

# DRAFT SURFACE WATER MANAGEMENT PLAN



**DRAIN LONDON**  
**CITY**  
**OF**  
**WESTMINSTER**



**City of Westminster**

# Quality Management

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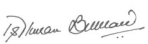
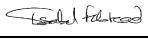

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**RELATED DOCUMENTS**

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## Executive Summary

### Draft SWMP Document Status

June 2011

This draft document has been produced to present the draft outputs of the City of Westminster. This document will remain a live draft allowing the Council to continue to input into the document and agree, in collaboration with relevant stakeholders, the findings and recommendations from the study, including agreement and sign-off of the draft Action Plan. This document does not form the final SWMP for the City of Westminster.

This report is the draft Surface Water Management Plan (SWMP) for the City of Westminster. The study forms part of the wider Drain London Tier 2 project, which involves the delivery of Surface Water Management Plans and Preliminary Flood Risk Assessments for each of the thirty two London Boroughs and the Corporation of City of London.

The draft SWMP builds on previous studies undertaken by the City of Westminster and has been delivered using a four phase approach; Phase 1 – Preparation; Phase 2 – Risk Assessment; Phase 3 – Options; and Phase 4 – Implementation and Review.

#### Phase 1 Preparation

Phase 1 builds on the work undertaken in the previous stage (Tier 1) of the Drain London project that collected and reviewed data from key stakeholders and partners. In addition to this Tier 1 established partnerships with adjacent LLFAs and the Environment Agency as well as other stakeholders responsible for local flood risk management, for example Thames Water and London Underground. The City of Westminster continues to work with these partners and stakeholders to share best practice and resources to deliver their responsibilities as Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA) 2010.

#### Phase 2 Risk Assessment

Drain London Tier 2 modelling was designed to analyse the impact of heavy rainfall events across each London Borough by assessing flow paths, velocities and catchment response. A direct rainfall method was used in the modelling approach that incorporated conservative allowance for the drainage network and infiltration. The dominant surface water flood mechanism in the City of Westminster is pluvial flooding, where water from an extreme rainfall event is not able to drain into the ground due to the heavy urban development in the city or where drainage capacity is exceeded.

The results of the modelling have been used to identify nine Local Flood Risk Zones (LFRZs) in the City of Westminster where flooding affects houses, businesses and infrastructure. From this two Critical Drainage Areas (CDAs) have been identified (**Figure 0 – CDA index Map**) where interlinked sources of flood risk (surface water, groundwater, sewer, main river) may cause flooding in LFRZs during severe weather.

In addition to the CDAs identified, it is recognised that City of Westminster experiences basement flooding as a result of sewer surcharge following heavy rainfall. The area affected by sewer surcharge in the City of Westminster is not identified by a specific LFRZ and because this is not represented in the model outputs, a CDA has not been identified. It is known that the basement flooding is caused by the sewer network in the Counters Creek catchment being filled from the connections in the upstream Boroughs. For this reason, the Counters Creek Catchment has been defined as a Policy area.

### **Phase 3 Options Assessment**

This draft SWMP outlines a surface water management strategy and long term action plan for the management of local surface water flood risk. This should be used to inform the City of Westminster's Local Flood Risk Management Strategy and in turn, influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. In addition to specific actions to manage issues identified in the CDAs and Policy Area, there are a number of generic actions that should be implemented city wide to ensure the long term and sustainable management of water that will also assist in managing surface water flooding and reducing the impact of flooding should it occur.

Details of the preferred options for each of the CDAs are outlined in **Chapter 4** of this report.

### **Phase 4 Implementation and Review**

The draft action plan for the City of Westminster is set out in phase 4 and identifies actions to implement the preferred options identified for the CDAs in the city, as set out in Phase 3. In addition to this, the action plan identifies actions that will assist the City of Westminster to deliver its responsibilities as LLFA under the FWMA.



## Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Survey
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CDA	Critical Drainage Area
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water or sewage at or below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
FCERM	National Strategy for Flood and Coastal Erosion Risk Management
FMfSW	Flood Map for Surface Water
Flood Defence	Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface and groundwater flood risk in England.
FLIPS	Flooding Local Improvement Projects. Non-return valves and pump devices installed to prevent sewage 'back-surfing' into basements in times of heavy rain and allow the property's sewage to flow properly into the sewer network.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
IUD	Integrated Urban Drainage
LB	London Borough
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location
Lead Local Flood Authority	Local Authority as defined in the FWMA responsible for taking the lead on local flood risk management
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
LRF	Local Resilience Forum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency have duties and powers
MSfW	Making Space for Water

Term	Definition
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding generated from a rainfall event and from water flowing over the surface of the ground; occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PA	Policy Area
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
Receptor	In flood risk management, receptor is defined as anything that is affected by flooding such as people, property, transport links and habitats.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act; <ul style="list-style-type: none"> <li>(a) the Environment Agency,</li> <li>(b) a lead local flood authority,</li> <li>(c) a district council for an area for which there is no unitary authority,</li> <li>(d) an internal drainage board,</li> <li>(e) a water company, and</li> <li>(f) a highway authority.</li> </ul>
RMA	Risk Management Authority
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment



Term	Definition
Significant Harmful Consequences	Memorable past floods or otherwise registered on a national scale (such as the summer 2007 event) even if only occurring over a relatively small area
SMP	Shoreline Management Plan
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface Water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
WAG	Welsh Assembly Government
WaSC	Water and Sewerage Company

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## Figures

The following figures are included in the body of the report. Additional figures are included in Appendix D

**Figure 0** - CDA Index Map

**Figure 1.4.1** - LiDAR Topographic Survey

**Figure 1.4.2** - Land Use Areas

**Figure 3.2.1a** - Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

**Figure 3.2.1b** - Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

**Figure 3.2.2** - Environment Agency Flood Map

**Figure 3.2.3** - Increased Potential for Elevated Groundwater Map

**Figure 3.8.1a** – Group3\_004: Paddington Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

**Figure 3.8.1b** - Group3\_004: Paddington Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

**Figure 3.8.2a** – Group3\_005: West Westminster Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

**Figure 3.8.2b** - Group3\_005: West Westminster Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

# 1.0 Introduction

## 1.1 What is a Surface Water Management Plan?

1.1.1 A Surface Water Management Plan (SWMP) is a plan which outlines the preferred surface water management strategy in a given location. In this context, surface water flooding is described as flooding from sewers and drains, groundwater, as well as runoff from land, small water courses and ditches that may occur as a result of heavy rainfall.

1.1.2 This SWMP study has been undertaken as part of the Drain London Project in consultation with key local partners who are responsible for surface water management and drainage in the London area – including Thames Water, the Environment Agency and Transport for London. The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

1.1.3 This document sets out a long-term action plan to manage surface water which will be used to inform the City of Westminster's Local Flood Risk Management Strategy, which in turn will influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

## 1.2 Background

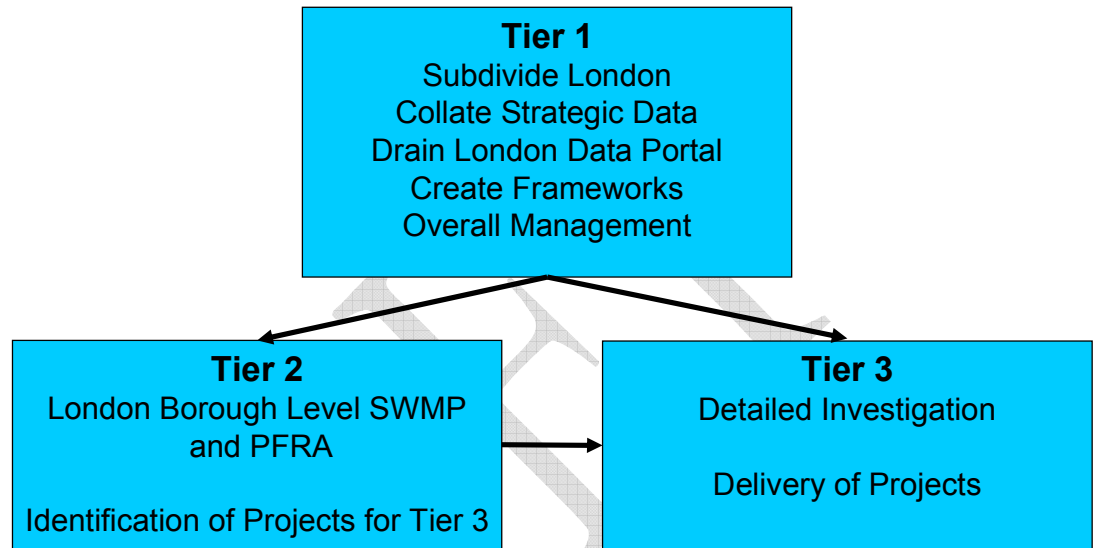
1.2.1 In May 2007 the Mayor of London consulted on a draft Regional Flood Risk Appraisal (RFRA). One of the key conclusions was that the threat of surface water flooding in London was poorly understood. This was primarily because there were relatively few records of surface water flooding and those that did exist were neither comprehensive nor consistent. Furthermore the responsibility for managing flood risk is split between the City of Westminster and other organisations such as Transport for London, London Underground, and Network Rail, and relationships between the Environment Agency and Thames Water and their role in the management of other sources of flood risk were unclear. To give the issue even greater urgency it is widely expected that heavy storms will increase in frequency with climate change.

1.2.2 The Greater London Authority, London Councils, Environment Agency and Thames Water commissioned a scoping study to test these findings and found that this was an accurate reflection of the situation. The conclusions were brought into sharp focus later in the summer of 2007 when heavy rainfall resulted in extensive surface water flooding in parts of the UK such as Gloucestershire, Sheffield and Hull causing considerable damage and disruption. It was clear that a similar rainfall event in London would have resulted in major disruption. The Pitt Review examined the flooding of 2007 and made a range of recommendations for future flood management, most of



these have been enacted through the Flood and Water Management Act 2010 (FWMA).

1.2.3 Defra recognized the importance of addressing surface water flooding in London and fully funded the Drain London project. The Drain London project is broken down using a ‘tier’ based approach as shown below in **Figure 1.1**.



**Figure 1.1: Drain London Project ‘Tier’ Structure**

1.2.4 **Table 1.1** below further describes the activities undertaken in each of the Tiers. The management groups are shown in **Figure 1.2**. This SWMP report is a direct output from Tier 2.

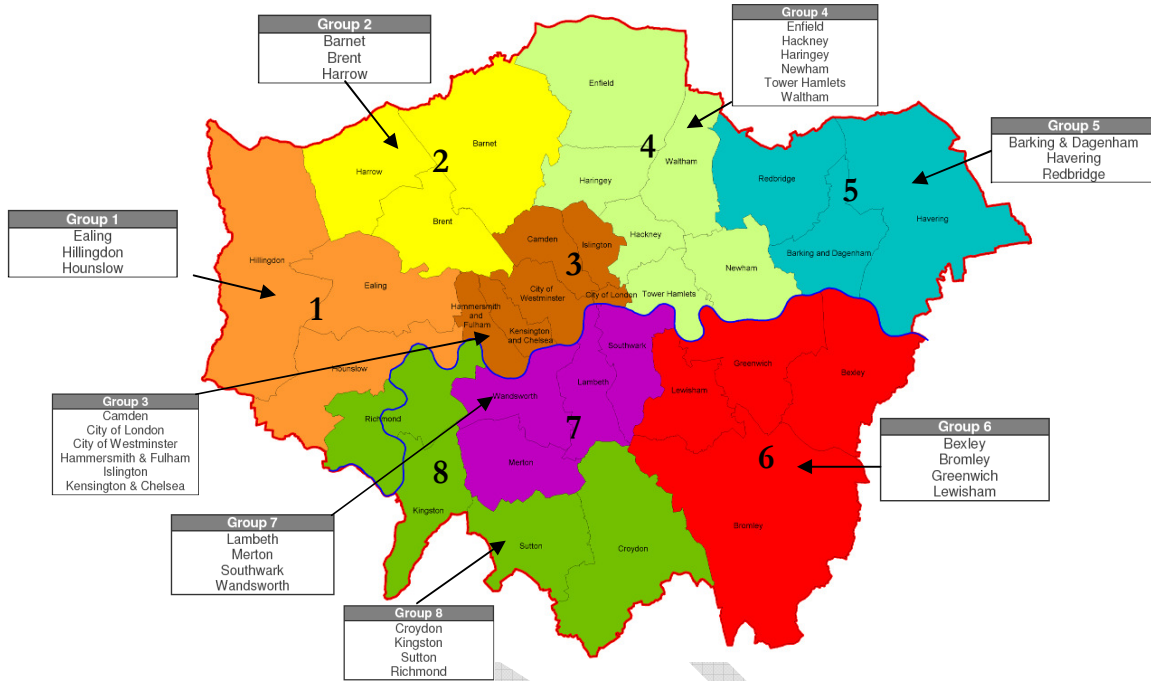
**Table 1.1: Summary of ‘Tier’ Activities**

Tier	Summary
Tier 1	<ul style="list-style-type: none"> <li>a) A high level strategic investigation to group the 33 separate boroughs into a smaller number of more manageable units for further study under Tiers 2 and 3.</li> <li>b) Collection and collation of relevant information across all London Boroughs and strategic stakeholders including the Environment Agency, Thames Water and Transport for London.</li> <li>c) Development of a web based ‘Portal’ to provide data management, data storage and access to the various data sets and information across the ‘Drain London Forum’ (DLF) participants and to consultants engaged to deliver Tiers 2 and 3.</li> <li>d) Develop technical framework documents and prioritisation tools to guide delivery of Tiers 2 and 3.</li> </ul>

Tier	Summary
Tier 2	<ul style="list-style-type: none"> <li>a) Delivery of 33 Borough-level intermediate Surface Water Management Plans (SWMPs) within the management groups to define and map Local Flood Risk Zones, Critical Drainage Areas and flood policy areas and produce an Action Plan for each borough.</li> <li>b) Delivery of 33 Borough-level Preliminary Flood Risk Assessments to comply with the Flood Risk Regulations 2009 requirements for Lead Local Flood Authorities (LLFAs).</li> <li>c) Define a list of prioritised Critical Drainage Areas for potential further study or capital works in Tier 3, using the prioritisation tool developed in Tier 1.</li> </ul>
Tier 3	<ul style="list-style-type: none"> <li>a) Further investigations into high priority Local Flood Risk Zones/Critical Drainage Areas to further develop and prioritise mitigation options.</li> <li>b) Delivery of demonstration projects of surface water flood mitigation solutions identified in Tier 2 SWMPs.</li> <li>c) Funding or co-funding within the London area for green roofs and other types of sustainable urban drainage (SUDS).</li> <li>d) Set up of at least two community flood plans in local communities at risk from flooding</li> </ul>

1.2.5

The objective of the Drain London Tier 2 is to produce draft Surface Water Management Plans (SWMPs) for each London Borough. Through the subsequent enactment of the FWMA, boroughs are required to produce Preliminary Flood Risk Assessments (PFRA). The Drain London project has been adjusted to deliver both a PFRA and a SWMP for each London Borough. This will be a major step in meeting borough requirements as set out in the FWMA. Another key aspect of the Act is to ensure that boroughs work in partnership with other Lead Local Flood Authorities and agencies. Drain London assists this by organising London Boroughs into different groups creating sub-regional partnerships that encourage partnership working as set out in **Figure 1.2**.



**Figure 1.2 – Drain London Sub-regional Partnerships**

**1.3**

**Objectives**

1.3.1

The objectives of the SWMP are to:

- Develop a robust understanding of surface water flood risk in and around Westminster, taking into account the challenges of climate change, population and demographic change and increasing urbanisation in London;
- Identify, define and prioritise Critical Drainage Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk (see definitions in **Section 3.8**);
- Make holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments;
- Establish and consolidate partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities;
- Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions;

- Deliver outputs to enable a real change on the ground rather than just reports and models, whereby partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions;
- Meet the City of Westminster's specific objectives as recorded at the outset of the development of the SWMP (further details below); and
- Facilitate discussions and report implications relating to wider issues falling outside the remit of this Tier 2 work, but deemed important by partners and stakeholders for effectively fulfilling their responsibilities and delivering future aspects of flood risk management.

### 1.3.2

The City of Westminster's specific aims and objectives were discussed at the various meetings held throughout the development of the SWMP. These are summarised below:

- Ensure that, where possible, there is consistency with the SFRA undertaken by the City of Westminster and avoid having similar terms that could confuse readers.
- Develop an action plan that is specific to the City of Westminster and which builds on Group 3 stakeholder workshops.
- Ensure the SWMP action plan promotes the integration and ownership of the relevant departments within the City of Westminster (those departments that deal with highways, parks, development control, emergency planning, etc).
- Investigate if the SUDS Approval Authority role (as required by the FWMA next year, see details in Section 1.7) could be led at Group 3 level.

## 1.4

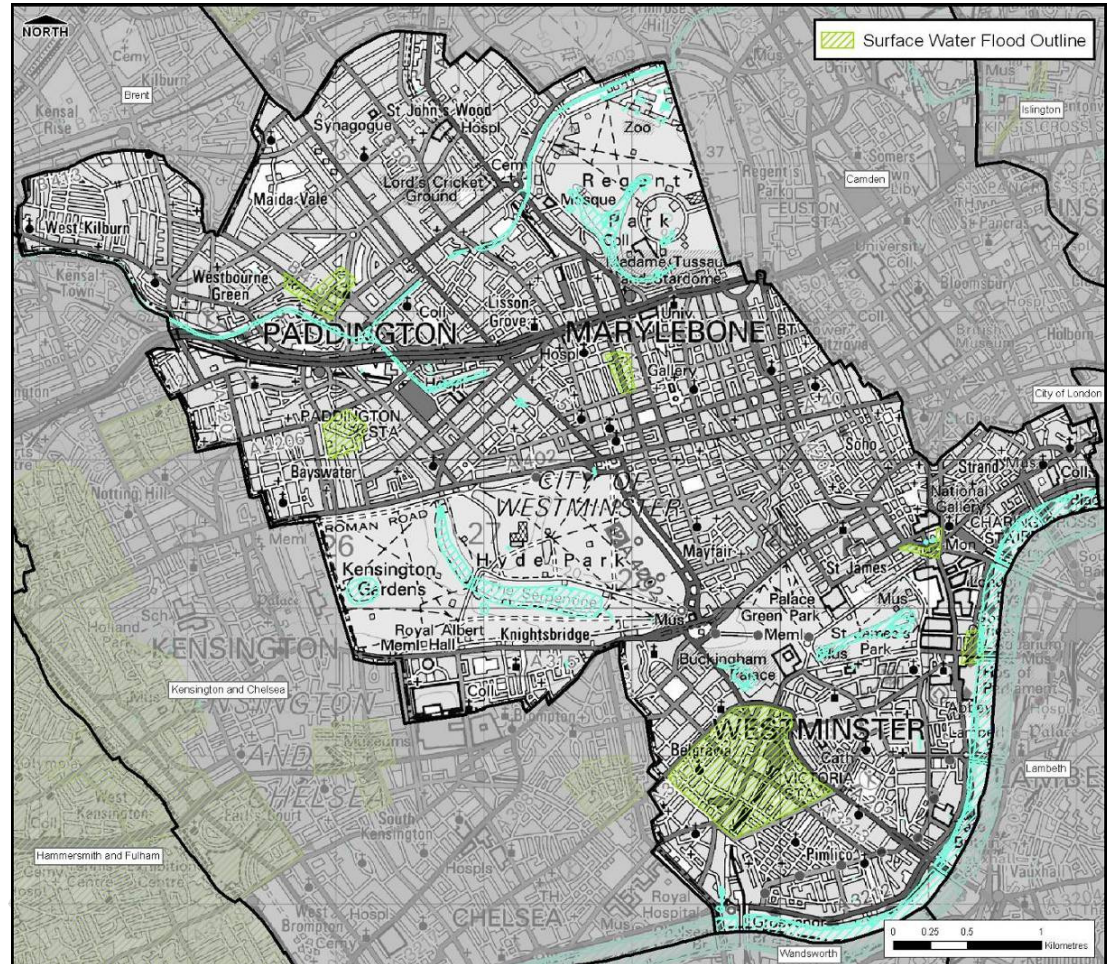
### Study Area

### 1.4.1

#### Topography and Land use

The study area covers the administrative boundary of the City of Westminster (see **Figure 1.3**). It is located in the north of London and covers an area of approximately 21.48km<sup>2</sup>. The City of Westminster sits between the London Borough of Brent to the north, London Borough of Camden and City of London to the east, the River Thames to the south and the Royal Borough of Kensington and Chelsea to the west. The A40 Westway, A501 Marylebone Road, and Oxford Street run west to east through the Borough connecting it to central London and neighbouring boroughs. All London Underground tube lines, except the Waterloo and City line, run throughout the City of Westminster.





**Figure 1.3 - Study Area and Locations of Past Floods** (the map shows those LFRZs identified that have evidence of flooding in the past)

- 1.4.2 The **LiDAR Topographic Survey Map** (Figure 1.4.1) shows that the general terrain gradients fall towards the River Thames in a north-westerly to south-easterly direction, where ground levels vary from around 50m to 0m AOD by the River Thames.
- 1.4.3 **Figure 1.4** below, taken from Westminster SFRA, shows the predominant land uses within the City of Westminster (also shown in the **Land Use Areas Map** Figure 1.4.2). The City of Westminster is heavily urbanised but has 4km<sup>2</sup> of Royal Parks and 31 Sites of Importance for Nature Conservation (SINCs); of these five are SINC of Metropolitan Importance, 21 historic squares and gardens. There are over 11,000 listed buildings and 55 Conservation Areas which cover approximately 75% of the city.



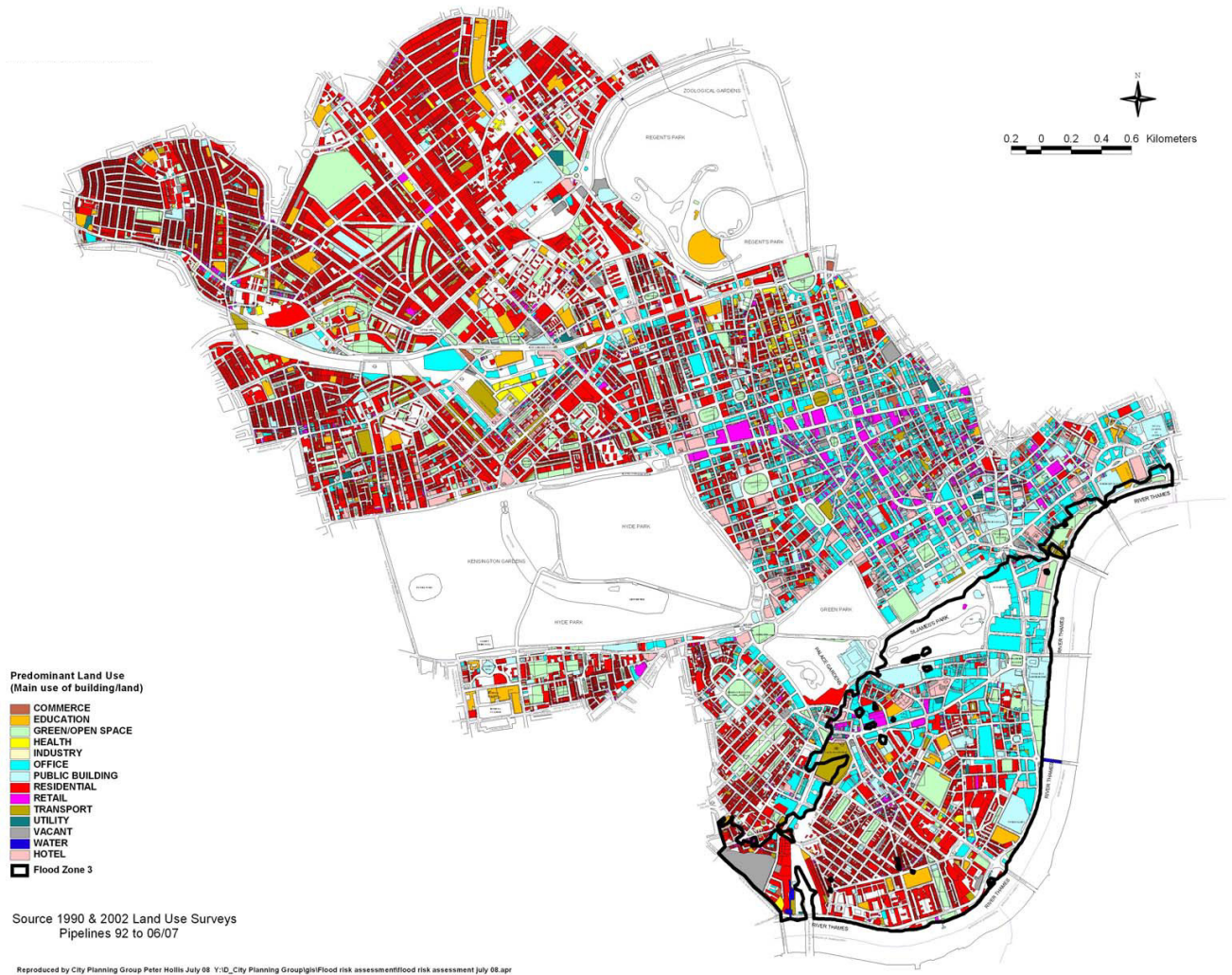


Figure 1.4 – Predominant Land Use in City of Westminster

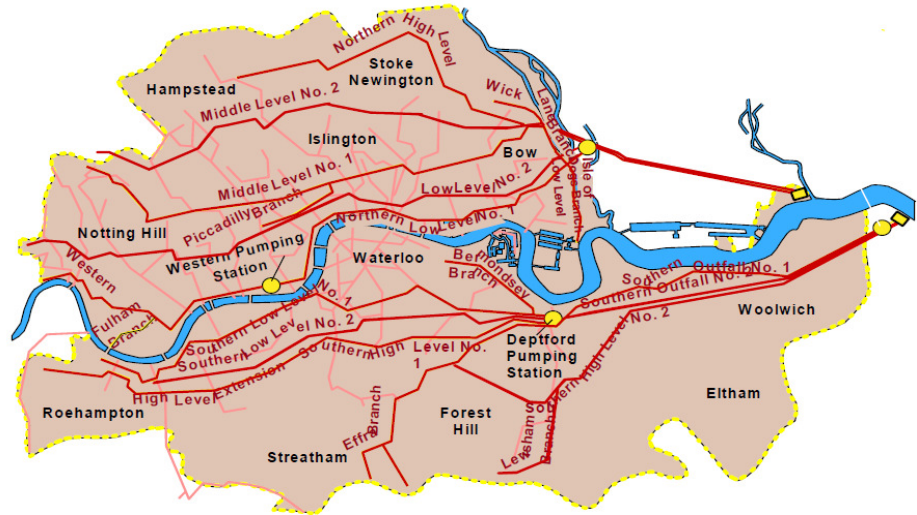
1.4.4

As would be expected in the heart of the London, the City of Westminster contains important national and local infrastructure as detailed below:

- Seven underground stations servicing ten of the eleven London Underground lines.
- Four overground railway stations including the transport hubs of Charing Cross, Paddington, Marylebone and Victoria.
- Seven police stations including Scotland Yard
- One fire station
- One ambulance station
- Universities and Colleges, including the University of Westminster, London School of Economics and the London Business School.
- H.M. Treasury and the Cabinet Office
- St Mary's Hospital
- 41 primary schools and 10 secondary schools
- Buckingham Palace, the Houses of Parliament as well as a number of head offices of large national and international companies.

- 1.4.5 The Core Strategy Proposals Map that was adopted in January 2010 identifies five proposal sites having an area of more than four hectares. These relatively significant development proposals for the City of Westminster are:
- a) Paddington station and Environs (transport infrastructure);
  - b) St Mary's Hospital (residential, leisure, offices and retail use);
  - c) Victoria railway station (transport and commercial uses);
  - d) Paddington New Yard (transport infrastructure); and
  - e) Chelsea Barracks (residential, community and local services and green open space for play).
- 1.4.6 **Historic Flooding**
- The City of Westminster was affected by the flood events of 1928 and 1953, when the Thames overtopped its defences. Aside from this historic fluvial flooding there are no detailed records of flooding from surface water held by the City of Westminster. However, Victoria Station was badly affected by flash flooding in 2007 and 2009, causing disruption to commuters.
- 1.4.7 The Thames Water DG5 records show some incidents of sewer flooding in the past decade, particularly along the Thames and in the north west of the City of Westminster.
- 1.4.8 **Interactions with Neighbouring Local Authorities**
- Evaluation of surface water flood risk needs to take into account interactions with adjacent LLFAs, local planning authorities, pipe network systems, catchment contributions and other sources of flood risk that are not constrained by administrative boundaries.
- 1.4.9 As outlined in **Figure 1.3** the City of Westminster shares boundaries with the London Boroughs of Brent (North), Camden, City of London (East) and Kensington and Chelsea (West). Modelling and mapping of surface water flow routes for extreme events demonstrates that City of Westminster has a few minor flow routes that do not extend far into and out of the city. These routes are observed in several locations as outlined below (see **Figure D8b**, **Figure D9b**, **Figure D10b** and **Figure D11b** in **Appendix D**).
- From London Borough of Camden into City of Westminster towards the Strand and St James area along the Charing Cross Road and Shaftsbury Avenue.
  - From the City of Westminster into the Royal Borough of Kensington and Chelsea along Kensington Gore, at the south west boundary of Hyde Park, toward Gloucester Road.
- 1.4.10 The Thames Water drainage system conveys foul flow together with surface runoff that enters the system through drain pipes and road gulleys. North of the River Thames, a series of deep west – east interceptor sewers collect high

level sewers draining south towards the river, transporting all flows to Beckton sewage treatment works in east London. Through this underground system (**Figure 1.5**), the City of Westminster receives flows from the Royal Borough of Kensington and Chelsea in the west. It transfers flow towards Camden and the City of London in the east.



**Figure 1.5: The Beckton Sewer Catchment**

1.4.11

**Future Urbanisation and Development**

The City of Westminster's growth strategy is set out in the its Core Strategy (adopted January 2011). This outlines an increase in housing by 2011 of 680 units per year, with an anticipated increased target of 770 units per year thereafter, looking to exceed the London Plan's target of 12,000 houses in the borough by 2025.

- 1.4.12 Future growth and redevelopment is planned for the Westminster Central Activity Zone (CAZ) which includes Marylebone and Fitzrovia, Knightsbridge, the Royal Parks and parts of Pimlico.
- 1.4.13 The London Plan identified Paddington, Victoria and Tottenham Court Road as Opportunity Areas. Future flood risk has been considered as part of the London Regional Flood Risk Assessment and redevelopment in these areas will need to improve surface water management and reduce flood risk.
- 1.4.14 Plans for further urbanisation and change of land use within the Borough will present a challenge to the current drainage system but also the opportunity to address and manage surface water flood risk associated with the drainage network.
- 1.4.15 The draft SWMP for the City of Westminster provides guidance and recommendations for the sustainable long term management of surface water flood risk in the city.

## 1.5 **Flooding Interactions**

- 1.5.1 The City of Westminster is protected from tidal and fluvial flooding from the River Thames through flood defences that provide a high standard of protection (1:1000 year for 2030 as estimated when the defences were designed).
- 1.5.2 There are two lost rivers in the City of Westminster, the River Westbourne and River Tyburn. These rivers were culverted and turned into sewers and form part of the current combined sewer network. The main method for removing surface runoff is from the Thames Water combined sewer system and this does not interact with the River Thames in normal storm conditions.
- 1.5.3 St James' Park Lake, Regent's Park Lake, Kensington Gardens Lake and the lakes in Buckingham Palace Garden are the remnants of the 'hidden' rivers in City of Westminster. Although the 'hidden' rivers themselves are unlikely to result in flooding, any water sources they serve are susceptible to flooding.
- 1.5.4 Other source of flood risk within the City of Westminster comes from the Regents Canal and the Serpentine.

### 1.5.5 **The River Thames**

The River Thames poses the most significant flood risk to the City of Westminster and although the City is currently well defended against such a risk through a combination of local defences and the Thames Barrier, a significant residual risk still remains since the consequences of flooding are high. The River Thames not only poses a direct risk from overtopping or breach of flood defences but also influences the risk of flooding from secondary sources such as sewer flooding.



1.5.6 **Regents Canal**

Regents Canal was constructed in 1820 to form the London arm of the Grand Union Canal. It stretches from Limehouse basin in Docklands to Paddington passing through Mile End, Hackney, Islington, King's Cross, Camden, Regents Park and Little Venice. Currently, the Camden lock system apparently holds a head of water of some 25 miles. The water levels within the Regents Canal are controlled by British Waterways and for this reason they are considered to pose a minimal risk of flooding.

1.5.7 There are no canal locks within Westminster itself, the closest lock is to the east, and the next lock is at Hampstead Road, which is the first of several locks through Camden. Any malfunction to the east of Westminster would cause the water to flow east, not into Westminster. To the west, the level of the canal starts to rise at Cowley lock, which is near the M25 and located 16 miles from Westminster.

1.5.8 **The Serpentine**

The Serpentine in Hyde Park sits within the administrative boundary of the City of Westminster and was created by damming in 1730. There is the potential risk of dam failure at the east end of the impoundment. The Serpentine falls under the Reservoirs Act 1975. The Royal Parks are responsible for preparing an on-site contingency plan and City of Westminster is responsible for preparing an off-site contingency plan.

1.5.9 **Thames Water Combined Sewer Network**

Most of City of Westminster is drained by the Thames Water combined sewer network that which receives foul flow together with surface runoff from roofs, roads and other areas of hard standing. This sewerage network was designed in the 1860s and has served London well. Over time the area connected to the sewer network has increased progressively reducing its capacity to accommodate heavy rainfall.

**1.6 Linkages to Other Plans**

1.6.1 The increased focus on flood risk over recent years is an important element of adaptation to climate change. The draft SWMP is a live document that should complement and coordinate with existing strategic and local plans. How Drain London links into these documents is set out below:

1.6.2 **Regional Flood Risk Appraisal (RFRA)**

This is produced by the Greater London Authority and gives a regional overview of flooding from all sources. The RFRA will be updated in 2012 to reflect the additional information on local sources of flood risk (surface water, groundwater and ordinary watercourses) from Drain London. This may also generate new policies that would be incorporated into the London Plan when it is reviewed.

**Table 1.2: RFRA Strategic Recommendations Relevant to the City of Westminster.**

**Recommendation 1** All Thames side planning authorities should consider in their SFRA and put in place DPD 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 wall/embankments, in line with policy 5.12, CFMPs and TE2100.

**Recommendation 5:** Developments all across London should reduce surface water discharge in line with the Sustainable Drainage Hierarchy set out in Policy 5.13 of the draft replacement London Plan.

**Recommendation 6:** Regeneration and redevelopment of London's fluvial river corridors offer a crucial opportunity to reduce flood risk. SFRA and policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in PPS25 and the Thames 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
- Ensure that the buildings with residual flood risk are designed to be flood compatible or flood resilient
- Use open spaces within developments which have a residual flood risk to act as flood storage areas

**Recommendation 8:** Organisations responsible for development with large roof areas should investigate providing additional surface water run-off storage.

**Recommendation 9:** Thames Water to continue the programme of addressing foul sewer flooding.

**Recommendation 10:** The groundwater flood risk is kept under review.

**Recommendation 11:** Network Rail should examine the London Rail infrastructure for potential flooding locations and flood risk reduction measures. For large stations, solutions should be sought to store or disperse rainwater from heavy storms; this may involve the need for off site storage.

**Recommendation 12:** London Underground and DLR should keep potential flood risks to their infrastructure and flood risk reduction measures under review and up to date.

**Recommendation 13:** TfL, Highways Agency and London boroughs should continue to monitor the flood risk and flood risk reduction measures at these locations and any others with a potential flood risk.

**Recommendation 18:** Operators of London's emergency services should ensure that emergency plans for flooding incidents are kept up to date and suitable cover arrangements are in place in the event of a flood affecting operational locations.

**Recommendation 19:** Operators of electricity, gas, water and sewerage utility sites should maintain an up to date assessment of the flood risk to their installations and considering the likely impacts of failure, programme any necessary protection measures, this may include secondary flood defences.

1.6.3 **Thames Catchment Flood Management Plan (CFMP)**

The Thames Catchment Flood Management Plan was published in 2008 by the Environment Agency and sets out policies for the sustainable management of flood risk across the whole of the Thames catchment over the long-term (50 to 100 years) taking climate change into account. More detailed flood risk management strategies for individual rivers or sections of river may sit under these.

1.6.4 The Plan emphasises the role of the floodplain as an important asset for the management of flood risk, the crucial opportunities provided by new development and regeneration to manage risk, and the need to re-create river corridors so that rivers can flow and flood more naturally.

1.6.5 This Plan will be periodically reviewed, approximately five years from when it was published, to ensure that it continues to reflect any changes in the catchment. There are links to Drain London where there are known interactions between surface water and fluvial flooding.

**Table 1.3: CFMP Policy Unit**

**TE2100 Policy Unit**

The TE2100 Policy Unit covers the whole of Group 3 including the City of Westminster.

The preferred policy is Policy 4; Areas of low, moderate or high risk where the Environment Agency are already managing the flood risk effectively but where further action may need to be taken to keep pace with climate change.

Key messages are:

- The most sustainable approach to managing future flood risk will be to bring about adaptation of the urban environment. There are some major opportunities to reduce flood risk through the appropriate location, layout and design of redevelopment. This will make properties more resilient or resistant to flood water, therefore reducing the consequences of flooding.
- The Environment Agency will continue to maintain existing defences where appropriate to do so. Where this is not possible flood defences will be replaced in conjunction with redevelopment and as part of an overall catchment scale plan.
- Strategic scale planning is vital to managing flood risk and meeting the needs of a community in a sustainable way.
- Emergency planning is integral to the approach to managing extreme flood events. Although flood risk may be low in places there is limited time for warning and action. It is important for local communities to be aware and prepared for a flood. The Environment Agency will work with other organisations and the communities at risk to focus on these issues.

1.6.6 **Preliminary Flood Risk Assessment (PFRA)**

These are required as part of the Flood Risk Regulations (see details in **Section 1.7**), which implement the requirements of the European Floods Directive. Drain London is producing one of these for each London Borough (LLFA), to give an overview of all local sources of flood risk. In London PFRAs will benefit from an increased level of information relating to surface water from the Drain London SWMPs. Boroughs will need to review these PFRAs every six years.

1.6.7 **Surface Water Management Plans (SWMP)**

Drain London is producing a draft SWMP for each London Borough (this document). They provide much improved probabilistic 2-dimensional modelling and data on what has been made available at a national scale by the Environment Agency. In addition they contain an Action Plan that has been developed in conjunction with both the City of Westminster and relevant other Risk Management Authorities. This data and actions and associated policy interventions will need to feed directly into the operational level of the Borough across many departments, in particular into spatial and emergency planning policies and designations and into the management of local authority controlled land.

1.6.8 **Strategic Flood Risk Assessments (SFRA)**

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25). This provides an important tool to guide planning policies and land use decisions. Current SFRAs have a strong emphasis on flooding from main rivers and the sea and are relatively weak in evaluating flooding from other local sources including surface water, groundwater and ordinary watercourses. The SFRA undertaken by City of Westminster contains detailed investigations of surface water flooding that have been used to underpin the validation of this study. The information from Drain London will assist in confirming and/or improving this understanding.

1.6.9 **Local Development Documents (LDD)**

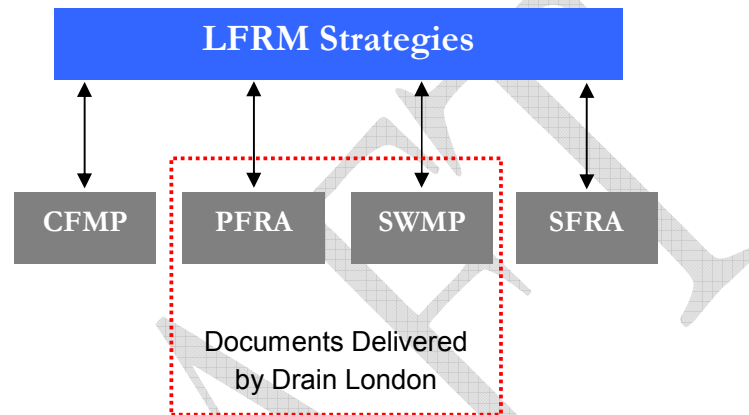
LDDs including the Core Strategy (adopted on 26 January 2011) and any future relevant Plans will need to reflect the results from Drain London. This may include citywide, or locally specific policies for the, for example Critical Drainage Areas. There may also be a need to review Area Action Plans where surface water flood risk is a particular issue. A future SFRA update will assist with this as will the reviewed RFRA and any updated London Plan policies. In producing Opportunity Area Planning Frameworks, the GLA and boroughs will also examine surface water flood risk more closely.

1.6.10 **Local Flood Risk Management Strategies**

The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce a LFRMS. The Flood Risk Regulations 2009 also require a Flood

Risk Management Plan (FRMP) of Flood Risk Areas by December 2015. Whilst Drain London will not actually produce these, the SWMPs, PFRAs and their associated risk maps will provide the necessary evidence base to support the development of LFRMS and FRMP. No new modelling is anticipated to produce these strategies.

**Figure 1.6** below illustrates how the current studies (CFMP, PFRA, SWMP and SFRA) link and underpin the development of a Local Flood Risk Management Strategy.



**Figure 1.6: Linkages between Flood Risk Management Documents**

1.6.11

**Strategic Environmental Assessment**

The Strategic Environmental Assessment (SEA) Directive (2001/42/EC) is implemented in the UK by 'The Environmental Assessment of Plans and Programmes Regulations 2004 (Statutory Instrument No.1633)'. Its objective is 'to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development'.

The flood risk management plans required under the Flood Risk Regulations 2009 fall under the scope of the SEA Directive.

1.7

**Existing Legislation**

1.7.1

The Flood and Water Management Act 2010 (FWMA) presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary water courses). 'Upper Tier' local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

1.7.2

The FWMA reinforces the need to manage flooding holistically and in a sustainable manner. This has grown from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007

floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt's Review of the Summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

### 1.7.3

The FWMA must also be considered in the context of the EU Floods Directive, which was transposed into law by the Flood Risk Regulations 2009 (the Regulations) on 10 December 2009. The Regulations requires three main types of assessment/plan:

- 1) Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by Lead Local Flood Authorities and the Environment Agency by the 22 December 2011. Flood Risk Areas, at potentially significant risk of flooding, will also be identified. Maps and management plans will be developed on the basis of these flood risk areas.
- 2) Flood Hazard Maps and Flood Risk Maps. The Environment Agency and Lead Local Flood Authorities are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.
- 3) Flood Risk Management Plans. The Environment Agency and Lead Local Flood Authorities are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

**Figure 1.7** illustrates how this SWMP fits into the delivery of local flood and coastal erosion risk management (FCERM), and where the responsibilities for this lie.



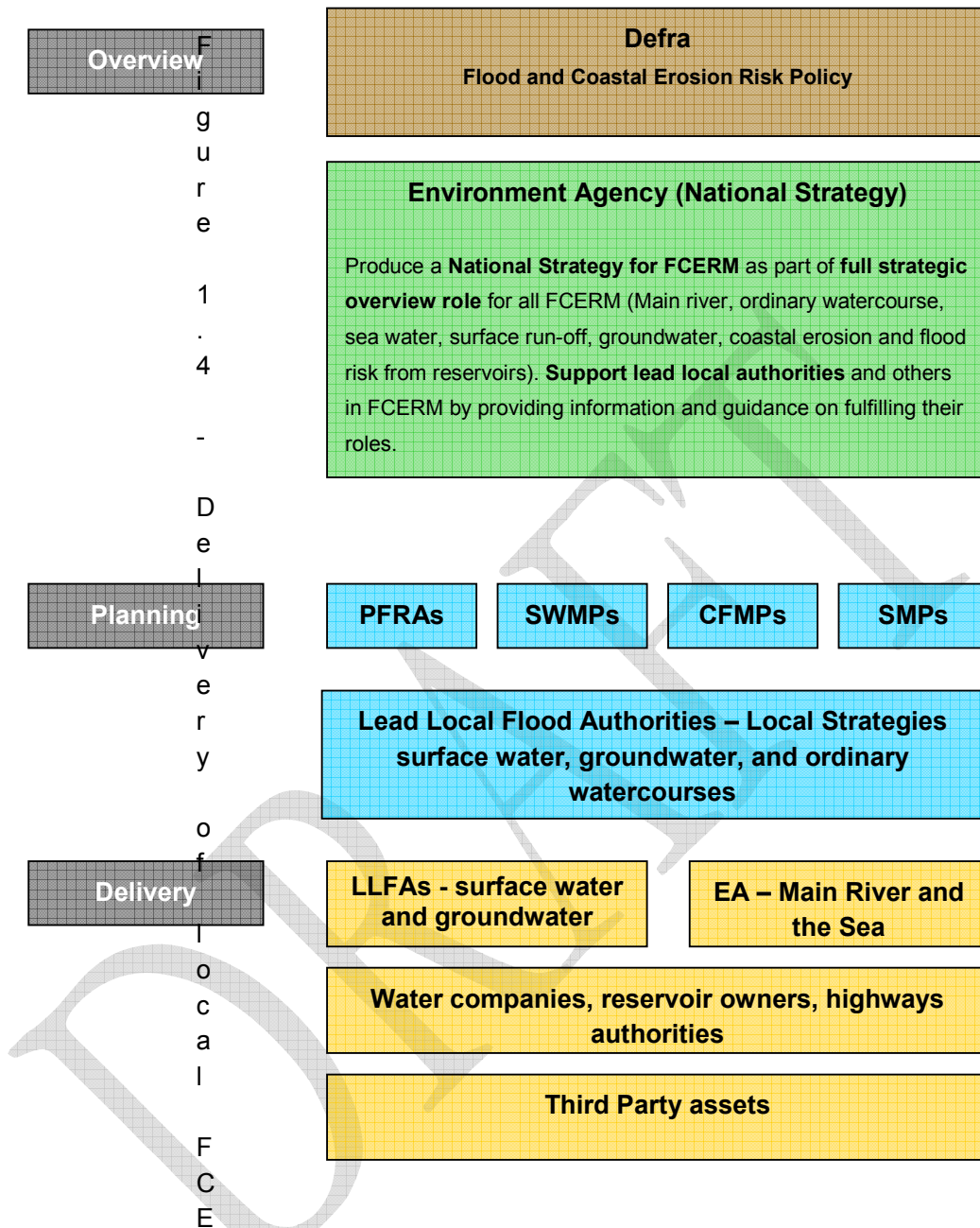


Figure 1.7 - Delivery of local FCERM

## 1.8 Peer Review

1.8.1 It is essential for the Drain London Project that SWMPs are consistent and comparable across Greater London. This is to facilitate:

- Fair, transparent and rapid allocation of funds to identified high priority flood risk areas within London;
- Collaborative working practices between stakeholders; and
- Building of local capability (Council officers and consultants doing work in the future will be able to make use of outputs regardless of who produced them for each Borough).

1.8.2 To ensure consistency and comparability between London Borough SWMPs produced, a Peer Review process has been used. The process involved the four consultant teams working on the Drain London SWMPs independently reviewing each others work. This has ensured that all outputs result from a consistent technical approach, are of a high technical quality and are communicated in the specified formats. The peer review report for this SWMP is included in **Appendix F**.

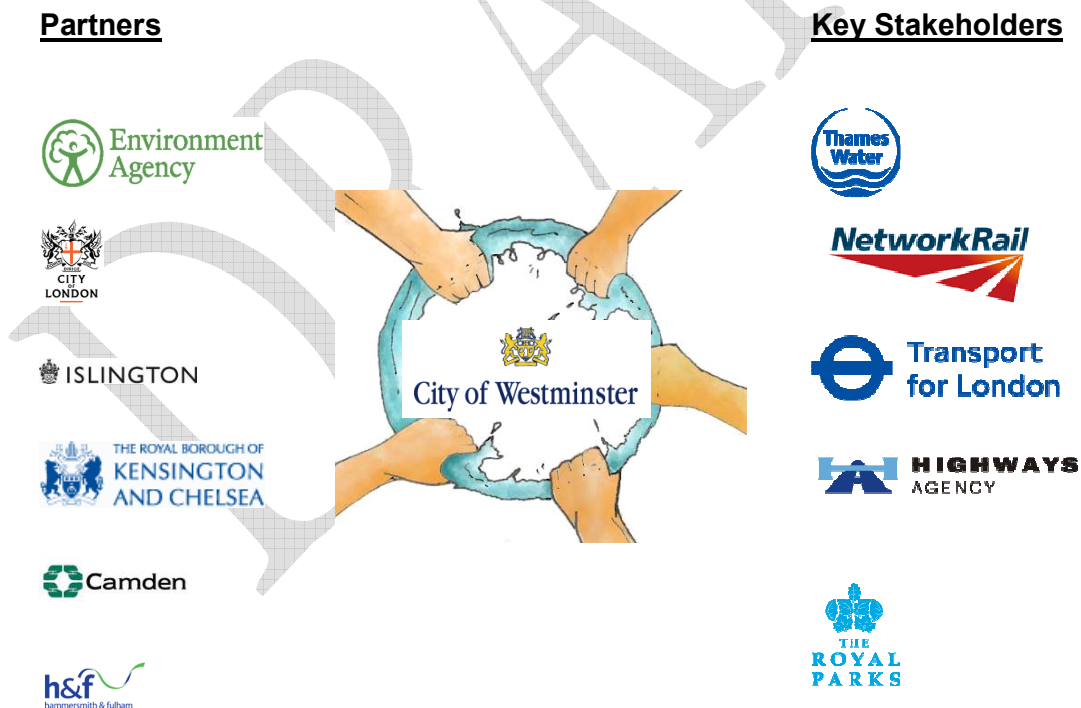
## 2.0 Phase 1 – Preparation

### 2.1 Leadership and Partnership

2.1.1 As Lead Local Flood Authority, it is the role of the City of Westminster to forge effective partnerships with the adjacent LLFA and the Environment Agency (this is currently the case with the Drain London project) as well as other key stakeholders – Thames Water, Network Rail, Transport for London and the Highways Agency. Some progress has been made toward establishing these partnerships already, although Network Rail and the Highways Agency have not yet fully engaged with the process. The City of Westminster through the LLFA duties will work to formalise these arrangements to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU).

2.1.2 **Figure 2.1** provides a schematic of the recommended partnership and stakeholder arrangements:

**Figure 2.1 - Partnership and Main Stakeholder Schematic Diagram**



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### 2.1.3 **Public Engagement**

It is recommended that the best vehicle for engaging the public is by integrating the management of local flood risk with other city wide initiatives, such as integrating with emerging development proposals and improving the amenity of parks and open spaces. This approach will require a sustained and coordinated approach within the City of Westminster.

2.1.4 It is recognised that members of the public may also have valuable information to contribute to the draft SWMP. Stakeholder engagement can be of significant benefit to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions in future flood risk management plans.

2.1.5 It is important to undertake some public engagement when formulating local flood risk management plans as this will help to inform future levels of public engagement. It is recommended that City of Westminster follow the guidelines outlined in the Environment Agency's 'Building Trust with Communities' document that provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

## 2.2 **Data Collection**

2.2.1 The collection and collation of strategic level data was undertaken as part of the Tier 1 work and disseminated to Tier 2 consultants by the GLA. Data was collected from each of the following organisations:

- City of Westminster
- British Airports Authority
- British Geological Survey
- British Waterways
- Environment Agency
- Greater London Authority
- Highways Agency
- London Underground
- Network Rail
- Thames Water
- Transport for London

2.2.2 A comprehensive data set was passed onto Tier 2 consultants and in some cases additional supplemental data was provided by individual organisations.

**2.3 Data Review**

2.3.1 The key information that was obtained is listed in **Table 2.1** below (a full list of the information is included in the Data Gap and Licensing Report issued by Tier 1 Consultants in October 2010):

**Table 2.1 – Summary of Key Drain London Tier 1 Data**

Source	Data/Studies
<b>Environment Agency</b>	Environment Agency Asset Data; Water Studies (including Thames Catchment Flood Management Plan, Thames Catchment Abstraction Management Strategy and Thames River Basin management Plan); Historic flood data (GIS flood event outlines extracted from NFCDD); Geostore data including Main River details, flood data for areas vulnerable to surface water flooding and Digital River Network (DRN) data for London; Numerous fluvial and surface water models located in the Greater London area; London hydrometric data including groundwater level data, rainfall data and river flow data; and Details of Flood Warning Areas in London
<b>The City of Westminster</b>	London Strategic Emergency Plan Contingency plan for major emergencies Westminster SFRA report and mapping Green roofs permitted since 2006
<b>Thames Water</b>	Foul water and surface water sewer network models in GIS format; Pumping station and manhole locations.
<b>Other</b> (Highways Agency, Transport for London, Network Rail, Local flood groups, fire brigade, etc)	Various assets; Flood records; GIS layers for land use types; BGS Susceptibility to Groundwater Flooding



- 2.3.2 Additional information has been obtained from the City of Westminster through an initial site visit followed by a more detailed virtual site visit/workshop of areas at risk of flooding.
- 2.3.3 Particular care has been taken by using the SFRA for the Borough as the primary document from which local flood risk information has been obtained. The reasoning behind this is that:
- a) the SFRA for the City of Westminster is relatively recent (completed in November 2009),
  - b) it has been thoroughly reviewed more than once by the city and the Environment Agency,
  - c) it has been formally approved by the city through the LDF planning process and
  - d) it has gathered relevant information from relevant local previous studies (Level 2 SFRA, FRAs, etc).
- 2.3.4 Virtual site visits/workshops were undertaken with staff from the Environment Agency, City of Westminster and Halcrow to identify local flood risk areas. This involved 'virtual walks' using a GIS environment and the use of Google Street View for 3D images.
- 2.3.5 The key GIS datasets used for the main stages of the SWMP and the virtual site visits are:
- a) OS maps,
  - b) the Thames Water pipe network system,
  - c) the river networks,
  - d) the flood zones and the historic flood map from the Environment Agency,
  - e) flood incident records,
  - f) local flood risk data from strategic data providers (for example the fire brigade),
  - g) the Environment Agency national Flood Map for Surface Water (FMfSW),
  - h) the Drain London surface water hazard and flood depth maps produced by Halcrow for the City Council,
  - i) a digital terrain model from LiDAR data to identify catchment boundaries and terrain gradients,
  - j) Thames Water postcode records of flooding,
  - k) the National Receptor Database and
  - l) the potential for elevated groundwater maps.

**Appendix A** provides further details of this data and their quality score.

**2.4 Other Responsibilities**

2.4.1 Aside from forging partnerships and coordinating and leading on local flood management there are a number of other key responsibilities that have arisen for LLFAs from the FWMA and the FRR. These responsibilities include:

**2.4.2 Investigating Flood Incidents**

Section 12 of the FRR 2009 outlines that LLFAs have a duty to investigate and record details of significant flood events within their area.

**2.4.3 Asset Register**

Section 21 of the FWMA 2010 sets a duty on each London Borough (LLFA) to maintain a register of structures or features, and a record of information about each of those structures or features, which, in the opinion of the authority, are likely to have a significant effect on flood risk in its area. From the 6 of April 2011 all LLFAs have a duty to maintain a register. The legal characteristics of the register and record are outlined below:

**Table 2.2 – Main characteristics of the Asset Register**

	<b>Register</b>	<b>Record (includes details of ownership and condition)</b>
a.	Must be made available for inspection at all reasonable times.	Up to the LLFA to decide if they wish to make it available for inspection
b.	Must contain a list of structures or features which in the opinion of the authority, are likely to have a significant effect on a local flood risk.	For each structure or feature listed on the register, the record must contain information about its ownership and state of repair.
c.	s.21 (2) of the Act allows for further regulations to be made about the content of the register and record. There is currently no plan to provide such regulations therefore their content should be decided on by the LLFA depending on what information will be useful to them.	
d.	There is no legal requirement to have a separate register and record although as indicated above, only the register needs to be made available for public inspection.	

- 2.4.4 Defra have provided each LLFA with templates to demonstrate what information should be contained in the asset register. Although these templates are not intended as a working tool, they provide a good example of how an asset register might be structured.
- 2.4.5 Populating the asset register is outside the scope of the Drain London project and is the responsibility of each London Borough. The expectation from Defra is that LLFAs (London Boroughs) will utilise a risk-based approach to populate the register and record with those structures or features considered the most significant first.
- 2.4.6 The City of Westminster has included the population of the asset register in its SWMP action plan. The City has set up a database for the asset register which will be populated from April 2011 onwards.
- 2.4.7 **Appendix B** provides a summary of the current status of the asset register for the City of Westminster as well as recommendation for suggested actions.
- 2.4.8 **SuDS Approval Body (SAB)**  
The FWMA 2010 establishes a SuDS Approval Body (SAB) at county or unitary local authority level (within London at Drain London Group level) to ensure national standards of sustainable drainage are enforced. Developers will be required to gain approval of their proposed drainage systems before they can begin construction. The SAB will be responsible for adopting and maintaining SuDS that serve more than one property, other than on public roads which are the responsibility of the Highways Authority.
- 2.4.9 **Local Flood Risk Management (LFRM) Strategies**  
LLFAs are required to develop, maintain, apply and monitor a local strategy for flood risk in its area. The local strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.
- 2.4.10 **Works Powers**  
LLFAs have powers to undertake works to manage local flood risk, consistent with the local flood risk management strategy for the area.
- 2.4.11 **Designation powers**  
LLFAs, as well as the Environment Agency have powers to designate structures and features that affect flooding or coastal erosion in order to safeguard assets that are relied upon for flood or coastal erosion risk management.

## 3.0 Phase 2 – Risk Assessment

### 3.1 Intermediate Assessment

3.1.1 The aim of the Phase 2 Intermediate Risk Assessment is to identify the sources and mechanisms of surface water flooding across the study area which are achieved through an intermediate assessment of pluvial flooding, sewer flooding, groundwater flooding and flooding from ordinary watercourses along with the interactions with main rivers and the sea. The modelling outputs are then mapped using GIS software.

3.1.2 SWMPs can function at different geographical scales and therefore necessarily at differing scales of detail. **Table 3.1** defines the potential levels of assessment within a SWMP. This SWMP has been prepared at a ‘city wide scale, fulfilling the objectives of a second level ‘Intermediate Assessment’ as highlighted in green.

**Table 3.1: SWMP Study Levels of Assessment [Defra 2010]**

Level of Assessment	Appropriate Scale	Outputs
1. Strategic Assessment	Greater London	Broad understanding of locations that are more vulnerable to surface water flooding. Prioritised list for further assessment. Outline maps to inform spatial and emergency planning.
2. Intermediate Assessment	Borough wide	Identify flood hotspots which might require further analysis through detailed assessment. Identify immediate mitigation measures which can be implemented. Inform spatial and emergency planning.
3. Detailed Assessment	Known flooding hotspots	Detailed assessment of cause and consequences of flooding. Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems.

3.1.3 As shown in **Table 3.1** above, the intermediate assessment is applicable across a large town, city or borough. In the light of extensive and severe historical flooding and the results from the over-arching national pluvial modelling (FMfSW 1:200yr event) suggesting that there are 46,000 properties at risk across the City of Westminster, it has been considered appropriate to adopt this level of assessment to further quantify the risks.

3.1.4 The purpose of this intermediate assessment is to further identify those parts of the City of Westminster that are likely to be at greater risk of surface water flooding and require more detailed assessment. The methodology used for this SWMP is summarised below. Further detail of the methodology is provided in **Appendix C**.

- A Direct Rainfall approach using TUFLOW software has been selected whereby rainfall events of known probability are applied directly to the ground surface and is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond.
- The outputs of the 2-dimensional pluvial modelling were reviewed at a large scale and compared against the SFRA pluvial modelling outputs, via the virtual site visits undertaken with key City of Westminster staff and the Environment Agency.

3.1.5 In many cases the outputs from the pluvial modelling (from Drain London and the SFRA) have been verified against historic surface water flood records

## 3.2 Risk Overview

### 3.2.1 Mapping of Surface Water Flood Risk

The mapping shown within this report (**Figures 3.2.1a** and **b**, and **Appendix D**) is suitable to identify broad areas which are more likely to be vulnerable to surface water flooding. This will allow the City of Westminster and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

3.2.2 In addition, the map can also be used as an evidence base to support the spatial planning process to ensure that surface water flooding is appropriately considered when allocating land for housing development. The map can be used to assist emergency planners in preparing their Multi-Agency response plans.

3.2.3 The Drain London maps show the predicted likelihood and extent of surface water flooding across all boroughs. They are good at predicting overland flow paths and areas where surface water flooding might occur in local depressions. They are adequate at representing the flooding from drains, small watercourses and ditches (known as ordinary watercourses). They do not represent the mechanisms that cause sewer flooding although sewer flooding can be more likely to occur in low lying areas with flat gradients; the



same locations where surface water ponds. Due to the coarse nature of the source data used, these are not detailed or accurate enough to reliably predict flooding at individual properties.

3.2.4 There may also be particular occasions when flooding occurs and the observed pattern of flooding does not in reality match the predicted patterns shown on these maps. The maps reflect all the data provided and have been produced using expert knowledge to create conclusions that are as reliable as possible. It is essential that the users of the maps understand the complexity of the data utilised in their production and are also aware of the limitations and uncertainties in the mapping and modelling (see **Section 3.3** and **Appendix C**). The maps are not intended to be used in isolation.

3.2.5 The City of Westminster and the Drain London Tier 1 and Tier 2 Consultants will not be liable if the maps by their nature are not as accurate as might be desired or are misused or misunderstood despite warning.

#### 3.2.6 **Mapping of Fluvial Flood Risk**

The Environment Agency Flood Zones 2 and 3 are shown in **Figure 3.2.2**. For the City of Westminster all regions that fall in the national flood zone are also designated 'Areas Benefiting Defences' (ABD). As previously mentioned in **Section 1.5**, the Thames is protected with defences of 1 in 1000 year standard of protection.

3.2.7 The Environment Agency's Flood Zones are updated on a quarterly basis and the ABD is held on the Agency's National Flood and Coastal Defences Database (NFCDD) and updated as and when new data is available.

3.2.8 As the main source of this type of flood risk is from the River Thames other important maps relate to the risk of breaching and/or overtopping of the defences. The City of Westminster SFRA provides information about the extent of flooding from breaching of the Thames defences. In particular Map 7 in the SFRA identifies rapid inundation zones (areas that would flood within 0 to 30minutes and from 30 minutes to one hour).

#### 3.2.9 **Summary of Definitions**

The following terminology is used throughout the draft SWMP. The spatial scale of these areas follows a hierarchy and is presented below from the smallest to largest:

1. **Local Flood Risk Zone (LFRZ)** is a discrete area of flooding that does not exceed the national criteria for a Flood Risk Area but affects houses, businesses and/or local infrastructure. The boundary is defined as the actual spatial extent of predicted flooding in a single location.
2. **Critical Drainage Area (CDA)** is a discrete geographic area where multiple and interlinked sources of flood risk cause flooding in one of

more LFRZs during severe weather affecting people, property and/or local infrastructure.

3. **Policy Area (PA)** is one or more CDAs linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis but can also accommodate geological concerns where these significantly influence the implementation of SuDS.

4. **Indicative Flood Risk Area (iFRA)** defined by Defra and the Environment Agency for the purposes of the PFRA. Greater London is covered by an Indicative Flood Risk Area.

### 3.3 Surface Water Flooding

#### 3.3.1 Mechanism of Flooding

Surface water flooding or pluvial flooding occurs in the City of Westminster when intense rainfall is unable to soak sufficiently into the ground (this is normally the case along the large relatively impermeable paved and roof areas in the area) and when road gully's have insufficient capacity to allow all surface water to enter the sewer drainage network.

3.3.2 In these conditions surface water builds up locally if the ground terrain is flat or travels following prevailing terrain gradients. Surface water flooding then occurs at locations where surface water flow paths converge, at local dips in the ground and/or due to overland obstructions. In particular, basement properties are vulnerable.

3.3.3 It is important to note that the mechanism of surface water flooding can be combined with surcharge from the combined sewer network (see Section 3.6). Surface water may not be able to enter the combined system because it is already full or overflowing as a result of the same storm event or a previous storm event.

3.3.4 The LLFA is responsible for the management of surface water flooding and flooding from highway drainage. Flooding from the highway drainage infrastructure occurs as a result of limited inflow capacity of the road drains and may be worsened by gully blockages.

#### 3.3.5 Surface Water Flood Modelling

Surface water flood risk is assessed through hydraulic modelling. The Environment Agency has undertaken national scale surface water modelling that has delivered the Flood Map for Surface Water (FMfSW). The outputs identify areas at risk of surface water flooding resulting from the 1 in 30 year and 1 in 200 year rainfall events (see **Figure D2a and b, Appendix D**).

3.3.6 To support the draft SWMP for the City of Westminster strategic level and refined modelling was undertaken. A Direct Rainfall approach using TUFLOW software has been used whereby rainfall events of known probability are applied directly to the ground surface and generated flows are routed overland

to provide an indication of potential flow path directions and velocities and areas where surface water will pond. The following scenarios were modelled:

- Surface Water Flood Depth 1 in 30 annual chance 3.3% AEP  
(**Figure D8a**)
- Surface Water Flood Hazard 1 in 30 annual chance 3.3% AEP  
(**Figure D8b**)
- Surface Water Flood Depth 1 in 75 annual chance 1.3% AEP  
(**Figure D9a**)
- Surface Water Flood Hazard 1 in 75 annual chance 1.3% AEP  
(**Figure D9b**)
- Surface Water Flood Depth 1 in 100 annual chance 1% AEP  
(**Figure 3.2.1a**)
- Surface Water Flood Hazard 1 in 100 annual chance 1% AEP  
(**Figure 3.2.1b**)
- Surface Water Flood Hazard 1 in 100 annual chance 1% AEP plus climate change (**Figure D10a**)
- Surface Water Flood Depth 1 in 100 annual chance 1% AEP plus climate change (**Figure D10b**)
- Surface Water Flood Depth 1 in 200 annual chance 0.5% AEP plus climate change (**Figure D11a**)
- Surface Water Flood Hazard 1 in 200 annual chance 0.5% AEP plus climate change (**Figure D11b**)

### 3.3.7

#### **Model Output Limitations**

The modelling undertaken has limitations which should be taken into account when interpreting potential surface water flooding (see further modelling details in **Appendix C**). The main limitations are described below:

- a) The combined sewers have not been modelled and therefore their variable capacity has not been taken into account (instead some of the rainfall has been removed at a constant rate of 6.5mm/hour everywhere).
- b) The modelled topography uses a 5m resolution grid based upon 1m resolution LiDAR data with a 200mm vertical accuracy. Any features at a resolution smaller than 5m have not been modelled.
- c) Obstructions such as railway embankments have been modelled however culvert crossings beneath them (unless clearly seen on OS maps) have not been modelled.

- d) Infiltration has been modelled through the use of variable runoff rates depending on land use however this is limited to the land use defined in OS Mastermap
- e) The capacity of the watercourses has been modelled as bankfull (level within the river to the top of the river bank) and therefore there is a tendency for surface water build up along the river floodplain.

### 3.3.8 **Historical Surface Water Flooding**

The outputs of the surface water modelling have been validated against the historical flood records provided by the Drain London Tier 1 Consultants and the City of Westminster (see **Figure D1**).

3.3.9 There are no detailed records of surface water flooding held by the City of Westminster, however surface water run-off invariably pools in low lying areas indicating a greater risk of surface water flooding. The design of buildings can also contribute to localised surface water flooding. Developments with large roof areas e.g. Westminster's four mainline railway stations, underpasses or low lying land can be especially vulnerable.

3.3.10 In 2007 and 2009 Victoria Station was closed due to flash flooding. In the latter event both the mainline and underground stations were closed, causing major disruption to commuters. Water overflowed from the roof drainage system causing flooding on the main concourse, flooding several retail outlets.

3.3.11 During the virtual site visits and subsequent consultations, the City of Westminster identified five areas that have been vulnerable to surface water flooding in the past (**Figure D1, Appendix D**). In addition to Victoria station these include: area around the south end of Shirland Road; Hallfield Estate near Paddington Station; Gloucester Place; Trafalgar Square; and Victoria Embankment.

## 3.4 **Ordinary Watercourse Flooding**

Ordinary watercourses flow through City of Westminster in the following locations:

- **Regents Canal** - The risk of overtopping and breach of the Regents Canal has not been considered in detail as part of this SWMP study. Any locations of raised canal embankments should be considered in more detail in close partnership with British Waterways. The water levels within the Regents Canal are controlled by British Waterways and they are considered to pose a minimal risk of flooding.
- **The Serpentine** - There is the potential risk of dam failure at the east end of the impoundment. The Serpentine falls under the Reservoirs Act 1975. The Royal Parks are responsible for preparing an on-site contingency plan and City of Westminster is responsible for preparing an off-site contingency plan.

### 3.5 Groundwater Flooding

#### 3.5.1 Mechanism of Flooding

Groundwater flows from the ground at the point where the water table meets the surface. Groundwater flooding is likely to occur in low-lying areas which are underlain by permeable rock (aquifers).

3.5.2 City of Westminster sits above a regional chalk aquifer covered with gravels and clay. Chalk shows some of the largest seasonal variations in groundwater levels, and is the most extensive source of groundwater.

3.5.3 The groundwater level in London is being addressed by the General Aquifer Research Development and Investigation Team (GARDIT) an informal group of interested parties, and through increased abstraction of groundwater, notably by Thames Water. Thames Water is opening 20 or more new pumping stations to extract groundwater to ensure the stability of water levels.

3.5.4 As part of the Drain London project, Jacobs/JBA combined a number of groundwater datasets to produce Increased Potential for Elevated Groundwater Maps. **Figure 3.2.3** shows those areas within the City of Westminster where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface.

3.5.5 Groundwater may become elevated by a number of means: a) above average rainfall for a number of months in Chalk outcrop areas; b) shorter period of above average rainfall in permeable superficial deposits, c) permeable superficial deposits in hydraulic continuity with high water levels in the river, d) Interruption of groundwater flow paths; and e) cessation of groundwater abstraction causing groundwater rebound.

3.5.6 Groundwater flooding is under the responsibility of the LLFA.

#### 3.5.7 Groundwater Flood Assessment

Groundwater flood risk is assessed through susceptibility mapping and any historical data. As part of the Drain London Project, Increased Potential for



Elevated Groundwater Maps has been developed to identify where groundwater could be at, or near ground surface (see **Figure 3.2.3** and further details in **Section 3.5.3**).

### 3.5.8 **Potential for Elevated Groundwater**

Large areas within the Drain London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances, groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique used aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment.

3.5.9 The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map (**Map 3.2.3**):

- British Geological Survey (BGS) Groundwater Flood Susceptibility Map;
- Jacobs Groundwater Emergence Maps (GEMs);
- Jeremy Benn Associates (JBA) Groundwater Flood Map; and
- Environment Agency/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps.

3.5.10 The increased Potential for Elevated Groundwater map shows those areas within the city where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface. As expected there are currently no areas where this occurs due to the significant pumping taking place.

3.5.11 The mapping indicates that elevated groundwater from permeable superficial soils are located around Marylebone, St James Park and Belgravia with sporadic pockets towards the southern end of the City of Westminster around Pimlico and Victoria.

3.5.12 In areas with an increased potential for groundwater, basements of buildings below ground level, buried surfaces and other assets held below ground level are vulnerable to flooding from groundwater. This can also lead to inundation of roads, commercial, residential and amenity areas as well as flooding of ground floors of buildings above ground level and overflowing of sewers and drains.

### 3.5.13 **Historical Groundwater Flooding**

Flooding from rising groundwater may pose a problem to underground infrastructure at various underground stations across the city as indicated on **Figure 3.2.3**, although there is only one record of groundwater flooding in the vicinity of Gloucester Road tube station.

3.5.14 The City of Westminster does not have any records of groundwater flooding incidents. The Environment Agency does have records of groundwater flooding which broadly correlate with **Figure 3.2.3**, with the exception of those records of flooding shown around Soho, St Johns Wood and Westbourne Green which do not correlate with the groundwater modelling.

### 3.6 Sewers

#### 3.6.1 Mechanism of Flooding

As outlined in section 1.5.3, the Thames Water drainage system conveys foul flow together with surface runoff that enters the system through drain pipes and road gulleys. North of the River Thames, a series of deep west – east interceptor sewers collect high level sewers draining south towards the river, transporting all flows to Beckton sewage treatment works in east London. Through this underground system (**Figure 1.5**), the City of Westminster receives flows from the Royal Borough of Kensington and Chelsea in the west. It transfers flow towards Camden and the City of London in the east.

3.6.2 During intense rainfall sewer flooding occurs as a result of:

- Surcharge within the sewer drainage network causing flooding in property basements with direct connections to the sewer.
- Surcharge within the sewer drainage network, causing flooding at the surface through manholes or through road gullies.
- Sewer flooding can also occur at other times due to blockages, but this mechanism is not considered in the SWMP.

3.6.3 Thames Water is responsible for the management of frequent sewer flooding. Property flooding incidents, that occur once every ten years (or more frequently), are placed on the 'DG5' register and subject to a cost benefit justification, protected by investment in new sewerage through the water company's asset investment programmes. Sewer flooding resulting from extreme events in severe weather is excluded from the DG5 register. Exceedance flow that occurs from a sewer considered to be of adequate capacity (in the eyes of the regulator (Ofwat), usually to a 30 year flood protection) is the responsibility of the LLFA to manage. In special circumstances, or if the design capacity of the sewer is deemed insufficient, a business case can be made to Thames Water to provide a higher level of protection from sewer flooding. It's also important to consider what the consequences of the exceedance flow are - ponding in the street (inconvenient but not a problem) or flooding of critical infrastructure.

#### 3.6.4 Thames Water Datasets

Thames Water has provided their DG5 data which shows the number of properties (sewer flood incidents) affected both externally and internally over the past decade. The data includes severe weather events which are normally excluded from Thames Water's official DG5 reporting. The dataset provided is

based on the postcode envelopes and does not give exact locations of where flood incidents have occurred, only the numbers affected in that area. This data is shown in **Figure D5** in **Appendix D**.

3.6.5 Thames Water also provided their network infrastructure, showing assets including sewers, pumping stations, sewage works and outfalls. This data was considered when looking at options for areas identified at risk. Any sewer related options should be mindful of the proposed Counter's Creek Scheme. **Figure D4** in **Appendix D** shows the Thames Water network in the City of Westminster.

3.6.6 **Historic Sewer Flooding**

The DG5 records show a number of past sewer flooding incidents particularly along the Thames and in the north west of the borough. The areas at highest risk are shown to be:

- W9 3 (87 properties affected in past decade)
- W9 2 (40 properties affected in past decade)
- NW6 5 (21 properties affected in past decade)
- W2 4 (51 properties affected in past decade)
- SW1 W8 (31 properties affected in the past decade)
- W1U 7 (22 properties affected in the past decade)
- W1U 3 (47 properties affected in the past decade)
- W1U 2 (76 properties affected in the past decade)
- W1G 9 (45 properties affected in the past decade)

### 3.7 Other Influences

3.7.1 As mentioned in **Section 1.5**, the City of Westminster is protected from tidal and fluvial flooding from the River Thames by defences that provide a high standard of protection. The Environment Agency flood zones maps provide a good representation of fluvial and/or tidal flood risk assuming that defences are not in place (see **Figure 3.2.2**).

3.7.2 As the main source of fluvial and/or tidal flood risk is from the River Thames, other important maps relating to the risk of breaching and/or overtopping of the defences, are provided in the City of Westminster's Strategic Flood Risk Assessment (SFRA). The SFRA also provides information about the extent of flooding from breaching of the Thames defences and, in particular, identifies rapid inundation zones.

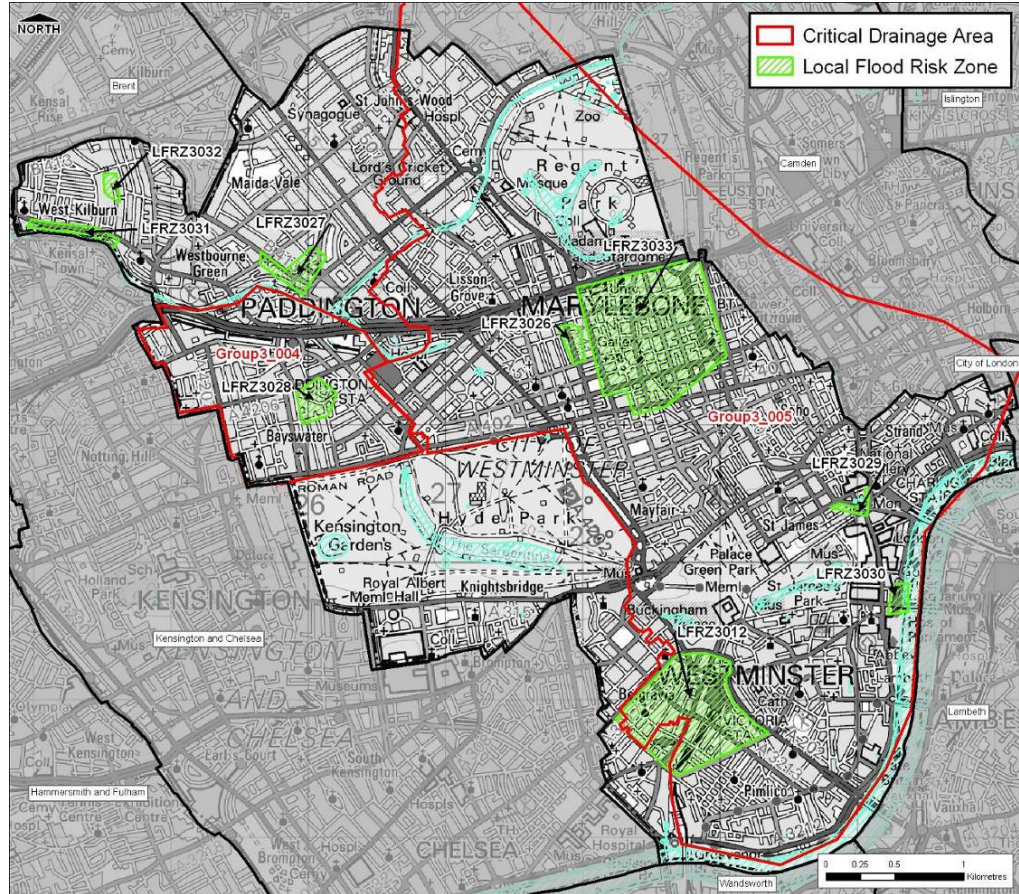
3.7.3 Other influences include the Regents Canal and the Serpentine in Hyde Park, with which there is limited interaction for the main sources of flood risk in the city. As the Regents Canal has its water level carefully monitored by British Waterways the risk of flooding posed is minimal.

### 3.8 Critical Drainage Areas

3.8.1 A critical drainage area (CDA) is a discrete geographic area and usually a hydrological catchment, where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones. Local Flood Risk Zones (LFRZs) are discrete areas/extents of predicted surface water flooding; these are in general shown as dark blue areas of deep flooding in the 1 in 100 year Rainfall Event Flood Depth Map or the dark orange areas in the corresponding Hazard Map (see **Figures 3.2.1a** and **3.2.1b** in **Appendix D**).

3.8.2 The critical drainage areas (CDA) and Local Flood Risk Zones (LFRZs) identified for the City of Westminster are shown in **Figure 3.1** below.





**Figure 3.1 – Critical Drainage Areas and key Local Flood Risk Zones**

3.8.3

Surface water modelling indicates a widespread vulnerability to surface water flooding across the City of Westminster and most of central London. This is in part due to the flat gradient and ‘noisy’ digital terrain data. In consultation with the City of Westminster, nine LFRZs have been identified, corroborated by modelling data (to a degree), the Environment Agency’s Flood Map for Surface Water, LiDAR and the Increased Potential for Elevated Groundwater data, but to a greater extent by records of historical incidents. Six of the LFRZs have an influencing CDA but three, connected to the Counters Creek sewer system, are considered differently as a special case. **Table 3.4** below summarises the LFRZs and associated CDAs.

**Table 3.4 – Critical Drainage Areas and Priority Local Flood Risk Zones**

CDA	LFRZ	Site ID	Source of Flooding	Verified?
Group 3_004	3028	Hallfield Estate	Basement flooding due to poor sewer connections and surface water ponding within estate.	Yes
Group 3_005	3012	Victoria Station	Flash flooding	Yes
	3026	Gloucester Place	Basement flooding during heavy rainfall	Yes
	3029	Trafalgar Square	Pluvial flooding	Yes
	3030	Victoria Embankment	Pluvial flooding	Yes
	3033	Marylebone	Extensive potential basement flooding due to surface water ponding.	Yes
N/A	3027	Shirland Road	Sewer flooding	Yes
N/A	3031	Harrow Road	Sewer flooding	Yes
N/A	3032	Bruckner Street	Sewer flooding	Yes

3.8.4

**CDA Group3\_004 Paddington (Hallfield Estate)**

As is characteristic of the Group 3 pluvial modelling, flood risk appears not to show specific flow routes, rather an ‘icecube tray’ effect of pockets of surface water ponding. The Hallfield Estate (LFRZ3028) is a site where known basement flooding has occurred in the past and surface water flooding has been identified by both the SFRA and Drain London modelling. TWUL has acted to fix basement flooding by installing FLIPS devices, however, this is only for properties where the sewer has backed up. As the estate is in a hollow, deep surface water flooding may occur and struggle to drain away effectively. The modelling shows the potential for flooding between 0.25m to 1m.



<b>Summary of CDA Group 3_004 – Paddington (Hallfield Estate)</b>	
LLFA(s)	City of Westminster
Flood Source	Pluvial and sewer
Property Count	Approximately 77 non-deprived households (33 of which with basements), seven commercial/industrial properties are at risk of flooding to a depth of greater than 0.03m
Critical Infrastructure	Two 'essential' infrastructure are at risk of flooding to a depth of greater than 0.03m. Infrastructure at risk includes electrical substations and Hallfield Junior and Infant School.
Validation	LLFA confirmed past basement flooding and surface water flooding identified in the Westminster SFRA
Assumptions	N/A
Associated Figures	<b>Figure 3.8.1a</b> – Group3_004: Paddington Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)
	<b>Figure 3.8.1b</b> - Group3_004: Paddington Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)

3.8.5

**CDA Group3\_005 East Westminster**

CDA Group3\_005 is made up of a large part of the City of Westminster and parts of the London Borough of Camden. It represents the area draining to the east of the City of Westminster through Regents Park.

As is characteristic of the Group 3 pluvial modelling, flood risk appears not to show specific flow routes, rather an 'icecube tray' effect of pockets of surface water ponding (depths of 0.25-1m and in some places greater than 1.5m). This occurs due to the majority of the road network being raised in comparison to the surrounding properties. Due to this, water could gather at basement level and rely on the drainage system to be cleared.

Victoria Station (LFRZ3012) has experienced surface water flooding resulting from heavy rainfall in recent history. The station was closed in 2007 due to flash flooding and again in 2009 when water overflowed from the roof drainage system causing flooding on the main concourse, and flooding several retail outlets. The modelling shows the potential for flooding to depths greater than 1.5m long the railway lines and on properties along Bridge Place.

Marylebone (LFRZ3033), south of Regents Park and the area around Gloucester Place (LFRZ3026) are vulnerable to basement flooding, and basement sewer flooding is known to have occurred here in the past as can be seen in **Figure D5 in Appendix D**. This shows that the drainage system may already be at capacity in this area meaning that surface water flooding is

more likely to occur. The modelling shows some areas with deep flooding, greater than 1.5m.

<b>Summary of CDA Group 3_005 – East Westminster</b>		
LLFA(s)	City of Westminster and London Borough of Camden	
Flood Source	Pluvial and sewer	
Property Count	Approximately 2,918 non-deprived households (2,751 of which with basements) and 2,150 commercial/industrial properties (1,753 of which with basements) are at risk of flooding to a depth of greater than 0.03m	Approximately 213 non-deprived households (204 of which with basements) and 142 commercial/industrial properties (104 of which with basements) are at risk of flooding to a depth of greater than 0.5m
Critical Infrastructure	Three 'essential', two 'highly vulnerable' and 54 'more vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.03m.	Four 'more vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.5m.
	These include: Mainline railways and station (Victoria), underground stations (Westminster LUL, Victoria LUL) schools (St Peter's Eaton Square Primary, University of Westminster, The St Marylebone School, St Vincent's RC, Trinity College of Music, College of Nursing.), electrical substations, fire station and hospitals (The Princess Grace, University College, Devonshire, National Heart, The Portland).	
Validation	LLFA confirmed past basement flooding. Victoria Station flooded in 2007 and 2009. DG5 data shows sewer flooding incidents in past decade.	
Assumptions	N/A	
Associated Figures	<b>Figure 3.8.2a</b> – Group3_005: East Westminster Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	
	<b>Figure 3.8.2b</b> - Group3_005: East Westminster Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	

3.8.6 **Policy Area: PA Group3\_008 - Counter's Creek Catchment**

The LFRZs 3027 (Shirland Road), LFRZ3031 (Harrow Road, West Kilburn) and LFRZ3032 (Bruckner Street, West Kilburn) have been identified but are not included within a CDA. These LFRZs have connections to the Counters Creek Policy Area or 'Zone of influence'. The main source of flooding in this area is regular sewer basement flooding which is not representing in the surface water mapping supplied.

3.8.7 The Counter's Creek catchment (see **Figure 3.2**) is a large sewer drainage system that spans the London boroughs of Brent, Ealing, Hounslow, Camden,

Hammersmith and Fulham, Kensington and Chelsea and the City of Westminster. A Policy Area (Group3\_008) has been drawn to match this catchment as almost all flooding issues spanning this area are interlinked due to the sewer network. Over the last 20 years, changes in land use, planning and population have meant an increase in the volume of water entering the system and the speed at which it gets there have increased.

3.8.8

The extent of the CDA and the LFRZ have been validated against sewer flooding data from TWUL as well as historical flood data and other information gained from meetings with the boroughs within the catchment. The City of Westminster is partially covered by this catchment.

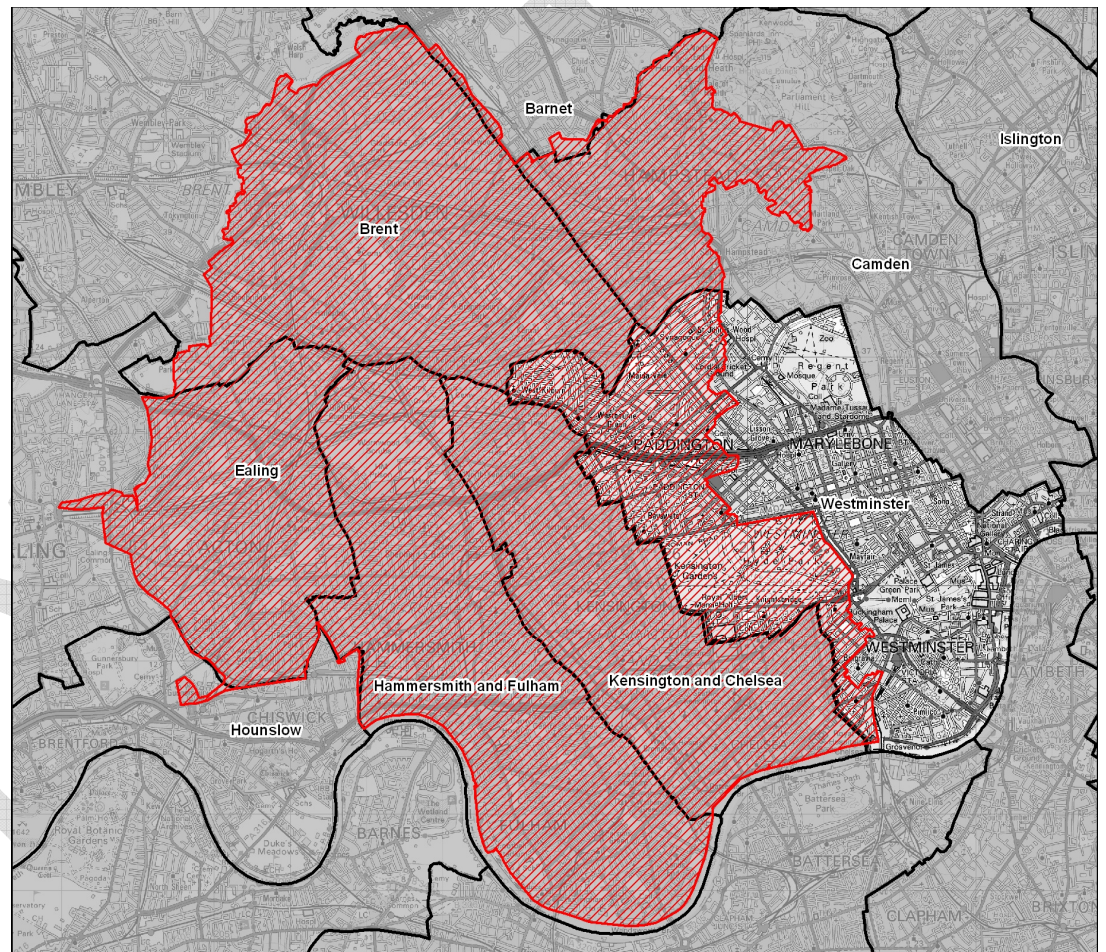


Figure 3.2 The Counter's Creek catchment (highlighted in red)



### 3.9 Summary of Risk

3.9.1 Pluvial modelling and historical records of flooding have identified two Critical Drainage Areas, with an additional three Local Flood Risk Zones and associated Policy Area. The risk in these areas is attributed to pluvial sources and sewer sources and in some cases has been validated by the LLFA.

3.9.2 As with most Group 3 Boroughs the modelling displays scattered and localised flood risk in the City of Westminster. This may reflect the vulnerability of basement properties and underground stations in the city.

3.9.3 As part of the Phase 2 assessment, a quantitative assessment of the number of properties at risk of flooding has been undertaken for each CDA. The rainfall event with a 1 in 100 chance of occurring in any given year has been used to inform the assessment, as specified in the Drain London Data and Modelling Framework.

3.9.4 A full summary of the results of the property count are included in **Table 3.6** below.

3.9.5 The surface water modelling also identifies 61 units of infrastructure at risk from flooding. This includes five 'Essential', two 'Highly Vulnerable' and 54 'More Vulnerable' infrastructure. The definition of infrastructure is given in **Section 3.9.6** below.

#### 3.9.6 Infrastructure

The definition of the "Infrastructure" category is an adaptation of the "Flood Vulnerability Categories" from PPS25 guidance. Following that guidance the main category is subdivided into three subcategories "Essential Infrastructure", "Highly Vulnerable" and "More Vulnerable". The definition of the subcategories is shown in **Table 3.5** below.

**Table 3.5 - Infrastructure Category Description**

<b>Essential Infrastructure</b>	<b>Highly Vulnerable</b>	<b>More Vulnerable</b>
Essential transport infrastructure which has to cross the area at risk	Police stations, Ambulance stations, Fire stations, Command Centres and telecommunications installations	Hospitals
Mass evacuation routes	Emergency dispersal points	Health services
Tube stations and entrances	Installations requiring hazardous substances consent	Educational establishments, nurseries
Essential utility infrastructure which has to be located in a flood risk area for operational reasons		Landfill, waste treatment and waste management facilities for hazardous waste
Electricity generating power stations and grid and primary substations		Sewage treatment works
Water treatment works		Prisons

Table 3.6 – Prioritisation Matrix Summary Table

CDA ID	Scheme Location	Moderation		Infrastructure						Households								Commercial/Industrial				Validation
		Primary	Secondary	Essential		Highly Vulnerable		More Vulnerable		Non-Deprived (All)		Non-Deprived (Basements)		Deprived (All)		Deprived (Basements)		All		Basements Only		
				All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	
Group3_004	Paddington	Health and Safety		2	0	0	0	0	0	77	0	33	0	0	0	0	0	7	0	0	0	Validated
Group3_005	East Westminster from Hampstead to the Thames	Regionally Important Infrastructure	Health and Safety	3	0	2	0	54	4	2918	213	2751	204	0	0	0	0	2150	142	1753	104	Validated

NOTE: The numbers of flooded properties for each CDA are calculated based upon those properties at risk in the local flood risk zones within the CDA.

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## 4.0 Phase 3 – Options

### 4.1 Objectives

- 4.1.1 The purpose of Phase 3 is to identify a range of structural and non-structural measures for alleviating flood risk and assess them to eliminate those that are not feasible or cost beneficial. The remaining options are then developed and tested against their relative effectiveness, benefits and costs. The target level of flood protection has been set at 1 in 75 years to align solutions with the likely level of insurance cover available to the general public. In the City of Westminster there is a significant area vulnerable to basement sewer flooding. The improvements suggested here provide a target level of flood protection at approximately 1 in 30 years.
- 4.1.2 To maintain continuity within the report and to reflect the flooding mechanisms within the City of Westminster the option identification has taken place on an area-by-area (site-by-site) basis following the process established in Phase 2. Therefore, the options assessment undertaken as part of the SWMP assesses and short-lists the measures for each CDA and identifies any non-standard measures available.
- 4.1.3 Phase 3 delivers a high level option assessment for each of the Critical Drainage Areas (CDAs) identified in Phase 2. No monetised damages have been calculated and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. Costs should be treated at an order of magnitude level of accuracy. The options assessment presented here follows that described in the Defra SWMP Guidance but is focussed on highlighting areas for further detailed analysis and immediate 'quick win' actions. Further detailed analysis may occur for high priority Critical Drainage Areas as defined by the Prioritisation Matrix in the next Tier (Tier 3) of the Drain London project.
- 4.1.4 The main goal when investigating options is to focus the mitigations at the locations (identified in **Section 3.8**) where flooding has been verified and where damages will be the greatest.
- 4.1.5 Any mitigation solutions at these locations need to address basement flooding as well as critical infrastructure flooding.

## 4.2 Measures

The measures available are summarised in the following **Table 4.1**:

**Table 4.1 – Source, Pathway and Receptor Options Available**

<b>Source Control Measures</b>	Green roofs
	Soakaways
	Swales
	Permeable paving
	Rainwater harvesting
	Detention basins
	Ponds and wetlands
	Partial or full disconnection of roof runoff from sewer system (combined with rainwater harvesting, garden flooding, infiltration or filling of ponds)
	Other 'Source' measures
<b>Pathway</b>	Increased capacity in drainage systems
	Separation of foul and surface water sewers
	Improved maintenance regimes
	Land management practices
	Managing overland flows (in particular sacrificial flooding of car parks, open spaces and other water compatible land uses) to detain and slow down surface water
	Managing overland flows (in particular new pipes through embankments to avoid deep flooding)
	Other 'Pathway' measures
<b>Receptor</b>	Improved weather warning
	Planning policies to influence development
	Temporary or demountable flood defences
	Social change, education and awareness
	Improved resilience measures
	Improved resistance measures
	Evacuation plans
	Emergency planning
	Other 'Receptor' measures

#### 4.2.1 **Summary of factors influencing selection of measures**

A number of factors will influence the combination of measures that can be integrated into sites within Local Flood Risk Zones. These could include:

- Cost of technology
- Changes to planning policy
- Impact of the flood and water management act

4.2.2 The selection of specific methods for specific sites will always be subject to detailed studies of local topography/flow routes, ground conditions, presence of underground services etc.

### 4.3 **Preferred Options**

4.3.1 Modelling and observed data do not show distinctive and discrete areas of surface water ponding in City of Westminster (and other Group 3 boroughs) which can lead to the easy identification of capital investment preferred options.

4.3.2 The nature of flooding from local sources within London is widespread and without a significant investment of money it will be impossible to solve all of them in one attempt. Preferred options have been chosen based upon those areas that are worst affected and for which historical flood information exists. Selection of these options has been supplemented by the outputs of the Drain London modelling. Even within these areas, the scale of flooding is too diverse, to be solved universally and cost-effectively. As a result, several options rely on the proposal of pilot schemes that aim to alleviate flooding for the worst affected properties and demonstrate the effectiveness of the proposed measures for future work.

4.3.3 The flat gradient and 'noisy' digital terrain data has resulted in a high level prediction which shows widespread pockets of flooding in basements and other low points. This is not believed to be an accurate representation of areas at risk from surface water flooding but is indicative of the risk any dense urban area will be exposed to.

4.3.4 The identification of capital schemes to alleviate specific flood problems has not been feasible. With the agreement of the City of Westminster, a range of non-structural options have been promoted in each of the CDAs around source control and flood resilience. CDAs were selected in areas where flooding has been observed in recent years. Other areas where flooding is predicted only have not been included for the reasons stated above.

4.3.5 All options identified will require further investigation through a feasibility study to establish which will bring maximum benefit for managing surface water flood risk in the City of Westminster.

4.3.6 These options are indicative only and scope what is possible using an approach that takes in the entire Local Flood Risk Zone (LFRZ). They are not

final options and would require more detailed further investigation. The rest of this chapter outlines a high level strategic approach.

4.3.7 Measures in each CDA were discussed and agreed in virtual site visits and workshops with the City of Westminster and other stakeholders

4.3.8 The LFRZs 3027 (Shirland Road), LFRZ3031 (Harrow Road, West Kilburn) and LFRZ3032 (Bruckner Street, West Kilburn) are zones of significant and regular basement sewer flooding; a form of flooding not predicted by surface water modelling but supported by observations and modelling reported by Thames Water. The resolutions of these problems are associated with the Counter's Creek sewerage scheme which is currently in the planning phase. These outline plans form the basis of the preferred option for these LFRZs.

The full options assessment is given in **Appendix E**.

4.3.9 **CDA Group3\_004 Paddington (Hallfields Estate)**

This area has suffered from sewer flooding in the past and as a result some FLIP devices have been installed by TWUL. Furthermore, model results indicate that this is a low point where surface water may pond.

The preferred option that requires further investigations includes source control measures of permeable paving and rainwater harvesting to increase the time it takes for run off generated by impermeable areas to get to this area. To achieve this property level storage is proposed including water reuse and disconnecting new and existing development from the combined sewer network will be implemented at a total cost of £256,720 (Permeable paving £65,720; rainwater harvesting £191,000).

4.3.10 **CDA Group3\_005 – East Westminster**

**Victoria Business Improvement District (BID)**

The Victoria BID is a partnership of businesses and organisations based in Victoria in City of Westminster. The partnership is working with Westminster City Council to ensure that green infrastructure opportunities are identified and incorporated into future plans for the area to reduce flood risk and improve biodiversity and amenity value in Victoria.

**Rain Gardens and Swales:** Opportunities have been identified at Vauxhall Bridge Road, Victoria Street, Ebury Street at a cost from £15,000.

**Green Roofs:** There is potential to create 25ha of additional green roofs across Victoria which would absorb up to 81,000m<sup>3</sup> of rainwater per annum. Victoria Station has experienced surface water flooding during periods of heavy rain and the provision of a green roof for Victoria station could be implemented at a cost of £1,460,000 (£146/m<sup>2</sup> for 10000m<sup>2</sup>).

Further details on the initiatives within the Victoria BID area can be found at <http://www.insw1.com/>

4.3.11 **Policy Area Group3\_008 – Counter’s Creek Catchment**

Basement sewer flooding associated with the Counters Creek sewer in West London is the principal local flooding concern for residents, officials and elected members of the Boroughs. Flooding occurs regularly (many times per year) and is due to hydraulic incapacity in the sewerage network and the fact that many basements have low level connections to the sewer system. Basement flooding occurs when no flooding appears on the surface.

4.3.12 The proposed interventions are to be implemented both local to the flooding and across the wider contributing catchment which extends beyond City of Westminster to neighbouring Boroughs which are also connected to the same sewerage system.

4.3.13 **Preferred options**

The preferred option is already being implemented or planned by Thames Water. It has three elements:

- Property resistance through FLIP (flooding local improvements project) devices which provide a one-way connection between the basement and the sewers. This ‘quick win’ intervention enables the discharge of wastewater from the property but prevents reverse flows from the sewer to the basement. FLIPS are financed by Thames Water but installed within properties. 1000 FLIP devices are being fitted across the Counters Creek catchment (including City of Westminster) at a cost of £9000 each. The £9 million programme will eliminate this source of flooding for 1000 properties. It is, however, a temporary and unsustainable intervention.
- SuDS Pilot Program is being implemented to assess the potential reduction in surface water to sewer in the long term the use of SUDS measures including driveway cut-off drains, drainpipe diversion, water butt/rainwater tanks and permeable paving.
- The pilot schemes will assess:
  - The reduction in surface water to sewer from each measure and how this varies with relevant parameters
  - Assessment of uptake and feasibility of install and development of practical solutions that are accessible for customers
  - What is possible through legislation and incentivising, for example design standards for SUDS measures, retrospective enforcement of legislation.
- A major sewerage scheme which will remove local hydraulic incapacity through a series of new shafts and tunnel connections; flows are passed downstream. The estimated cost of this scheme is £440million and will protect at least 7500 properties from the risk of regular

basement sewer flooding providing a level of protection of at least 1 in 30 years.

4.3.14

**Quick Wins**

A couple of early measures could also be implemented within the two identified CDAs and the Policy area (and City wide) as quick win actions:

- Kerb raising and ramping could be installed to protect below-ground infrastructure (e.g. tube station entrances and large below-ground car parks or storage/loading areas)
- Consideration of localised threshold step raising where steps have been removed at pavement level or do not exist.
- Community flood plans to enlist community support in the implementation of receptor measures (especially measures to increase basement property flood resilience)
- Improved gulley maintenance – this was discussed as a quick win measure, however, it was not viewed as having a significant benefit to the City of Westminster as the limitation is with the existing sewer capacity and the fact that in storm conditions the City receives flows from upstream Boroughs. The council already have a risk based approach to target gulley maintenance.

4.3.15

**Generic measures**

Concerns over the capital cost and sustainability of the major sewerage scheme have prompted calls for a different approach to be delivered in parallel to reduce the needs for such major capital works. Any such programme will require the support of property owners and the associated London Boroughs, including City of Westminster.



- 4.3.16 The principal reason why basement sewer flooding has worsened in recent years is an increase in paved/roof area which discharges runoff to the combined sewer. Thames Water data indicates that the area has increased 17% since 1971 during a period where the sewerage network capacity has remained broadly static. The generic measure is therefore to seek to reverse this trend by disconnecting (or least slowing) runoff connections to the combined sewer system. This can be done by attenuation at the property level (e.g. through green roofs or water butts) or disconnection of surface water, redirecting it to watercourses.
- 4.3.17 As a forthcoming SuDS Approval Body, City of Westminster will have new powers to ensure that any new or re-development scheme implements source control and only discharges to sewer at limited run-off rates in accordance with new SuDS standards. Discharge to sewer can only be made once all other options have been ruled out. City of Westminster should enforce these new rules vigorously to reduce the risk of basement sewer flooding in the future.
- 4.3.18 It is recommended that City of Westminster work with communities identified as being at risk of flooding to produce a Community Flood Plan (CFP). CFPs aim to enable communities to understand flood risk in their local area including responsibilities and the actions they can take to prepare for, respond to and recover from flooding.
- 4.3.19 City of Westminster should promote and enable (through the Planning system) the use of SuDS retrofit measures in properties, highways and paved areas of public open space. This is most easily done when refurbishment or repair is occurring and via marketing to encourage the installation of property storm water storage devices. The latter can be attractive when combined with rainwater harvesting which will also reduce the demand of and cost for potable water for businesses and householders.

#### 4.4 Preferred Options Summary

- 4.4.1 **Table 4.2** below give a summary of the preferred options as discussed above and outlines the benefits of implementing the preferred scheme in the City of Westminster.

Table 4.2 Summary Table of Preferred Options

CDA ID	Scheme Location	Scheme Category	Infrastructure						Households				Commercial/Industrial		Capital Cost Band
			Essential		Highly Vulnerable		More Vulnerable		Non-Deprived (All)		Deprived (All)		All		
			Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	
Group3_004	Paddington	Combination of Measures	100	100	100	100	100	100	100	100	100	100	100	100	£251k - 500k
Group3_005	East Westminster	Source control, attenuation and super SUDS	50	0	100	0	5	100	5	5	0	0	5	5	£1m - 10m

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## 4.5 Option Prioritisation

- 4.5.1 The Prioritisation Matrix was developed out of the need for a robust, simple and transparent methodology to prioritise the allocation of funding for surface water management schemes across the 33 London Boroughs by the Drain London Programme Board. As such, the prioritisation should be understood in the high-level decision-making context it was designed for. It is not intended to constitute a detailed cost-benefit analysis of individual surface water flood alleviation schemes.
- 4.5.2 The information in **Table 4.2** will be used by the Drain London Programme Board to populate the Drain London Prioritisation Matrix and identify schemes to be taken forward under Tier 3.
- 4.5.3 Inputs to the Prioritisation Matrix have been submitted to the Board. They will provide feedback to all London Boroughs to influence the Action Plan prepared as part of Phase 4.
- 4.5.4 The Board's feedback will be included in the Final SWMP Report.

## 5.0 Phase 4 – Implementation and Review

### 5.1 Action Plan

5.1.1 The purpose of Phase 4 of the SWMP is to identify actions and responsibilities for the ongoing management of surface water flood risk identified in Phases 1 to 3.

5.1.2 A draft action plan has been developed in consultation with the City of Westminster separately and as part of a Group 3 workshop, which has been useful in identifying common tasks between LLFAs.

5.1.3 The objectives of the action plan are to:

1. outline the actions required to implement the preferred options identified in Phase 3 (**Section 4**);
2. Identify the partners or stakeholders responsible for the implementation of the actions;
3. Provide an indication of the priority of the actions and timescales for delivery;
4. Outline actions required to meet the requirements for the City of Westminster as a LLFA under the FWMA 2010.

5.1.4 The action plan is subdivided in generic actions, investigation/feasibility/design and flood mitigation actions.

5.1.5 The generic actions are management tasks that the LLFA needs to undertake to fulfil its obligations as an LLFA. The flood mitigation actions relate to the actual implementation of investigations/feasibility studies/designs.

5.1.6 The generic actions have been grouped as follows:

- **Communications/Partnerships** Actions to communicate risk internally or externally to LLFA or create/improve flood risk related partnerships.
- **Flood and Water Management Act/Flood Risk Regulations** Duties and actions as required by the FRR and FWMA – Refer to Appendix A of the LGG 'Preliminary Framework to assist the development of the Local Strategy for Flood Risk Management' (February 2011) for minimum requirements.
- **Financial/Resourcing/Capacity Building** Actions to secure funding internally/externally to support works or additional resources to deliver actions.
- **Policy Action** Spatial planning or development control actions.

**Table 5.1** below provides a full summary of the action plan.

## 5.0 Phase 4 – Implementation and Review

**Table 5.1 – Summary of Action Plan**

Action Type	ID	Action		Priority Ranking	Timing	
		What?	How?		Timeframe	Approx. Duration
Flood and Water Management Act/ Flood Risk Regulations	1	Duty to investigate and report flooding incidents.	Investigate flooding incidents in its area (where appropriate or necessary) to identify which authorities have relevant flood risk management functions and what they have done or intend to do. The lead local flood authority will then be required to publish the results of any investigation, and notify any relevant authorities.  Set up Investigations register and notice and enforcement procedures	High	Short	On-going
Flood and Water Management Act/ Flood Risk Regulations	2	Duty to investigate and to maintain a register	To ensure greater co-ordination of information and avoid situations where bodies do not accept responsibility. Set up Investigations register and notice and enforcement procedures	High	Short	On-going
Flood and Water Management Act/ Flood Risk Regulations	3	Designation of Third Party Assets	List of all flood risk management structures and features, owners and planning approvals required to change designated features as part of development as designated by LLFA. Designation of Flood risk management features and structures maintain a register of structures or features which they consider have a significant effect on flood risk in their area, at a minimum recording ownership and state of repair. The register must be available for inspection and the Secretary	High	Short	On-going
Flood and Water Management Act/ Flood Risk Regulations	4	Set up SUDs Approval Body in partnership or independently	Awaiting further guidance from Defra	High	Medium	On-going
Flood and Water Management Act/ Flood Risk Regulations	5	Produce documents required in Phase 1 implementation of the Flood and Water Management Act.	1) Preliminary Flood Risk Assessment. 2) Surface Water Management Plan. 3) Flood Hazard Maps. 4) Review of Strategic Flood Risk Assessment. 5) Flood Risk Management Strategy and associated SEA. 6) Communicate findings for flood risk assessments and final	High	Short/Medium	2011-2015

5.0 Phase 4 – Implementation and Review

Action Type	ID	Action		Priority Ranking	Timing	
		What?	How?		Timeframe	Approx. Duration
			<p>policy approach and action plan to manage flood risk.</p> <p>7) Set up Flood Risk Asset Register.</p> <p>8) Set up SUDs Approval Body.</p> <p>9) Investigation of floods register and notification and enforcement procedures.</p>			
Communications / Partnerships	6	Co-ordinate management of flood risk (internally)	Internal flood risk management Group	High	Short/Medium	2011-2015
Communications / Partnerships	7	Co-ordinate Flood Risk Management (externally)	Central London flood risk management forum	High	Short	On-going
Financial/Resourcing/Capacity Building	8	Capacity Building	<p>Flood and Water Management Website, e-learning links and training pages</p> <p>Officers to attend DEFRA capacity building workshops on Flood and Water Management Act 2010</p>	High	Short	2011/12
Flood and Water Management Act/ Flood Risk Regulations	9	Prepare consultation responses to forthcoming advice and guidance on Flood and Water Management Act 2010	Consultation Responses	High	Short/Medium	2011-2015
Flood and Water Management Act/ Flood Risk Regulations	10	Establish Data Sharing agreements with key partners	Data sharing portal set up through Update Drain London Geoportal with flood records	High	Short	2011
Flood and Water Management Act/ Flood Risk Regulations	11	Preparation of documents to assess flood risk in Westminster	PFRA, SWMP	High	Short	June – Dec 2011
Financial/Resourcing/Capacity Building	12	Prepare prioritisation matrix for interventions at 'area' and local level to manage flood risk hotspots, critical drainage locations identified in PFRA	Prioritisation matrix for critical locations, to inform future action plans to manage flood risk	High	Short	2011/12
Financial/Resourcing/Capacity Building	13	Identify possible funding streams to make interventions to mitigate flood risk in critical drainage locations	Funding strategy for implementation of surface water management plan.	High	Short	2011/12



5.0 Phase 4 – Implementation and Review

Action Type	ID	Action		Priority Ranking	Timing	
		What?	How?		Timeframe	Approx. Duration
Communications / Partnerships	14	Manage consultation and sign off of PFRA	PFRA for submission to the Environment Agency by June 22 <sup>nd</sup> 2011	High	Short	March – April 2011
Communications / Partnerships	15	Manage consultation and sign off and adoptions of SWMP which sets out options for managing surface water flood risk in the city.	SWMP to inform final Flood Risk Strategy and Action Plan 2015	High	Short	April – December 2011
Financial/Resourcing/Capacity Building	16	Prepare funding assessment for implementation of SWMP	Funding strategy for implementation of surface water management plan.	High	Short	December 2011 – March 2012
Flood and Water Management Act/ Flood Risk Regulations	17	Prepare surface water flood risk management policies for City management Development Plan Document and Sustainable Design SPD	Evidence based flood risk management policy	High	Short	Ongoing
Flood and Water Management Act/ Flood Risk Regulations	18	Preparation of documents to assess flood hazard in City of Westminster	Production of flood hazard maps by June 2013	High	Medium	2011-2013
Communications / Partnerships	19	Prepare communications plan for all stakeholders to share outputs of flood risk assessment and flood risk management. Raise awareness of flood risk, flood resilience and resistance and emergency procedures in the event of flooding.	Leaflet to raise awareness of flood risk in the city and best practice guidance to manage the risk	High	Medium	2012/13
Flood and Water Management Act/ Flood Risk Regulations	20	Implementation of SWMP Action Plan	Programme of work and funding strategy to implement SWMP to minimise surface water flood risk in City of Westminster	High	Medium	2013/14
Communications / Partnerships	21	Prepare Flood Risk Management Emergency Response procedures based on flood risk assessments	Engage with Emergency Planning teams	High	Medium	2012/13
Flood and Water Management Act/ Flood Risk Regulations	22	Review of SFRA	Revised SFRA in 2013/14	High	Medium	2013/14

### 5.0 Phase 4 – Implementation and Review

Action Type	ID	Action		Priority Ranking	Timing	
		What?	How?		Timeframe	Approx. Duration
Flood and Water Management Act/ Flood Risk Regulations	23	Preparation of Local Flood Risk Management Strategy for City of Westminster	Local Flood Risk Management Strategy for City of Westminster 2015	High	Short/Medium	2011-2015
Communications / Partnerships	24	Manage consultation and sign off of local flood risk strategy	Consultation responses	High	Long	2015
Communications / Partnerships	25	Prepare summary of flood risk management strategy	Non technical summary document on flood risk in City of Westminster	High	Long	2015
Flood and Water Management Act/ Flood Risk Regulations	26	Monitor and review and revise flood risk management strategies	6 yearly review of flood risk assessment, hazard maps and local flood risk management strategy.	High	Long	2015 onward

## 5.2 Implementation Programme

5.2.1 The implementation programme showing actions, responsibilities and timeframes is shown in **Figure 5.1**. The complete Action Plan is given in **Appendix I**.

**Figure 5.1 – Implementation Programme**

ID	Task	Responsibility	Financial Year 2011/12			Financial Year 2012/2013			
			Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Duty to investigate and report flooding incidents.	BUILT ENVIRONMENT/CITY MANAGEMENT							
2	Duty to investigate and to maintain a register	BUILT ENVIRONMENT/CITY MANAGEMENT							
3	Designation of Third Party Assets	BUILT ENVIRONMENT/CITY MANAGEMENT							
4	Set up SUDs Approval Body in partnership or independently	BUILT ENVIRONMENT/CITY MANAGEMENT							
5	Produce documents required in Phase 1 implementation of the Flood and Water Management Act.	BUILT ENVIRONMENT/CITY MANAGEMENT							
6	Co-ordinate management of flood risk (internally)	BUILT ENVIRONMENT/CITY MANAGEMENT							
7	Co-ordinate Flood Risk Management (externally)	BUILT ENVIRONMENT/CITY MANAGEMENT							
8	Capacity Building	BUILT ENVIRONMENT/CITY MANAGEMENT							
9	Prepare consultation responses to forthcoming advice and guidance on Flood and Water Management Act 2010	BUILT ENVIRONMENT/CITY MANAGEMENT							
10	Establish Data Sharing agreements with key partners	BUILT ENVIRONMENT/CITY MANAGEMENT							
11	Preparation of documents to assess flood risk in Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT							
12	Prepare prioritisation matrix for interventions at 'area' and local level to manage flood risk hotspots, critical drainage locations identified in PFRA	BUILT ENVIRONMENT/CITY MANAGEMENT							
13	Identify possible funding streams to make interventions to mitigate flood risk in critical drainage locations	BUILT ENVIRONMENT/CITY MANAGEMENT							
14	Manage consultation and sign off of PFRA	BUILT ENVIRONMENT/CITY MANAGEMENT							
15	Manage consultation and sign off and adoptions of SWMP which sets out options	BUILT ENVIRONMENT/CITY							

	for managing surface water flood risk in the city.	MANAGEMENT							
16	Prepare funding assessment for implementation of SWMP	BUILT ENVIRONMENT/CITY MANAGEMENT							
17	Prepare surface water flood risk management policies for City management Development Plan Document and Sustainable Design SPD	BUILT ENVIRONMENT/CITY MANAGEMENT							
18	Preparation of documents to assess flood hazard in City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT							
19	Prepare communications plan for all stakeholders to share outputs of flood risk assessment and flood risk management. Raise awareness of flood risk, flood resilience and resistance and emergency procedures in the event of flooding.	BUILT ENVIRONMENT/CITY MANAGEMENT							
20	Implementation of SWMP Action Plan	BUILT ENVIRONMENT/CITY MANAGEMENT	2013/14						
21	Prepare Flood Risk Management Emergency Response procedures based on flood risk assessments	BUILT ENVIRONMENT/CITY MANAGEMENT							
22	Review of SFRA	BUILT ENVIRONMENT/CITY MANAGEMENT	2013/14						
23	Preparation of Local Flood Risk Management Strategy for City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT							
24	Manage consultation and sign off of local flood risk strategy	BUILT ENVIRONMENT/CITY MANAGEMENT	2015						
25	Prepare summary of flood risk management strategy	BUILT ENVIRONMENT/CITY MANAGEMENT	2015						
26	Monitor and review and revise flood risk management strategies	BUILT ENVIRONMENT/CITY MANAGEMENT	2015 onwards						

### 5.3 Review Timeframe and Responsibilities

The actions within the action plan fall into short, medium and long term categories. The short term actions have been identified as urgent and will be reviewed within two months of implementation. Medium term actions will be reviewed at the end of the financial year and long term actions, with lower priority, will be reviewed beyond the first year.

Immediate actions from the Act (required by Defra from April 2011) include (actions 7-12):

- Maintain a local flood risk asset register
- Use its power to request relevant information to exercise its functions
- Investigate and report how a flood event is managed (within and/or outside the LLFA)
- Produce quality plan (to demonstrate that LLFA is implementing its duties)
- Plan for next year SUDS Approving Body (SAB) role
- Delivery of local Flood Risk Management Strategy through the LDF

The City of Westminster has identified Lead Departments who will take responsibility for implementing the plan. This is summarised in **Table 5.2**.

**Table 5.2 – Lead Departments and Officers and their responsibilities**

ID	Task	Responsibility		Other Stakeholders
		Lead Organisation	LLFA Department	
1	Duty to investigate and report flooding incidents.	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	LLFAs, GLA, EA, RFDC Thames Water, etc GLA , TfL, British Waterways
2	Duty to investigate and to maintain a register	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	LLFAs, GLA, EA, RFDC Thames Water, etc GLA , TfL, British Waterways
3	Designation of Third Party Assets	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Central London Flood Risk Group, EA, DEFRA, Thames Water, Property owners,
4	Set up SUDs Approval Body in partnership or independently	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	London LLFAs Group, EA, DEFRA, Thames Water, Property owners. risk authorities
5	Produce documents required in Phase 1 implementation of the Flood and Water Management Act.	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Regional Flood Defence Committee, London Lead Local Flood Authorities, GLA, DEFRA, EA
6	Co-ordinate management of flood risk (internally)	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	–
7	Co-ordinate Flood Risk Management (externally)	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	DRAIN London, Central London Forward, Thames Water, Environment Agency, GLA, DEFRA, RFDC
8	Capacity Building	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	DEFRA, London LLFAs
9	Prepare consultation responses to forthcoming advice and guidance on Flood and Water Management Act 2010	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	-
10	Establish Data Sharing agreements with key partners	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Central London Flood Risk Group, Drain London Forum, EA, TW, GLA, RFDC
11	Preparation of documents to assess flood risk in Westminster	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Drain London Group 3, EA, TW, Halcrow Group Ltd
12	Prepare prioritisation matrix for interventions at 'area' and local level to manage flood risk hotspots, critical drainage locations identified in PFRA	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Drain London Forum, Halcrow Group Ltd, Central London Sub Group



13	Identify possible funding streams to make interventions to mitigate flood risk in critical drainage locations	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Drain London Forum, Halcrow Group Ltd, Central London Sub Group
14	Manage consultation and sign off of PFRA	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	-
15	Manage consultation and sign off and adoptions of SWMP which sets out options for managing surface water flood risk in the city.	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	-
16	Prepare funding assessment for implementation of SWMP	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	EA, RFDC, LLFAs
17	Prepare surface water flood risk management policies for City management Development Plan Document and Sustainable Design SPD	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Central London LLFA Sub Group, RFDC
18	Preparation of documents to assess flood hazard in City of Westminster	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	-
19	Prepare communications plan for all stakeholders to share outputs of flood risk assessment and flood risk management. Raise awareness of flood risk, flood resilience and resistance and emergency procedures in the event of flooding.	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Central London Flood Risk Group, TWUL, ABI, EA, Defra
20	Implementation of SWMP Action Plan	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	Central London Flood Risk Group, RFDC
21	Prepare Flood Risk Management Emergency Response procedures based on flood risk assessments	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	London Resilience
22	Review of SFRA	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	EA, TWUL, British Waterways, GLA, English Heritage
23	Preparation of Local Flood Risk Management Strategy for City of Westminster	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	EA, TWUL, British Waterways, GLA, English Heritage
24	Manage consultation and sign off of local flood risk strategy	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	-
25	Prepare summary of flood risk management strategy	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	EA, LLFA

			MANAGEMENT	
26	Monitor and review and revise flood risk management strategies	City of Westminster	BUILT ENVIRONMENT/CITY MANAGEMENT	

## 5.4 Ongoing Monitoring

5.4.1 The partnership arrangements established as part of the SWMP process (e.g., the City of Westminster, EA and TWUL working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

5.4.2 The SWMP Action Plan should be reviewed and updated once every six years as a minimum, but there may be circumstances which might trigger a review and/or an update of the action plan in the interim, for example:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- Outcome of investment decisions by partners is different to the preferred option, which may require a revision to the action plan, and;
- Additional (major) development or other changes in the catchment which may affect the surface water flood risk.

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## Appendix A – Data Review

Appendix A gives a review of the data provided as part of Drain London Tier 1 package of works and that used within this SWMP. An assessment of the quality of the data has been completed, using the criteria set out in the Defra SWMP Guidance, which is summarised in Table A-1.

**Table A-1 Data Review Scoring System (from Table 3-1 in Defra SWMP Guidance 2010)**

<b>Data Quality Score</b>	<b>Description</b>	<b>Explanations</b>	<b>Example</b>
<b>1</b>	Best available	No better available; not possible to improve in the near future	High resolution LiDAR, river flow data, rain gauge data
<b>2</b>	Data with known Deficiencies	Best replaced as soon as new data is available	Typical sewer or river model that is a few years old
<b>3</b>	Gross assumptions	Not invented but based on experience and judgement	Location, extent and depth of surface water flooding
<b>4</b>	Heroic assumptions	An educated guess	Ground roughness for 2d models

## Appendix B – Asset Register Recommendation

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## Appendix C – Risk Assessment Technical Details

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## Appendix D – Maps

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## Appendix E – Options Assessment Details

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## Appendix F – Peer Review

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## Appendix G – Spatial Planner Information Pack

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# Appendix H – Resilience Forum and Emergency Planner Information Pack

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## Appendix I – Action Plan

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