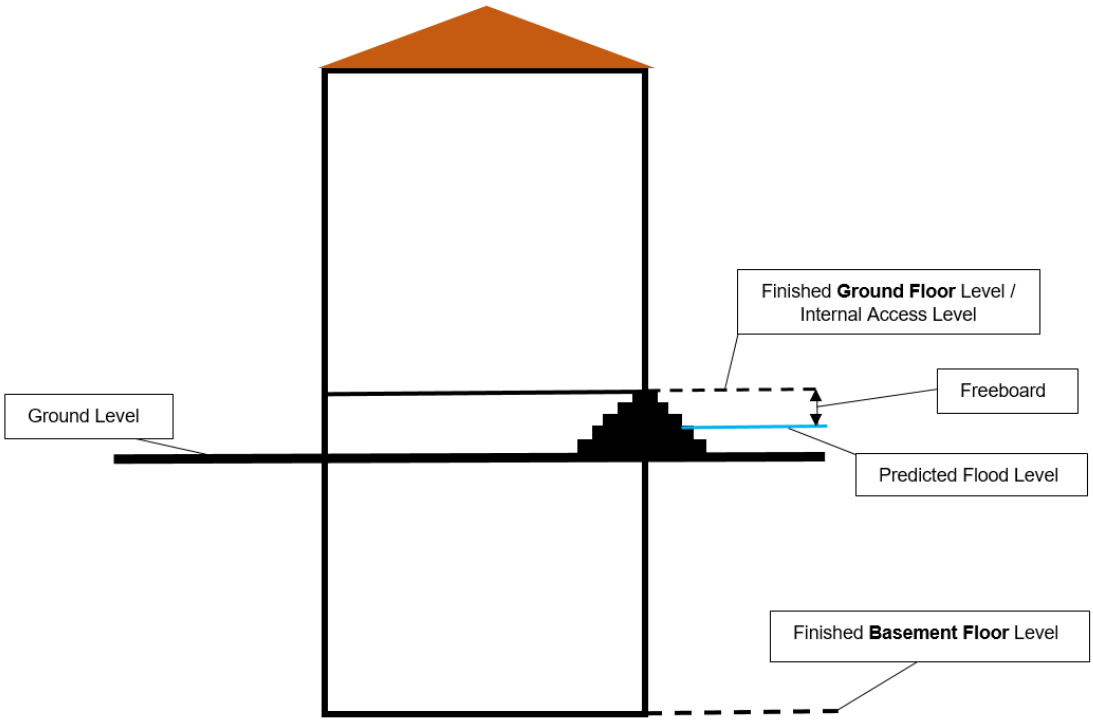
332. Under some circumstances, the Environment Agency may permit basement developments within a Flood Zone 3 outside of tidal breach hazard areas, but the London Borough of Richmond upon Thames has overarching power over permissions and Policy DM SD 6 of the DMP should always be followed.

333. It is also important to not locate any essential services, storage space for key provisions and equipment at basement level; they should be designed to be located above predicted flood level so that they remain operational during a flood event.

334. All basement development should be installed with a pumped sewerage system to prevent flooding from back flow in public sewerage system as recognised in Part H of the Building Regulations.

335. Issues of groundwater ingress to basement levels should be addressed by property owners.

336. For avoidance of doubt in interpretation, the figure below shows the differences between Ground Floor Level / Internal Access Level and Basement Flood Level.



7.6.4 Sustainable Drainage Systems (SuDS)

337. SuDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of surface water is considered an essential element of reducing future flood risk to both the site and its surroundings. Reducing the rate of discharge from urban sites to greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the Borough. Greenfield run-off is the surface water drainage regime from a site prior to development.

338. SuDS may improve the sustainable management of water for a site by[39]:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing volumes and the frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open space and wildlife habitat;
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

339. In catchment terms, any reduction in the amount of water that originates from any given site is likely to be small. But if applied across the catchment in a consistent way, the cumulative effect of a number of sites could be significant.

340. The London Borough of Richmond upon Thames supports the London Plan drainage hierarchy when disposing of surface water from a development site. Therefore, development should comply with the hierarchy, which is as follows:

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

341. It is recommended that developers are required to demonstrate that this hierarchy has been considered in the design of their surface water management system.

There are numerous different ways that SUDS can be incorporated into a development and the most commonly found components of a SUDS system are described in the following table[40]. More than one technique can be used on a development site. The appropriate application of a SuDS scheme to a specific development is heavily dependent upon the layout, topography and geology of the site (and its surrounds).

342. Detailed advice on the selection, design and maintenance of SuDS is given in the CIRCIA SuDS Manual[41]. Careful consideration of the site characteristics must be assured to ensure the future sustainability of the adopted drainage system.

Pervious surfaces	Surfaces that allow inflow of rainwater into the underlying construction or soil.
Green roofs	Vegetated roofs that reduce the volume and rate of runoff and remove pollution.
Filter drain	Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
Filter strips	Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Swales	Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
Basins, Ponds and Wetlands	Areas that may be utilised for surface runoff storage.

[39] Interim Code of Practice for Sustainable Drainage Systems National SUDS Working Group, 2004
[40] Interim Code of Practice for Sustainable Drainage Systems National SUDS Working Group, 2004
[41] The SUDS Manual (C753), CIRIA, November 2015

Infiltration Devices	Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.
Bioretention areas	Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground

343. For more guidance on SuDS, the following documents and websites are recommended as a starting point:
- Non Statutory Technical Standards: Sustainable drainage systems March 2015I
- The use of SuDS in high density development – Guidance Manual (SR666), HR Wallingford, 2005
- The SUDS Manual (C753), CIRIA, November 2015 http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx
- http://www.susdrain.org/

7.7 Local Community Actions to Reduce Flood Damage

344. Approximately 6,500 of the Borough's 100,665 properties are located within Flood Zone 2 medium probability, approximately 13,300 properties within Flood Zone 3a high probability and around 600 properties in Flood Zone 3b functional floodplain[42]. It is essential therefore to ensure a broad awareness with respect to flood risk, providing the community with the knowledge (and tools) that will enable them to help themselves should a flood event occur.

345. The following 'community based measures' are cost effective solutions that local communities may introduce to minimise the damage sustained to their own homes in the case of flooding. Further guidance is provided by the EA, Defra and CLG[43] (refer to the National Flood Forum at www.floodforum.org.uk). The document 'Improving the Flood Performance of New Buildings: Flood Resilient Construction' provides specific advice about how to design new buildings to be more resilient to floods.

346. It is recommended that the Local Authority seek to proactively raise awareness within the community with respect to flooding (and indeed 'self-help' flood risk reduction opportunities) through, for example, the circulation of a targeted newsletter to affected residents to coincide with the release of the LBRuT SFRA.

7.7.1 Designing for Flood Risk

347. There are four main approaches to designing for flood risk:

- Flood Avoidance: Constructing a building and its surroundings (at site level) in such a way to avoid being flooded.
- Flood Resistance: Constructing a building in such a way to prevent flood water entering the building and damaging its fabric.
- Flood Resilience: Constructing a building in such a way that although flood water may enter the building its impact is reduced.
- Flood Repairable: Constructing a building in such a way that although flood water enters a building, elements that are damaged by flood water can be easily repaired or replaced. This is also a form of flood resilience.

Flood Avoidance:

- Applying the sequential approach at the site level by locating more vulnerable development in lower flood risk areas, whilst using areas at higher risk of flooding for amenity area and other water-compatible or less vulnerable uses.
- Raising of floor levels above the anticipated maximum flood level including climate change ensures that the interior of the property is not directly affected by flooding,

[42] Analysis by overlaying Borough's LLPG records with EA flood maps (May 2015)
[43] Improving the Flood Performance of New Buildings – Flood Resilient Construction (May 2007)

avoiding damage to furnishings, wiring and interior walls. It is highlighted that plumbing may still be impacted as a result of mains sewer failure.

- Raising land to create higher ground, without increasing the risk of flooding elsewhere.

Flood Resistance:

348. Flood resistance comprises of measures designed for stopping water entering a property. Such measures must be installed as a complete package, and advice should be sought from a specialist. Every entry point for flood water must be stopped i.e. doors, air-bricks, gaps round pipes, sinks and toilets. There are two types of resistance measures, permanent and temporary measures. Permanent measures include the use of low permeability materials such as plastics and water resistant sealants. Temporary measures include for example the installation of flood resistant door guards, skirts, fences and gates.

349. When constructing new properties, permanent flood resistance measures are always preferable to temporary measures as they do not require intervention by the property occupants (e.g. a flood gate needs to be securely shut and remain so, flood skirts need to be slid across the door etc.).

350. For existing homes, the use of flood boards/gates can be a successful measure as well as the placement of a temporary watertight seal across doors, windows and air bricks to avoid inundation of the building interior. This may be suitable for relatively short periods of flooding, however the porosity of brickwork may result in damage being sustained should water levels remain elevated for an extended period of time. This may lessen the effectiveness of flood proofing to existing properties affected by flooding from larger river systems such as the Thames.

351. Flood resistance is not recommended for floods deeper than 600mm. This has the potential to place high levels of hydrostatic and/or hydrodynamic pressure on the structure of the building, placing occupants at risk. It also has the potential to cause sudden inundation of the building if the level of resistance to flood waters is breached by the water depth or velocity. Therefore, flood resistance measures are generally less desirable than flood resilience measures (see below) when flood waters are deeper.

Flood Resilience and Repairable:

352. Flood resilience measures comprise of measures designed to reduce flood damage costs and recovery time. Resilient design is favoured where the flood water levels are likely to be greater than 600mm in height. Unlike resistance measures, improvements can be made separately and can yield individual benefits. Many of the measures can be done while redecorating, for little or no extra cost.

353. Developers are strongly recommended to have regard to "Improving the Flood Performance of New Buildings[44]" when identifying the materials to be used in any new development proposal located in an area at risk of flooding.

354. Flood resilience also encompasses many other practical and design based initiatives, such as raising of electrical wiring and sockets within flood affected buildings and chasing electricity through ceilings rather than beneath the floor, as this reduces the risks to health and safety, and also reduces the time required after a flood to rectify the damages sustained. Flood resilience can also include locating electrical appliances and heating systems above the predicted height of flood water, fitting one-way valves on water pipes to prevent drainage systems from backing up, choosing interior fittings such as kitchen units and floor coverings with flood risk in mind and ensure they are more flood resilient.

355. Flood repairable in many ways is the same as flood resilience, however this considers measures that result in the least harm in the event of damage occurring.

[44] Improving the Flood Performance of New Buildings – Flood Resilient Construction (May 2007)

7.7.2 Flood Warning and Evacuation Plans

356. In line with the NPPF, Flood Warning and Evacuation Plans should be in place for those areas at an identified risk of flooding. Developers should ensure that appropriate evacuation and flood response procedures are in place to manage the residual risk associated with an extreme flood event, and include how such plans will be implemented. This will also need to be considered in locations where there is a residual risk of flooding due to the presence of defences. It is recommended that all major development proposals (10 dwellings or 1000sqm of non-residential or more) submit a Flood Warning and Evacuation Plan. Minor developments at risk of flooding are also encouraged to produce a Flood Warning and Evacuation Plan.

7.8 Emergency Planning

357. The Borough is designated as a Category 1 Responder under the Civil Contingencies Act 2004. As such, the Borough has defined responsibilities to assess risk, and respond appropriately in case of an emergency, including (for example) a major flooding event. The Borough's primary responsibilities are[45]:

a) from time to time assess the risk of an emergency occurring;
b) from time to time assess the risk of an emergency making it necessary or expedient for the person or body to perform any of his or its functions;
c) maintain plans for the purpose of ensuring, so far as is reasonably practicable, that if an emergency occurs the person or body is able to continue to perform his or its functions;
d) maintain plans for the purpose of ensuring that if an emergency occurs or is likely to occur the person or body is able to perform his or its functions so far as necessary or desirable for the purpose of:
i. preventing the emergency,
ii. reducing, controlling or mitigating its effects, or
iii. taking other action in connection with it

7.8.1 Recommendations for Emergency Planning

358. The SFRA provides a summary of the possible sources of flooding within the Borough and may be used to inform the assessment of flood risk in response to the requirements of the above Act. The data within the SFRA allows emergency planning processes to be tailored to the needs of the area and be specific to the risks faced.

359. Emergency Planning should use the SFRA findings when reviewing and/or updating the Richmond Multi-Agency Flood Plan.

360. Emergency Planning should advise the appropriate borough service areas of the need to have in place arrangements for:

- Updating the Multi-Agency Flood Plan in the light of the SFRA findings to determine the suitability of refuge centres and evacuation routes.
- Considering the likelihood of all sources of flooding as shown on the maps of this report, and responding accordingly.
- Ensuring that where necessary and appropriate, specific evacuation plans are in place for existing vulnerable institutions in the floodplain and other areas at high flood risk, as shown in the attached maps.
- Ensuring that safe evacuation routes and access routes (see Figure F) for emergency services are planned from any existing area of flood risk to rest centres.

[45] Civil Contingencies Act 2004

- Acknowledging the role of the Environment Agency in a flood event in the Multi-Agency Flood Plan, and liaise with the Environment Agency on flood warning and response to flooding.
- Using the SFRA to educate local people to improve flood awareness, in cooperation with the Environment Agency. This should include measures that people can take to make their homes more resilient or resistant to flooding from all sources, and encourage all those at fluvial and tidal flood risk to sign up to the Environment Agency's Floodline Warnings Direct service.

7.8.2 Recommendations for the LPA with respect to Emergency Planning

- The LPA should formally consult with Emergency Planning in the Borough on the submitted Flood Warning and Evacuation Plans for major developments in Flood Zone 2 or 3.

- The advice of Emergency Planners on the submitted Flood Warning and Evacuation Plans should be followed.

361. The Environment Agency monitors river levels within the River Thames catchment. Based upon weather predictions provided by the Met Office, the Agency makes an assessment of the anticipated maximum water level that is likely to be reached within the following hours (and/or days). Where these predicted water levels are expected to result in the inundation of populated areas[46], the Environment Agency will issue a series of flood warnings within defined flood warning areas, encouraging residents to take action to avoid damage to property in the first instance.

362. As water levels rise and begin to pose a risk to life and/or livelihood, it is the responsibility of the emergency services to coordinate the evacuation of residents, working in cooperation with the Local Planning Authority to ensure safe shelter can be provided. Figure F provides anticipated flood depths upon primary access routes during the 1% chance in any one year design flood. It is essential that a robust plan is in place that clearly sets out (as a minimum):

- roles and responsibilities;
- paths of communication;
- evacuation routes;
- community centres to house evacuated residents;
- contingency plans in case of loss of power and/or communication.

363. Coordination with the emergency services and the Environment Agency is imperative to ensure the safety of residents in time of flood. Areas within the Borough that are adjoining the River Thames, and are at risk of river and/or tidal flooding (as indicated by the shaded NPPF flood risk zones in the adjoining maps), are often susceptible to widespread weather phenomenon, and considerable forewarning will generally be provided to encourage preparation in an effort to minimise property damage and risk to life. This highlights the importance of awareness raising with respect to the potential risk (and impacts) of flooding within the Borough.

364. In contrast, areas suffering from localised flooding issues (including flooding from the River Crane and Beverley Brook) will tend to be susceptible to 'flash' flooding, associated with storm cells that pass over the Borough. Storms of this nature result in high intensity, often relatively localised, rainfall. It is anticipated that events of this nature will occur more often as a result of possible climate change over the coming decades. Events of this nature are difficult to predict accurately, and the rapid runoff that follows will often result in flooding that cannot be sensibly forewarned.

[46] Restricted to those urban areas situated within Environment Agency flood warning zones

365. It is very important to recognise that the river (and tidal) flooding depicted within the adjoining flood risk maps is unlikely to occur in isolation. Flooding of this nature will typically occur during heavy, prolonged rainfall across the Borough, and is likely to coincide with other emergency incidents, for example localised flooding due to sewer failure. Whilst it is essential that a safe route of escape (above the maximum river flood level) is provided as part of the design process, it should be emphasised that the safety of escape routes may be hindered at the time of evacuation. For this reason, it is imperative that full control is provided to the emergency services during a flooding situation to determine the timing and route of any evacuation.

366. Finally, all urbanised areas are potentially at some degree risk of localised flooding due to heavy rainfall. The blockage of gullies and culverts as a result of litter and/or leaves is commonplace, and this will inevitably lead to localised problems that can only realistically be addressed by reactive maintenance. It is also important to recognise that future planning decisions may alter the risk of flooding to people and property within the Borough, introducing (and/or removing) properties from areas that are potentially at risk of flooding. These decisions may therefore impact upon the emergency response required during periods of flooding in future years.

367. It is recommended that the Borough advises the Local Resilience Forum of the risks raised in light of the LBRuT SFRA, ensuring that the planning for future emergency response can be reviewed accordingly.

368. Further guidance can be found at: http://www.richmond.gov.uk/final_guidance_on_producing_a_flood_emergency_plan_nov_2011.pdf

7.9 Insurance

369. Many residents and business owners perceive insurance to be a final safeguard should damages be sustained as a result of a natural disaster such as flooding. Considerable media interest followed the widespread flooding of 2000 when it became clear that the insurance industry was rigorously reviewing their approach to providing insurance protection to homes and businesses situated within flood affected areas. The recent widespread flooding of July 2007 has further exacerbated the discussion surrounding the future of insurance for householders and business owners situated within flood affected areas.

370. The future availability of flood insurance within the UK will be underwritten by an organisation known as 'Flood Re' (http://www.floodre.co.uk/). Flood Re will be implemented from April 2016. A summary of the key aspects of Flood Re are:

- Flood Re will be run and financed by insurers as a not-for- profit fund which will cover the cost of flood claims from high risk homes.
- Insurers will pass the flood risk element from those households deemed at high risk of flooding to the fund.
- Premiums for the flood risk will be calculated based on Council tax banding up to a maximum limit depending on the band.

371. Further guidance on obtaining flood insurance is provided by the National Flood Forum (http://www.nationalfloodforum.org.uk/trouble-getting-insurance/).

8 Conclusion & Recommendations

372. A considerable proportion of the London Borough of Richmond upon Thames (LBRuT is at risk of flooding. The risk of flooding posed to properties within the Borough arises from a number of sources including river flooding, surface water, sewer and groundwater flooding.

373. The Borough is characterised by a number of major river systems including the River Thames, the River Crane (and tributaries) and Beverley Brook. Collectively, these represent a major source of flood risk to properties within the Borough. A collation of potential sources of flood risk has been carried out in accordance with NPPF, developed in close consultation with both the Borough and the Environment Agency. The Borough has been broken down into zones of 'high', 'medium' and 'low' risk in accordance with the NPPF, providing the basis for the application of the NPPF Sequential Test.

374. Investment in flood defence has been delivered within the Borough, providing a degree of protection to existing property in the form of raised embankments, flood control structures and diversion channels. A residual risk of flooding remains however, associated both with an event that may exceed the design capacity of the defences, and / or a structural failure.

375. A planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the Sequential Test. Specific planning recommendations have been provided for all urban centres at flood risk within the Borough.

376. Where other planning considerations must guide the allocation of sites following the application of the Sequential Test, specific recommendations have been provided to assist the Borough and the developer to meet the Exception Test. These should be applied as development control recommendations for all future development (refer Section 7.4).

377. Council policy is essential to ensure that the recommended development control recommendations can be imposed consistently at the planning application stage. This is essential to achieve future sustainability within the Borough with respect to flood risk management. Current Core Strategy Policy CP3 and DMP Policy DM SD 6 are considered generally robust. Policies on local flood risk, sustainable drainage and the protection of flood defences are included as part of the Development Management DPD. These will be further developed in light of the suggested development control recommendations presented by the Richmond upon Thames SFRA (refer Section 7.4).

378. Emergency planning is imperative to minimise the risk to life posed by flooding within the Borough. It is recommended that the Borough advises the Local Resilience Forum of the risks raised in light of the Richmond SFRA, ensuring that the planning for future emergency response can be reviewed accordingly.

8.1 Level 2 SFRA

379. The principal purposes of a Level 2 SFRA is to facilitate application of the Sequential and Exception Tests. This more detailed study should consider the detailed nature of the tidal flood hazard, taking account of the presence of flood risk management measures such as flood defences.

380. A Level 2 SFRA should build on the source information that would be comprised within a Level 1 SFRA and contain:

- maps showing the distribution of flood risk across all flood zones from all sources of flooding, taking climate change into account;
- an appraisal of the current condition of flood defence infrastructure and of likely future flood management policy with regard to its maintenance and upgrade;

- an appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure, including an appropriate allowance for climate change;
- guidance on appropriate policies for sites which could satisfy parts a) and b) of the Exception Test, and on the requirements that would be necessary for a flood risk assessment supporting a planning application for a particular application to pass part c) of the Exception Test;
- guidance on the preparation of flood risk assessments for sites of varying risk across the flood zones, including information about the use of sustainable drainage techniques;
- identification of the location of critical drainage areas and identification of the need for Surface Water Management Plans; and
- meaningful recommendations to inform policy, development control and technical issues.

381. A Level 2 SFRA will be required if development is allocated in flood risk areas. It will need to specifically inform the town centre development (if the town centre is at risk of flooding) and allocations that require the Exception Test. Richmond and Twickenham have been identified for planned development in the Core Strategy, and if the Exception Test is required for anticipated development in these areas, further detail from a Level 2 SFRA is needed. It is anticipated that a Level 2 SFRA will be produced along with the Borough's Site Allocations DPD to consider whether the sites referred to fall within areas of flood risk shown in the SFRA maps.

8.2 A Living Document

382. The SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the district and upon detailed flood risk mapping carried out by the Environment Agency, who will continue their rolling programme of flood risk mapping. This, in addition to observed flooding that may occur throughout a year, will improve the current knowledge of flood risk within the district and may marginally alter predicted flood extents within the Borough. Given that policy documents and flood risk information is continually being improved and updated, a periodic review of the Richmond SFRA is imperative.

383. It is recommended that the Richmond SFRA is reviewed on a regular basis. The following key questions should be addressed as part of the SFRA review process:

Question 1
Has any flooding been observed within the Borough since the previous review? If so, the following information should be captured as an addendum to the SFRA:

- What was the mapped extent of the flooding?
- On what date did the flooding occur?
- What was the perceived cause of the flooding?
- If possible, what was the indicative statistical probability of the observed flooding event? (i.e. how often, on average, would an event of that magnitude be observed within the Borough?)
- If the flooding was caused by overtopping of the riverbanks, are the observed flood extents situated outside of the current Zone 3a? If it is estimated that the frequency of flooding does not exceed, on average, once in every 100 years then the flooded areas (from the river) should be incorporated into Flood Zone 3a to inform future planning decision making.

Question 2
Have any amendments to NPPF or the NPPG been released since the previous review? If so, the following key questions should be tested:

- Does the revision to the policy guidance alter the definition of the NPPF Flood Zones presented within the SFRA?
- Does the revision to the policy guidance alter the decision making process required to satisfy the Sequential Test?
- Does the revision to the policy guidance alter the application of the Exception Test?

- Does the revision to the policy guidance alter the categorisation of land use vulnerability, presented within Table 2 of NPPG?

If the answer to any of these core questions is 'yes' then a review of the SFRA recommendations in light of the identified policy change should be carried out.

Question 3

Has the Environment Agency issued any amendments to their flood risk mapping and/or standing guidance since the previous policy review? If so:

- Has any further detailed flood risk mapping been completed within the Borough, resulting in a change to the 5%, 1% or 0.1% chance in any year flood outline? If yes, then the Flood Zone 3b and Flood Zone 3a flood outlines should be updated accordingly.
- Has the assessment of the impacts that climate change may have upon rainfall and/or river flows over time altered? If yes, then a review of the impacts that climate change may have upon the Borough is required.
- Do the development control recommendations provided in Section 7.4 of the SFRA in any way contradict emerging EA advice with respect to (for example) the provision of emergency access or the setting of floor levels? If yes, then a discussion with the EA is required to ensure an agreed suite of development control requirements are in place.
- Have any new / updated surface water or other sources of flooding maps been produced and published?

It is highlighted that the Environment Agency reviews the Flood Zone Map on a quarterly basis. If this has been revised within the Borough, the updated Flood Zones will be automatically forwarded to the Borough for their reference. *It is recommended that only those areas that have been amended by the Environment Agency since the previous SFRA review are reflected in Flood Zone 3 and Flood Zone 2 of the SFRA flood maps.* This ensures that the more rigorous analyses carried out as part of the SFRA process are not inadvertently lost by a simple global replacement of the SFRA flood maps with the Flood Zone Maps.

Question 4

Has the implementation of the SFRA within the spatial planning and/or development control functions of the Borough raised any particular issues or concerns that need to be reviewed as part of the SFRA process?

Appendix A
Assessment of Risk to Life – Flood Hazard
London Borough of Richmond upon Thames

Definition of Flood Hazard (Tidal or Fluvial)

The assessment of flood risk generally considers the maximum extent to which flooding will occur during a particular flood event. This provides the basis for assessing broadly the areas potentially impacted by flooding. Of equal importance however is the speed with which flooding occurs as river levels rise. The inundation of floodwaters into low lying areas can pose a considerable risk to life.

Substantial research has been carried out internationally into the risk posed to pedestrians during flash flooding. This research has concluded that the likelihood of a person being knocked over by floodwaters is related directly to the depth of flow, and the speed with which the water is flowing. This is referred to as 'Flood Hazard'.

For example, if a flood flow is relatively deep but is low energy (i.e. slow moving), then an average adult will be able to remain standing. Similarly, if the flow of water is moving rapidly but is very shallow, then once again an average adult should not be put off balance. If the flow is both relatively deep and fast flowing, then a person will be washed off their feet, placing them at considerable risk. The risk to health and safety as a result of submerged hazards during flooding conditions (given the often murky nature of floodwaters) is also a consideration.

Defra and the Environment Agency have developed a suite of documents entitled 'Flood Risk to People' (FD2320 and FD2321). This provides guidance to assess and delineate flood hazard in a consistent manner within the UK. Future detailed site based Flood Risk Assessments should also make reference to this document when assessing the potential risk to life posed by flooding (and flood defence failure) as outlined below.

Flood Hazard due to River Flooding

The speed and depth with which the River Thames floods the Borough of Richmond upon Thames is an important consideration. Deep, fast flowing water may potentially pose risk to life. This must be considered when planning future development.

The results of the existing detailed two dimensional hydraulic analysis of the fluvial reaches of the Lower Thames system (i.e. upstream of Teddington Lock), the River Crane and Beverley Brook have been examined to identify areas where floodwaters could pose a risk to life. These results have been used as the basis for delineating the approximate 'high flood hazard zone' for planning purposes.

It has been assumed that the 'extreme, significant and moderate hazard' zones are defined as the product of depth x velocity of the flow, in accordance with 'Flood Risk to People' (FD2320), and it is broadly suggested that development is steered away from these areas wherever possible. Typically, the 'extreme and significant' hazard areas are particularly evident where floodwaters bypass natural meanders in the river channel, resulting in either deep water and/or high velocities.

In summary, the likelihood of a rapid river level rise within the River Thames and possible rapid inundation of urban areas within the London Borough of Richmond upon Thames posing a risk to life is considered to be negligible. This is primarily due to the large River Thames system and its substantial upper contributing catchment area which allows the Environment Agency, with its current flood warning system, to provide forewarning of two (2) days of a pending flood event. It should be noted that the Environment Agency endeavours to meet its flood warning targets but this cannot be guaranteed.

Flood Hazard due to Flood Defence Failure

Structural (breach) Failure

There are a small number of raised defences within the Borough of Richmond upon Thames, providing protection against fluvial and tidal flooding from the River Thames. Flood defences are typically raised structures that alter natural flow patterns and prevent floodwater from entering property in times of flooding.

There is always a residual risk that these defences may fail, resulting from either overtopping and/or breach failure. The latter could result in rapid inundation into overbank areas behind the defence, posing a potential risk to residents, pedestrians and property that may be in the path of the floodwaters.

It is recognised that a breach failure of the River Thames defences will, over a period of time, result in the inundation of a relatively large area. The extent of inundation will be entirely dependent on the height of the defence, the height of the river level, and the location of the breach failure. Within Richmond, it is important to recognise that the topography of the Borough is such that the dispersal of floodwater following a breach may equally affect any area within Zone 3a High Probability.

It is important to highlight however that, following the initial 'burst' of water through the defences the flood wave will be relatively shallow and unlikely to pose a risk to life. The greatest Flood Hazard is the rapid, deep and fast flowing water immediately behind the breach. Tidal defence breach modelling, and assessment of flood hazard following a breach, is outlined in Appendices B and C respectively.

Structural Condition

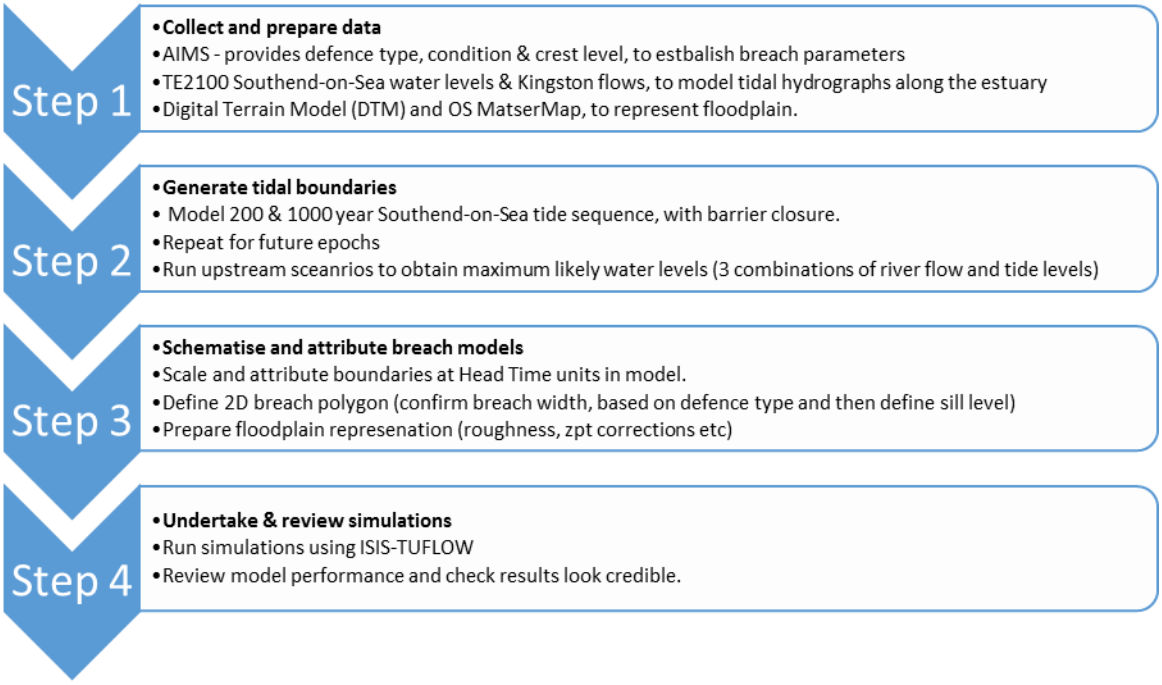
Spatial planning decisions are taken to allocate land for future development that will provide homes and business premises for decades, if not centuries. It is argued that the structural condition of the defences at the time of the decision is somewhat irrelevant. It is not possible for the planning process for 'foretell' decisions with respect to future investment in flood defence. Rather a 'worst case' situation must be considered, such that the planning decision can be made with the assurance that the residual risk of defence failure does not affect the future sustainability of the proposed development.

It is essential that the structural condition of the defences is reviewed at the time of construction (planning application). The commitment to long term maintenance must also be considered to ensure the future integrity of the defence over the lifetime of the development. To this end, it is important to recognise that the structural integrity of the existing flood defences is integral to the sustainability of both existing and future development in Richmond. Without the raised defences, the severity and frequency of flooding in these areas will increase. It is essential that the detailed site based Flood Risk Assessment for all potential future development in defended areas of the Borough considers both the likelihood and consequence of defence failure near the proposed site.

Appendix B
Breach Modelling Methodology

Breach Modelling - Thames Tidal Breach Modelling Study (EA / CH2M Hill, March 2015)

The method applied to this study follows the same approach adopted in the previous tidal Thames breach modelling, but updates the data used to set up and simulate each breach. The method is summarised in the figure below:



The method used to define the breaches involved using modelled ISIS breach units linked to Tuflow floodplain model to create 1D/2D models. This approach provides significant benefits compared to the method applied in the previous study undertaken in 2012. By allowing updates of hydraulic model breach characteristics including breach sill level, width, weir coefficient and formation over time, without the need to change multiple Tuflow files. This provides the benefit of enabling future users test new defence specific breach characteristics if required.

Using a 1D breach unit in conjunction with the River Thames tidal water levels, results in the creation of a flow hydrograph that is then input in to the Tuflow flood plain model. This was undertaken using a Tuflow SX line to distribute the flow across the same width as the breach width. The SX line (inflow in to the 2D domain) location is explained below in 'Determining Breach Sill Level' below:

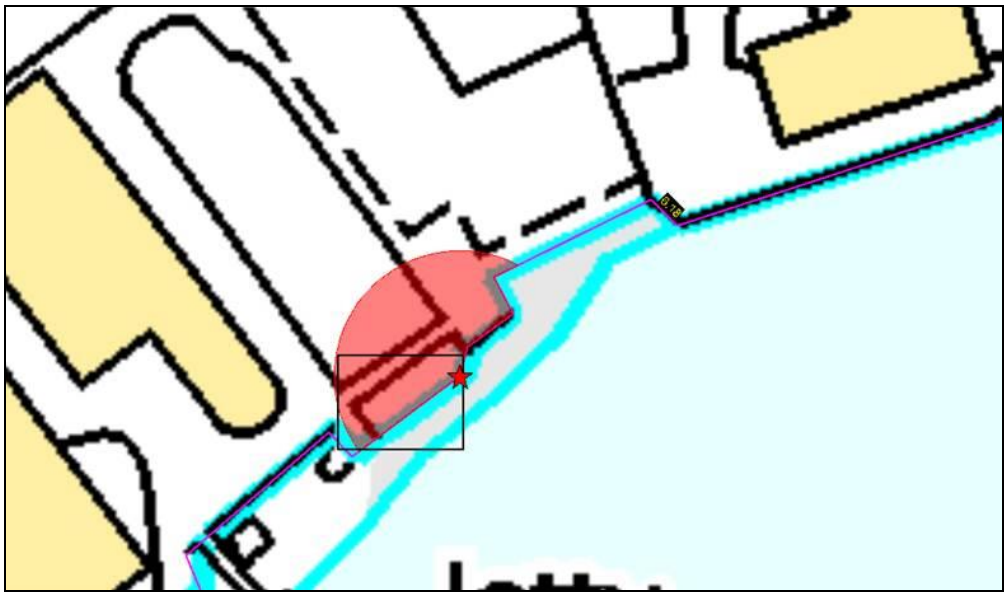
Breach Width

The factors and physics that influence the overall breach width are extremely complex, and the application of a generic approach to the identified breach locations is problematic due to the complexity of interacting failure modes, loading conditions, data scarcity and the non-homogeneity of most defences along the River Thames. The current breach guidance is based on observed historical breach data and specifies that hard defence breaches should be modelled as 20m wide, and soft defence breaches as 50m wide.

Breach Sill (Invert) Level

The original breach polygons (providing locations) from the 2012 Thames Breach Modelling Study were used as the location of the proposed breaches in this updated study. For some breach locations, the distance the breach extended in to the floodplain (the scour distance) and the modelled breach sill level were subsequently thought to be unrealistic and to result in overly conservative flood risk estimates.

To represent more realistic breach scour distances in to the floodplain and therefore breach sill levels, the breach scour distance was extended in the floodplain by the same distance as the breach width. This process is detailed below:



In the example above, the black rectangle is the original breach location polygon from the previous study. The red star shown is the breach centroid. Once this breach centroid was created, the old breach polygon was no longer used in this study.

A search radius was then created from the breach centroid, extending out by the same distance as the full breach width (20m for hard defences and 50m depending for soft defences), and trimmed to the flood defence line. In this example the red shading is the 20m radius from the breach centroid, trimmed to the flood defence line.

A GIS query was then undertaken to determine the lowest elevation within the breach radius polygon, which has then been taken as the breach sill level (Invert Level) used in the 1D breach unit. It should be noted that the variation in floodplain levels within these small (especially when only 20m) search areas was generally found to be minimal.

An automated GIS approach was taken to generate search radius for the breach locations and to automatically extract a breach sill level from the DTM. A reality check on the breach sill levels was undertaken to ensure that the correct elevation was extracted during the automated process.

Key Assumptions

Breaching of flood defences is very rare, in a large part because the Environment Agency is effective at maintaining a targeted programme of inspection and maintenance for their most critical assets. As such, evidence about how a breach would develop, and therefore, how to represent such events in a model, is hard to establish. From previous studies (especially the 2011/12 study), we understand the model to be sensitive to the following assumptions:

- Grid resolution – the resolution at which the height of the ground is represented in the model can have a local impact on flow paths across the floodplain. In this study, a 5m model grid is used.
- Type of ground model – the ground model can take various forms. LiDAR is collected with buildings still present, but can then be filtered to remove buildings. Buildings will vary in permeability and the level of obstruction that they cause to flood waters. Assumptions need to be made, and in this study, buildings are represented as solid blocks, 5 metres high. Alternative ways of representing them would be via short ‘stubs’ (say 300mm above ground level) or simply as areas of very high roughness.

- Roughness – In reality, a variety of factors will influence the roughness of the floodplain, so we start by adopting empirical values based on local land use, and then undertake sensitivity tests around these baseline values.
- Grid orientation – As with the previous 2011/12 study, all embayment's have been modelled using the same north-south grid orientation.
- Inflow location relative to river – The inflow location (model boundary) is always placed land side of the defence. This is consistent with the 2011/12 study, and provides a more conservative (bigger) estimate of flood extent.
- Timing of breach – In the model, a 35 hour tidal sequence is run through the breach, spanning 3 tidal peaks. The breach is 'open', adopting the designated sill level throughout the simulation. Different assumptions concerning timing of breach (and barrier closure in the event of a breach upriver of the Thames Barrier) would affect the volume of water inundating the floodplain.

The Thames Tidal Breach Modelling Study Report (March 2015) provides further background and reporting on model sensitivity to the above assumptions. ***Note that the Environment Agency has an ongoing programme to update breach and they should be consulted in all cases to ensure the best available information is used to inform development.***

Appendix C
Assessment of Flood Hazard

Assessment of Flood Hazard

The flood hazard has been calculated as a product of depth and velocity in accordance with Table E1 below (Defra FD2320).

Table E1 Hazard to People as a Function of Velocity and Depth[47]

Depth Velocity Factor D* (V+0.5)	Flood Hazard	Description
< 0.75	Low	Caution
0.75 – 1.25	Moderate	Dangerous for some people
1.25 – 2.5	Significant	Dangerous for most people
> 2.5	Extreme	Dangerous for all

The Tidal and Fluvial Flood Hazard Maps for the SFRA can be seen in Figures C-1 to C-10.

[47] Defra/EA - Flood Risks to People, FD 2321/TR1, March 2006.

Appendix D

London Borough of Richmond upon Thames SFRA

User Guide

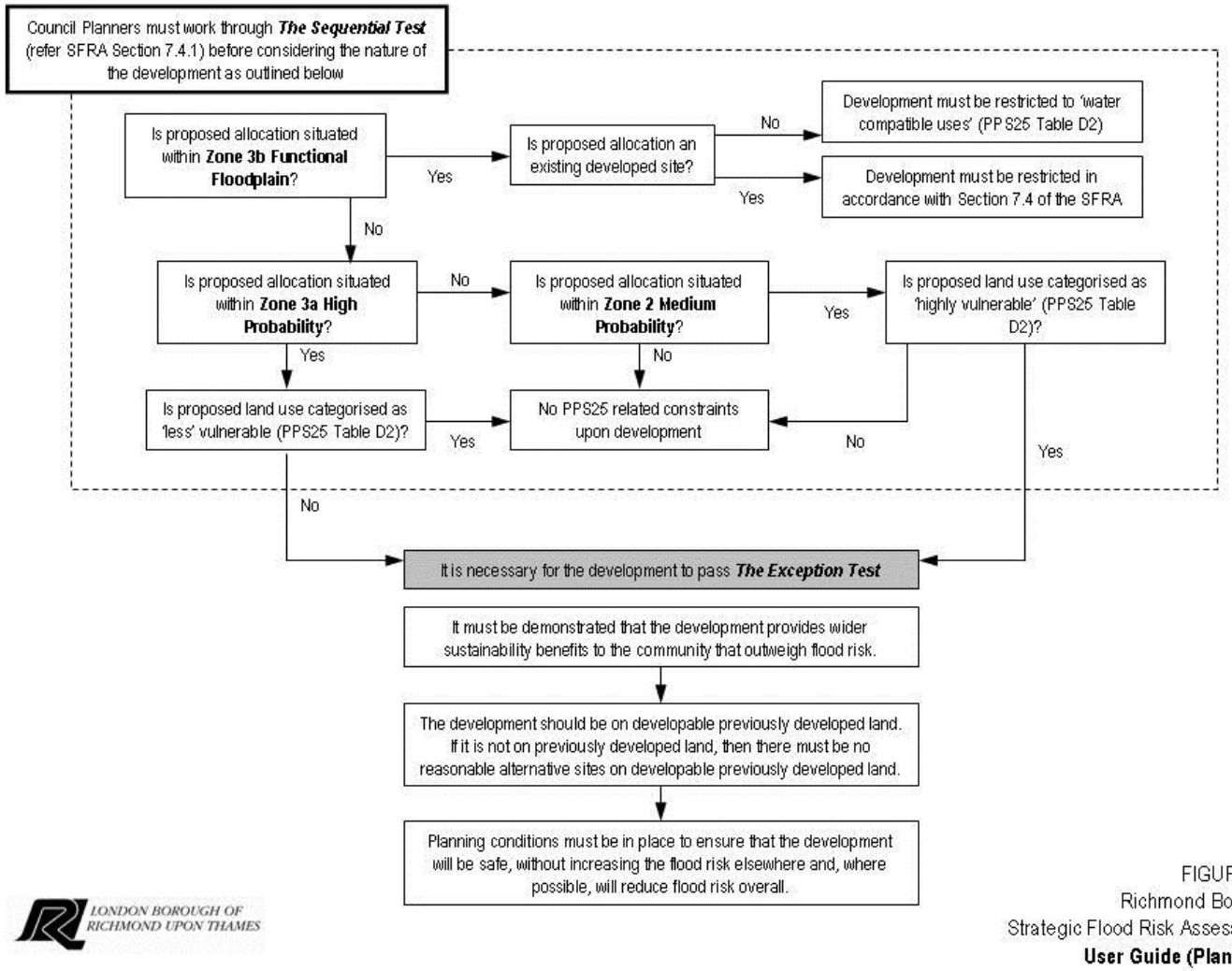


FIGURE A1
Richmond Borough
Strategic Flood Risk Assessment
User Guide (Planning)

PPS25 and its Practice Guide have now been superseded by the NPPF – but the process above remains the same within the NPPF.

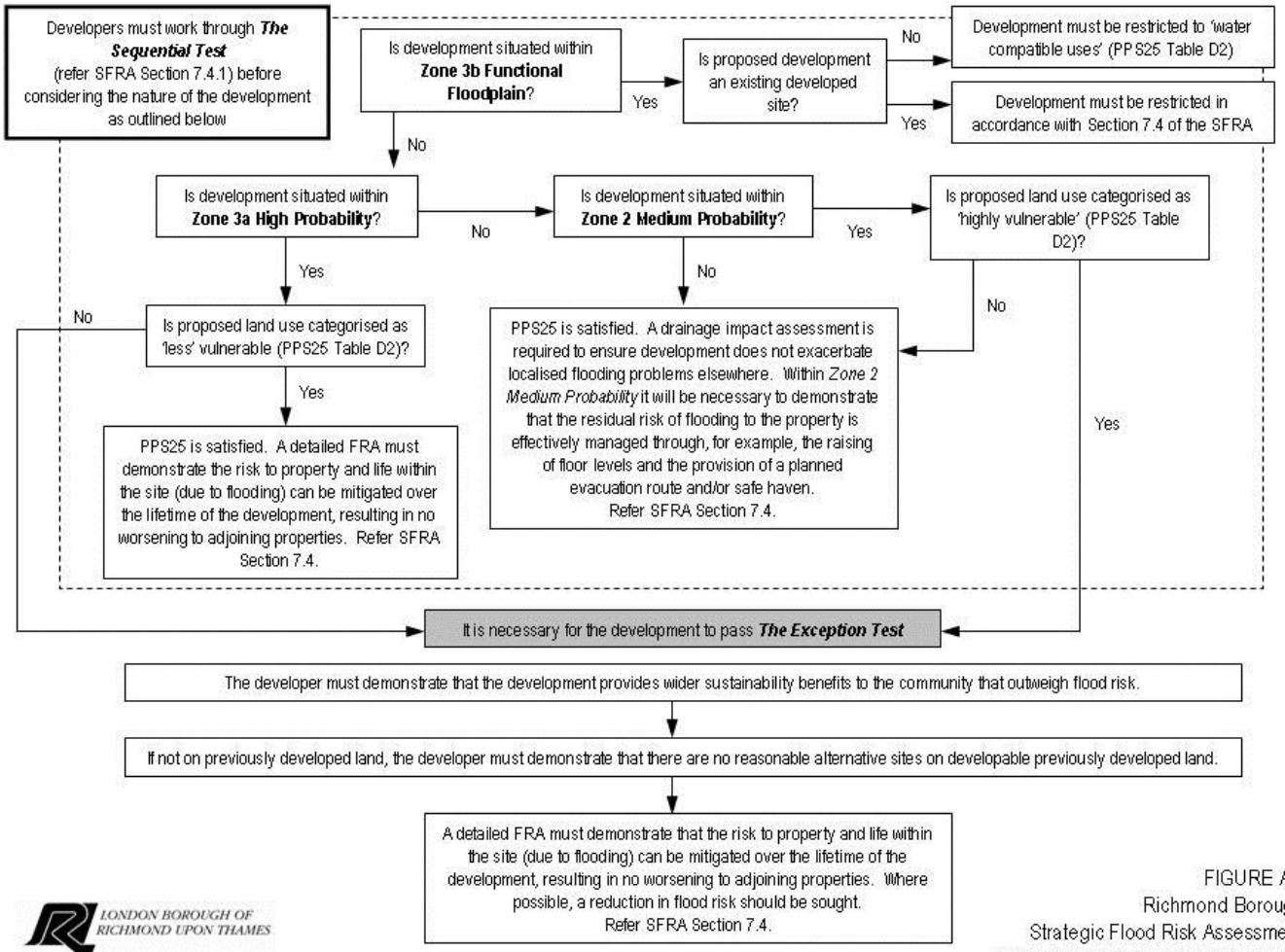


FIGURE A2
Richmond Borough
Strategic Flood Risk Assessment
User Guide (Development Control)

PPS25 and its Practice Guide have now been superseded by the NPPF – but the process above remains the same within the NPPF.

Appendix E
Safe Access & Egress Design Requirements

‘Safe’ access and egress is to be designed to meet the following strict criteria:

“FD 2320/TR2: Flood Risk Assessment Guidance for New Development”, provides advice on the assessment of safe access and exit:

“New developments are required to provide safe access and exit during a flood and the measures by which this will be achieved should be clear in the Flood Risk Assessment (FRA). Safe access and exit is required to enable the evacuation of people from the development, provide the emergency services with access to the development during a flood and enable flood defence authorities to carry out any necessary duties during the period of flood. A safe access or exit route is a route that is safe for use by occupiers without the intervention of the emergency services or others. Safe routes should be identified both inside and beyond the boundary of the new development. Even where a new development is above the floodplain and considered acceptable with regard to its impact on flood flows and flood storage, it should be demonstrated that the routes to and from the development are also safe to use.

The requirements for safe access and exit from new developments in flood risk areas are as follows, in decreasing 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 a 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. The public should not drive vehicles in floodwater.*

Where a dry route is not possible and a route with low flood hazard is identified, the route should not have any service covers that could be removed, or other underwater hazards. It is often difficult to see underwater hazards even in shallow water, particularly at night or if the water is silty. In addition, the route should be clearly marked, for example using painted posts.”

Developments within Zone 3b Functional Floodplain, Zone 3a High Probability and Zone 2 Medium Probability, and are **NOT** offered protection from flood defences:

- ‘Dry’ escape (defined as above the 1% chance in any year fluvial flood level taking into account climate change or the year 2100 tidal flood level - whichever is higher), should be provided for all ‘more vulnerable’ (including residential) and ‘highly vulnerable’ development;
- 'Safe' should preferably be dry (as defined above) for all other uses such as educational establishments, hotels and 'less vulnerable' land use classifications.

Developments within Zone 3a High Probability and Zone 2 Medium Probability, and **ARE** offered protection from flood defences:

- 'Safe' access should preferably be dry for ‘highly vulnerable’ uses;
- 'Safe' access should incorporate the ability to escape to levels above the breach water level[48].

In all instances, it will be necessary to ensure that Emergency Planning in LBRuT Council and the emergency services (consulted via Emergency Planning), accept the proposals.

[48] Defined assuming the full hydrostatic loading of the flood defence upon collapse (as a worst case scenario)

For *major 'highly vulnerable' development*, 'safety' will also need to be ensured through the development of a robust evacuation plan. This should clearly define routes to dry (i.e. 'unflooded') land. This may include routes through flood waters, providing the depth and speed of flow across the evacuation route are below the 'moderate' flood hazard rating threshold in 'Flood Risk to People' (Defra, FD2320)[49].

For *infrastructure development*, 'safety' will also need to be ensured through the development of a robust evacuation plan. This should clearly define dry escape routes (above the 100 year plus climate change flood level) to dry (i.e. 'unflooded') land.

In exceptional circumstances, dry access for 'more vulnerable' and/or 'highly vulnerable' development may not be achievable. In these exceptional circumstances, liaison must be sought with the Environment Agency and Emergency Planning in LBRuT Council to ensure that the safety of site tenants can be satisfactorily managed.

[49] Refer Defra Research Paper FD2320 'Flood Risk to People'

Appendix F
UK Climate Projections 2009
Precipitation

UK Climate Projections 2009 - Precipitation

NOTE: Climate change allowances for the UK were revised by the EA in February 2016 – Guidance can be found here). SFRA Users should consult with the Environment Agency to ensure the most up to date combination of climate change allowance policy and climate change predictions are applied in Flood Risk Assessments and related planning application reviews.

Progression from the 2020s to the 2080s of **changes in summer mean precipitation** under the **high emissions scenario** for the London (administrative) region: Changes at probability levels of 10, 33, 50, 67 and 90% are indicated by different colours and the middle line shows the central estimate.

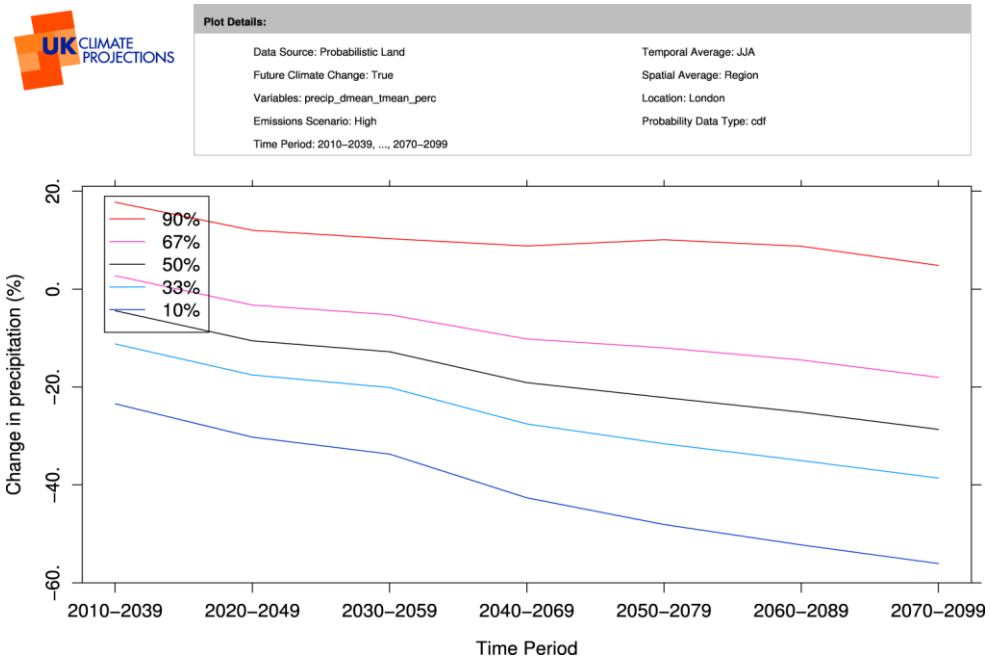


Figure 1: Changes in summer mean precipitation for London (Source:

Progression from the 2020s to the 2080s of **changes in winter mean precipitation** under the **high emissions scenario** for the London (administrative) region: Changes at probability levels of 10, 33, 50, 67 and 90% are indicated by different colours and the middle line shows the central estimate.

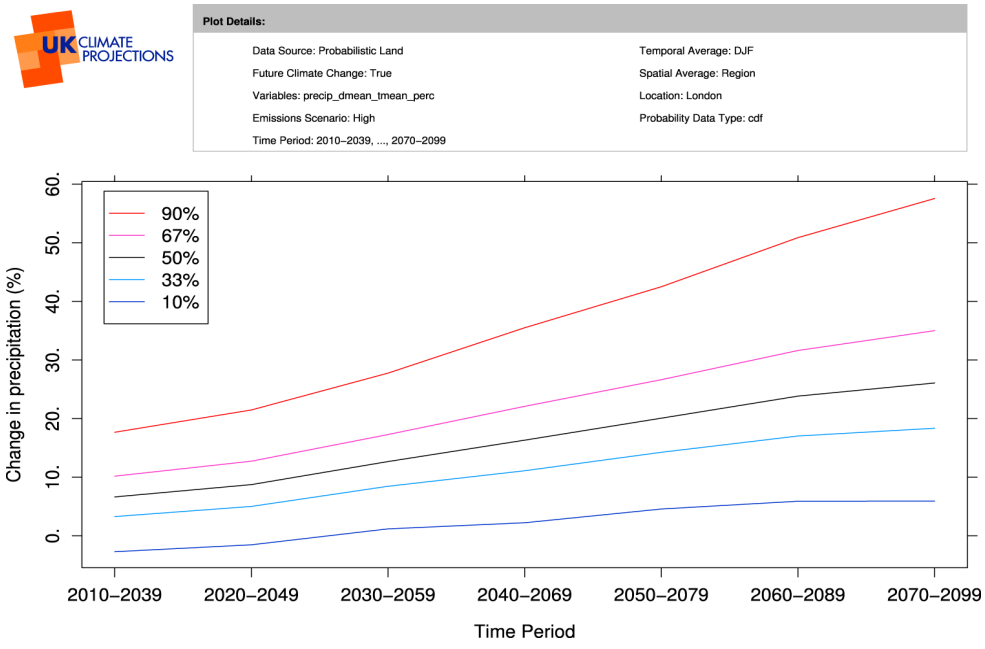


Figure 2: Changes in winter mean precipitation for London (Source: UKCP09)

Appendix G
Sequential Test
Town Centre Boundaries, including 400m buffer area

Refer to Figures:

Annex G East Sheen
Annex G Richmond Town
Annex G Teddington
Annex G Twickenham Town
Annex G Whitton