SURFACE WATER MANAGEMENT PLAN

DRAIN LONDON

LONDON BOROUGH OF TOWER HAMLETS

GREATER**LONDON**AUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

TOWER HAMLETS

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RELATED DOCUMENTS

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    - London Borough of Waltham Forest
    - London Borough of Newham
- The Environment Agency
- The Greater London Authority
- London Councils
- The London Fire Brigade
- Network Rail
- Thames Water
- Transport for London and London Underground

Executive Summary

This document forms the Surface Water Management Plan (SWMP) for the London Borough (LB) of Tower Hamlets. The report outlines the preferred surface water management strategy for the borough. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

The SWMP has been delivered as part of the Tier 2 package of works of the Drain London Project and builds upon previous work undertaken as part of the Tier 1 package of works. A four phase approach has been undertaken in line with Defra's SWMP technical guidance documentation (2010). These are:

- Phase 1 – Preparation;
- Phase 2 – Risk Assessment;
- Phase 3 – Options; and
- Phase 4 – Implementation and Review.

Phase 1: Preparation

Phase 1 builds upon work undertaken during Tier 1 of the Drain London Project. The Tier 1 work involved the collection and review of surface water data from key stakeholders and the building of partnerships between key stakeholders responsible for local flood risk management. It was also decided that London would be delineated into 8 working groups. The LB of Tower Hamlets forms part of Group 4 along with the LB's of Enfield, Hackney, Haringey, Newham, and Waltham Forest.

These six boroughs also form the North London Strategic Flood Group. The Group has been established in order for these local authorities to determine best practice and resources to enable each authority to discharge their responsibilities as Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA) 2010.

Phase 2: Risk Assessment

As part of the Phase 2 Risk Assessment, direct rainfall modelling has been undertaken across the entire borough for five specified return periods. The results of this modelling have been used to identify Local Flood Risk Zones (LFRZs) where flooding affects houses, businesses and/or infrastructure. Those areas identified to be at more significant risk have been delineated into Critical Drainage Areas (CDAs) representing one or several LFRZs as well as the contributing catchment area and features that influence the predicted flood extent.

Within the LB of Tower Hamlets, 14 CDAs have been identified and are presented in the figure below. The chief mechanisms for flooding in the LB of Tower Hamlets can be broadly divided into the following categories:

- Topographical Low Lying Areas - areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Cuttings: stretches of railway track in cuttings are susceptible to surface water flooding and, if flooded, will impact on services;
- Railway Embankments - discrete surface water flooding locations along the upstream side of the raised rail embankment;
- Topographical Low Points – areas which are at topographical low points throughout the borough which result in small, discrete areas of deep surface water ponding;
- Sewer Flood Risk – areas where extensive and deep surface water flooding is likely to be the influence of sewer flooding mechanisms alongside pluvial and groundwater sources; and

- Fluvial/Tidal Flood Risk (River Lee) - areas where extensive and deep surface water flooding is likely to be the influence of fluvial flooding mechanisms (alongside pluvial, groundwater and sewer flooding sources).

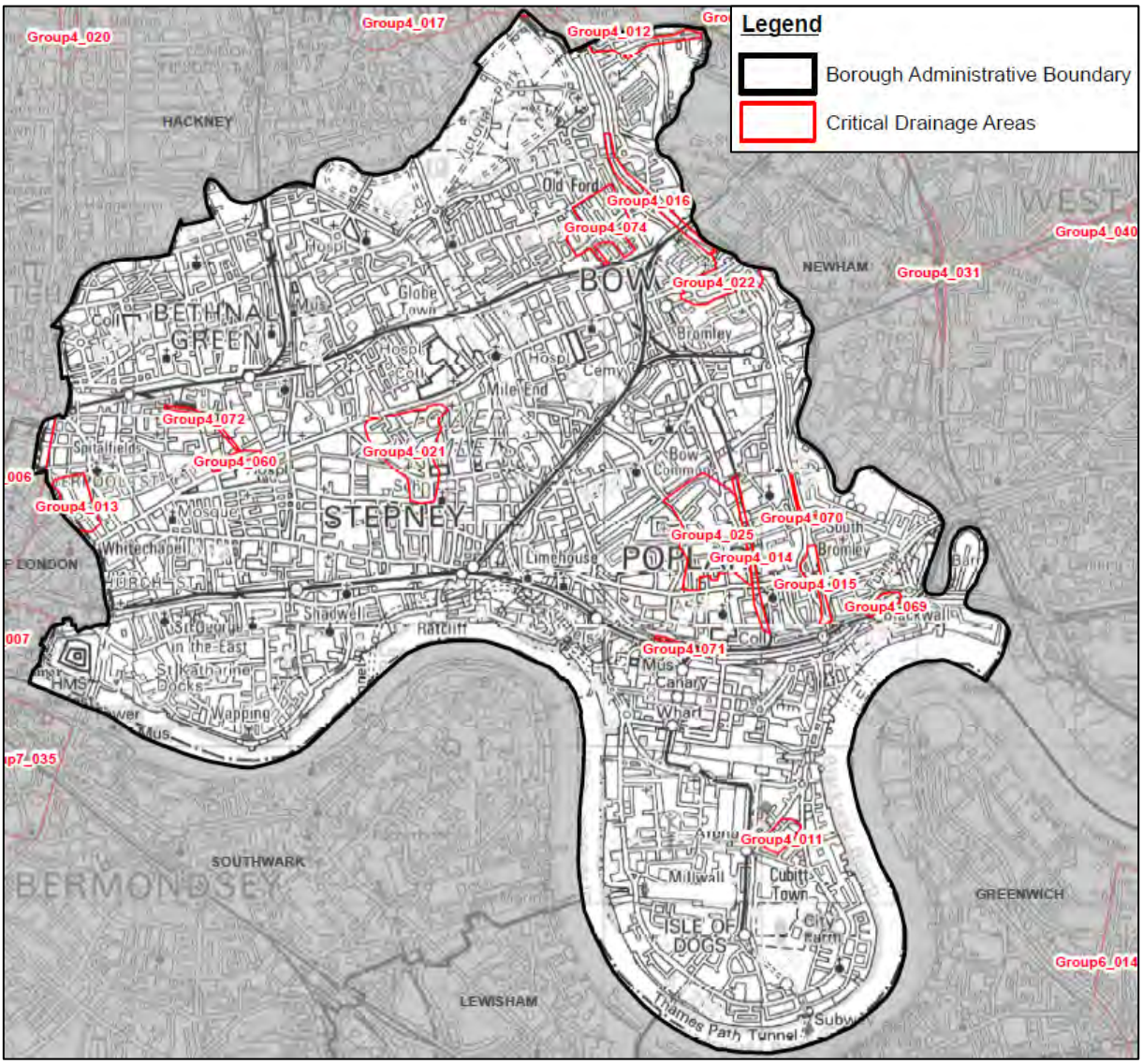

Figure i Critical Drainage Areas within the London Borough of Tower Hamlets

Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 100 probability of occurrence in any given year. A review of the results demonstrate that 11,500 residential properties and 3,800 non-residential properties in the LB of Tower Hamlets could be at risk of surface water flooding of a depth greater than 0.03m during a 100 year rainfall event (above an assumed 0.1m building threshold).

A review of these statistics coupled with local knowledge of the study area identifies that the following CDAs are at greatest risk of flooding in terms of the number of receptors at risk:

CDA ID	Infrastructure		Households				Commercial / Industrial		Total
			Non-Deprived		Deprived				
	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	
Group4_021	4	1	0	0	227	0	11	0	242
Group4_013	1	0	32	9	53	0	65	0	151
Group4_025	2	0	0	0	139	0	5	0	146
Group4_074	0	0	0	0	112	0	1	0	113
Group4_022	2	1	0	0	87	2	7	1	96

One of the CDAs within the LB of Tower Hamlets has cross-boundary issues – Group4_012, the northern portion of which extends into the LB of Hackney. This CDA will require joint management to implement the potential options and manage surface water flood risk.

Phase 3 Options Assessment

There are a number of opportunities for measures to be implemented across the borough to reduce the impact of surface water flooding. Ongoing maintenance of the drainage network and small scale improvements are already undertaken as part of the operations of the borough. In addition, opportunities to raise community awareness of the risks and responsibilities for residents should be sought, and the LB of Tower Hamlets may wish to consider the implementation of a Communication Plan to assist with this.

It is important to recognise that flooding within the borough is not confined to just the CDAs, and therefore, throughout the borough there are opportunities for generic measures to be implemented through the establishment of a policy position on issues including the widespread use of water conservation measures such as water butts and rainwater harvesting technology, use of soakaways, permeable paving, Bioretention carpark pods and green roofs. In addition, there are borough-wide opportunities to raise community awareness.

For each of the CDAs identified within the borough, site-specific measures have been identified that could be considered to help alleviate surface water flooding. These measures were subsequently short listed to identify a potential preferred option for each CDA.

Pluvial modelling undertaken as part of the SWMP has identified that flooding within the LB of Tower Hamlets is heavily influenced by existing and historic river valleys, and impacts a number of regionally important infrastructure assets. Chapter 4 identifies the preferred surface water flood risk management options and measures to address the flood risk within the borough. Borough-wide, it is recommended that in the short-to-medium term the LB of Tower Hamlets:

- Engage with residents regarding the flood risk in the borough, to make them aware of their responsibilities for property drainage (especially in the CDAs) and steps that can be taken to improve flood resilience;
- Provide an ‘Information Portal’ via the LB of Tower Hamlets website, for local flood risk information and measures that can be taken by residents to mitigate surface water flooding to/around their property;
- Prepare a Communication Plan to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public; and
- Improve maintenance regimes, and target those areas identified to regular flood or known to have blocked gullies.

Phase 4 Implementation & Review
Phase 4 establishes a long-term Action Plan for the LB of Tower Hamlets to assist in their role under the FWMA 2010 to lead in the management of surface water flood risk across the borough. The purpose of the Action Plan is to:

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery; and
- Outline actions required to meet the requirements for the LB of Tower Hamlets as LLFA under the FWMA 2010.

The SWMP Action Plan is a 'living' document, and as such, should be reviewed and updated regularly, particularly following the occurrence of a surface water flood event, when additional data or modelling becomes available, following the outcome of investment decisions by partners and following any additional major development or changes in the catchment which may influence the surface water flood risk within the borough.

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, see below
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. A national data set held by the Environment Agency and based on high level modelling which shows areas potentially at risk of surface water flooding.
Catchment Flood Management Plan (CFMP)	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, see below.
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, see entry above
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This UK Parliamentary Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums have a duty to 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 below the level of the ground.
Defra	Government Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model: a topographic model consisting of terrain elevations for ground positions at regularly spaced horizontal intervals. DEM is often used as a global term to describe DSMs (Digital Surface Model) and DTMs (Digital Terrain Models).
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.
DSM	Digital Surface Model: a topographic model of the bare earth/underlying terrain of the earth's surface including objects such as vegetation and buildings.
DTM	Digital Terrain Model: a topographic model of the bare earth/underlying terrain of the earth's surface excluding objects such as vegetation and buildings. DTMs are usually derived from DSMs.
EA	Environment Agency: Government Agency reporting to Defra charged with protecting the Environment and managing flood risk in England.
Indicative Flood Risk Areas	Areas determined by the Environment Agency as potentially 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.

Term	Definition
FCERM	Flood and Coastal Erosion Risk Management Strategy. Prepared by the Environment Agency in partnership with Defra. The strategy is required under the Flood and Water Management Act 2010 and will describe what needs to be done by all involved in flood and coastal risk management to reduce the risk of flooding and coastal erosion, and to manage its consequences.
FMfSW	Flood Map for Surface Water. A national data set held by the Environment Agency showing areas where surface water would be expected to flow or pond, as a result of two different chances of rainfall event, the 1 in 30yr and 1 in 200yr events.
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).
Flood Risk Area	See entry under Indicative Flood Risk Areas.
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	An Act of Parliament which forms 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 water flood risk in England. The Act was passed in 2010 and is currently being enacted.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse (river or stream). In this report the term Fluvial Flooding generally refers to flooding from Main Rivers (see later definition).
FRR	Flood Risk Regulations, see above.
IDB	Internal Drainage Board. An independent body with powers and duties for land drainage and flood control within a specific geographical area, usually an area reliant on active pumping of water for its drainage.
iPEG	Increased Potential Elevated Groundwater (iPEG) maps. The iPEG mapping shows those areas within the borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface. The mapping was carried out on a London-wide scale by Jacobs/JBA in March 2011.
IUD	Integrated Urban Drainage, a concept which aims to integrate different methods and techniques, including sustainable drainage, to effectively manage surface water within the urban environment.
LB	London Borough, e.g. LB Haringey, London Borough of Haringey
LDF	Local Development Framework. The spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004 and given detail in Planning Policy Statements 12. These documents typically set out a framework for future development and redevelopment within a local planning authority.
LFRZ	Local Flood Risk Zone, see below.
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 responsible for taking the lead on local flood risk management. The duties of LLFAs are set out in the Floods and Water Management Act.
LiDAR	Light Detection and Ranging, a technique to measure ground and building levels remotely from the air, LiDAR data is used to develop DTMs and DEMs (see definitions above).
LLFA	Lead Local Flood Authority, see above.

Term	Definition
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 and respond in an emergency. Roles and Responsibilities are defined under the Civil Contingencies Act.
LPA	Local Planning Authority. The local authority or Council that is empowered by law to exercise planning functions for a particular area. This is typically the local borough or district Council.
LRF	Local Resilience Forum, see above.
Main River	Main rivers are a statutory type of watercourse in England and Wales and are usually larger streams and rivers, but may also include some smaller watercourses. A main river is defined as a watercourse marked as such on a main river map, and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only.
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency. A receptor could include essential infrastructure such as power infrastructure and vulnerable property such as schools and health clinics.
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs are termed Ordinary Watercourses.
PA	Policy Area, see below.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment, see below.
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 from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
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
PPS25	Planning and Policy Statement 25: Development and Flood Risk
Preliminary Flood Risk Assessment	Assessment required by the EU Floods Directive which summarises flood risk in a geographical area. Led by Local Authorities.
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, combined with the consequence of the flood.
Risk Management Authority	Defined by the Floods and Water Management Act as “the Environment Agency, a lead local flood authority, a district council for an area for which there is no unitary authority, an internal drainage board, a water company, and a highway authority”.
RMA	Risk Management Authority, see above
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment, see below

Term	Definition
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.
Strategic Flood Risk Assessment	A strategic framework for the consideration of flood risk when making planning decisions at Local Level.
SuDS	Sustainable Drainage Systems, see below.
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. Includes swales, wetland sand ponds.
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
TE2100	The Thames Estuary 2100 Project. Led by the Environment Agency, the project was established in 2002 with the aim of developing a long-term tidal flood risk management plan for London and the Thames estuary.
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
UKCIP	The UK Climate Impacts Programme. Established in 1997 to assist in the co-ordination of research into the impacts of climate change. UKCIP publishes climate change information on behalf of the UK Government and is largely funded by Defra.
WaSC	Water and Sewerage Company

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1 Introduction

1.1 What is a Surface Water Management Plan?

1.1.1 A Surface Water Management Plan (SWMP) is a plan produced by the Lead Local Flood Authority (in this case London Borough of Tower Hamlets) which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs 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 also establishes a long-term action plan to manage surface water and 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 in London is split between boroughs and other organisations such as Transport for London, London Underground, Network Rail and relationships with the Environment Agency and Thames Water and the responsibility for managing sources of flood risk were unclear. To give the issue even greater urgency it is widely expected that heavy storms with the potential to cause flooding 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 The Department for Environment, Food and Rural Affairs (Defra) recognised the importance of addressing surface water flooding in London and fully funded the Drain London project. The Drain London project is being delivered through 3 ‘Tiers’ as shown in Figure 1-1.

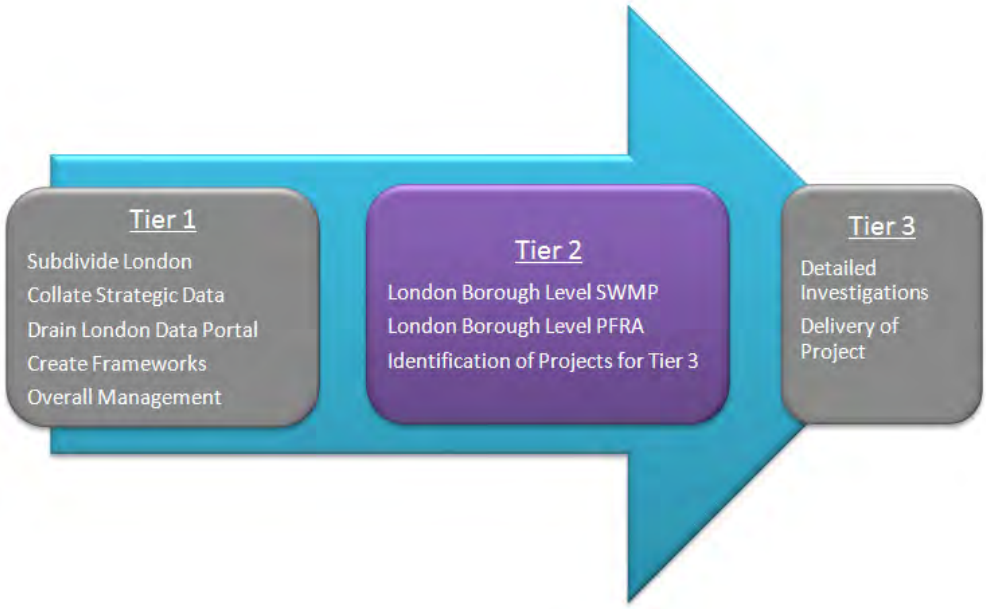


Figure 1-1 Drain London Project 'Tier' Structure

1.2.4 A description of the works within each Tier is described in Table 1-1. This SWMP forms part of Tier 2 package of works.

Table 1-1 Summary of Drain London Project 'Tier' Structure

Phase	Summary of works
Tier 1	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 in order to develop and refine an SWMP for each. b) 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' participants and to Tier 2 & 3 consultants. c) c) Provide programme management support for the duration of the Drain London project, including Tiers 2 and 3.
Tier 2	a) Delivery of 33 borough-level **Surface Water Management Plans** to identify Local Flood Risk Zones and Critical Drainage Areas. b) Creation of 33 borough-level **Action Plans** including capital and maintenance actions and programmes of work for each partner/stakeholder as well as actions required to meet the responsibilities as Lead Local Flood Authority required by the FWMA 2010. c) Preparation of 33 borough-level **Preliminary Flood Risk Assessments** to meet the requirements of the Flood Risk Regulations 2009 on Lead Local Flood Authorities. d) d) List of prioritised Critical Drainage Areas for potential further study or capital works in Tier 3 using the Drain London Tier 1 **Prioritisation Matrix**.
Tier 3	a) Detailed investigations into high priority Critical Drainage Areas to further develop and prioritise mitigation options. b) b) Development of cross-organisational action plans that include a costed list of identified flood risk management mitigation measures and community level flood plans.

1.2.5 As described in Table 1-1, Tier 2 of the Drain London project involves the preparation of SWMPs for each London Borough. Through the subsequent enactment of the FWMA boroughs are also required to produce Preliminary Flood Risk Assessments (PFRA). The Drain London project has been extended 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 F&WM Act. Another key aspect of the Act is to ensure that boroughs work in partnership with other Local Risk Authorities. Drain London assists this by creating sub-regional partnerships as set out in Figure 1-2 below.

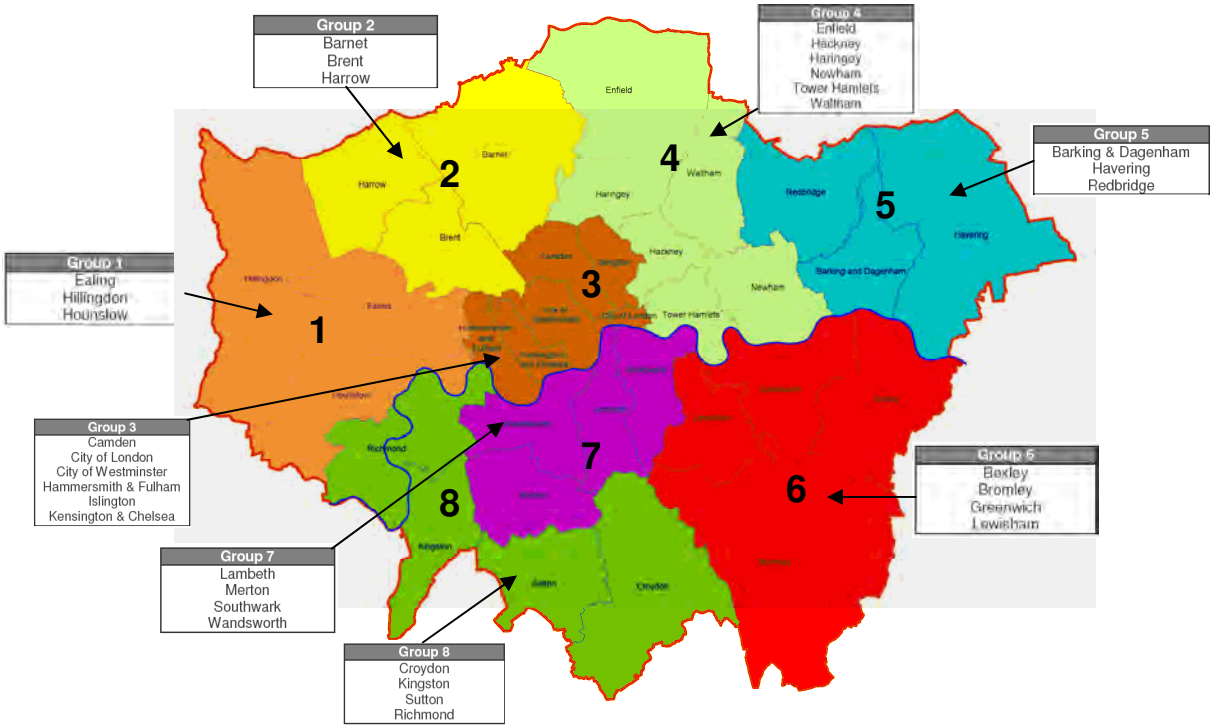


Figure 1-2 Drain London Sub-regional Partnerships

1.3 SWMP Process

1.3.1 The Defra SWMP Technical Guidance (2010) provides the framework for preparing SWMPs. This report has been prepared to reflect the four principal stages identified by the guidance (refer Figure 1-3):

- Preparation; Identify the need for a SWMP, establish a partnership with the relevant stakeholders and scope SWMP (refer to Chapter 2);
- Risk Assessment; Identify which level of detail is required for the SWMP – a Level 2 Intermediate assessment was selected for this study (refer to Chapter 3);
- Options: Identify options/measures (with stakeholder engagement) which seek to alleviate the surface water flood risk within the study area (refer to Chapter 4); and
- Implementation and Review: Prepare Action Plan and implement the monitoring and review process for these actions (refer to Chapter 5).

Figure 1-3 Recommended Defra SWMP Process (Source Defra 2010)

1.3.2 The scope of the Tier 2 work (refer to Table 1-1) falls within Phase 2 (Risk Assessment) and Phase 3 (Options) and partially within Phase 4 (Implementation and Review).

1.4 Objectives

1.4.1 The objectives of the SWMP are to:

- Develop a robust understanding of surface water flood risk in and around the study area, 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;

- 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 whereby partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions;

- Meet borough specific objectives as recorded at the outset of the development of the SWMP (further details below);

- 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.

1.4.2 Borough specific aims and objectives were discussed at the various meetings held throughout the development of the SWMP. These are summarised below:

- *Identify surface water flood risk areas to assist with spatial planning and future development;*
- *Identify surface water flood risk areas to assist with emergency planning within the borough;*
- *Provision of mapping which is suitable for public distribution;*
- *Determine (if possible) options to alleviate flood risk within the identified Critical Drainage Areas;*
- *Provide a clear Action Plan which the Council can implement (and/or areas to investigate) to assist in the further understanding of pluvial and groundwater flooding within the borough.*

1.5 Study Area

Location and Characteristics

1.5.1 The London Borough (LB) of Tower Hamlets is located in east London and borders the LBs of Newham to the east, Hackney to the north, and City of London to the west. The financial centre of Canary Wharf lies within the Borough on the Isle of Dogs, and in the south west corner is the Tower of London. The Borough boundary encompasses an area of 2,000ha which is heavily urbanised, consisting of commercial, residential and industrial landuses. **Error! Reference source not found.** (and Figure 3 within Appendix D) provides an overview of the landuses within Tower Hamlets.

1.5.2 A review of the borough has found that it contains the following significant infrastructure:

- Kilometres of Network Rail, Docklands Light Railway and London underground rail line along with tube/rail stations infrastructure;

- There are five hospitals within the borough, generally located along the A11 in the centre and in the north;

- There are five fire stations fairly evenly spread across the borough; and

- Sixteen (16) A roads.

Major Rivers and Waterways within the Borough

1.5.3 The LB of Tower Hamlets is bound by the River Lee to the east and the River Thames to the south. The River Lee flows in a southerly direction, discharging into the River Thames in the south east corner of the borough near Canning Town. The watercourse drains a large rural catchment to the north of London, extending as far as Luton and encompassing parts of Hertfordshire and Essex, also flowing through the London Boroughs of Enfield, Waltham Forest, Haringey and Hackney.

1.5.4 Other watercourses of note include the Grand Union Canal, the Hertford Union Canal and the Limehouse Cut. The Grand Union Canal flows in from the LB of Hackney and bisects the borough from north to south, discharging in the Limehouse Basin. The Limehouse Cut and the Hertford Union Canal flow in a east-westerly direction between the River Lee and the Grand Union Canal. All three of these watercourses are artificial.

1.5.5 Figure 7 in Appendix D shows the locations of these watercourses within the borough.

Topography and Geology

1.5.6 The topography of the LB of Tower Hamlets generally slopes in an easterly direction towards the River Lee. The highest parts of the borough are in the north-west along the boundary with the LB of Hackney. The lowest parts of the Borough are generally found along the frontage with the River Thames. Areas of low ground are found in Wapping, South Bromley and the Isle of Dogs. There is the potential for flood waters to pond in such areas.

1.5.7 The LB of Tower Hamlets lies within the London Basin, which has been shaped by a relatively thick (few hundred metres) chalk syncline. The basin has been infilled over time by a series of clays and sands, the most notable deposit being the fossil rich and impermeable London Clay. The clay layer can be up to a maximum of 150m thick beneath London. More recently in geological terms, the London Clay has been overlain by drift deposits from river terraces. As the River Lee has altered path and scoured channels deeper through time, they have left deposits of sand and gravel in terrace formations upon the underlying geology.

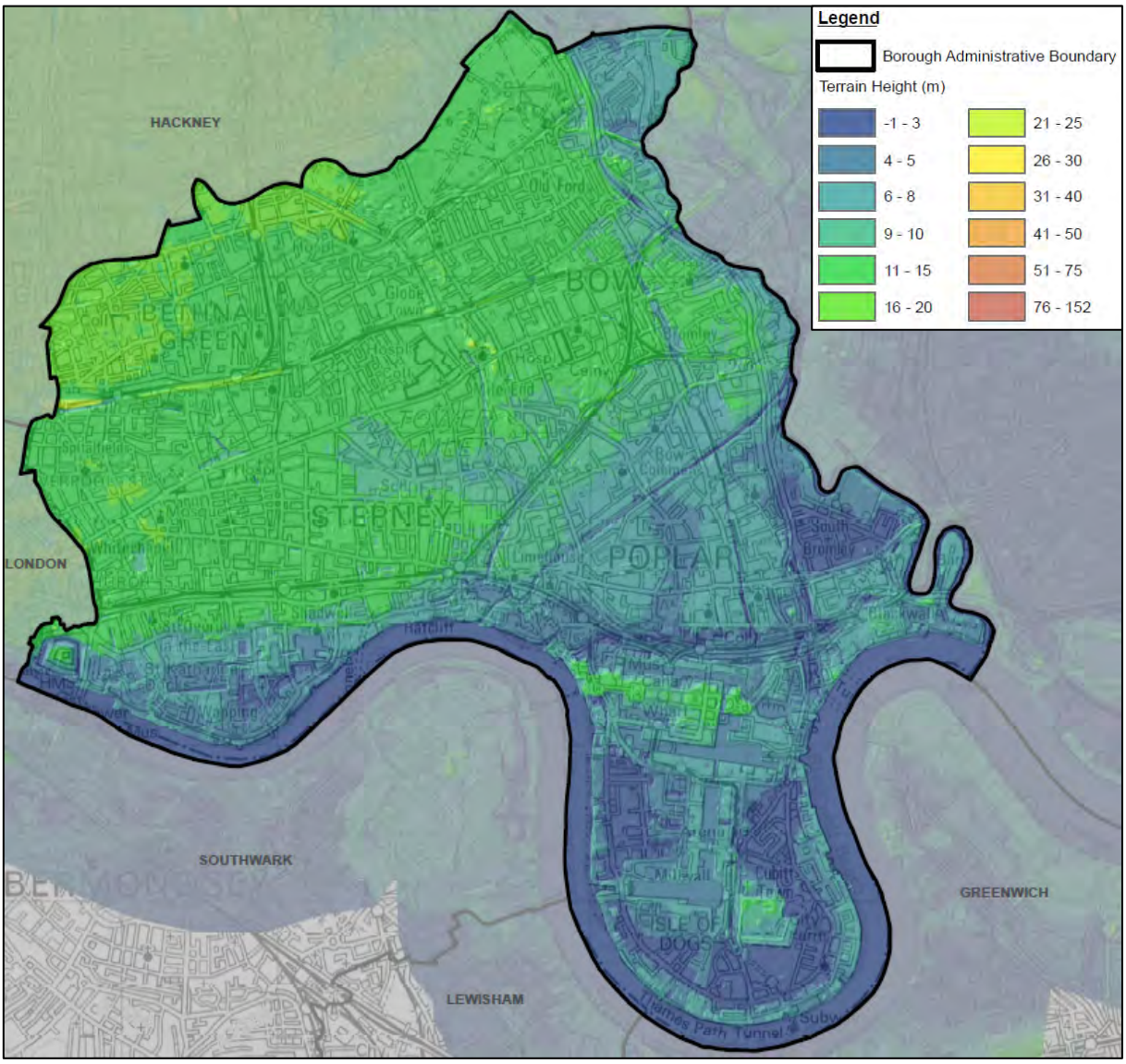


Figure 1-4 LiDAR Representation of the Topography within Tower Hamlets

Significant future development plans

1.5.8 The Local Development Framework (LDF) for the London Borough of Tower Hamlets identifies growth areas in:

- Lower Lee Valley;
- Millenium Quarter and Crossharbour;
- Wapping;
- Fish Island;
- Bethnal Green North;
- Bishopsgate Goodsyard;
- Wood Wharf; and

- Ocean Estate.

1.5.9 In each instance an Area Action Plan will be produced to provide further guidance on how development should be brought forward.

1.5.10 Plans for urbanisation and redevelopment within the LB of Tower Hamlets may present a challenge to the existing drainage systems. However, it is also affords a crucial opportunity to address long-standing issues and problems relating to surface water flooding through strategic improvements and upgrades to the drainage system. The SWMP for the LB of Tower Hamlets should afford a particular focus on these areas allocated for further development and urbanisation and identify any potential locations for strategic improvements and upgrades to the existing drainage systems.

1.5.11 In the case of four of the identified growth areas – Lower Lee Valley, Millenium Quarter and Crossharbour, Wood Wharf and Fish Island – development offers the opportunity to reduce flood risk in 'critical drainage areas' identified in section 3.8 of this report.

Interactions with neighbouring Boroughs / County Councils

1.5.12 The need for an integrated approach between neighbouring boroughs has become apparent due to cross boundary flooding and drainage issues in recent years. This has become evident in the Drain London programme where a number of 'critical drainage areas' identified in section 3.8 of this report span across more than one borough.

1.5.13 The LB of Tower Hamlets forms part of the 'Group 4' group of boroughs, established as part of the Drain London programme, formed to assist delivery of Drain London, but also to establish an ongoing working partnership for managing local flood risk in the area. The aims of this partnership are to understand flood risk to the group boroughs and to share best practice management procedures. Drain London Group 4 includes the London Boroughs of:

- Enfield
- Hackney
- Haringey
- Newham
- Tower Hamlets
- Waltham Forest

1.6 Flooding Interactions

1.6.1 The SWMP technical guidance (Defra 2010) identifies four primary sources of surface water flooding that should be considered within a SWMP as described below:

- **Pluvial flooding**: High intensity storms (often with a short duration) are sometimes unable to infiltrate into the ground or be drained by formal drainage systems since the capacity of the collection systems is not large enough to convey runoff to the underground pipe systems (which in turn might already be surcharging). The pathway for surface water flooding can include blockage, restriction of flows (elevated grounds), overflows of the drainage system and failure of sluice outfalls and pump systems.

- **Sewer flooding**: Flooding which occurs when the capacity of the underground drainage network is exceeded, resulting the surcharging of water into the nearby environment (or within internal and external building drainage networks). The discharge of the drainage network into waterways and rivers can also be affected if high water levels in receiving waters obstruct the drainage network outfalls.

- **Ordinary Watercourses**: Flooding from small open channels and culverted urban watercourses (which receive most of their flow from the urban areas) can either exceed their capacity and cause localised flooding of an area or can be obstructed (through debris or illegal obstruction) and cause localised out of bank flooding of nearby low lying areas.

- **Groundwater flooding:** Flooding occurs when the water level within the groundwater aquifer rises to the surface. In very wet winters these rising water levels may lead to flooding of areas that are normally dry. This can also lead to streams that only flow for part of the year being reactivated. These intermittent streams are typically known as bournes. Water levels below the ground can rise during winter (dependant on rainfall) and fall during drier summer months as water discharges from the saturated ground into nearby watercourses.

1.6.2 Figure 1-5 provides an illustration of these flood sources. Each of these sources of flood risk a futher explained within Chapter 3 of this report.

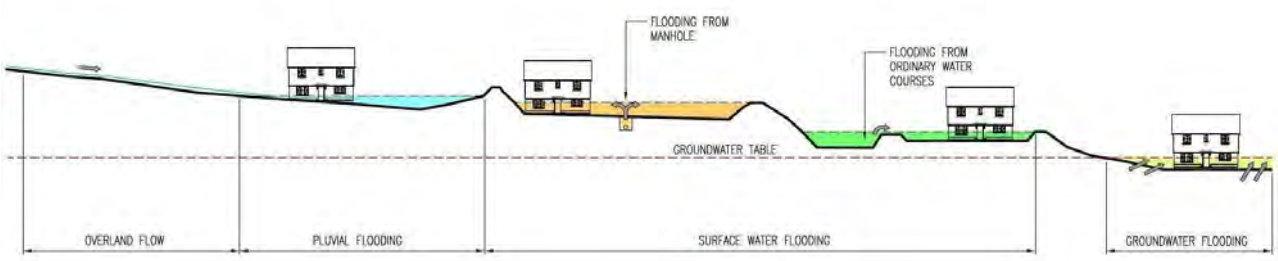


Figure 1-5 Illustration of Flood Sources (source: WSP, 2010).

1.7 Linkages with Other Plans

1.7.1 The increased focus on flood risk over recent years is an important element of adaptation to climate change. The clarification of the role of London Boroughs as Lead Local Flood Authorities (LLFA) is welcomed. The creation of a number of new documents can at times be confusing. Drain London links into all of these:

Regional Flood Risk Appraisal (RFRA)

1.7.2 The RFRA 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.

Thames Catchment Flood Management Plan (CFMP)

1.7.3 The Thames Catchment Flood Management Plan (CFMP) 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.

1.7.4 The CFMP 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.

1.7.5 This CFMP 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.

Preliminary Flood Risk Assessment (PFRA)

1.7.6 These are required as part of the Flood Risk Regulations which implement the requirements of the European Floods Directive. Drain London is producing one of these for each London Borough (each of which is a Lead Local Flood Authority), to give an overview of all local sources of flood risk. In London the PFRA process is greatly assisted by the new data and information relating to surface water which comes from the Drain London SWMPs. Boroughs must review these PFRAs every 6 years.

Surface Water Management Plans (SWMP)

1.7.7 Drain London is producing one of these for each London Borough. They provide detailed information on the potential for surface water flooding, based on probabilistic 2-dimensional modelling. This information improves greatly on data which has previously been provided at a national scale by the Environment Agency. In addition each SWMP contains an Action Plan that has been developed in conjunction with both the borough and relevant other Risk Management Authorities. This data and actions and associated policy interventions will 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.

Strategic Flood Risk Assessments (SFRA)

1.7.8 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 (due to past priorities and a lack of data) in evaluating flooding from other local sources including surface water, groundwater and ordinary watercourses. The information from Drain London will improve this understanding.

1.7.9 Currently a Level 1 SFRA has been produced for the LB of Tower Hamlets. This was completed in August 2008 and can be obtained from the LB of Tower Hamlets website. The borough has plans to update the SFRA in 2011.

1.7.10 The LB of Tower Hamlets is also covered by the East London SFRA, which was drafted in June 2005. This report covers the London Boroughs of Lewisham, Greenwich, Bexley, Havering, Barking and Dagenham, Newham, Waltham Forest, Redbridge, Hackney and Tower Hamlets. The East London SFRA was commissioned by Thames Gateway London Partnership and includes the collaboration between the ten boroughs in East London and the London Corporation. This document was drafted to meet the requirements of PPG25 and is now considered out of date as it does not meet the requirements in PPS25.

Local Development Documents (LDD)

1.7.11 LDDs including the Core Strategy and relevant Area Action Plans (AAPs) will need to reflect the results from Drain London. This may include policies for the whole borough or for specific parts of boroughs, 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. The updated SFRA 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.

Local Flood Risk Management Strategies

1.7.12 The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce a Local Flood Risk Management Strategy by December 2012. Whilst Drain London will not directly deliver a LFRMP, the SWMPs, PFRAs and their associated risk maps will provide the necessary evidence base to support the development of LFRMS and it is anticipated that no, or limited new modelling will be necessary to produce these strategies.

1.7.13 The schematic diagram (Figure 1-6 below) illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

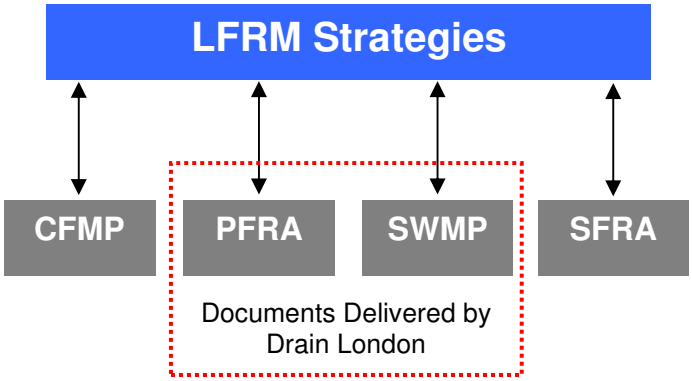


Figure 1-6 Linkages of LFRM Strategy Reports

1.8 Existing Legislation

1.8.1 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.

1.8.2 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.

1.8.3 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 to be produced:

a) 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.

b) 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.

c) 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.

1.8.4 Figure 1-7, below, illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

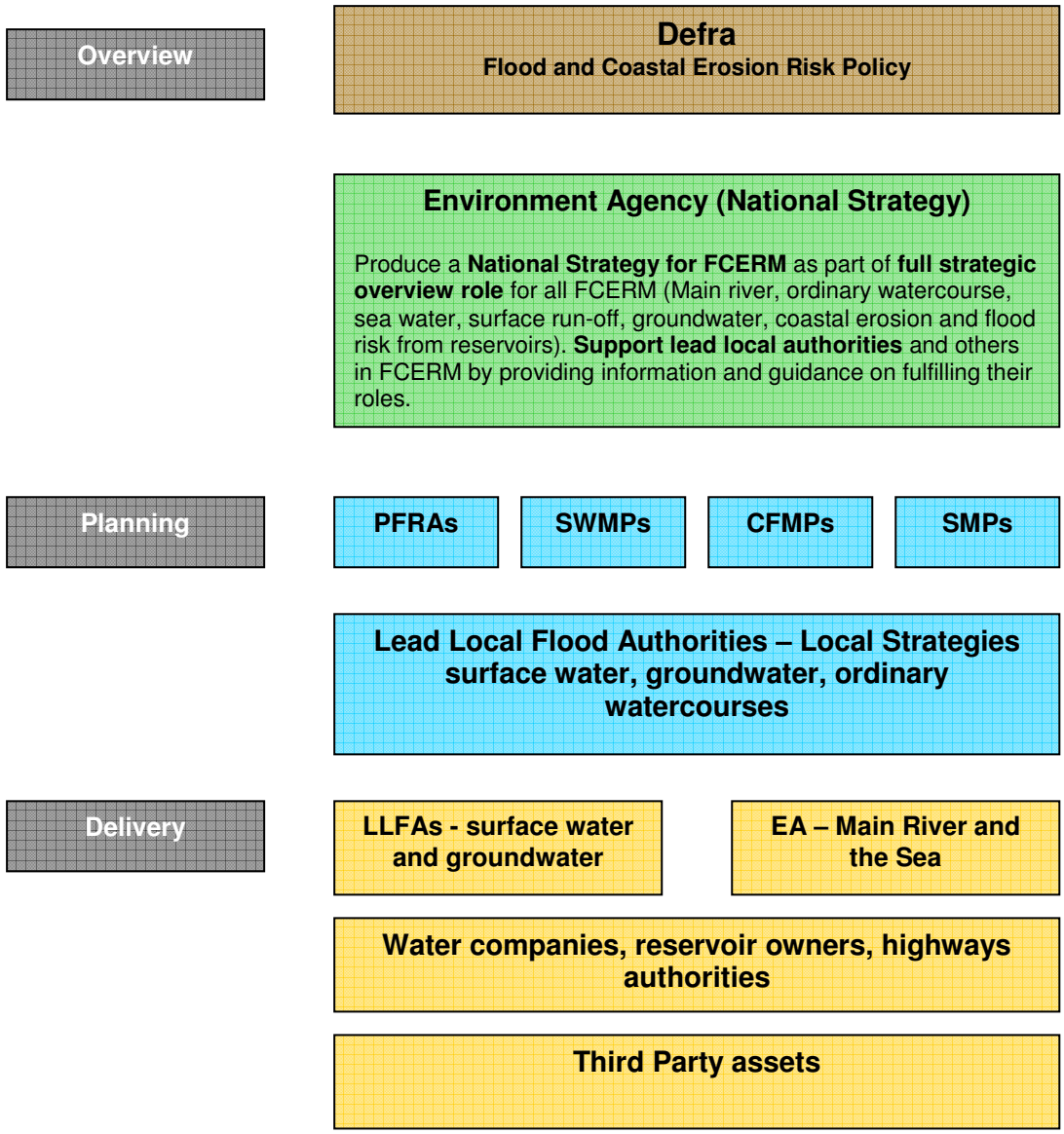


Figure 1-7 Where the SWMP is located within the delivery of local flood and coastal risk management

1.9 Peer Review

1.9.1 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).

1.9.2 To ensure consistency and comparability between London Borough SWMPs produced, a Peer Review process has been used. The process involved the four consultant teams who are working on the Drain London SWMPs independently reviewing each other's 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.

1.10 LLFA Responsibilities

1.10.1 Aside from forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Local Lead Flood Authorities from the Flood & Water Management Act 2010, and the Flood Risk Regulations 2009. These responsibilities include:

- **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out. .
- **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.
- **SuDS Approving Body** – LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area. This responsibility is anticipated to commence from April 2012.
- **Flood risk management strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management 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.
- **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.

- **Designation powers** – LLFAs, as well as district councils and the Environment Agency have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management.

1.10.2 These LLFA requirements have been considered in the production of this document. The SWMP will assist the LLFA in providing evidence for points 1, 2 and 3.

2 Phase 1: Preparation

2.1 Partnership

2.1.1 The Flood and Water Management Act 2010 defines the Lead Local Flood Authority (LLFA) for an area as the unitary authority for the area, in this case LB of Tower Hamlets. As such, the LB of Tower Hamlets is responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the Environment Agency, Thames Water Utilities Ltd, Transport for London, Network Rail and London Underground as well as others. Ideally these working arrangements should be formalised 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). It is recommended that the partnerships created as part of the Drain London Tier 1 work are maintained into perpetuity.

2.1.2 As mentioned in section 1.5.13 of this report, the LB of Tower Hamlets forms part of the Drain London 'Group 4' group of boroughs, established as part of the Drain London programme. Group 4 are currently represented on the Thames Regional Flood Defence Committee (RFDC) by Councillor Chris Bond, Cabinet Member for Environment from the LB of Enfield.

2.1.3 Members of the public may also have valuable information to contribute to the SWMP and to an improved understanding and management of local flood risk within the borough. Public engagement can afford significant benefits 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 proposed in future flood risk management plans.

2.2 Data Collection

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

- LB of Tower Hamlets
- 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 provided to the Tier 2 consultants.

2.2.3 Table 2-1 provides a summary of the data sources held by partner organisations and provides a description of each dataset, and how the data was used in preparing the SWMP. This data was collated centrally by the Greater London Authority through the Drain London project, including centralising relevant data sharing agreements and licensing. This data was then disseminated to consultants Capita Symonds with Scott Wilson for the preparation of the LB of Tower Hamlets SWMP.

Table 2-1 Data Sources and Use

	Dataset	Description	Use in this SWMP
Environment Agency	Main River centre line	GIS dataset identifying the location of Main Rivers across London	To define waterway locations within the borough.
	Environment Agency Flood Map (Flood Zones)	Shows extent of flooding from rivers during a 1 in 100yr flood and 1 in 1000yr return period flood. Shows extent of flooding from the sea during 1 in 200yr and 1 in 1000yr flood events. Ignores the presence of defences.	To identify the fluvial and tidal flood risk within the borough and areas benefiting from fluvial and tidal defences.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the EA and developed in response to Pitt Review recommendations.	To assist with the verification of the pluvial modelling
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.	To assist with the verification of the pluvial modelling
	Groundwater Flooding Incidents	Records of historic incidents of groundwater flooding as recorded by the Environment Agency.	To identify recorded groundwater flood risk – assist with verifying groundwater flood risk
	National Receptors Dataset	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.	Utilised for property/infrastructure flood counts and to determine CDA's.
	Indicative Flood Risk Areas	National mapping highlighting key flood risk areas, based on the definition of 'significant' flood risk agreed with Defra and WAG.	Initial review to determine national view on flood risk areas within the borough.
	Historic Flood Outline	Attributed spatial flood extent data for flooding from all sources.	Used to assist with the verification of modelling results and CDA locations (where available)
	Rainfall Data	15 minute and daily rainfall gauge records from approximately 1990 – 2010 for gauge sites across London.	Used in the initial stages of rainfall modelling to determine appropriate model durations and hyetographs.
	Source protection zones	Show zones around important groundwater sources which may be impacted by contamination that might cause pollution in the area. The maps show three main zones (inner, outer and total catchment).	Within the assessment of groundwater flooding to determine permeable geology
	Asset data	Details on the location and extent of flood defences across Group 4 as well as a system asset management plans.	To determine asset locations within the pluvial modelling process.
.ondon Borough of Tower Hamlets	Strategic Flood Risk Assessments (SFRA)	SFRAs may contain useful information on historic flooding, including local sources of flooding from surface water, groundwater and flooding from canals.	Provide a background to the flood risk in the borough.
	Anecdotal information relating to local flood history and flood risk areas	Anecdotal information from authority members regarding areas known to be susceptible to flooding from excessive surface water, groundwater or flooding from ordinary watercourses.	Assist with CDA confirmation but not necessarily used as verification evidence.

	Dataset	Description	Use in this SWMP
	Core Strategy Development Plans	Local Development Scheme, details on Area Action Plans and Place Shaping Priority Areas.	Understanding of areas of future development.
Thames Water	DG5 Register for Thames Water Utilities areas	DG5 Register logs and records of sewer flooding incidents in each area.	Mapping sewer flooding incidents.
	Sewer pipe network	GIS dataset providing the geo-referenced location of surface water, foul and combined sewers across Group 1. Includes pipe size and some information on invert levels.	Verifying CDA locations and Phase 3:Options Assessment
	Basements	GIS dataset showing Thames Water Utilities recording of basement locations.	Defining CDAs and utilised within the property count information
British Waterways	British Waterway's canal network	Detailed GIS information on the British Waterway's canal network, including the location of canal centrelines, sluices, locks, culverts, etc.	Centrelines have been incorporated within modelling to define canal locations
British Geological Society	Geological datasets	Licensed GIS datasets including: Geological indicators of flooding; Susceptibility to groundwater flooding; Permeability; Bedrock and superficial geology.	Understanding the geology of the borough
GLA	Deprived Areas	Index of Multiple Deprivation, ranking all London Ward's.	Used within the prioritisation matrix and for property counts
	Administrative boundaries	Greater London Borough boundaries	Providing study boundaries
	Ordnance Survey Mapping, MasterMap	Vector mapping of the London area	Utilised within the pluvial modelling to determine "roughness" within the borough
London Fire Brigade	Historic flooding records	London Fire Brigade call outs to incidents of flooding between January 2000 and December 2009. Does not specify the source of flooding.	Understanding of possible flood locations within the borough – records do not indicate what type of flooding occurred at each location.
London nderground and Network Rail	Historic flooding records	Recorded incidents of flooding to London Underground and National Rail infrastructure	Verification of pluvial modelling results and CDA designations

	Dataset	Description	Use in this SWMP
Transport for London	Pump Station Locations	Pdf mapping identifying the location of road underpass pump station owned and maintained by TfL.	Understanding which assets include pumping stations and to assist in the verification of pluvial outputs and the optioneering exercise
Infoterra	LiDAR topographical data	High resolution elevation data derived from airborne sources – at a 1m grid. A laser is used to measure the distance between the aircraft and ground and between the aircraft and the vegetation canopy or building tops. Typical (unfiltered) accuracy ranges are +/- 0.15m.	Filtered LiDAR was utilised within the creation of the pluvial models to define the ground surface of the catchment and to understand the general topography of the catchment and wider borough.

2.3 Data Review

2.3.1 The most significant data gap across the LB of Tower Hamlets relates to records of past 'local' flooding incidents. This is a common issue across the UK as record keeping of past floods has historically focussed on flooding from rivers or the sea. Records of past incidents of surface water, sewer, groundwater or ordinary watercourse flooding have been sporadic.

2.3.2 Thames Water have provided postcode linked data on records of sewer flooding, (known as the DG5 register) however more detailed data on the location and cause of sewer flooding is not currently available.

2.3.3 Similarly, the London Fire Brigade have recorded incidents of call outs relates to flooding, however there is no information on the source of flooding (e.g. pipe bursts or rainfall), or probability, hazard or consequence of the flooding.

Future Groundwater Flooding

2.3.4 Groundwater flooding is dependent on local variations in topography, geology and soils. The causes of groundwater flooding are generally understood however it is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

2.3.5 There is a lack of reliable measured datasets to undertake flood frequency analysis and even with datasets this analysis is complicated due to the non-independence of groundwater level data. Surface water flooding incidents are sometimes mistaken for groundwater flooding incidents, e.g. where runoff via infiltration seeps from an embankment, rather than locally high groundwater levels.

2.3.6 Drain London have commissioned specific groundwater emergence maps, known as increased Potential for Elevated Groundwater (iPEG) maps, to assist in determining the areas within Greater London that are possibly at risk of groundwater flooding.

Future Surface Water Flooding

2.3.7 The Environment Agency data sets 'Areas Susceptible to Surface Water Flooding' and second generation 'Flood Map for Surface Water' are national scale assessments suitable for broadly identifying surface water flood risk. The datasets are of a resolution suitable for assessments such as the PFRA, however are limited in their use in addressing the next stages of the Flood Risk Regulations (2009), e.g. Hazard Maps and in producing SWMPs and useful Action Plans

The outputs from Drain London will assist in addressing this data limitation. These EA data sets were utilised in the model validation phase.

Flooding Consequences

2.3.8 The National Receptors Database (NRD), version 1.0 data set, was provided for all London Boroughs in December 2010. This data set was provided to allow property counts to be undertaken for all SWMPs. Version 1.1 of the NRD has subsequently been issued and contains modifications and corrections since version 1.0. However, in order to avoid repetition of work, and ensure consistency between the SWMP, PFRA and the EA Pluvial flooding (Areas Susceptible to Surface Water Flooding and Flood Map for Surface Water), it was decided to complete the SWMP using NRD version 1.0.

2.4 Security, Licensing and Use Restrictions

2.4.1 A number of datasets used in the preparation of this SWMP are subject to licensing agreements and use restrictions.

2.4.2 The following national datasets provided by the Environment Agency are available to lead local flood authorities for local decision making:

- EA Flood Zone Map;
- Areas Susceptible to Surface Water Flooding;
- Flood Map for Surface Water; and
- National Receptor Database.

2.4.3 A number of the data sources used are publicly available documents, such as:

- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Preliminary Flood Risk Assessment; and
- Index of Multiple Deprivation.

2.4.4 The use of some of the datasets made available for this SWMP has been restricted. These include:

- Records of property flooding held by the Council and by Thames Water Utilities Ltd;
- British Geological Society geology datasets; and
- London Fire Brigade call outs for flooding.

2.4.5 Necessary precautions must be taken to ensure that all restricted information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the terms and conditions of use accompanying the data. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

2.5 LLFA Asset Register Requirements

2.5.1 As indicated in Section 2.5, the FWMA requires that the LLFA maintains an asset register which records information about structures and features that are likely to have a significant impact on flood risk within the LLFAs jurisdictional boundary.

2.5.2 As of the 6th April 2011, all LLFAs will need to maintain a register. Defra have determined the legal characteristics of the register and records, this is provided in Table 2-2:

Table 2-2 Asset Register (source: Defra, 2011 Lead Local Flood Authority Duty to Maintain a Register)

	Register	Record
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.	

2.5.3 A template and guidance documentation was provided to the LLFAs in March 2011. Although these templates were not designed to be a working tool, they do demonstrate what information could be contained within the register and how it could be structured.

2.5.4 The creation of the asset register was not within the scope of the Drain London project and is the responsibility of the LLFA. It is recommended that the LLFAs utilise a risk-based approach when creating the asset register, and begin recording structures or features which are considered the have the greatest influence on flooding first.

2.5.5 It is important to note that the register will be a “live” document, and is expected to be updated over time as more structures and features are identified and added.

2.6 Review of Asset Management Systems

2.6.1 Criteria to assess the existing asset management system of all London Boroughs was developed as part of the Drain London Tier 2 exercise to ensure consistency over the Greater London study area. This criteria is listed below:

- Level 1 – The borough knows where their assets are, what they look like and what condition they are in. Register system may take the form of a spreadsheet or hard copy records.

- Level 2 – The borough is aware of the ‘Local Authority Flood Risk Asset Tool’ currently being produced by the EA / Defra. Their register is GIS based (basic proprietary system only) or uses a highways based asset management system database. Their register captures information generally aligned with guidance provide by the Tool and the EA NFCDD system where practical. They know where their assets are and carry out reactive maintenance of significant structures as required.

- Level 3 – The borough has a detailed understanding of Asset Registers as required by the Flood and Water Management Act. Their register system accurately replicates the 'Local Authority Flood Risk Asset Tool' data standards and related NFCDD structures to an attribute level. Their register is GIS based (advanced proprietary or bespoke system) or is completely integrated with an existing asset management system. They know where their assets are and carry out periodic maintenance on the structures using a risk based priority system.

2.6.2 LB Tower Hamlets provided some asset information as part of the Drain London Tier 1 'data collection' exercise and based on the current review of the asset register appears to be Level 1. Table 2-3 provides a summary of the actions required to meet the full level 3 status as defined above.

Table 2-3 LLFA Asset Register Recommendations

Data	Format	Recommendations
Highway flooding and drainage records – including location and serviceability of road gullies.	GIS	Compile: • GIS layer of Highway flooding • GIS Layers of drainage network flooding. • GIS layer of gullies with serviceability state
Drainage network information – sewers (surface, foul, combined), culverts, drains (surface water, highway), gullies, ditches, other open drainage channels	GIS	Compile GIS layers of: • Sewers (surface, foul, combined) • Culverts from PDFs • Drains (surface water, highway) • Gullies • Ditches • Other open drainage channels
Local Authority led flood risk improvement schemes	Database	Keep a live document which records all such scheme details and contact details.
SuDS schemes information (Council adopted SuDS)	Database	Going forward keep a live document which records all such scheme details and contact details.
Balancing pond and lake information	Database and GIS	Keep a live document which records all such scheme details along with a GIS layer detailing asset and location information.
Critical local asset records (assets which are known to, or have the potential to flood)	GIS	Compile: • GIS layer of Critical local asset records
Historic sewer records (if any)	GIS	Inquire if any records are available from Thames Water etc. If available as drawings/photos compile GIS layer of historic sewer records available.
Historic construction records of drainage assets	GIS	Locate and create GIS layer of plans and drawings relating to foul and surface water drainage

Capacity and condition of 'ordinary' watercourses essential to operation of the urban drainage systems, including culverted watercourses and flow models (where they exist).	GIS	Compile GIS layer of capacity and condition of 'ordinary' watercourses.
New development drainage studies and supporting information	Database	Start collecting new development drainage studies and supporting information.
Road gulley cleaning/maintenance records	Database	Create record
Maintenance regimes and records of all assets	Database	Create record

2.6.3 Appendix B of this report contains further information on the Asset Register recommendations for the LB of Tower Hamlets.

3 Phase 2: Risk Assessment

3.1 Intermediate Assessment

Aims

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 will be 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 will then be 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 the 'borough' scale and fulfils the objectives of a second level 'Intermediate Assessment'.

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 suggesting that there are 17,200 properties at risk across the borough during a 1 in 200 year return period rainfall event, it is appropriate to adopt this level of assessment to further quantify the risks.

3.1.4 The purpose of this intermediate assessment will be to further identify those parts of the borough 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 modelling approach using TuFLOW software has been selected whereby rainfall events of known probability are applied directly to the ground surface and water is routed by the model over a representation of the ground surface to provide an indication of potential flow path directions and velocities and areas where surface water may pond.

- The direct rainfall modelling has been supported by hydraulic field visits and has been undertaken in conjunction with the LB of Tower Hamlets staff and/or EA staff.

- The outputs from the pluvial modelling have been verified (where possible) against historic surface water flood records.

3.2 Risk Overview

3.2.1 The following sources of flooding have been assessed and are discussed in detail in the following sections of this report:

- Pluvial flooding: runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or a watercourse. Figures 13 to 22 in Appendix D present mapped results of the surface water modelling;

- Sewer flooding; flooding which occurs when the capacity of the underground drainage system is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather or tidal conditions;

- Flooding from ordinary watercourses: flooding which occurs as a result of the capacity of the watercourse being exceeded resulting in out of bank flow (water coming back out of rivers and streams); and

- Flooding from groundwater sources: occurs when the water level within the groundwater aquifer rises to the surface.

3.2.2 The identification of areas at risk of flooding has been dominated by the assessment of surface water and ordinary watercourse flooding as these sources are expected to result in the greater consequence (risk to life and damage to property), as well as the quality of the information available for informing the assessment.

Mapping Limitations

3.2.3 The mapping shown within this report is suitable to identify broad areas which are more likely to be vulnerable to surface water flooding. This allows the LB of Tower Hamlets and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

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

3.2.5 Please note that these maps only show the predicted likelihood of surface water flooding (this includes flooding from sewers, drains, small watercourses and ditches that occurs in heavy rainfall in urban areas) for defined areas, and due to the coarse nature of the source data used, are not detailed enough to account for precise addresses. Individual properties therefore may not always face the same chance of flooding as the areas that surround them.

3.2.6 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. We have done all we can to ensure that the maps reflect all the data available to us and have applied our expert knowledge to create conclusions that are as reliable as possible. It is essential that

anyone using these maps fully understands the complexity of the data utilised in production of the maps, is aware of the limitations and does not use the maps in isolation.

3.2.7 We will not be liable if the maps by their nature are not as accurate as might be desired or are misused or misunderstood despite our warnings. For this reason we are not able to promise that the maps will always be completely accurate or up to date. We are also not liable for any future flooding that is not highlighted in this report.

3.3 Surface Water Flooding

Description

3.3.1 Surface water flooding is the term used to describe flooding which occurs when intense, often short duration rainfall is unable to soak into the ground or to enter drainage systems and therefore runs over the land surface causing flooding. It is most likely to occur when soils are saturated so that they cannot infiltrate any additional water or in urban areas where buildings tarmac and concrete prevent water soaking into the ground. The excess water can pond (collect) in low points and result in the development of flow pathways often along roads but also through built up areas and open spaces. This type of flooding is usually short lived and associated with heavy downpours of rain.

3.3.2 The potential volume of surface runoff in catchments is directly related to the size and shape of the catchment to that point. The amount of runoff is also a function of geology, slope, climate, rainfall, saturation, soil type, urbanisation and vegetation.

Causes and classifications

3.3.3 Surface water flooding can occur in rural and urban areas, but usually causes more damage and disruption in the latter. Flood pathways include the land and water features over which floodwater flows. These pathways can include drainage channels, rail and road cuttings. Developments that include significant impermeable surfaces, such as roads and car parks may increase the volume and rate of surface water runoff.

3.3.4 Urban areas which are close to artificial drainage systems, or located at the bottom of hill slopes, in valley bottoms and hollows, may be more prone to surface water flooding. This may especially be the case in areas that are down slope of land that has a high runoff potential including impermeable areas and compacted ground.

Impacts of surface water flooding

3.3.5 Surface water flooding can affect all forms of the built environment, including:

- Residential, commercial and industrial properties;
- Infrastructure, such as roads and railways, telecommunication systems and sewer systems;

It can also impact on:

- Agriculture; and
- Amenity and recreation facilities.

3.3.6 Flooding from land is usually short-lived and may only last as long as the rainfall event. However occasionally flooding may persist in low-lying areas where ponding occurs. Due to

the typically short duration, flooding from land tends not to have as serious consequences as other forms of flooding, such as flooding from rivers or the sea however it can still cause significant damage and disruption on a local scale.

Historic Records – Surface Water Flooding

3.3.7 There were no historical records of surface water flooding available from the LB of Tower Hamlets. This is not to say that no such incidents have occurred or that there is no future flood risk to the Borough from surface water.

Methodology for Surface Water Flooding

3.3.8 As part of the SWMP process hydraulic modelling has been undertaken. Several 2-dimensional direct rainfall models were created, using the TUFLOW software, to determine the causes and consequences of surface water flooding within the LB of Tower Hamlets. The results of the models provide an indication of key flowpaths, velocities and areas where water is likely to pond.

3.3.9 As the extents of the models have been based upon catchment boundaries, and not borough boundaries, several models were required to cover the area occupied by the LB of Tower Hamlets. This was carried out to appropriately represent cross-boundary interaction and allow for Drain London Tier 2 consultants to undertake a collaborative modelling approach. Figure 3-1 below indicates the extent of the models utilised within the assessment of the LB of Tower Hamlets.

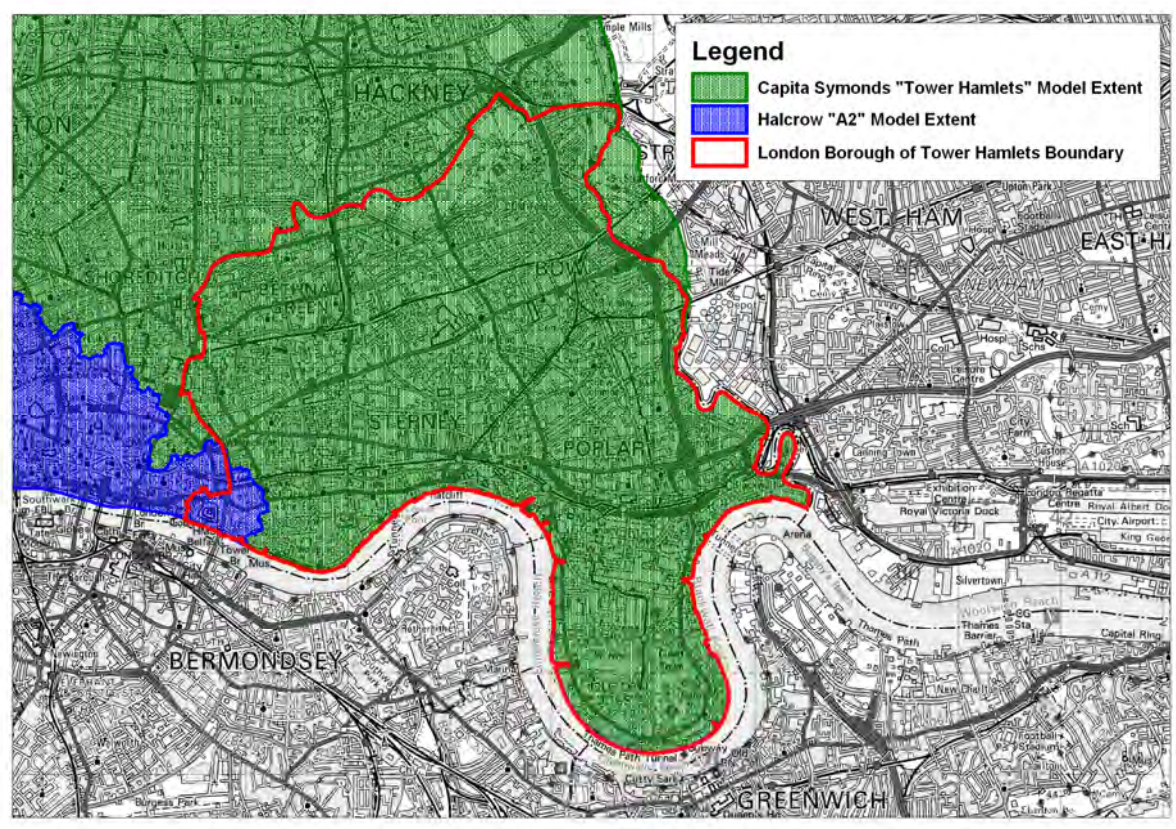


Figure 3-1: Model coverage for the London Borough of Tower Hamlets

3.3.10 The hydraulic models were run for the following return periods:

- 1 in 30 year event;
- 1 in 75 year event;
- 1 in 100 year event;
- 1 in 100 year event with allowance for climate change (30% increase in rainfall); and
- 1 in 200 year event

3.3.11 As part of this study, maps of maximum water depth and hazard for each of the return periods above have been prepared and are presented in Appendix D of this report. When viewing the maps, it is important that the limitations of the modelling are considered. The key assumptions include the use of a continuous loss (6.5mm/hr) to represent the presence of the underground drainage network. The model does not take into account any capacity issues associated with the drainage network such as surcharging of manholes leading to backing up of surface water, blocked outfalls etc. Refer to Appendix C for a more detailed discussion on the hydraulic modelling methodology.

3.3.12 Figures 13 to 17 in Appendix D indicates that water is predicted to pond over a number of roads and residential properties. These generally occur at low points in the topography such as the area east of Bartlett Park, Poplar and along the Thames frontage on the Isle of Dogs.

3.3.13 Railway lines with 'cuttings', motorway underpasses, and tunnel entrances were also observed to be particularly susceptible. Examples of this flooding mechanism includes the entrances to the Blackwall and Limehouse Tunnels, the DLR track through Langdon Park Station, and the A102 underpass beneath the A13, South Bromley.

3.3.14 Discussions with Council staff at Tower Hamlets have provided anecdotal support for several of the locations identified as being susceptible to surface water flooding as there were limited existing records.

3.3.15 The results of the assessment have been used to identify 'Local Flood Risk Zones' (LFRZs) and 'Critical Drainage Areas' (CDAs) across the LB of Tower Hamlets. These critical CDAs are identified in Figure 23 of Appendix D. Section 3.8 provides a short summary of the risk of flooding within each CDA.

Uncertainty in flood risk assessment – Surface Water Modelling

3.3.16 The surface water modelling provides the most detailed information to date on the mechanisms, extent and hazard which may result from high intensity rainfall across the LB of Tower Hamlets. However, due to the strategic nature of this study and the limitations of some data sets, there are limitations and uncertainties in the assessment approach that the reader should be aware of.

3.3.17 There is a lack of reliable measured datasets and the estimation of the return period (probability) for flood events is therefore difficult to verify. The broad scale mapping provides an initial guide to areas that may be at risk, however there are a number of limitations to using the information:

- The mapping does not include underground sewerage and drainage systems;
- The mapping should not be used in a scale to identify individual properties at risk of surface water flooding. It can be used as a general indication of areas potentially at risk.
- Whilst modelled rainfall inputs has been modified to reflect the possible impacts of climate change it should be acknowledged that this type of flooding scenario is uncertain and

likely to be very site specific. More intense short duration rainfall and higher more prolonged winter rainfall are likely to exacerbate flooding in the future.

3.4 Ordinary Watercourse Flooding

Description

3.4.1 All watercourses in England and Wales are classified as either 'Main Rivers' or 'Ordinary Watercourses'. The difference between the two classifications is based largely on the perceived importance of a watercourse, ad in particular it's potential to cause significant and widespread flooding. However this is not to say watercourses classified as Ordinary Watercourses cannot cause localised flooding. The Water Resources Act (1991) defines a 'Main River' as "a watercourse shown as such on a Main River Map". The Environment Agency keep and maintain information on the spatial extent of the Main River designations. The Floods and Water Management Act (2010) defines any watercourse that is not a Main River an Ordinary Watercourse – including ditches, dykes, rivers, streams and drains (but not public sewers).

3.4.2 The Environment Agency have duties and powers in relation to Main Rivers. Local Authorities, or in some cases Internal Drainage Boards, have powers and duties in relation to Ordinary Watercourses.

3.4.3 Flooding from Ordinary Watercourses occurs when water levels in the stream or river channel rise beyond the capacity of the channel, causing floodwater to spill over the banks of the watercourse and into the adjacent land. The main reasons for water levels rising in ordinary watercourses are:

- Intense or prolonged rainfall causing flow to increase in watercourses, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- Constrictions/obstructions within the channel causing flood water to backup;
- Blockage/obstructions of structures causing flood water to backup and overtop the banks; and
- High water levels preventing discharge at the outlet of the ordinary watercourse (often into a Main River).

3.4.4 Table 3.3 summaries the watercourses present in the borough and the classification.

Table 3-2: Watercourses in the London Borough of Tower Hamlets

Watercourse	Classification	Responsibility under the FWMA
River Lee	Main River	EA
River Lee Navigation	Main River	
Limehouse Cut	Main River	
Grand Union/Regents Canal	Artificial Watercourse	British Waterways
Hertford Union Canal		
Numerous unnamed ditches	Ordinary Watercourse	LB of Tower Hamlets

Impacts of Flooding from Ordinary Watercourse

3.4.5 The consequence of ordinary watercourse flooding is dependent upon the degree of hazard generated by the flood water (as specified within the Defra/Environment Agency research on Flood Risks to People - FD2321/TR2) and what the receptor is (e.g. the consequence of a hospital flooding is greater than that of a commercial retailer). The hazard posed by flood water is related to the depth and velocity of water, which, in Ordinary Watercourses, depends on:

- Constrictions in the channel causing flood water to backup;
- The magnitude of flood flows;
- The size, shape and slope of the channel;
- The width and roughness of the adjacent floodplain; and
- The types of structures that span the channel.

3.4.6 The hazard posed by floodwater is proportional to the depth of water, the velocity of flow and the speed of onset of flooding. Hazardous flows can pose a significant risk to exposed people, property and infrastructure.

3.4.7 Whilst low hazard flows are less of a risk to life (shallow, slow moving/still water), they can disrupt communities, require significant post-flood clean-up and can cause costly and possibly permanent structural damage to property.

Historic Records – Ordinary Watercourse Flooding

3.4.8 There were no historical records of flooding from ordinary watercourses available from the LB of Tower Hamlets. This is not to say that no such incidents have occurred or that there is no future flood risk to the borough from ordinary watercourses.

Methodology for Assessing Ordinary Watercourses

3.4.9 Ordinary watercourses have been included in the surface water flood modelling. Watercourses have been defined by digitising breaklines along the centre line of each watercourse. Elevations of watercourses have been determined from LiDAR to represent a “bank full” scenario.

3.4.10 Structures along the watercourse have been modelled as either 1D or 2D elements, depending on the length and location of the structure. The dimensions of structures have been determined from asset information obtained in the data collection stage where available or inferred from site visits or LiDAR data.

3.4.11 The assessment of flood risk from ordinary watercourses in Tower Hamlets has been based on outputs from the Drain London surface water modelling described in Appendix C and presented in Figures 13 to 17 in Appendix D. The figures indicate that the LB of Tower Hamlets is at a low risk of flooding from ordinary watercourses with little to no standing water observed in the floodplain. This is found to be consistent with the Environment Agency Flood Zone Maps (figure 6) and increases confidence in the outputs of the surface water model.

3.4.12 Please note that the risk of flooding from fluvial and tidal sources are covered within the SFRA for the LB of Tower Hamlets (August 2008). The SFRA can be obtained from the LB of Tower Hamlets website.

Uncertainties and Limitations – Ordinary Watercourse Modelling

3.4.13 As with any hydraulic model, these models have been based on a number of assumptions which may introduce uncertainties into the assessment of risk. The assumptions within the models should be noted and understood such that informed decisions can be made when using model results.

3.4.14 In relation to ordinary watercourses, the limits of the modelling include (but are not limited to):

- Modelling of structures has not been based on detailed survey data;
- The watercourses are assumed to be bank full at the start of the rainfall event, hence river flows and channel capacities have not been taken into account; and
- Only one storm duration was considered for this study.

3.4.15 Taking these uncertainties and constraints into consideration, the estimation of risk of flooding from rivers presented in this report is considered robust for the level of assessment required in the SWMP.

3.5 Groundwater Flooding

Description

3.5.1 Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. In short groundwater flooding is water which emerges from the ground from either a specific point (such as a spring) or over a wide diffuse location. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Groundwater floods tend to be long in duration developing over weeks or months and prevailing for days or weeks.

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

- Direct contribution to channel flow.
- Springs erupting at the surface.
- Inundation of drainage infrastructure.
- Inundation of low-lying property (basements).

Impacts of Groundwater Flooding

3.5.3 The main impacts of groundwater flooding are:

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

- Flooding of buried services or other assets below ground level – prolonged inundation of buried services can lead to interruption and disruption of supply;

- Inundation of roads, commercial, residential and amenity areas – inundation of grassed areas can be inconvenient, however the inundation of hard-standing areas can lead to structural damage and the disruption of commercial activity. Inundation of agricultural land for long durations can have financial consequences; and

- Flooding of ground floors of buildings above ground level – can be disruptive, and may result in structural damage. The long duration of flooding can outweigh the lead time which would otherwise reduce the overall level of damages.

3.5.4 In general terms groundwater flooding rarely poses a risk to life.

Historical Records

3.5.5 Limited records of flood incidents attributed to groundwater flooding in the LB of Tower Hamlets were available for this study. In fact, only one record was found, provided by the Environment Agency occurring on Eric Street, Mile End on the 21st December 2004. Standing water was observed to occur.

Methodology used for Groundwater Mapping

3.5.6 As part of the Drain London project Drain London Tier 1 consultants commissioned a dataset referred to as the Increased Potential Elevated Groundwater (iPEG) maps. The iPEG mapping assists in identifying areas which have an increased potential to experience groundwater flooding. The iPEG map shows those areas within the borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface. The assessment was carried out at a Greater London scale.

3.5.7 The four data sources listed below have been utilised to produce the 'increased Potential for Elevated Groundwater' (iPEG) map:

- 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.

3.5.8 More information on the production of the iPEG map is discussed in Appendix C.

3.5.9 The iPEG mapping is presented in Figure 10 of Appendix D together with historic records of flooding which have been identified as related to groundwater. The mapping shows an increased potential for ground water to rise most noticeably in the north-west corner of the borough in Bethnal Green and extending into parts of Stepney Green and Poplar.

3.5.10 This identified area coincides with gravel and silt deposits shown in Figure 12 of Appendix D. Gravel and silt deposits are more permeable than the underlying clay layer and flooding can occur when the groundwater rises through the permeable layer and meets the impermeable layer, resulting in flooding at the surface.

3.5.11 As noted in section 3.5.5 of this report, only one historical record of flooding attributed to groundwater was documented for the LB of Tower Hamlets. The location of this incident lies at the edge of the area identified as having an increased potential for groundwater. It is

recommended that as more records of groundwater flooding are collected, these are used in the validation of the iPEG mapping.

Uncertainties and Limitations – Groundwater Flooding

3.5.12 Not all areas underlain by permeable geology are shown on the iPEG maps. Only where there is the highest degree of confidence in the assessment are the areas delineated as areas where groundwater may be an issue. This ensures resources are focused on the most susceptible areas. In all areas underlain by permeable substrate, groundwater should still be considered in planning developments.

3.5.13 Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas.

3.5.14 For this reason within iPEG areas, locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the iPEG map should not be used as a "flood outline" within which properties at risk can be counted. Rather it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so what would be the major flow pathways that water would take.

3.5.15 It should be noted that this assessment is broad scale and does not provided a detailed analysis of groundwater, it only aims to provide an indication of where more detailed consideration of the risks may be required.

3.5.16 The causes of groundwater flooding are generally understood. However groundwater flooding is dependent on local variations in topography, geology and soils. It is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

3.5.17 There is a lack of reliable measured datasets to undertake flood frequency analysis on groundwater flooding and even with datasets this analysis is complicated due to the non-independence of groundwater level data. Studies therefore tend to analyse historic flooding which means that it is difficult to assign a level of certainty.

3.5.18 The impact of climate change on groundwater levels is highly uncertain. More winter rainfall may increase the frequency of groundwater flooding incidents, but drier summers and lower recharge of aquifers may counteract this effect.

3.6 Sewers

Description

3.6.1 Flooding from foul and combined sewers occurs when rainfall exceeds the capacity of networks or when there is an infrastructure failure. In the LB of Tower Hamlets the sewer network is a largely combined foul and surface water system.

Causes of sewer flooding

3.6.2 The main causes of sewer flooding are:

- Lack of capacity in the sewer drainage networks due to original under-design;
- Lack of capacity in sewer drainage networks due to an increase in flow (such as climate change and/or new developments connecting to the network);
- Exceeded capacity in sewer drainage networks due to events larger than the system designed event;
- Loss of capacity in sewer drainage networks when a watercourse has been fully culverted and diverted or incorporated into the formal drainage network (lost watercourses);
- Lack of maintenance or failure of sewer networks which leads to a reduction in capacity and can sometimes lead to total sewer blockage;
- Failure of sewerage infrastructure such as pump stations or flap valves leading to surface water or combined foul/surface water flooding;
- Groundwater infiltration into poorly maintained or damaged pipe networks; and
- Restricted outflow from the sewer systems due to high water or tide levels in receiving watercourses ('tide locking').

Impacts of Sewer Flooding

3.6.3 The impact of sewer flooding is usually confined to relatively small localised areas but flooding is associated with blockage or failure of the sewer network, flooding can be rapid and unpredictable. Flood waters from this source are also often contaminated with raw sewage and pose a health risk. The spreading of illness and disease can be a concern to the local population if this form of flooding occurs on a regular basis.

3.6.4 Drainage systems often rely on gravity assisted dendritic systems, which convey water in trunk sewers located at the lower end of the catchment. Failure of these trunk sewers can have serious consequences, which are often exacerbated by topography, as water from surcharged manholes will flow into low-lying urban areas.

3.6.5 The diversion of "natural" watercourses into culverted or piped structures is a historic feature of the London drainage network. Where it has occurred, deliberately or accidentally it can result in a reduced available capacity in the network during rainfall events when the sewers drain the watercourses catchment as well as the formal network. Excess water from these watercourses may flow along unexpected routes at the surface (usually dry and often developed) as its original channel is no longer present and the formal drainage system cannot absorb it.

Historic Records – Sewer Flooding

3.6.6 There were no historical records of sewer flooding available from the LB of Tower Hamlets or Thames Water. This is not to say that no such incidents have occurred or that there is no future flood risk to the Borough from sewer flooding.

3.6.7 The risk of flooding from sewers is increasing due to the increasing urbanisation of areas and rising rainfall intensities. Several recent flood events across the country have been attributed to the failure of the drainage network to contain runoff during severe storm events. The combined surface water and foul water drainage system in London dates from Victorian times and cannot cope with runoff from the ever-growing city and increasing rainfall intensities.

3.6.8 The data provided by Thames Water for use in this SWMP shows postcodes where properties are known to have experienced sewer flooding prior to June 2010. Figure 9 in Appendix D displays this data along with other known records of sewer flooding. The data provides a broad overview of flood incidents in the Borough as it is not property specific, instead providing information in postcode sectors (a four digit postcode). As some of these sectors extend into other London Boroughs, it is not possible to determine the exact number of properties that have experienced a sewer flooding incident. The Thames Water dataset is summarised for the London Borough of Tower Hamlets in Table 3-3.

3.6.9 The majority of the incidents of sewer flooding are clustered in the north of the borough around Bow and Victoria Park – post codes E3 2, E3 5, E9 5 and E9 7. The post code areas of E9 5 and E9 7 extend into the LB of Hackney and it cannot therefore be said with certainty within which borough the incidents have occurred. However, considering Victoria Park covers majority of the post code areas within the LB of Tower Hamlets, it is likely that the majority of the incidents have occurred within the LB of Hackney.

3.6.10 The relatively high number of incidents reported in post code areas E3 2 and E3 5 may be the result of a shallow gradient drainage network, as it is observed that the topography in Bow is relatively uniform.

Table 3-3: Number of Thames Water sewer flood records within the London Borough of Tower Hamlets

Post Code Sector	2 in 10 external	2 in 10 internal	1 in 10 external	1 in 10 internal	1 in 20 external	1 in 20 internal	Severe	Total Properties
E1 1H	0	0	0	0	0	1	0	1
E1 1N	0	0	0	0	0	1	0	1
E1 2L	0	0	0	0	0	1	0	1
E1 3J	0	0	0	0	0	1	0	1
E1 4A	0	0	0	0	0	2	0	2
E1 4L	0	0	0	0	0	1	0	1
E1 4U	0	0	0	0	0	2	0	2
E1 6B	0	0	0	0	0	1	0	1
E1 6Q	0	0	0	0	0	1	0	1
E1 6R	0	0	0	0	0	2	0	2
E1 7N	0	0	0	0	0	1	0	1
E1 7T	0	0	0	0	0	1	0	1
E1 8B	0	0	0	0	0	2	0	2
E1 8D	0	0	0	0	0	2	0	2
E14 0	0	0	0	0	0	3	0	3
E14 3	0	0	0	0	1	2	0	3
E14 6	0	0	0	0	1	0	0	1
E14 7	0	0	0	1	0	1	0	2
E14 8	0	0	0	0	0	2	0	2
E14 9	0	0	0	0	0	0	1	1
E2 0	0	0	1	0	0	0	0	1
E2 6	0	0	0	0	1	3	0	4
E2 7	0	0	0	1	0	3	0	4
E2 9	0	0	0	0	0	1	0	1
E3 2	0	0	0	5	0	4	0	9
E3 5	0	0	0	0	0	13	0	13
E9 5	0	0	0	0	0	52	0	52
Total	**0**	**0**	**1**	**7**	**3**	**102**	**1**	**114**

Methodology for Drainage Network Modelling

3.6.11 Consultation with Thames Water determined that the sewer system across London could be assumed to have an approximate capacity of 6.5mm/hr. This was represented in the surface water modelling by removing 6.5mm/hr from the rainfall totals for the duration of the model.

3.6.12 The sewer system was not modelled explicitly hence interaction between the sewer system and surface water modelling is not investigated. This was beyond the scope of the borough wide study but in specific areas where the sewer network has been identified to be of particular relevance to flood risk more detailed integrated modelling may be required at a later date.

Uncertainties in Flood Risk Assessment – Sewer Flooding

3.6.13 Assessing the risk of sewer flooding over a wide area is limited by the lack of data and the quality of data that is available. Furthermore, flood events may be a combination of surface water, groundwater and sewer flooding.

3.6.14 An integrated modelling approach is required to assess and identify the potential for sewer flooding but these models are complex and require detailed information. Obtaining this information can be problematic as datasets held by stakeholders are often confidential, contain varying levels of detail and may not be complete. Sewer flood models require a greater number of parameters to be input and this increases the uncertainty of the model predictions.

3.6.15 Existing sewer models are generally not capable of predicting flood routing (flood pathways and receptors) in the above ground network of flow routes - streams, dry valleys, highways etc.

3.6.16 Use of historic data to estimate the probability of sewer flooding is the most practical approach, however does not take account of possible future changes due to climate change or future development. Nor does it account for improvements to the network, including clearance of blockages, which may have occurred.

3.7 Other Influences of Flooding

Main River Fluvial and Tidal Flooding

3.7.1 Interactions between surface water and tidal/fluvial flooding are generally a result of watercourses unable to store excess surface water runoff. Where the watercourse in question is defended, surface water can pond behind defences. This may be exacerbated in situations where high water levels in the watercourse prevent discharge via flap valves through defence walls.

3.7.2 Main rivers have been considered in the surface water modelling by assuming a ‘bank full’ condition, in the same way that ordinary watercourses have been modelled. Structures such as weirs, locks and gates along watercourses have not been explicitly modelled.

3.7.3 The River Lee and River Thames, which border Tower Hamlets on the east and south respectively, both have flood defences protecting the borough during a fluvial or tidal flood event. Figure 7 in Appendix D shows the Environment Agency flood zone maps where the majority of the southern portion of the borough is observed to benefit from these existing defences. In addition, the Thames Barrier also currently provides protection to the borough in excess of the 0.1% annual probability event. The presence of these defences and the Thames Barrier may reduce the probability of flooding, however does not eliminate the risk entirely.

There is still a residual risk of flooding resulting from overtopping or a breach of the defences during a tidal or fluvial event. This could result in deep and fast flowing water entering Tower Hamlets potentially resulting in significant consequences.

3.7.4 Further information on fluvial (Main River) flooding, tidal flooding, and the residual risk of a breach in defences can be found in the LB of Tower Hamlets SFRA (August 2008).

Artificial Drainage Bodies

3.7.5 There are four canals located within the LB of Tower Hamlets and a number of docks and basins, each controlled by lock gates and/or weirs to maintain water levels. Due to regular inspection and maintenance carried out by British Waterways, the risk of flooding from canals, docks and basins within the LB of Tower Hamlets is considered low.

3.8 Critical Drainage Areas

3.8.1 A critical drainage area (CDA) is defined by the Drain London Tier 2 Technical Specification as *"a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or river) often cause flooding in a Flood Risk Area during severe weather thereby affecting people, property or local infrastructure."*

3.8.2 Within these CDAs, Local Flood Risk Zones have been identified. These are defined as *"the actual spatial extent of predicted flooding in a single location. LFRZs are discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure."* Local Flood Risk Zones (LFRZs) across the LB of Tower Hamlets have been identified based on both the probability and consequence of flooding from the above 'local' sources. The approach taken has therefore considered the local circumstances in defining and agreeing with each borough its LFRZs, whilst seeking to maintain consistency in the overall level of risk to people and property.

3.8.3 Figure 3-3 below shows an example of a CDA and LFRZ. Note that the LFRZ has not been delineated with a boundary to prevent implying properties not shown at risk to be within a flood risk "zone". This approach has been adopted across the whole of the Drain London study area.

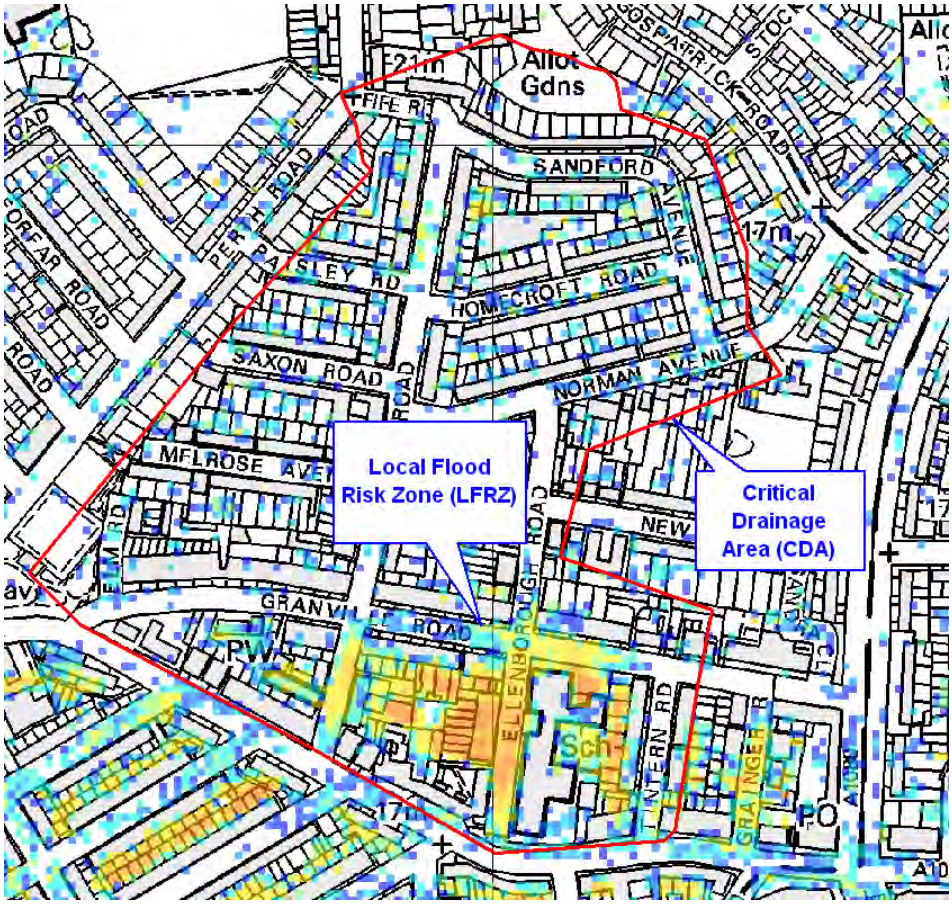


Figure 3-2 Example Critical Drainage Area (CDA) and Local Flood Risk Zone (LFRZ)

3.8.4 75 critical drainage areas have been identified across Group 4, including 14 within the LB of Tower Hamlets. Figure 1 in Appendix D shows the location of these 14 CDAs within the borough. Figures 23 to 24 indicate the flood depth and flood hazard in each CDA for the 1 in 100 year rainfall event. The naming of the CDAs has been carried out across the entire Group this are not necessarily sequential across individual boroughs.

3.8.5 Guidance on the depths and velocities (hazard) of floodwater that can be a risk to people is shown within Figure 3-3.

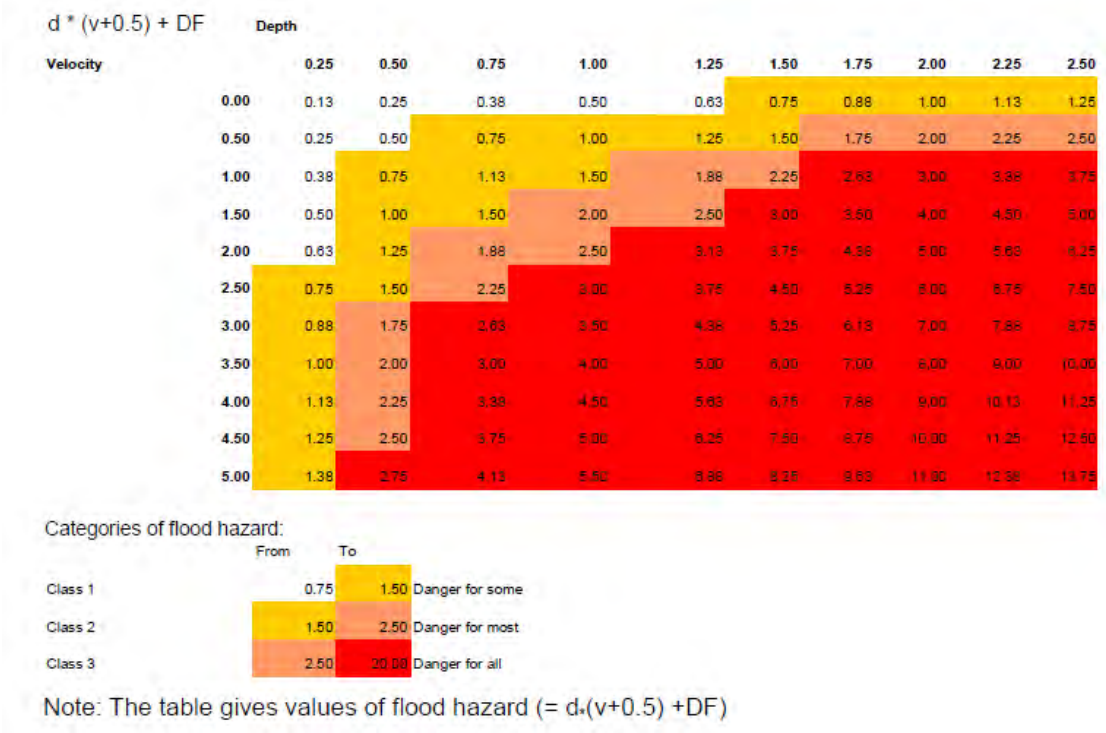


Figure 3-3 Combinations of flood depth and velocity that cause danger to people (Source: Defra/Environment Agency research on Flood Risks to People - FD2321/TR2)

3.8.6 This information has been converted into a hazard rating (defined within Table 3-4) which can be seen within all hazard related figures within Appendix D, figures 18 to 22.

Table 3-4 Legend for Hazard Rating Figures

Degree of Flood Hazard	Hazard Rating (HR)		Description
Low	<0.75	Caution	Flood zone with shallow flowing water or deep standing water
Moderate	0.75b – 1.25	Dangerous for some (i.e. children)	Danger: Flood zone with deep or fast flowing water
Significant	1.25 -2.5	Dangerous for most people	Danger: Flood zone with deep fast flowing water
Extreme	>2.5	Dangerous for all	Extreme danger: Flood zone with deep fast flowing water

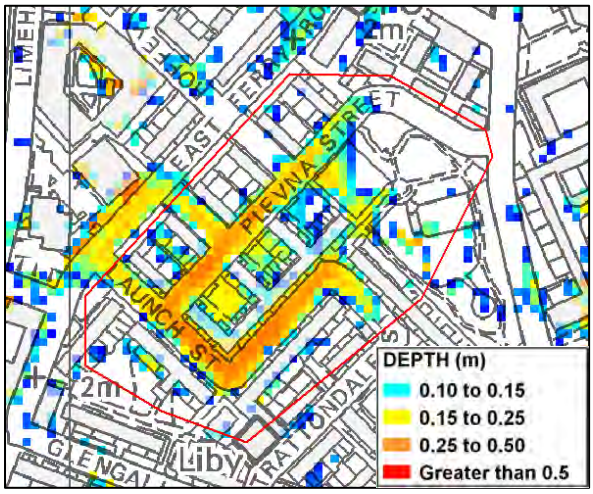
3.8.7 The following sections of the report provide a summary of the location, probability, consequences and mechanisms of flooding in each CDA within the borough. Each accompanying figure shows the extent of the CDA displayed with the 1 in 100 year maximum depth results.

CDA: Group4_011

Location: Plevna Street and Launch Street, Isle of Dogs

Description: Flooded area is the low point within the catchment and is surrounded on all sides by much higher ground levels. Surface water observed to enter the area from East Ferry Road and Manchester Road (near Marshfield Street). Flooding is predominantly limited to the street, however may pose a risk to properties on Plevna Street and Launch Street.

Validation: Good correlation with EA Surface Water Map for both 30 year and 200 year event. Four London Fire Brigade records of flooding are located within the area.

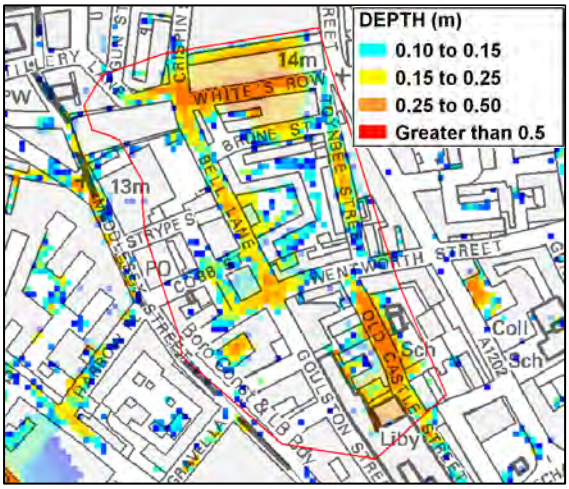


CDA: Group4_013

Location: White's Row, Spitalfields

Description: Surface water flows in a northerly direction along Bell Road before ponding in low-lying areas. Flood waters generally confined to roads such as Bell Road, White's Row, Toynbee Street and Old Castle Street, however some residential properties along White's Row are shown to be at risk.

Validation: Areas of flooding correlate well with EA's Surface Water Map for both 30yr and 200yr events. London Fire Brigade have 18 recorded incidents in this area concentrated around Brune Street, Toynbee Street and Wentworth Street. There is no information provided as to the source of flooding.



CDA: Group4_014

Location: DLR track surrounding Langdon Park and All Saints DLR Stations

Description: Overland flow from the east and west flowing into the railway cutting then flowing in a southerly direction. Ponding on the tracks occurs as ground levels along the track begin to rise at the intersection with Poplar High Street. DLR trains are unlikely to operate with this depth of water disrupting a key transport route for many residents, especially those commuting to the financial district of Canary Wharf.

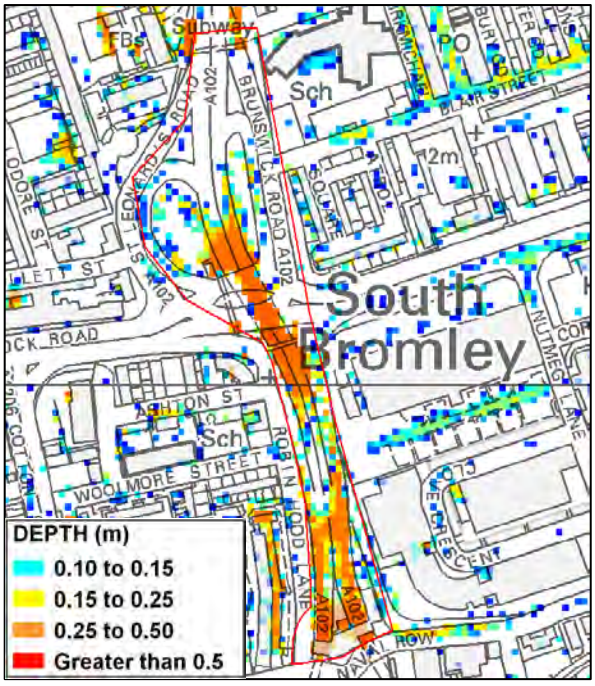
Validation: Correlates reasonably well with the EA Surface Water Maps for the 200yr event however the EA maps show noticeably less flooding for the 30yr event. A number of London Fire Brigade records of flooding for properties on either side of the railway cutting.

CDA: Group4_015

Location: Northern approach of the Blackwall Tunnel, South Bromley

Description: There are peaks and troughs along the A102 as it approaches the Blackwall Tunnel. The road dips down as it passes beneath East India Dock Road (A13) then rises as it passes Woolmore Road before sloping downwards into the Tunnel. Runoff from surrounding higher ground is able to flow onto the A102 as walls along the sides of the road are not solid.

Validation: The model results show more flooding at the mouth of the Blackwall Tunnel than shown in the EA Surface Water Maps. The intersection of the A102 and East India Dock Road (A13) correlates reasonably well with the Surface Water Maps. London Fire Brigade have 1 recorded "non-residential" incident occurring in 2008 located at the mouth of the tunnel.

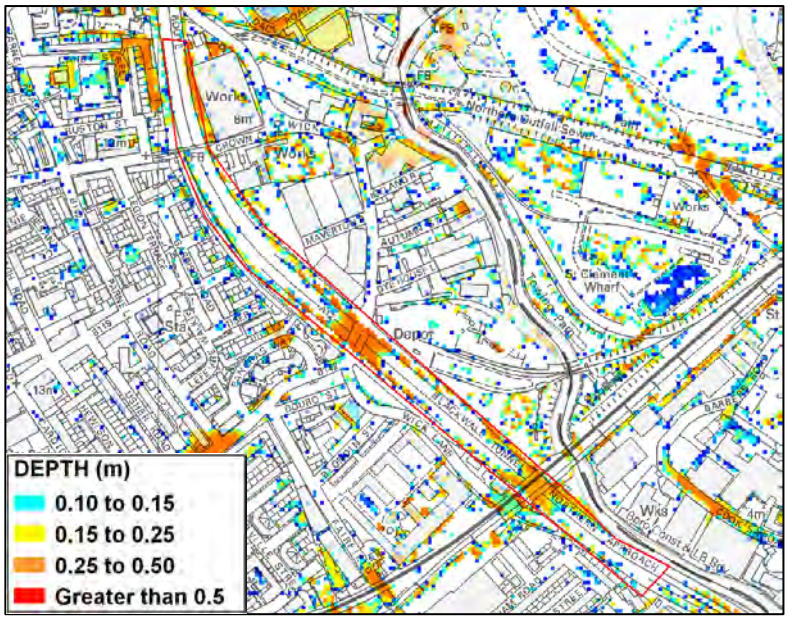


CDA: Group4_016

Location: A12, Northern approach to Blackwall Tunnel in Bow.

Description: Surface water flowing from north and south directions on the A12 and ponding in low area. Some overland flow from the east and west falling into the cutting. The location of deepest water is where the B142 crosses over the A12. Vehicles are impassable at these depths causing significant transport problems to the area.

Validation: Correlates well for both 30 year and 200 year events when compared to the EA Surface Water Maps.

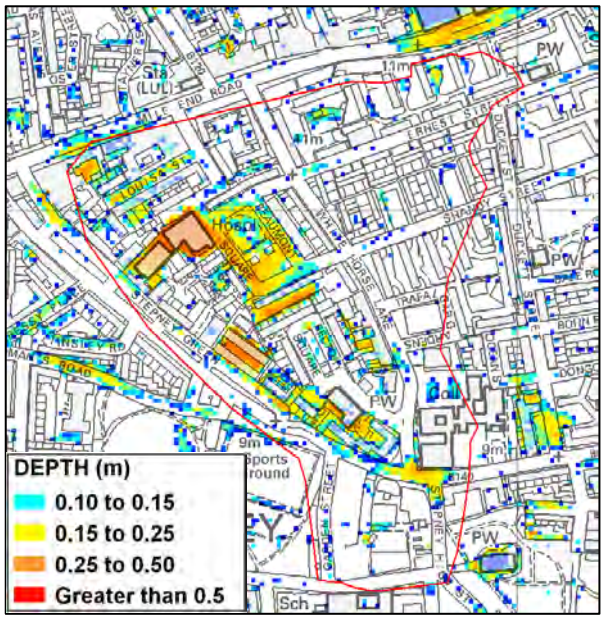


CDA: Group4_021

Location: Beaumont Square, Stepney Green

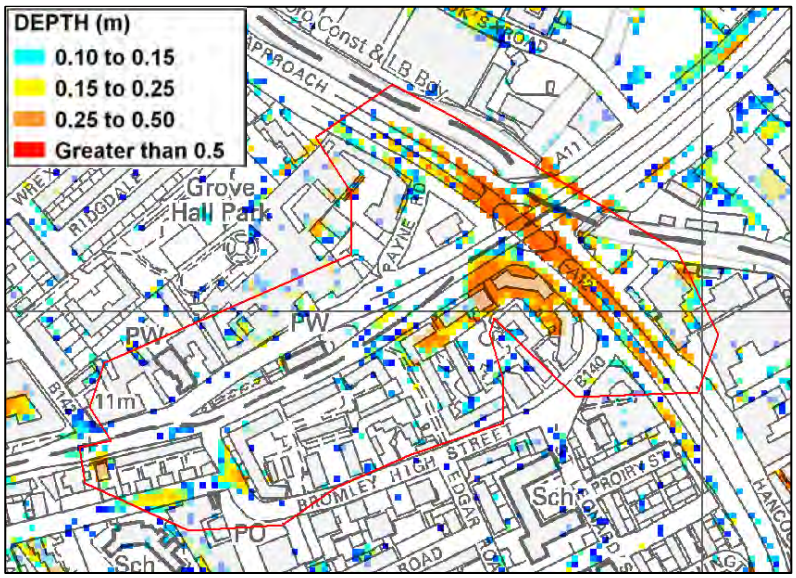
Description: The subject area is a local low point and is surrounded by high ground to the north, south and west. To the east lies the Grand Union Canal which is the lowest point in the catchment. Flooding is primarily predicted to occur at residential properties along Stepney Green Road and at the London Independent Hospital.

Validation: Generally good correlation with EA Surface Water Map for both 30 year and 200 year event. Five London Fire Brigade records of flooding within the area from 2001 - 2006.



CDA: Group4_022

Location: Intersection of A11 and A12 in Bromley by Bow

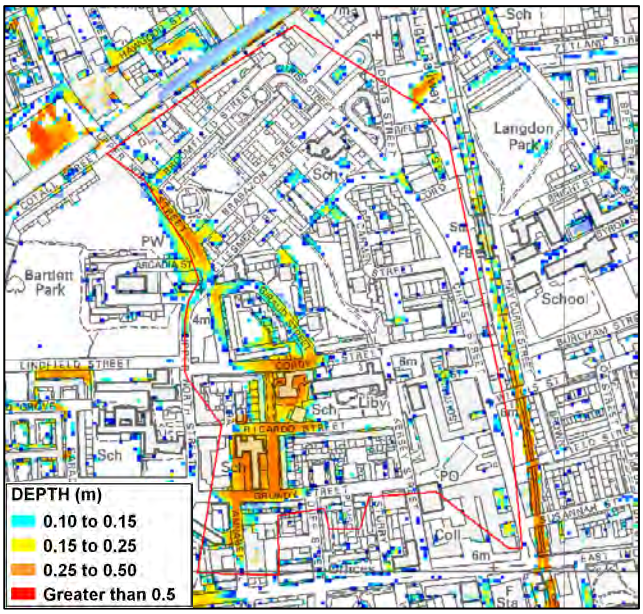


Description: Surface water observed to pond at the location where the A12 passes beneath the A11 as a result of overland flow from both northerly and southerly directions. The buildings located at the southern corner of the junction are flooded as a result of overland flow from a southerly direction. This CDA falls within the "Lower Lea Valley regeneration and growth" area.

Validation: The modelled results correlate well with the EA Surface Water Maps for the 200 year event in parts of the flooded area, but not where the A12 passes beneath the A11. London Fire Brigade have four recorded incidents in the vicinity of the hotspot area. The dates of the incidents range from 2002 to 2008.

CDA: Group4_025

Location: Cordelia Street, Ricardo Street, and Grundy Street, South Bromley

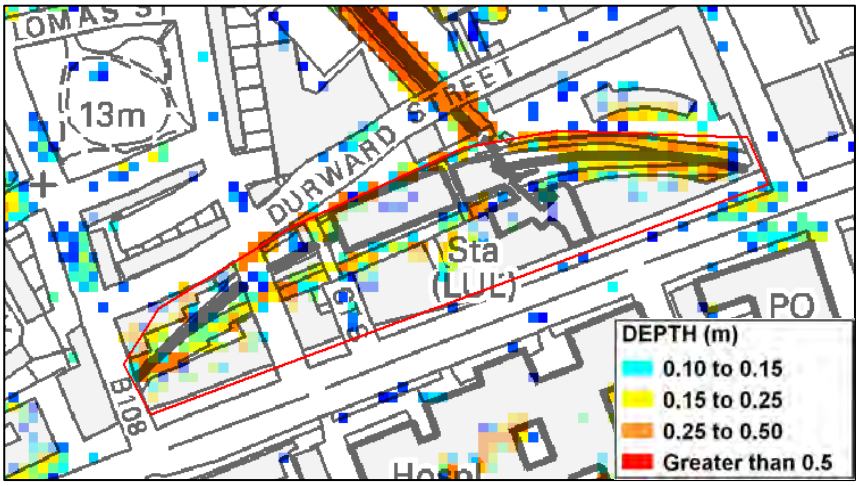


Description: Main flow route for surface water begins at Upper North Street flowing in a southerly direction with water ponding along Grundy Street. Surface water is also observed to runoff from Hobday Street and Cordelia Street flowing in a westerly direction. The area is surrounded by high ground in all directions. East India Dock Road to the south is raised above the flooded area and impedes the flow of water. This area falls within the "Lower Lea Valley regeneration and growth" area.

Validation: Areas of flooding correlate well with EA Surface Water Map for both 30yr and 200yr events. London Fire Brigade have 6 recorded incidents in the vicinity of the hotspot area. There is no information provided as to the source of flooding.

CDA: Group4_060

Location: Whitechapel Tube Station, Whitechapel

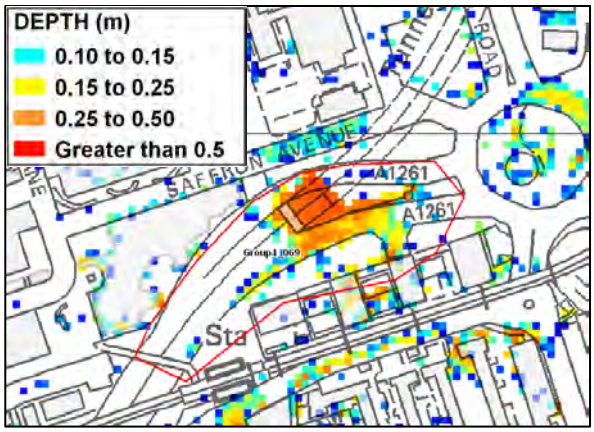


Description: Surface water flowing from crest along railway tracks in an easterly and westerly direction. Some water shown to pond at the tunnel entrances.

Validation: Not validated. The modelled results do not correlate with the EA Surface Water Maps for both the 30yr and 200yr events. Both results show ponding water at the tunnel entrances however the Drain London results show a larger flood extent overall. No other historical records.

CDA: Group4_069

Location: A1261 Aspen Way Tunnel, East India

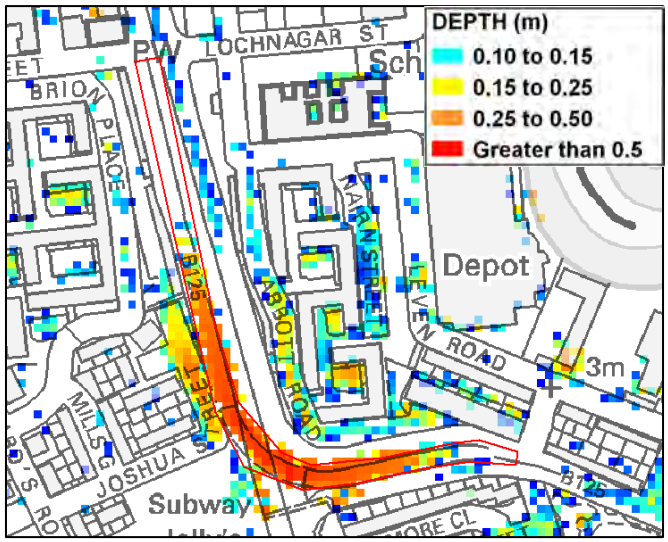


Description: Surface water from a southerly direction flowing towards the entrance of the Aspen Way Tunnel beneath Saffron Avenue and Leamouth Road in East India. The A1261 is considered nationally important infrastructure as the motorway is a main part of the road network in east London.

Validation: Not validated. Modelled results show a larger flood extent than the EA Surface Water Maps for both the 30yr and 200yr events. Two London Fire Brigade records of flood related callouts within the flood risk zone at properties. These occurred in 2008 and 2009.

CDA: Group4_070

Location: B125 Abbott Road underpass beneath A12, South Bromley



Description: Surface water flowing from the north and east towards the Abbott Road underpass.

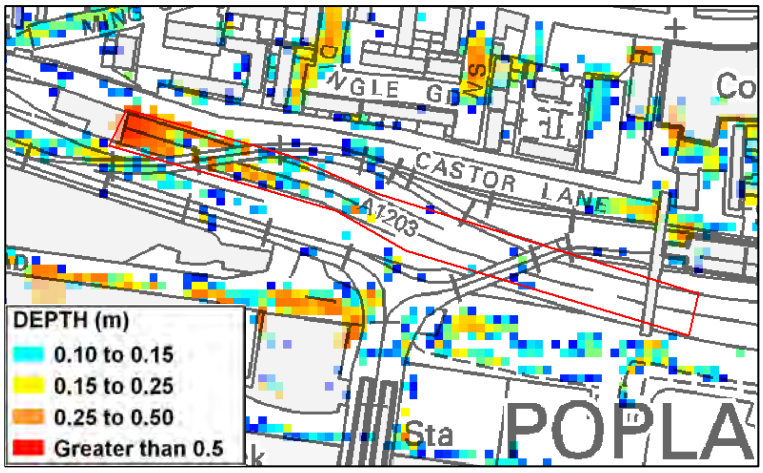
Validation: Not validated. Model results show a larger flood extent when compared to the EA Surface Water Maps for both the 30yr and 200yr events. LB Tower Hamlets advised flooding has occurred here as a result of a watermain burst nearby.

CDA: Group4_071

Location: Limehouse Link tunnel entrance, Poplar

Description: Surface water flowing from the east and ponding at the entrance to the Limehouse Link Tunnel.

Validation: Model results correlate well with EA Surface Water Maps for both the 30yr and 200yr events. No other records of flooding.

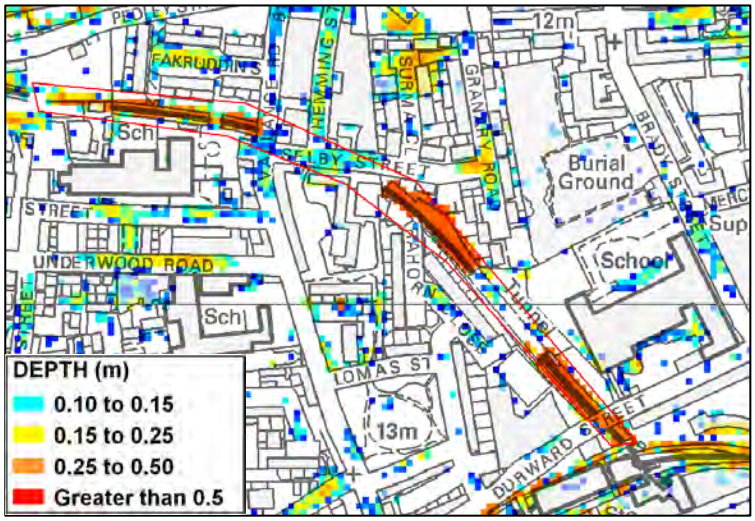


CDA: Group4_072

Location: London Overground tracks between Shoreditch and Shadwell, Whitechapel

Description: Railway is in a cutting at this location passing through a number of tunnels between Shoreditch and Shadwell Stations.

Validation: The model results show a good correlation with the EA Surface Water Maps for the 200yr event however, shows noticeably more flooding in the 30yr event. No historical records of flooding.

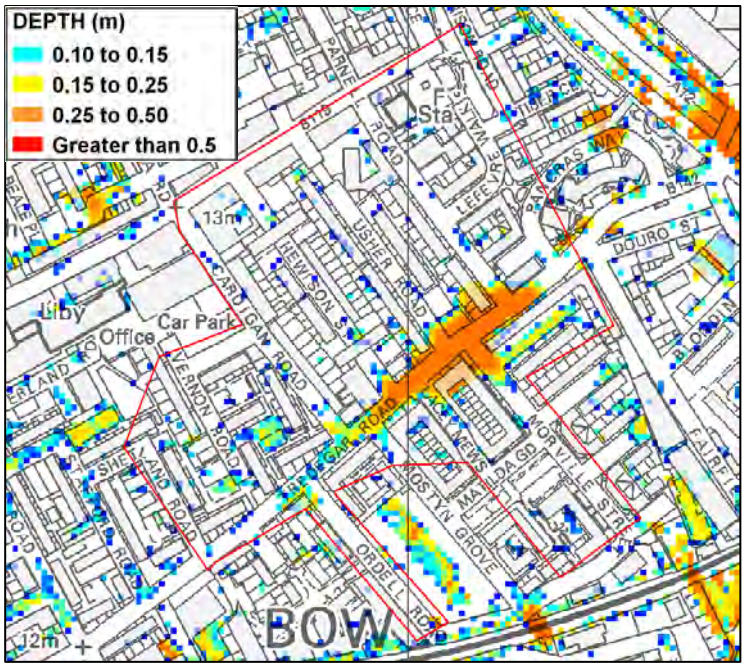


CDA: Group4_074

Location: Tredegar Road between Cardigan and Parnell Roads in Bow

Description: The flooded area is the lowest point in a small catchment. Overland flow can be seen flowing to this point in a southerly direction down Parnell Road and Cardigan Road, and in an easterly direction along Tredegar Road. A number of locally important infrastructure is located in the area, such as a fire station, community hall and school. Tredegar Road is a key thoroughfare for locals accessing the A12.

Validation: Both 30 year and 200 year flood events correlate well with the EA Surface Water Maps. Three



London Fire Brigade flood records in the immediate vicinity of the flooded area. The dates of these incidents ranges from 2003 to 2006.

3.9 Summary of Risk

3.9.1 Table 3-5 (below) identifies the surface water flood risk to infrastructure, households and commercial/industrial receptions. The table is a summary of the information submitted to the Drain London Board of Prioritisation Matrices for each CDA.

Table 3-5: Summary of Surface Water Flood Risk in CDAs in the London Borough of Tower Hamlets

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	
Group4_011	Plevna Street and Launch Street.	Synergy	Environmental	0	0	0	0	0	0	2	0	0	0	48	0	0	0	0	0	0	0	Validated
Group4_013	White's Row, Spitalfields.	Health and Safety	None	0	0	0	0	1	0	32	9	0	0	53	0	0	0	65	0	0	0	Validated
Group4_014	DLR track surrounding Langdon Park and All Saints DLR Stations.	Regionally Important Infrastructure	Deliverability	2	2	1	0	0	0	0	0	0	0	8	0	0	0	1	0	0	0	Validated
Group4_015	Northern approach of the Blackwall Tunnel.	Nationally / strategically important infrastructure	Synergy	2	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	Validated
Group4_016	A12, Northern approach to Blackwall Tunnel in Bow	Nationally / strategically important infrastructure	Synergy	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Validated
Group4_021	Stepney Green Road and surrounding properties, including the London Independent Hospital	Health and Safety	Combination of two or more of the above	0	0	2	0	2	1	0	0	0	0	227	0	0	0	11	0	0	0	Validated
Group4_022	Intersection of A11 and A12 in Bromley by Bow	Nationally / strategically important infrastructure	Synergy	1	1	0	0	1	0	0	0	0	0	87	2	0	0	7	1	0	0	Validated
Group4_025	Cordelia Street, Ricardo Street, and Grundy Street	Synergy	Combination of two or more of the above	0	0	1	0	1	0	0	0	0	0	139	0	0	0	5	0	0	0	Validated
Group4_060	Railway tracks surrounding Whitechapel Tube Station, Whitechapel	Regionally Important Infrastructure	None	2	0	0	0	0	0	0	0	0	0	19	0	0	0	31	0	0	0	Non-Validated
Group4_069	Aspen Way Tunnel beneath Saffron Avenue and Leamouth Road, East India	Nationally / strategically important infrastructure	Health and Safety	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Non-Validated
Group4_070	B125 Abbott Road underpass beneath A12, South Bromley	Regionally Important Infrastructure	Synergy	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Non-Validated
Group4_071	Limehouse Link tunnel entrance, Poplar	Nationally / strategically important infrastructure	Combination of two or more of the above	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Validated
Group4_072	London Overground tracks between Shoreditch and Shadwell	Regionally Important Infrastructure	None	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Validated
Group4_074	Tredegar Road between Cardigan and Parnell Roads in Bow	Health and Safety	None	0	0	0	0	0	0	0	0	0	0	112	0	0	0	1	0	0	0	Validated

4 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 (options) with the potential to alleviate flood risk and to then assess each option in order to eliminate those that are not feasible or do not make economic sense. The remaining options are then developed and tested against their relative effectiveness, benefits and costs. The target level of flood protection from surface water flooding has been set at 1 in 75 years. This aligns with the likely level of flood protection necessary to enable commercial insurance cover to be provided to the general public.

4.1.2 The option identification has taken place on an area-by-area (site-by-site) basis following the process established in Phase 2. The options assessment assesses and short-lists the measures for each CDA in turn..

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 rather than through detailed analysis. Costs should therefore be treated at an order of magnitude level of accuracy. The options assessment presented here follows the process 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 CDAs, as defined by the Prioritisation Matrix, within the next Tier (Tier 3) of the Drain London project.

4.2 Measures

4.2.1 Surface water flooding is often highly localised and complex. Its management is therefore highly dependent upon the characteristics of the critical drainage area and there are few solutions which will provide benefits in all locations. This section outlines potential measures which have been considered for mitigating the surface water flood risk within LB of Tower Hamlets.

4.2.2 The SWMP Plan Technical Guidance (Defra 2010) identifies the concept of Source, Pathway and Receptor as an appropriate basis for understanding and managing flood risk. Figure 4-1 identifies the relationship between these different components, and how some components could be considered within more than one category.

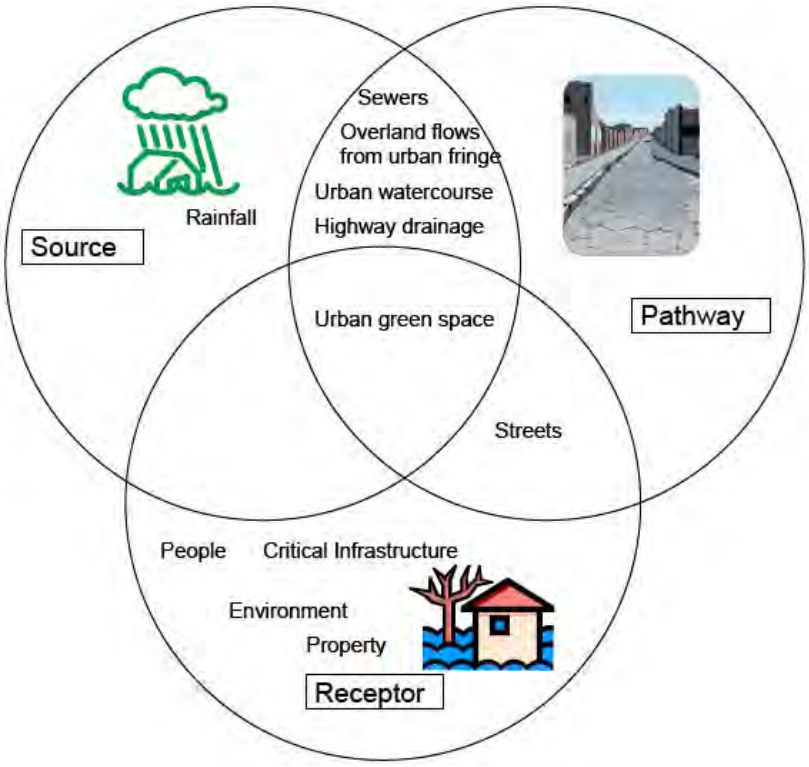


Figure 4-1 Illustration of Sources, Pathways & Receptors (extracted from SWMP Technical Guidance, Defra 2010)

4.2.3 When identifying potential measures it is useful to consider the source, pathway, receptor approach (refer to Figure 4-1 and Figure 4-2). Both structural and non-structural measures were considered in the optioneering exercise undertaken for the identified CDAs. Structural measures can be considered as those which require fixed or permanent assets to mitigate flood risk (such as a detention basin, increased capacity pipe networks). Non-structural measures may not involve fixed or permanent facilities, and the benefits to of flood risk reduction is likely to occur through influencing behaviour (education of flood risk and possible flood resilience measures, understanding the benefits of incorporating rainwater reuse within a property, planning policies etc).

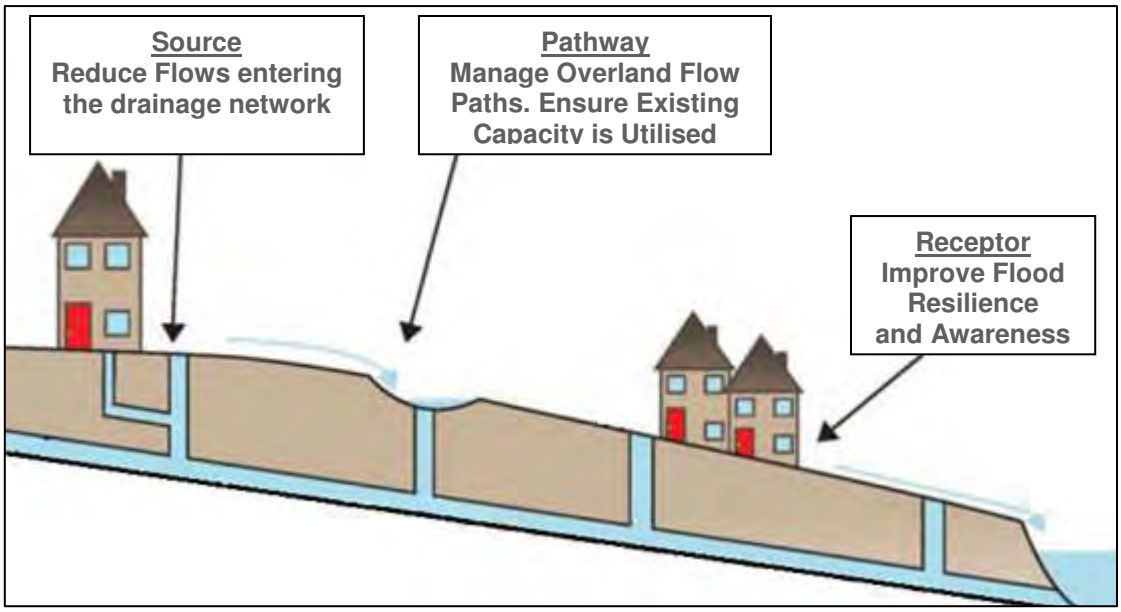


Figure 4-2 Source, Pathway and Receptor Model (adapted from Defra SWMP Technical Guidance, 2010)

4.2.4 Methods for managing surface water flooding can be divided into methods which influence either the Source, Pathway or Receptor, as described below, (refer to Table 4-1.):

- Source Control: Source control measures aim to reduce the rate and volume of surface water runoff through increasing infiltration or storage, and hence reduce the impact on receiving drainage systems. Examples include retrofitting SuDS (e.g. Bioretention basins, wetlands, green roofs etc) and other methods for reducing flow rates and volume.

- Pathway Management: These measures seek to manage the overland and underground flow pathways of water in the urban environment, and include: increasing capacity in drainage systems; separation of foul and surface water sewers etc.

- Receptor Management: This is considered to be changes to communities, property and the environment that are affected by flooding. Mitigation measures to reduce the impact of flood risk on receptors may include improved warning and education or flood resilience measures.

Table 4-1 Typical Surface Water Flood Risk Management Measures

	Generic measures	Site specific measures
	• Do Nothing (do not continue maintenance) • Do Minimum (continue current maintenance)	
Source control	• Bioretention carpark pods • Soakaways, water butts and rainwater harvesting • Green roofs • Permeable paving • Underground storage; • Other 'source' measures	• Swales • Detention basins • Bioretention basins; • Bioretention carpark pods; • Bioretention street planting; • Ponds and wetlands
Pathway Management	• Improved maintenance regimes • Increase gulley assets	• Increase capacity in drainage system • Separation of foul & surface water sewers • Managing overland flows • Land Management practices • Other 'pathway' measures
Receptor Management	• Improved weather warning • Planning policies to influence development • Social change, education and awareness • Improved resilience and resistance measures • Raising Doorway/Access Thresholds' • Other 'receptor' measures	• Temporary or demountable flood defences - collective measure

Excluded Measures

4.2.5 Section 4.4 discusses the preferred options for each of the CDAs in turn (The CDAs are as described in Section 3). Two specific options were considered but generally excluded for all CDAs during the optioneering exercise, there were;

- Do Nothing: no longer undertaking maintenance (e.g. no longer maintaining gulley pits)
- Do Minimum: continuing the current maintenance regime (e.g. maintaining the current level of maintenance on a gulley pit).

4.2.6 The *Do Nothing* approach was excluded as a preferred option as it will provide no benefit to reducing the flood risk within a Local Flood Risk Zone (LFRZ) and wider CDA. Utilising this approach would in fact be likely to lead to an increase the probability and consequence of flooding in the borough

4.2.7 The *Do Minimum* approach was excluded as a preferred option due to the predicted effects of climate change increasing the intensity and volume of rainfall. Maintaining the proposed maintenance regime will only be beneficial to the CDAs and LFRZs whilst rainfall intensities and volumes remain at a level similar to that of current conditions. If intensities and volumes increase as a result of climate change (as is anticipated) then the standard of protection afforded by assets (e.g. gulley pits) will diminish over time.

4.3 Proposed Surface Water Drainage Policy

4.3.1 It should be acknowledged that the CDAs only account for a small portion of the areas that could be affected by surface water flooding. The CDAs are the areas where the impact of surface water flooding is expected to be greatest but it is recommended that the Council implement policies which will reduce the flood risk from surface water flooding throughout the borough and promote Best Management Practices to the implementations of SuDS and the reduction of runoff volumes.

4.3.2 The SWMP Action Plan (discussed in Section 5) which is a major output of this project recommends that the following policies are implemented within the boundaries of the LLFA to reduce the flood risk within the borough:

Policy 1*: All developments across the borough (excluding minor house extensions less than 250m^2) which relate to a net increase in impermeable area are to include at least one 'at source' SuDS measure (e.g. waterbutt, rainwater harvesting tank, bioretention planter box etc). This is to assist in reducing the peak volume of runoff discharging from the site.*

Policy 2*: Proposed 'brownfield' redevelopments greater than 0.1 hectare are required to reduce post development runoff rates for events up to and including the 1 in 100 year return period event with an allowance for climate change (in line with PPS25 and UKCIP guidance) to 50% of the existing site conditions. If this results in a discharge rate lower than the Greenfield conditions it is recommended that the Greenfield rate (calculated in accordance with IoH124[1]) are used.*

Policy 3: *Developments located in Critical Drainage Areas (CDAs) and greater than 0.5 hectare are required to reduce runoff to that of a predevelopment Greenfield runoff rate (calculated in accordance with IoH124). It is recommended that a SuDS treatment train is utilised to assist in this reduction.*

4.3.3 The borough may also wish to consider the inclusion of the following policy to manage the pollutant loads generated from proposed development applications:

Policy 4: *Best Management Practices (BMP) are required to be demonstrated for all development applications within the LB of Tower Hamlets. The following load-reduction targets must be achieved when assessing the post-developed sites SuDS treatment train (comparison of unmitigated developed scenario versus developed mitigated scenario):*

- 80% reduction in Total Suspended Sediment (TSS);

- 45% reduction in Total Nitrogen (TN);

- 60% reduction in Total Phosphorus (TP); and

- 90% reduction in litter (sized 5mm or greater).

[1] Defra/Environment Agency, September 2005, Flood and Coastal Defence R&D Programme: Preliminary Rainfall Runoff Management for Developments (R&D Technical Report W5-074/A/TR/1 Revision D)

4.4 Preferred CDA Options

4.4.1 This section discusses the preferred option identified for each CDA based on the measures discussed in Table 4-1. A figure showing the preferred option has been provided where this is thought to enhance the description. The locations of the capital works shown in the figures are indicative only. It is strongly recommended that a feasibility assessment is carried out at each CDA prior to the commencement of any capital works.

4.4.2 Detailed option appraisal assessments were undertaken on a range of options for each CDA before the preferred option was chosen. This process was fully documented and details can be found within Appendix E.

CDA: Group4_011

The preferred option for this CDA includes storage beneath Plevna and Launch Streets with localised entry capacity improvements. The implementation of SUDS as part of the "Millennium Quarter" regeneration is also recommended as part of a mid-long term reduction in flood risk.

Other measures that were considered include separation of foul and surface water systems which would have health benefits through improvements in water quality. This measure was not preferred as it is unlikely to be cost-beneficial.

CDA: Group4_013

The preferred option for this CDA includes property level flood protection for residents and local entry capacity improvements. Flood protection measures do not reduce the probability of flooding however, allows for a quicker recovery, as well as reducing the danger to people.

Other measures that were considered include underground road storage, however it was deemed likely that only a limited volume of storage could be achieved. The separation of foul and surface water systems would result in increased conveyance and storage to both systems however, is unlikely to be cost-beneficial.

CDA: Group4_014

The preferred option for this CDA includes increasing capacity in the existing drainage system serving the railway and the implementation of a regional flood plan.

Other measures that were considered include underground storage beneath the railway tracks. This measure was thought be difficult to implement in this case, due to the potential structural issues with constructing in close proximity to the railway line. The creation of a preferential flow route was also considered, however the elevation and narrow width of the rail corridor means this is unlikely to be not feasible.

CDA: Group4_015

The preferred option for this CDA includes increasing capacity in the existing drainage system and improving local entry capacities along the A102. The implementation of a regional flood plan is also recommended to assist in minimising disruption to motorway users during a flood event.

Other measures that were considered include the implementation of flood gates at the entrances of the tunnel. This measure was discounted as it relies on an adequate flood warning system and would result in severe disruption to road users.

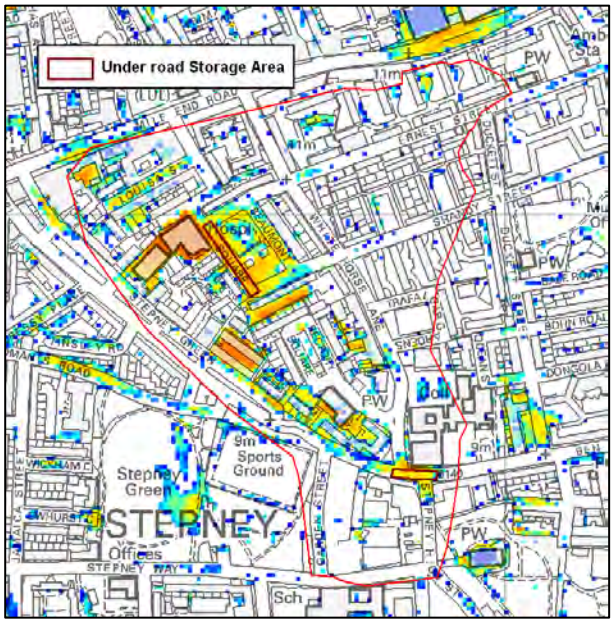
CDA: Group4_016

The preferred option for this CDA includes increasing capacity in the existing drainage system and pump station. Increasing or improving local entry capacities will assist in conveying water into the drainage system provided there is some capacity. The implementation of a regional flood plan is also recommended to assist in minimising disruption to motorway users during a flood event.

Other measures that were considered include a "do nothing" approach. This measure was discounted as the A12 is considered as significantly important infrastructure as it is a key transport route in East London.

CDA: Group4_021

The preferred option for this CDA includes storage in Beaumont Square along with flood resistance measures retrofitted at the hospital and local housing blocks. The implementation of a green roof at the hospital could assist in reducing local runoff. Increasing the size or number of gullies in the local road network will assist in conveying water into the drainage system.



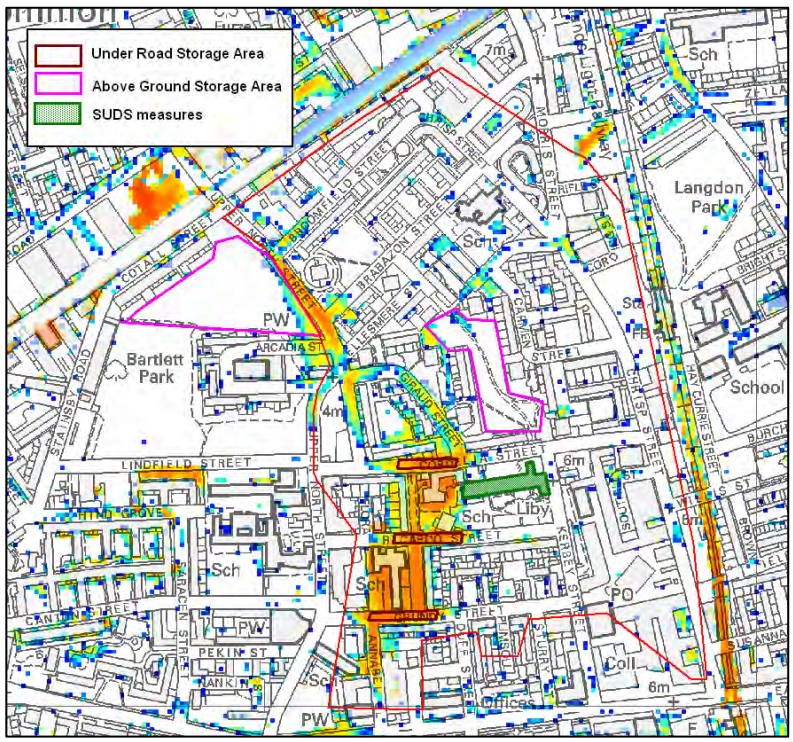
Other measures that were considered include the installation of above ground storage in Stepney Green sports grounds. Storage in the sports grounds could reduce the amount of surface water flowing from the south-west however, the local flood risk zone would still be vulnerable to runoff from the north and is therefore unlikely to meet cost-benefit criteria.

CDA: Group4_022

The preferred option for this CDA includes upgrading the pumping system and constructing underground storage in the form of a larger pump station wet well. The implementation of additional road gullies discharging to the storage unit is also recommended along with retrofitting at risk properties with flood resistant measures and the implementation of a regional flood plan for the A12.

Other measures that were considered include above ground for storage to capture runoff before it enters the A12. As the area is densely urban, no suitable locations to capture runoff were found and the measure was disregarded.

CDA: Group4_025



The preferred option for this CDA includes above ground storage in Bartlett Park and the creation of a storage swale in the green space between Ellesmere Road and Cordelia Street. Below ground storage beneath Cordelia, Ricardo, and Grundy Streets with increased entry capacity is also recommended along with the retrofitting of SUDS to existing library buildings where possible.

Other measures that were considered include a similar measure to the preferred option however with resilience/resistance measures in place instead of above and below ground storage. Storage is preferred in this case as resilience/resistance measures do not reduce the probability of flooding, only the consequences.

CDA: Group4_060

The preferred option for this CDA includes increasing capacity in the existing drainage system serving the railway and the implementation of a regional flood plan to assist in minimising disruption to tube users during a flood event.

Other measures that were considered include underground storage beneath the railway tracks. This measure was thought be difficult to implement in this case, due to the potential structural issues with constructing in close proximity to the railway line. The creation of a preferential flow route was also considered, however the elevation and narrow width of the rail corridor means this is unlikely to be not feasible.

CDA: Group4_069

The preferred option for this CDA includes increasing capacity in the existing drainage system serving the road and the implementation of a regional flood plan to assist in minimising disruption to motorway users during a flood event.

Other measures that were considered include the implementation of flood gates at the entrances of the tunnel. This measure was discounted as it relies on an adequate flood warning system and would result in severe disruption to road users.

CDA: Group4_070

The preferred option for this CDA includes underground storage beneath the road with localised entry capacity improvements and the implementation of a regional flood plan.

Other measures that were considered include a similar measure to the preferred option however with increasing the capacity of the existing drainage/pumping system in place of underground storage. This measure was discounted as it could increase flood risk to those downstream.

CDA: Group4_071

The preferred option for this CDA includes increasing capacity in the existing drainage system along with improving local entry capacities and the implementation of regional flood planning.

Other measures that were considered include the implementation of flood gates at the entrances of the tunnel. This measure was discounted as it relies on an adequate flood warning system and would result in severe disruption to road users.

CDA: Group4_072

The preferred option for this CDA includes increasing capacity in the existing drainage system and the implementation of regional flood planning.

Other measures that were considered include underground storage beneath the railway tracks. This measure was thought be difficult to implement in this case, due to the potential structural issues with constructing in close proximity to the railway line.

CDA: Group4_074

The preferred option for this CDA includes the installation of underground storage beneath the basketball court along Usher Road and the retrofitting of flood resistance measures at the electricity sub-station and for properties at risk. Increasing the size/number of gullies along Tredegar Road is also recommended to encourage more surface water to enter the drainage network.

Other measures that were considered include separation of foul and surface water systems which would have health benefits through improvements in water quality. This measure was not preferred as it is unlikely to be cost-beneficial.

4.5 Preferred Options Summary

4.5.1 It is recognised that numerous CDAs have been identified throughout the borough, and it may not be possible, with available resources and funds, to address identified surface water flood risk within all of these in the short to medium term. It is therefore important to prioritise those schemes that are deemed to be most beneficial and address those areas known to experience surface water flooding within the borough. Discussions with the LB of Tower Hamlets through the Options Workshop and throughout the study have confirmed that priority should be assigned to addressing surface water flooding risk in those areas that:

- Experience regular or significant surface water / groundwater / sewer flooding;
- Contain basement properties;
- Contain critical infrastructure; and / or
- Through the pluvial modelling undertaken, are predicted to face significant surface water flooding depths (>0.5m) and hazard (high flow velocities and depth) for the 1 in 100 year rainfall event.

4.5.2 Table 4-2 provides an estimate of the percentage of surface water flood risk eliminated or mitigated as a result of implementing the preferred option. A capital cost band is also provided to give an indication as to the investment required. A band as opposed to a definitive figure has been provided to reflect the strategic nature of the SWMP study and options identification. All costs are indicative and should only be used for preliminary estimates due to the generalised nature of the information used to compile it. An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs provided as part of Tier 1 of the Drain London Project to mitigate the 1 in 75 year event. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied, as determined in the Drain London Prioritisation Matrix Guidance:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints.
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

4.6 Short – Medium Term Recommendations

4.6.1 Accounting for the nature of the surface water flooding in the LB of Tower Hamlets, the options identified through the Phase 3 – Options Assessment, and requirements under the FWMA 2010 and Flood Risk Regulations 2009, it is considered that the following actions should be prioritised in the short to medium-term:

- Undertake a Surface Water Catchment Drainage Study for CDA's shown to be at highest risk in terms of number of receptors affected: Group4_013, Group4_021 and Group4_025. This assessment should be undertaken with the LB of Tower Hamlets, Thames Water and TfL, to greater information on the flood risk within the CDAs along with obtaining a greater understanding of the drainage capacity within each area. It is recommended that the study continues the work undertaken as part of this SWMP and consider the following:
    - Determining the capacity in the existing sewer network, and likely spill volumes during the modelled return periods utilised in this study (refer to Section 3.3);
    - Update rainfall hyetographs utilised in the model so as to reflect the CDA area more accurately (only recommended for models which are trimmed to the CDA catchment);
    - Undertaking detailed pluvial modelling of the area, incorporating updated drainage capacity assumptions including sewer capacity information from Thames Water, where available;
    - Undertaking detailed pluvial modelling of the area, incorporating updated permeable area infiltration assumptions – ideally based on area/site specific permeability/percolation testing;
    - Identifying and recording surface water assets including their asset type, location and condition (required as part of the Asset Register);
    - Topographical survey of assets and structures which may influence flooding and overland flow paths – to be included in the 1D or 2D model element (as required) to provide a greater understanding of their influence;
    - Determining the current condition of gullies and carrier pipes;
    - Determining the capacity of gullies and carrier pipes;
    - Determining the connections to Thames Water surface water sewers and assets;
    - Undertaking CCTV surveys for those areas where there are known blockages in the local pipes and/or surface water sewers;
    - Clearing those gullies or pipes identified as blocked during investigations (as part of annual maintenance routine);
    - Determining upgrade requirements and costs for the local drainage infrastructure and seek funding opportunities to implement these; and
    - Providing updates to the Drain London pluvial models, to update the Flood Depth and Hazard maps for these areas with local drainage capacity information;

  - Once updated modelling has been undertaken it is recommended that the preferred options for flood alleviation in the catchment (including the consideration of upgrades to the local and/or sewer drainage network, flood storage and/or source control SuDS) are reassessed through the detailed model, and that cost of implementing these are undertaken to identify the most cost-beneficial option(s) for mitigating surface water flood risk in the catchment.

- Undertake a feasibility study for providing source control and flow path management measures in all open space areas within the borough;
- Confirm the flood risk to all Network Rail, Transport for London and Highways Agency assets and agree a timeframe for the detailed assessment of areas of concern;
- Undertake a borough wide feasibility study to determine which roads may be retrofitted to include bioretention carpark pods;
- Improve maintenance regimes, and target those areas identified as having blocked gullies;
- Identify and record surface water assets as part of the Asset Register, prioritising those areas that are known to regularly flood and are therefore likely to require maintenance / upgrading in the short-term;
- Collate and review information on Ordinary Watercourses in the borough to gain an improved understanding of surface water flooding in the vicinity of these watercourses;
- Provide an 'Information Portal' via the LB of Tower Hamlets website, for local flood risk information and measures that can be taken by residents to mitigate surface water flooding to / around their property. This could be developed in conjunction with the North London Strategic Flood Group and include:
  - A list of appropriate property-level flood risk resilience measures that could be installed in a property;
  - A list of 'approved' suppliers for providing local services, such as repaving of driveways, installation of rainwater tanks and water butts etc;
  - link to websites/information sources providing further information;
  - An update on work being undertaken in the borough by the Council and/or the Stakeholders to address surface water flood risk; and,
  - A calendar showing when gullies are to be cleaned in given areas, to encourage residents to ensure that cars are not parked over gullies / access is not blocked during these times.
- Production of a Communication Plan to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public.

4.7 Option Prioritisation

4.7.1 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 all 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 nor to restrict the work that each LLFA may wish to seek funding for or commence.

4.7.2 The prioritisation methodology is primarily based upon existing Environment Agency and Defra guidance but has been tailored to the high-level prioritisation task at hand and is specific to the pan-London context.

4.7.3 The information within Table 4-2 was submitted for input into the Prioritisation Matrix by the Drain London Programme Board. The Board will then compare all Critical Drainage Area options across London and prioritise them for funding as part of Tier 3 works. Feedback will then be provided to all consultants at a London Borough level to influence the Action Plan prepared as part of Phase 4. CDA detailed investigations or 'quick win' measures receiving funding from Tier 3 will be identified as immediate actions, but others may require longer term planning and actions for implementation across relevant organisations.

4.7.4 Board feedback will be included in the final SWMP report.

Table 4-2 Benefits and Costs of CDA Measures

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 (%)	
Group4_011	Plevna Street and Launch Street.	Other or combination of above	0	0	0	0	0	0	0	0	0	30	0	0	101k - 250k
Group4_013	White's Row, Spitalfields.	Community Resilience	0	0	0	0	0	0	30	40	30	40	30	40	101k - 250k
Group4_014	DLR track surrounding Langdon Park and All Saints DLR Stations.	Other or combination of above	0	100	0	0	0	0	0	0	0	0	0	0	501k - 1m
Group4_015	Northern approach of the Blackwall Tunnel.	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	251k - 500k
Group4_016	A12, Northern approach to Blackwall Tunnel in Bow	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	1m - 10m
Group4_021	Stepney Green Road and surrounding properties, including the London Independent Hospital	Other or combination of above	0	0	0	50	0	100	0	0	5	25	0	10	501k - 1m
Group4_022	Intersection of A11 and A12 in Bromley by Bow	Other or combination of above	0	100	0	0	0	100	0	0	0	50	0	50	1m - 10m
Group4_025	Cordelia Street, Ricardo Street, and Grundy Street	Other or combination of above	0	0	0	100	0	100	0	0	0	30	0	20	1m - 10m
Group4_060	Railway tracks surrounding Whitechapel Tube Station, Whitechapel	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	90	251k - 500k
Group4_069	Aspen Way Tunnel beneath Saffron Avenue and Leamouth Road, East India	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	251k - 500k
Group4_070	B125 Abbott Road underpass beneath A12, South Bromley	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	51k - 100k
Group4_071	Limehouse Link tunnel entrance, Poplar	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	251k - 500k
Group4_072	London Overground tracks between Shoreditch and Shadwell	De-culvert / Increase conveyance	0	100	0	0	0	0	0	0	0	0	0	0	501k - 1m
Group4_074	Tredegar Road between Cardigan and Parnell Roads in Bow	Other or combination of above	0	0	0	0	0	0	0	0	0	100	0	0	101k - 250k

Note: The Drain London Prioritisation Matrix requires an estimation of the percentage of total number of units that have the potential to benefit from the proposed scheme. This has been determined by calculating the number of units within the LFRZ that the scheme has been designed to mitigate, as a percentage of the number of units within the CDA as a whole. The input is restricted to multiples of five percent (5%). It should be noted that the information within this table is purely for input into the Drain London Prioritisation Matrix and should be treated as such.

5 Phase 4: Implementation and Review

5.1 Action Plan

5.1.1 An Action Plan has been created for each LLFA within the Drain London area. The Action Plan is a simple summary spreadsheet that has been formulated by reviewing the previous phases of the SWMP in order to create a useful set of actions relating to the management and investigation of surface water flooding going forward. It is the intention that the Action Plan is a live document, maintained and regularly updated by the borough, as actions are progressed and investigated. It should be understood that following further detailed investigation the preferred option in each CDA, and even in some cases the need for any action other than basic investigation in a particular CDA may be discounted. Likewise new actions may be identified by the borough, or may be required by changing legislation and guidance overtime.

5.1.2 The Action Plan identifies (Table 5-1 outlines the Action Types used to categorise actions in the Action Plan):

- Actions required to satisfy the FWMA and FRR requirements, (these are common to all LLFAs);
- Future studies and consultations for investigation and confirming the level of flood risk within the borough;
- Who is responsible for delivery of each action, along with who might provide support;
- When actions should be undertaken, reviewed and updated.
- Linkages between actions;
- An estimation of costs for investigations and optioneering works – including possible sources of funding – for the CDAs within the borough;

Table 5-1 Type of Actions within the Action Plan

Action Type	Abbreviation	Description
Flood and Water Management Act / Flood Risk Regulations	FWMA / FRR	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
Policy Action	Policy	Spatial planning or development control actions
Communication / Partnerships	C + M	Actions to communicate risk internally or externally to LLFA or create / improve flood risk related partnerships
Financial / Resourcing	F + R	Actions to secure funding internally / externally to support works or additional resources to deliver actions

Action Type	Abbreviation	Description
Investigation / Feasibility / Design	I / F / D	Further investigation / feasibility study / Design of mitigation
Flooding Mitigation Action	FMA	Maintenance or capital works undertaken to mitigate flood risk

5.2 Summary of Key Actions

5.2.1 The LB of Tower Hamlets Action Plan has been delineated into the following themes:

- Actions for the Council to review with regard to the FWMA and FRR;
- General Actions and investigations that apply to the wider borough and can include the identified CDA's and consultation with the community; and
- CDA specific actions and investigations.

5.2.2 The latest Action Plan can be downloaded from http://db.tt/BlqUjWoO.
The complete version of the Action Plan is held and maintained by the LB of Tower Hamlets.

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5.3 Implementation Programme

5.3.1 Gantt chart to follow once Peer Review and Action Plan review complete.

5.4 Review Timeframe and Responsibilities

5.4.1 Proposed actions have been classified into the following categories:

- Short term; Actions to be undertaken within the next six months
- Medium term: Actions to be undertaken within the next year.
- Long term. Actions to be undertaken beyond the first year of implementation.

5.4.2 The Action Plan identifies the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action. After an action has been addressed, it is recommended that the responsible department (responsible for completing the action) review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required.

5.4.3 It is recommended that the Action Plan is reviewed and updated on a quarterly basis to reflect any necessary amendments. In order to capture the works undertaken by the Council and other stakeholders, it is recommended that the Action Plan review should not be greater than an annual basis. For clarity, it is noted that the FWMA places immediate or in some cases imminent new responsibilities on Lead Local Flood Authorities, of which LB Tower Hamlets is one. The main actions required are contained in the Action Plan (Action ID Numbers 3 - 13) but are also summarised below:

- Develop, maintain, apply and monitor a Strategy for local flood risk management of the area.
- Duty to maintain a local flood risk asset register.
- Investigate flood incidents and record in a consistent manner.
- Establish a SuDS Approval Body (SAB).
- Contribute towards achievement of sustainable development.
- On-going responsibility to co-operate with other authorities through sharing of data and expertise.
- Preparation of flood risk management plans

5.5 Ongoing Monitoring

5.5.1 The partnership arrangements established as part of the SWMP process (e.g. LB of Tower Hamlets, neighbouring boroughs, EA and TWUL, etc, 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.

5.5.2 In addition, maintaining the working partnership between the 'Group 4' group of boroughs is recommended in order to gain an understanding of flood risk across the boroughs and to share best practice management procedures.

5.5.3 The SWMP Action Plan should be reviewed and updated annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim. In fact, Action Plan updates may be as frequent as every few months. Examples of something which would be likely to trigger an Action Plan review include:

- 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.

5.5.4 It is in the interest of LB of Tower Hamlets that the SWMP Action Plan remains current and up-to-date. To help facilitate this, it would be useful for the LB of Tower Hamlets to liaise with other flood risk management authorities and monitor progress.

5.6 Incorporating new datasets

5.6.1 The following tasks should be undertaken when including new datasets in the LB of Tower Hamlets SWMP:

- Identify new dataset.
- Save new dataset/information.
- Record new information in log so that next update can review this information.

5.7 Updating SWMP Reports and Figures

5.7.1 In recognition that the SWMP will be updated in the future, the report has been structured in chapters according to the SWMP guidance provided by Defra. By structuring the report in this way, it is possible to undertake further analyses on a particular source of flooding and only have to supersede the relevant chapter, whilst keeping the remaining chapters unaffected.

5.7.2 In keeping with this principle, the following tasks should be undertaken when updating SWMP reports and figures:

- Undertake further analyses as required after SWMP review
- Document all new technical analyses by rewriting and replacing relevant chapter(s) and appendices.
- Amend and replace relevant SWMP Maps.
- Reissue to departments within the LB of Tower Hamlets and other stakeholders.

6 References

Cabinet Office, June 2008, The Pitt Review - Learning Lessons from the 2007 Floods

Capita Symonds Ltd, 2011, Preliminary Flood Risk Assessment for London Borough of Tower Hamlets

Defra, March 2005, Making Space for Water - Taking forward a new Government strategy for Flood and Coastal Erosion Risk Management in England

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Defra, 2006, Flood and Coastal Defence Appraisal Guidance, FCDPAG3 Economic Appraisal, Supplementary Note to Operating Authorities – Climate Change Impacts October 2006. http://www.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcd3climate.pdf

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Environment Agency, December 2010, Preliminary Flood Risk Assessment (PFRA) Final Guidance, Report GEHO1210BTGH-E-E

Environment Agency, December 2010, Preliminary Flood Risk Assessment (PFRA) Annexes to the Final Guidance, Report GEHO1210BTHF-E-E

Greater London Authority, 2010, Drain London: Data and Modelling Framework

Greater London Authority, 2010, Drain London: Data and Modelling Framework Appendices

Local Government Group, February 2011, Preliminary Framework to assist the development of the Local Strategy for Flood Risk Management 'A Living Document'
http://www.lga.gov.uk/lga/aio/17064046

LB Tower Hamlets, August 2008, London Borough of Tower Hamlets: Level 1 Strategic Flood Risk Assessment.

WSP, February 2010, Thatcham Surface Water Management Plan Volume One

Table A1 identifies the review score information (as provided by Drain London Tier 1 consultant) for Table A2.

Table A – 1. Review Score Criteria

Data Quality Score	Description	Explanations	Example
1	Best possible	No better available; not possible to improve in the near future	High resolution LiDAR, River/sewer flow data,Rain gauge data
2	Data with known deficiencies	Best replaced as soon as new data are available	Typical sewer or river model that is a few years old
3	Gross assumptions	Not invented but based on experience and judgement	Location, extent and depth of much surface water flooding. Operation of un-modelled highway drainage 'future risk' inputs e.g. rainfall, population
4	Heroic assumptions	An educated guess	Ground roughness for 2D models
N/A			

Table A – 2. Data Review

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Defence_OCG4 &5.zip	PROTECT- COMMERCIAL. Location of Thames Tidal defences with condition grade 4 or 5 (shapefile)	Extract from NFCDD	2	Tidal Defences
Environment Agency	FailingAssets.zip	PROTECT COMMERCIAL. Thames Tidal defences with condition grade 4 or 5 (report from NFCDD)	Extract from NFCDD	2	Tidal Defences
Environment Agency	System Asset Management Plan Summary Reports.zip	PROTECT COMMERCIAL. System Asset Management Plan Summary Reports for South London, containing strategic drivers, major assets, failing assets and planned interventions.	Extract from NFCDD	2	Asset Management
Environment Agency	FRM_Systems_ NE.zip	PROTECT COMMERCIAL. System Asset Management Plan Summary Reports for North London, containing strategic drivers, major assets, failing assets and planned interventions.	Extract from NFCDD	2	Asset Management
Environment Agency	FRM_Systems_ SE.zip	System Asset Managament Plan Shapefile showing location of systems in London.	No known limitations	2	Asset Management
Environment Agency	Maintenance programmes for 2009-10.zip	Environment Agency maintenance programmes for 2009-2010 for London.	No known limitations	2	Maintenance
Environment Agency	Routine_maintenance_2010_2011_Web_version_June.xls	Environment Agency routine maintenance activities 2010-2010 for London.	No known limitations	2	Maintenance

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Other_Maintenance_activities_2010-11.xls	Environment Agency other (non-routine) maintenance activities 2010-2011 for London.	No known limitations	2	Maintenance
Environment Agency	catchment_50k.zip	Catchment area shapefile for Thames Region, attributed with catchment names and codes.			Catchment Area
Environment Agency	TE2100_Product Catalogue_V1_090924.xls	Excel spreadsheet of reports and data produced by Thames Estuary 2100 project. Not all reports and data are available for supply. Please get in touch with Tom Sampson at EA to enquire about reports or data which are relevant to Surface Water Management Plans in London.	Catalogue of reports provided. Not all reports and data are available for supply. Please get in touch with Tom Sampson at EA to enquire about reports or data which are relevant to Surface Water Management Plans in London.		Thames Estuary
Environment Agency	London_Discharges 04-10.xls	All discharge consents in London with grid reference.	No known limitations. Grid reference provided but not mapped.		Discharges
Environment Agency	LONDON_GQA 04-10.xls	2008 general quality assessments in London (not georeferenced)	File not georeferenced.	2	Water Quality
Environment Agency	London_WFD Status&Targets 04-10.xls	Water Framework Directive water quality status and targets (not spaitally referenced)	File incomplete. Should refer to Environment Agency website for up-to-date information.	3	Water Quality
Environment Agency	North_London_Fisheries Reports.zip	North London fisheries reports or studies	Nonly covers North London. No information provided for South London.	2	Water Quality
Environment Agency	Thames_CFMP_July_2008.zip	Thames Catchment Flood Management Plan (July 2008)	No known limitations.	2	Flood Management
Environment Agency	Thames_CFMP_Summary_Report_December_2009.pdf	Thames Catchment Flood Management Plan Summary Report (December 2009)	No known limitations.	2	Flood Management
Environment Agency	Thames_Region_CAMS.zip	Thames Region Catchment Abstraction Management Strategies	No known limitations.	2	Abstraction
Environment Agency	Thames_River_Basin_Management_Plan_2009.zip	Thames River Basin Management Plan (December 2009)	No known limitations.	2	Water Quality

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	flood_event_outline_10k_London.zip	Flood Event Outlines in London extracted from NFCDD. Only attribute fields approved for access have been supplied. Attributes: shapefile name - official NFCDD name (explanation) FLOODEVENT - Flood Event Code (unique code for flood event) FLOODEVE0 - Outline Code (unique code for each outline) FLOODEVE1 - Flood Event Name STARTDATE - Start Date ENDDATE - End Date SOURCEOFBO - Source of boundary (source of data) SOURCEOFFL - Source of flooding (e.g. main river) CAUSEOFFLO - Cause of flooding (e.g. overtopping of defences) FLIVIALFLA - Fluvial Ind (true/false if fluvial) TIDALFLAG - Tidal Ind (true/false if tidal) COASTALFLA - Coastal Ind (true/false if coastal) FLOODMAPIN - HFM Ind (flag indicating if outline is included on historic flood map)	No known limitations.	2	Historic Flooding
Environment Agency	Historic Flood Map OI193911.zip	Supplied through Geostore.Historic Flood Map Events is the maximum extent of all recorded individual Historic Flood Events Outlines from river, the sea and groundwater springs and shows areas of land that have previously been subject to flooding in England & Wales. The data is updated every three months, but may not change quarter to quarter if there have been no significant flood events in the preceding period. The dataset consists of spatial data only.Please note that this map shows flooding to the land and does not necessarily indicate that properties within the Historic Flood Map were flooded internally. It is also possible that the pattern of flooding in this area has changed and that this area would now flood under different circumstances. In addition, abscence of coverage by the Historic Flood Map for an area does not mean that the area has never flooded, only that we do not currently have records of flooding in this area.	No known limitations.	2	Historic Flooding

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Flood Map OI193910.zip	Supplied through Geostore. The Flood Map shows the areas across England and Wales that could be affected by flooding from rivers or the sea. It also shows flood defences and the areas that benefit from them. Flood Map is designed to raise awareness among the public, local authorities and other organisations of the likelihood of flooding, and to encourage people living and working in areas prone to flooding to find our more and take appropriate action. The Flood Map includes the following layers of information: Flood Zone 3 is the Agency's best estimate of the areas of land with a 100 to 1 (or greater) chance of flooding each year from rivers, or with a 200 to 1 chance (or greater) of flooding each year from the sea. Flood Zone 2 is the Agency's best estimate of the areas of land between Zone 3 and the extent of the flood from rivers or the sea with a 1000 to 1 chance of flooding in any year. It includes those areas defined in flood zone 3. Flood Defences shows those defences constructed during the last five years with a standard of protection equal to or better than 1 percent for rivers and 0.5 percent from the sea. (Some additional defences area also shown.) Areas Benefiting from Flood Defences shows those areas that would benefit from the presence of defences in a 1 percent fluvial / 0.5 percent tidal flood event. Flood Storage Areas shows those areas that act as a balancing reservoir, storage basin or balancing pond. Their purpose is to attenuate an incoming flood peak to a flow level that can be accepted by the downstream channel. It may also delay the timing of a flood peak so that its volume is discharged over a longer time interval.	No known limitations.	2	Flood Management and Planning
Environment Agency	Main River 10k OI183819.zip	Supplied through geostore. Main river centrelines showing which river sections are classified as main as approved by the Secretary of State.	No known limitations.	2	Flood Management and Planning
Environment Agency	Areas Susceptible to Surface Water Flooding OI170589.zip	Supplied through geostore.Flood data for areas naturally vulnerable to surface water flooding from a 1 in 200 year return period, 6.25 hour duration rainfall event over a 5 x 5km area.	No known limitations.	2	Flood Management and Planning
Environment Agency	Detailed River Network OI183820.zip	Supplied through geostore. The Detailed River Network (DRN) is the only large-scale, accurate and fully attributed digital river centreline covering England and Wales. The DRN is captured from the water features theme of the OS MasterMap topographic layer and built into a network using automated rules. Other input datasets and extensive local Environment Agency staff knowledge has been used to augment the core geometry to incorporate critical spatial detail and attribution, such as flow direction and path, not available from the OS mapping and to verify the accuracy of the centreline itself. The dataset has full-feature network geometry cross-referenced with OS MasterMap following Digital National Framework principles.	No known limitations.	2	Flood Management and Planning

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	NaFRA2008.zip	Supplied through geostore. NaFRA 2006 Spatial Flood Likelihood Category (FLC) Grid (version 8.2) is the latest output using the Risk Assessment for flood and coastal defence for Strategic Planning (RASP) High Level Method Plus (HLM+). It is a broad-brush assessment of the likelihood of flooding at a national scale, based on assessments undertaken for 85 river catchments and coastal cells, where a cell is an area of land measuring 50m by 50m. NaFRA 2008 Spatial (FLC) Grid enables a comparison of the relative risks and their distribution within each of these catchments, rather than a detailed, local assessment of the risk at a specific location. The calculations provide an indication of the likelihood of flooding at the centre of each cell. These results are then placed into three risk categories as used by the insurance industry. The three risk categories are: - low - the chance of flooding each year is 0.5 per cent (1 in 200) or less - moderate - the chance of flooding in any year is 1.3 per cent (1 in 75) or less but greater than 0.5 per cent (1 in 200) - significant - the chance of flooding in any year is greater than 1.3 per cent (1 in 75)	No known limitations.	2	Flood Management and Planning
Environment Agency	Readme.txt	Information related to downloaded Geostore data and licence issues. Environment Agency data supplied to Scott Wilson for use on behalf of the Greater London Authority, 7th May 2010 and 13th July 2010.	No known limitations. Only pertains to licensing/downloaded data.	1	Flood Management and Planning
Environment Agency	Model coverage_SE Thames_2010_28Apr10.zip	Shapefile of model availability in the Environment Agency, Thames South East Area.	No known limitations.	2	Flood Management and Planning
Environment Agency	Detailed Mapping Progress_Apr10.xls	Spreadsheet of detailed mapping progress and planned updates in Thames South East Area	No known limitations.	2	Flood Management and Planning
Environment Agency	Beverley Brook Product 5 Model Report.zip	Fluvial flood model. Beverley Brook Product 5 - model reports. Final Report_Beverley Brook_09 06 09	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Beverley Brook Product 6 Model Output Data.zip	Fluvial flood model. Beverley Brook Product 6 - model output data. Contains: ISIS & Tuflow results files, flood extents and report with model outputs.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Beverley Brook Product 7 CaVMID.zip	Fluvial flood model. Beverley Brook Product 7 - CaVMID (Calibrated & Verified Model Input Data). Contains ISIS-Tuflow model input files including hydrological inflows.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill IUD Product 5 Model Report.zip	Surface water modelling and planning. Hogsmill IUD Product 5 - model reports. Includes: Hogsmill Pilot IUD - Final Report_Vol 1_170608, Hogsmill IUD Pilot Vol 2_170608, Hogsmill IUD Final_Vo1 3, Hogsmill IUD Exe Summary_18.06.08	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Hogsmill IUD Product 7 CaVMID.zip	Surface water Infoworks model files. Hogsmill IUD Product 7 - CaVMID (Calibrated & Verified Model Input Data). Contains: Hogsmill Final 2D Models Infoworks	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 1 2003 Product 5 Reports.zip	Fluvial flood model. Hogsmill Phase 1 Product 5 - model reports. Final Hydrology Report, Final Hydraulic report	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 1 2003 Product 6 Model Outputs.zip	Fluvial flood model. Hogsmill Phase 1 Product 6 - model output data. Contains: flood outlines, ISIS results, Flow & level spreadsheet, ArcGIS shapefiles	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 1 2003 Product 7 CaVMID.zip	Fluvial flood model. Hogsmill Phase 1 Product 7 - CaVMID (Calibrated & Verified Model Input Data). Contains ISIS model input files including hydrological inflows.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 2 Product 5 Reports.zip	Fluvial flood model. Hogsmill Phase 2 Product 5 - model reports. TH662_Hogsmill_Hydraulic_Report	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 2 Product 6 Model outputs.zip	Fluvial flood model. Hogsmill Phase 2 Product 6 - model output data. Contains: flood outlines, ISIS & tuflow results, Flow & level spreadsheet, ArcGIS shapefiles	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Hogsmill Phase 2 Product 7 CaVMID.zip	Fluvial flood model. Hogsmill Phase 2 Product 7 - CaVMID (Calibrated & Verified Model Input Data). Contains ISIS-Tuflow model input files including hydrological inflows.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Ravensbourne Product 5 Reports.zip	Fluvial flood model. Ravensbourne 2009 Product 5 - model reports. Contains: Ravensbourne Model Review, Response to Ravensbourne Model Review, Ravensbourne Culvert Survey Report, Ravensbourne 2D Modelling 2009, Ravensbourne Hazard Mapping Report.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Ravensbourne Product 6 Model Outputs.zip	Fluvial flood model. Ravensbourne 2009 Product 6 - model output data. Contains: flood outlines, ISIS & tuflow results, Flow & level spreadsheet, ArcGIS shapefiles, Hazard maps,	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Ravensbourne Product 7 CaVMID.zip	Fluvial flood model. Ravensbourne 2009 Product 7 - CaVMID (Calibrated & Verified Model Input Data). Contains ISIS-Tuflow model input files including hydrological inflows.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Ravensbourne Delivery Plan Product 5 reports.zip	Surface water flood model. Ravensbourne Delivery Plan (2009). Product 5 - reports. Contains: Ravensbourne Delivery Plan April 2009 V13, Ravensbourne Delivery Plan Maps April 2009.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Ravensbourne Delivery Plan Product 6 Model Outputs.zip	Surface water flood model. Ravensbourne Delivery Plan (2009). Product 6 - model outputs . Contains: tuflow output files	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Beam,Ingrebourne and Marshes East Model 2006.zip	Beam, Ingrebourne & Marshes East Model (Jacobs, 2006) GIS - Modelled outlines, nodes, reservoir units Model - .dat files, .ixy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Beam,Ingrebourne and Marshes West Model 2006.zip	Beam, Ingrebourne & Marshes West Model (Halcrow, 2006) GIS - Modelled outlines, nodes, reservoir units Model - .ief files, .gxy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	River Brent Modelling and Mapping Study 2009.zip	River Brent Modelling & Mapping Study (Jacobs, 2009) GIS - modelled outlines, nodes Model - .ied files, .gxy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	River Crane Modelling and Mapping Study 2008.zip	Provided in: North London Flood Model Products 5, 6 & 7 River Crane Modelling & Mapping Study (Halcrow, 2008) GIS - modelled outlines, nodes Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Lower Colne Improvement Scheme Modelling 2004.zip	Lower Colne Improvement Scheme Modelling (PBA, 2004) GIS - modelled outlines, nodes, reservoir units Model - .ied, .dat and .ixy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	River Pinn Flood Mapping Study 2008.zip	River Pinn Mapping Study (Mott MacDonald, 2008) GIS - modelled outlines, nodes, ABDs Model - .dat, .feb, .gxy, .ief, .zzd, .zzl Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Beam,Ingrebourne and Marshes (West) Mayes Brook Model 2006.zip	Beam, Ingrebourne & Marshes (West) - Mayes Brook (Halcrow, 2006) GIS - Modelled outlines, nodes, reservoir unitsModel - .dat, .ied, .feb, .gxy	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Lower Roding Strategy Modelling 2005.zip	Lower Roding Strategy Model (B&V, 2005) GIS - Modelled outlines, nodes, reservoir units Model - .dat, .ied, .feb, .gxy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Middle Roding Section 105 Modelling 2003.zip	Middle Roding Section 105 model (Jacobs, 2003) GIS - Modelled outlines, nodes, reservoir units Model - .dat, .ied, .feb, .gxy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	Newham SFRA.zip	Newham SFRA modelling (Capita Symonds, 2010) Inflows (excel)	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Silk Stream FAS Modelling 2007.zip	Silk Stream FAS modelling (Halcrow, 2007) GIS - Modelled outlines, nodes Model - .dat	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Upper Colne Strategy Modelling 2004.zip	Upper Colne Strategy Modelling (Halcrow, 2004) GIS - Modelled outlines, nodes, reservoir units Model - .dat, .gxy Reports + appendices	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Erith Product 5 Reports.zip	Integrated flood risk model. Erith Marshes Ditches & Dykes study. Product 5 - model reports. Contains: Erith Marshes Ditches and Dykes Study Surface Water Management Final Report, Erith Marshes Ditches and Dykes Hydrology Phase 2	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Erith Product 6&7 Model files.zip	Integrated flood risk model. Erith Marshes Ditches & Dykes study. Product 6&7 - infoworks model files of baseline and scenario tests.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Thamesmead Product 5 Reports.zip	Integrated flood risk model. Thamesmead canals masterplan evidence base. Product 5 - model reports. Contains: Thamesmead Canal Corridor Enhancement Masterplan, 26621 C025 Thamesmead Canal Corridor DRAFT Model Report v1.0, 26621-C021 - WQ Report Chapter v4 - FINAL DRAFT 9Apr10, 26621-C022 Thamesmead_ECOLOGY_12Apr10, 26621-C024 - CL Report Chapter	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Thamesmead Product 6&7 model files.zip	Integrated flood risk model. Thamesmead canals masterplan evidence base. Product 6&7 - infoworks model files of baseline and scenario tests.	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Lee Detailed Model.zip	River Lee detailed model. Contains GIS modelled outlines and nodes	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Wandle Product 5.zip	Fluvial model Wandle Product 5 - model reports	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	Wandle Product 6	Fluvial model Wandle Product 6 - model output data	No known limitations but must be aware input data and modelling assumptions used in generating models.	2	Flood Management and Planning
Environment Agency	NE_Flowdata_Apr10.xls	River flow data from 2004 to 2010 in North London	No known limitations.	2	River Flow

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	NE_Groundwaterdata_Apr10.xls	Groundwater level data from 2004 to 2010 in North London	No known limitations.	2	Groundwater Level
Environment Agency	NE_Rainfalldata_Apr10.xls	Rainfall data from 2000 to 2010 in North London	No known limitations.	2	Rainfall
Environment Agency	EA_Hydrometric_data_network_London.zip	Shapefile of hydrometric data network in London including river, rain and groundwater monitoring locations.	No known limitations.	2	Monitoring Locations
Environment Agency	SE_Flowdata_May10.xls	River flow data from 2004 to 2010 in South London	No known limitations.	2	River Flow
Environment Agency	SE_Wandle_GW.xls	Groundwater level data from 2004 to 2010 in the Wandle catchment South London	No known limitations.	2	Groundwater Level
Environment Agency	SE_Ravensbourne_GW.xls	Groundwater level data from 2004 to 2010 in the Ravensbourne catchment South London	No known limitations.	2	Groundwater Level
Environment Agency	SE_Hogsmill_GW.xls	Groundwater level data from 2004 to 2010 in the Hogsmill catchment South London	No known limitations.	2	Groundwater Level
Environment Agency	SE_Thamesmead_GW.xls	Groundwater level data from 2004 to 2010 in the Thamesmead catchment South London	No known limitations.	2	Groundwater Level
Environment Agency	SE_Beverley_Brook_GW.xls	Groundwater level data from 2004 to 2010 in the Beverley Brook catchment South London	No known limitations.	2	Groundwater Level
Environment Agency	SE_Rainfall_May10.xls	Rainfall data from 2000 to 2010 in South London	No known limitations.	2	Rainfall
Environment Agency	NE_Thames_Drift_Geology_GW Vulnerability_map.pdf	North London drift geology groundwater vulnerability map	No known limitations.	2	Groundwater Vulnerability
Environment Agency	NE_Thames_GW_Nitrate_Vulnerability_Map.pdf	North London groundwater nitrate vulnerability map	No known limitations.	2	Groundwater Nitrate Vulnerability
Environment Agency	NE_Thames_Solid_Geology_GWVulnerability_map.pdf	North London solid geology groundwater vulnerability map	No known limitations.	2	Groundwater Vulnerability
Environment Agency	LondonRainfall.zip	Rainfall data from all relevant rainagauges in London	No known limitations.	1	Rainfall data
Environment Agency	FWAs_NE_March_2010.zip	Flood Warning Areas in North London	No known limitations.	2	Flood Management and Planning
Environment Agency	FWAs_SE_March_2010.zip	Flood Warning Areas in South London	No known limitations.	2	Flood Management and Planning

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Environment Agency	EAGEOSTORE_OI204652.zip	The National Receptor Dataset (NRD) is a collection of risk receptors primarily intended for use in flood and coastal erosion risk management. It is available for use by Local Planning Authorities, Environment Agency and their contractors. NRD is a spatial dataset which contains a number of GIS layers categorised into themes of information including buildings, environment, heritage, transport, utilities. These are defined in more detail in this document. Coverage is provided for England and Wales (where available) only. The data stored within the NRD meets the information requirements of a range of Flood and Coastal Risk Management (FCRM) practitioners within the Local Planning Authorities and Environment Agency. This first version of the dataset has been designed to meet the needs of Preliminary Flood Risk Assessments and the Environment Agency's National Flood Risk Assessment.	No known limitations.		Flood and Coastal Risk Management, buildings, environment, heritage, transport, utilities
Thames Water	TWL_1A_NoData.txt	This data is not readily available and would be difficult to create. TW would be concerned about how this data could be interpreted if it were created.	N/A	N/A	TW Sewer Network Model
Thames Water	Pipes_33_LA.zip	GIS layer provided on CD. Contains details of the sewer network, both foul and surface water for all 33 London boroughs (location and pipe heights).	Unsure how the network is updated/maintained but this is the best information currently available.	1	TW Sewer Network Model
Thames Water	Pumping_Station_1_33_LA.zip	GIS layer provided on CD. Contains details of the pumping station name, location, area, owner etc	Unsure how the network is updated/maintained but this is the best information currently available.	1	Pumping stations
Thames Water	Pumping_Station_2_33_LA.zip	GIS layer provided on CD. Contains details of the pumping station name, location, area, owner etc	Unsure how the network is updated/maintained but this is the best information currently available.	1	Pumping stations
Thames Water	Manhole_33_LA.zip	GIS layer of manhole locations (xref) purpose, some cover and invert levels where available	Unsure how the network is updated/maintained but this is the best information currently available.	1	manhole locations
Thames Water	CSO_locations_33_LA.zip	GIS layer of CSOs, location, receiving watercourse name, discharge type etc	Unsure how the network is updated/maintained but this is the best information currently available.	1	CSO overflow locations
Thames Water	TWL_1F_NoData.txt	This data is not specifically highlighted but is on the network plans - users will have to manually identify.	N/A	N/A	sewer outfalls
Thames Water	STW_locations_33_LA.zip	GIS layer of Sewage Treatment Work locations.	Best information available.	1	sewerage storage
Thames Water	TWL_1GNoData.txt	This is part of the sewer network GIS. Where storage systems are above ground (legacy systems) they will be visible on maps. Deep tank sewers are not always highligted but can be identified on the sewer network GIS (user will have to trace along the network to find increases in pipe sizes). Deep shafts are not all mapped.	N/A	N/A	sewerage storage

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Thames Water	TWL_1H_NoData.txt	These are not seperated out on the network - may be able to find them in the sewer network if you know where they are. TW have the responsibility for some watercourses where they should not have as they should be the responsibility of the LA. TW are keen to see as an output of the SWMP, a resolution of assets and culvert ownership.	N/A	N/A	culvert location
Thames Water	TWL_1I_NoData.txt	This data is not readily available as some are mapped and some are not. The network ops team will have this information but there are 3x west teams, 2x central teams and 1x east team.	N/A	N/A	hydrobrake flow control
Thames Water	TWL_1J_NoData.txt	There is no specific information on SUDS schemes within London (there are about 350 SuDS assetts across Thames Region that TW have adopted). Where SuDS are located on-line, there is a question over who is responsible for them. On the GIS sewer network a SuDS scheme is identified by a gap in the network - this should be cross referenced with aerial photography and council information. Some SuDS are let to local councils who then are responsible for maintenance.	N/A	N/A	sustainable drainage systems SUDS
Thames Water	TWL_2A_NoData.txt	Not available at this time - TW will supply extracts of the model for specific CDAs if required by consultants as part of the SMWP studies	The infoworks model will be very large to transfer for the whole of London	N/A	TW Sewer Network Model
Thames Water	TWL_2B_NoData.txt	Not available at this time - TW will supply extracts of the model for specific CDAs if required by consultants as part of the SMWP studies	N/A	N/A	TW Sewer Network Model
Thames Water	TWL_2C_NoData.txt	There is a lot of data (boxes of CDs). If CCTV survey is required in specific CDAs - TW will supply if available (the survey supporting reports may be more useful than the actual survey)	N/A	N/A	CCTV survey
Thames Water	TWL_3A_NoData.txt	This information is based on a 4-figure post code. No greater level of detail can be provided as it is protected by the data protection act. The request for this information will have to come from the Las. TW noted that in areas where flooding may be an issue, there could be opportunities for LA to work with TW to reduce the catchment size outfalling to a particular location/problem sewer.	N/A	N/A	DG5 sewer flooding
Thames Water	TWL_3B_NoData.txt	TW were unsure if this would be of any use as would be more important on smaller diameter sewers. TW looking into provision of this data.	N/A	N/A	sewer blockage
Thames Water	TWL_3C_NoData.txt	TW only have reports in delivering solutions in areas where flooding occurs. These reports will hold info about previous flooding at specific areas. TW to look into provision of this data.	N/A	N/A	flood events records
Thames Water	TWL_4A_NoData.txt	These are high level reports which will outline where problem areas are located. They are currently being created as part of the AMP 5/6 process. TW to find out timescales for this, however, it should be noted that the drainage area plans will be made up of the information provided above.	N/A	N/A	Drainage Area Plans
Thames Water	TWL_4B_NoData.txt	All assets should be at the required standard - this data is limited.	N/A	N/A	Drainage asset condition records
Thames Water	TWL_4C_NoData.txt	There is a great deal of data which would take a long time to collate for the whole of london. TW to be contacted directly for specific maintenance records in CDAs if required.	N/A	N/A	Drainage maintenance records
Thames Water	TWL_4D_NoData.txt	see above	N/A	N/A	Infrastructure condition/performance data

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Thames Water	hogsmill IUD.zip	IUD for Brent and Hogsmill have been downloaded from the internet	These reports were written in 2008, guidance may have been superceded	2	Integrated Urban Drainage studies
Thames Water	TWL_4G_NoData.txt	As part of AMP5 TW are looking at increasing their understanding of the system. As part of AMP6 TW are looking to produce additional detailed network modelling.		N/A	AMP investments linked to surface water
British Waterways	Water Control Manual_London v 1.3.pdf	Water Control Manual for London v1.3	Continually Updated. Next update due November 2010.	1	Canal, Maintenance, Control
British Waterways	BW_Canals_Within_London_Boroughs.zip	GIS shapefile of British Waterways Canals in London	GIS layer of Britsh Waterways Canal Network in Greater London administrative area.	1	Canal
British Waterways	Anecdotal Flood Records 20100622.doc	Anecdotal Flooding Records	Summary of anecdotal flood records, or other notable details.	1	Canal flooding, overtopping
British Geological Survey	DiGMapGB-50 V5.18.zip	DiGMapGB-50 V5.18 GIS Layers (1:50k)	Best data available	2	Geology Mapping
British Geological Survey	Parent Materials.zip	Soil Parent Material Model GIS Layer	Best data available	2	Soil
British Geological Survey	Permeability V5.zip	Permeability V5 GIS Layer	Best data available	2	Permeability
British Geological Survey	Susceptibility to Groundwater Flooding.zip	Susceptibility to Groundwater Flooding GIS Layer	Best data available	2	Groundwater Flooding
British Geological Survey	Geologcal Indicators of Flooding V5.1.zip	Geological indicators of flooding GIS layer	Best data available	2	Groundwater Flooding
Greater London Authority	London_Assembly_constituency.zip	GIS Shapefile of London Assembly Constituency	No known limitations	1	Boundaries
Greater London Authority	London_Borough.zip	GIS Shapefile London Boroughs	No known limitations	1	Boundaries
Greater London Authority	London_Borough_Excluding_MHW.zip	GIS Shapefile of London Boroughs with River Thames boundary mapped.	No known limitations	1	Boundaries
Greater London Authority	London_GLA_Boundary.zip	GIS Shapefile of London GLA Boundary	No known limitations	1	Boundaries

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Greater London Authority	London_GLA_Boundary_within_England.zip	GIS Shapefile of London GLA Boundary within England	No known limitations	1	Boundaries
Greater London Authority	London_Inner_Boundary.zip	GIS Shapefile of London Inner Boundary	No known limitations	1	Boundaries
Greater London Authority	london_subregions_2006.zip	GIS Shapefile of London Subregions 2006	No known limitations	1	Boundaries
Greater London Authority	London_Ward.zip	GIS Shapefile of London Ward	No known limitations	1	Boundaries
Greater London Authority	London_Ward_CityMerged.zip	GIS Shapefile of London Ward City Merged	No known limitations	1	Boundaries
Greater London Authority	London_Westminster_Constituency.zip	GIS Shapefile of London Westminster Constituency	No known limitations	1	Boundaries
Greater London Authority	Areas for Regeneration LP 2009.zip	GIS MapInfo file of London Plan 2009 Areas for Regeneration	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	Areas_for_Intensification_PointData_LP2009.zip	GIS MapInfo file of London Plan 2009 Areas for Intensification	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	blueribbon network.zip	GIS Shapefile of London Plan 2009 Blueribbon Network	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	CAZ_Boundary_LP2009.zip	GIS MapInfo file of London Plan 2009 Central Activities Zone Boundary	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	Inner_Outer_London_Boundaries_LP2009.zip	GIS MapInfo file of London Plan 2009 Inner Outer London Boundaries	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	Opportunity_Area_PointData_LP2009.zip	GIS MapInfo file of London Plan 2009 Opportunity Area	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	SILs_pointdata_Sep09.zip	GIS MapInfo file of London Plan 2009 Strategic Industrial Locations (September 2009)	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	Subregions_LP2009.zip	GIS MapInfo file of London Plan 2009 Subregions	Based on London Plan 2009.	2	London Plan 2009
Greater London Authority	mastermap.zip	OS Mastermap Layers in ESRI Shapefile and MapInfo format	No known limitations	1	OS Mapping
Greater London Authority	OS10k.zip	OS 1:10k Layers in ESRI Shapefile and MapInfo format	No known limitations	1	OS Mapping
Greater London Authority	OS50k.zip	OS 1:50k Layers in ESRI Shapefile and MapInfo format	No known limitations	1	OS Mapping
Greater London Authority	VirtualLondonLidar.zip	Virtua London Lidar Imagery in ESRI Shapefile and MapInfo format	Imagery only.	2	Imagery

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Greater London Authority	GISDataCatalogue.xls	Catalogue of GIS holdings for GLA	No known limitations but will be updated regually so may need to check for updated version	2	Data Catalogue
London Fire Brigade	flooddata.csv	Spreadsheet containing all records of flooding shouts since 2000	Best available data	2	Flooding records
London Fire Brigade	Flooding photos.zip	Zip folder containing photos of flood incidents	Best available data		Flooding records
London Fire Brigade	Flood Incident Photos.doc	Word document describing photos	Best available data		Flooding records
London Fire Brigade	LFB Maps.zip	PDF maps showing frequency of calls due to flooding in London. Created using the data set provided to us in excel spreadsheet	Best available data		Flooding records
London Underground	LUG_1A_NoData.txt	Not available	N/A	N/A	LU assets
London Underground	LUG_1B_NoData.txt	Not available	N/A	N/A	surface water flood risk assets
London Underground	Manager's review report.doc	Provided two files containing records of flooding incidents of both the tracks and stations in July 2007	Anecdotal data	2	historic records of flooding
London Underground	Flood risk.xls	Provided two files containing records of flooding incidents of both the tracks and stations in July 2007	Anecdotal data	2	historic records of flooding
London Underground	Paddington Train Stranded.jpg	Photograph showing train stranded at Paddington Train.	Anecdotal data	2	historic records of flooding
London Underground	LUG_1D_NoData.txt	Not available	N/A	N/A	Operating Incidents
London Underground	Copy of Pump Site Data for GLA.xls	excel spreadsheet detailing pumping regime provided	No known limitations	2	LU pumping surface water
London Underground	LUG_1F_NoData.txt	No recorded data	N/A	N/A	flood mitigation measures
London Underground	LUG_1G_NoData.txt	No recorded data	N/A	N/A	station flood resilience plans
Network Rail	540889_IMDM_CoreEK_18082009.pdf	Maps taken from the main Network Rail database. No external consultant has access and so no shape files are available	Best data available	2	Railway Flooding
Network Rail	540888_Routes_CoreEK_17102008.pdf	Maps taken from the main Network Rail database. No external consultant has access and so no shape files are available	Best data available	2	Railway Flooding
Network Rail	nationalrailnetworkmap.pdf	Map taken from Network rail website, showing whole rail network	Best data available	2	Railway Flooding

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Network Rail	Flood incident summary_SPC_ ECM1_HDB Routes.doc	Document outlines overall drainage/Flooding issues on sections of the line.	Best data available	2	Railway Flooding
Network Rail	New Southgate site visit 7thJan09.doc	Site report on Southgate flooding incident	Best data available	2	Railway Flooding
Network Rail	Potters Bar site visit .doc	Site report on potters bar flooding incident	Best data available	2	Railway Flooding
Network Rail	New Southgate site visit of 4th May 10.doc	Site report on second Southgate flood incident	Best data available	2	Railway Flooding
Network Rail	ECM1 5.0000 Alexander Palace.zip	Photos of flooding at Alexander Palace station	Best data available	2	Railway Flooding
Network Rail	SPC1 12.0076 12.0559 Drain Up Elstree Tunnel 20080606 V4.doc	Site report of flooding at Elstree tunnel	Best data available	2	Railway Flooding
Network Rail	MCJ1 - Drainage Survey.zip	Drainage survey for the MCJ1 line	Best data available	2	Railway Flooding
Network Rail	10Chain_Diagram_Key.pdf	PDF showing the diagram key for the drainage surveys	Best data available	2	Railway Flooding
Network Rail	Flood incident summary_MCJ1 Route.doc	Word document describing flooding problems in the last 5 years on the MCJ1 line	Best data available	2	Railway Flooding
Network Rail	Flood Sites _LNW Route.xls	Excel spreadsheet give details of flooding on the LNW route	Best data available	2	Railway Flooding
Network Rail	Areas Prone To Flooding Within M25 - SE Routes.xls	Excel spreadsheet listing details of lines prone to flooding with territory	Best data available	2	Railway Flooding
Network Rail	Network Rail SE Routes.pdf	PDF map showing SE route	Best data available	2	Railway Flooding
Network Rail	Park Hill Park, Croydon.zip	Zip folder containing photos of landslide caused by surface water at Park Hill	Best data available	2	Railway Flooding
Network Rail	2007-07-20 - Fulwell to Hampton after summer storm.zip	Zip folder containing photos of flooding on the Fulwell to Hampton line during 2007 flooding.	Best data available	2	Railway Flooding

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Network Rail	Flood incident summary_S_SE territory.doc	Document listing all data sets provided and brief description of some of them.	Best data available	2	Railway Flooding
Network Rail	NET_1E_NoData.txt	No data provided. But covers the line coming out of Paddington Station	No data available		Railway Flooding
Network Rail	NET_1F_NoData.txt	In the long term by May 2011 each borough will have information pack following completion of national drainage survey	No data available		Rail Network
Transport for London	Pump stations.zip	Location of seven (7) pump stations in central London including: Eastway Tunnel Pump House, Blackfriars Underpass, Glencoe Street Pump House, Bow Road Pump House, Old Fort Road Pump House, Redpath Pump House, York Road/Trinity Road Pump Station. Layout of nine (9) pump stations in south London, including: New Malden, Purley Cross, Crittalls Corner, South Lane, Bushey Road, Cambridge Ave, Keswick Ave, Warren Drive, Deer Park. Layout of nineteen (19) pump stations in north London	It is assumed that TFL have send the most up to date and accurate data that is currently available.	1	TFL pump station locations and details
Transport for London	TFL Gullies Pan London with Northings and Eastings.xls	Spreadsheet with the location, asset type, assed id, borough name, x and y of gulleys	It is assumed that TFL have send the most up to date and accurate data that is currently available.	1	tfl gulley location spreadsheet and details
Transport for London	TFL_1B_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Transport for London	TLRN.zip	Transport for London Road Network provided	It is assumed that TFL have send the most up to date and accurate data that is currently available.	1	TFL road network
Transport for London	TFL_1D_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Transport for London	TFL_1E_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Transport for London	TFL_1F_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Transport for London	TFL_1G_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Transport for London	TFL_1H_NoData.txt	Data not received from TFL	N/A	N/A	N/A
Highways Agency	Draft IAN HADDMS data population March 2008.pdf	Asset inventory data guidance document (draft, March 2008).	Best data available	2	Drainage Assets
Highways Agency	Asset_Inventory_GIS_Data.zip	Asset inventory data as ESRI Shapefiles.	Best data available	2	Drainage Assets
Highways Agency	HWA_1B_NoData.txt	Included within the asset inventory where they are present - See Item 1A.	N/A	N/A	Drainage Assets
Highways Agency	HWA_1C_NoData.txt	Included within the asset inventory where they are present - See Item 1A.	N/A	N/A	Critical Assets

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Highways Agency	HWA_1D_NoData.txt	The Highways Agency has established a national flood register to collate flooding incident records from all sources, not just call centres. This is new and is currently poorly populated. There is no data for the Greater London Area.	N/A	N/A	Flooding Records
Highways Agency	Flooding_Hotspot_Area5.zip	A flood risk assessment has recently been carried out and a map extract has been provided as ESRI Shapefile.	Best data available	2	Susceptible Assets
Highways Agency	HWA_1F_NoData.txt	The Highways Agency has established a national flood register to collate flooding incident records from all sources, not just call centres. This is new and is currently poorly populated. There is no data for the Greater London Area.	N/A	N/A	Flooding Records
Highways Agency	HWA_1G_NoData.txt	Specific records of the designed capacity for each item of HA drainage are not available. The HA's design guidance is consolidated in HD33/06 which is available from http://www.standardsforhighways.co.uk/dmrb/vol4/section2.htm	N/A	N/A	Drainage Assets
Highways Agency	HA Drainage and Flood Data Description rev 03 2010_07_16.pdf	Description of the flood and drainage data provided by the Highways Agency for the Drain London project.	For information.	1	Data Information
Natural England	tqawitab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Ancient Woodland
Natural England	tqeshtab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Environmental Stewardship
Natural England	tqnnrtab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	National Nature Reserves
Natural England	tqramtab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	RAMSAR Sites
Natural England	tqssstab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Sites of Special Scientific Interest

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Natural England	tqsactab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Special Areas of Conservation
Natural England	tqspatab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Special Protection Areas
Natural England	tqsittab.zip	For TQ Tile	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	SSSI Unit
Natural England	ellnrtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Local Nature Reserves
Natural England	emcpktab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Country Parks
Natural England	mgaontab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Areas of Outstanding Natural Beauty
Natural England	ebmgrtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Millennium Green
Natural England	bpcgmtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Coastal floodplain grazing marsh
Natural England	bpldatab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Lowland dry acidic grassland

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
Natural England	bplhltab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Lowland heath
Natural England	bpdwdtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Deciduous Woodland
Natural England	bpmudtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Mudflat
Natural England	egndwtab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Deciduous woodland networks
Natural England	egngstab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Grassland Networks
Natural England	egnhttab.zip	England Wide	Best available at the time downloaded. May be updated periodically so read docs in folder and check web site for updates	1	Heathland Networks
LB of Tower Hamlets	TOW_1A_NoData.txt	No records available	N/A	N/A	Surface Water Flooding
LB of Tower Hamlets	TOW_1B_NoData.txt	No floods in July 2007	N/A	N/A	Flood Records July 2007
LB of Tower Hamlets	TOW_1C_NoData.txt	Highways team working with gully cleansing contractor to identify all gully locations. Currently data limited to the list of Borough streets. Work is progressing to develop a GIS map of the gully locations. Medium term action.	N/A	N/A	Highways flooding drainage
LB of Tower Hamlets	TOW_1D_NoData.txt	None known	N/A	N/A	Flooding Hotspot
LB of Tower Hamlets	TOW_1E_NoData.txt	No data provided/available	N/A	N/A	Flooding Anecdotal
LB of Tower Hamlets	TOW_2A_NoData.txt	No data provided/available	N/A	N/A	Planned Development
LB of Tower Hamlets	sde_corp_GI_open_spaces.zip	GIS layer of open spaces	No known limitations.	1	Open Spaces

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
LB of Tower Hamlets	Health_Services.zip	GIS layer of health services	No known limitations.	1	Critical Assets
LB of Tower Hamlets	Community_Services.zip	GIS layer of community services	No known limitations.	1	Critical Assets
LB of Tower Hamlets	TOW_2D_NoData.txt	See Item 1C.	N/A	N/A	Drainage Network
LB of Tower Hamlets	TOW_2E_NoData.txt	No data provided/available	N/A	N/A	Ordinary Watercourses
LB of Tower Hamlets	Aerial Photography.zip	Aerial photography for Borough (2007).	Best available information. Flown in 2007.	2	Aerial Photography
LB of Tower Hamlets	TOW_3B_NoData.txt	Not available/able to be licensed.	N/A	N/A	LiDAR
LB of Tower Hamlets	TOW_4A_NoData.txt	Emergency Planning colleagues are collating information through the Borough Emergency Management Forum for inclusion in the Multi Agency Flood Plan. Not provided in time for data collection.	N/A	N/A	Flood Key Infrastructure
LB of Tower Hamlets	TOW_4B_NoData.txt	None	N/A	N/A	Flood Improvement Scheme
LB of Tower Hamlets	TOW_4C_NoData.txt	All schemes are required by policy to include SUDS. Limited monitoring of implementation takes place. No work stream in place to provide this data. Long term action.	N/A	N/A	SUDS
LB of Tower Hamlets	LBTH_SFRA_August_2008.zip	Level 1 SFRA (August 2008). Awaiting release of information from updated SFRA.	2008 version. Updated version producing but awaiting information.	2	SFRA
LB of Tower Hamlets	TOW_4E_NoData.txt	May be in SFRA. See 4D	N/A	N/A	SFRA
LB of Tower Hamlets	TOW_4F_NoData.txt	None	N/A	N/A	Flood Major Incidents
LB of Tower Hamlets	TOW_4G_NoData.txt	None	N/A	N/A	Flood Insurance Claims
LB of Tower Hamlets	TOW_4H_NoData.txt	None	N/A	N/A	Housing Maintenance
LB of Tower Hamlets	TOW_4I_NoData.txt	No formally collected data set. Highways Emergency Callout officers (5 staff) respond to call outs to floods arising from heavy rain. Each will have a recollection of regular locations. It may be possible to pull some information together from a one off session. It may also be possible to identify regularly blocked gullies from Seibel (Contact Centre CRM system) and map the information on GIS. Medium term action.	N/A	N/A	Flood Calls
LB of Tower Hamlets	TOW_4J_NoData.txt	See 4I for Highways. Access to Geo Store (EA) should reveal areas susceptible to surface water flooding	N/A	N/A	Severe Weather Streets
LB of Tower Hamlets	TOW_4K_NoData.txt	None	N/A	N/A	Balancing Pond
LB of Tower Hamlets	TOW_4L_NoData.txt	None	N/A	N/A	Critical Assets

Organisation	File	Information from Supplier	Limitations, uncertainty or perceived weakness	Review Score	Keyword
LB of Tower Hamlets	TOW_4M_NoData.txt	Thames Water hold this.	N/A	N/A	Historic Sewer Records
LB of Tower Hamlets	TOW_4N_NoData.txt	Thames Water hold this but LBTH Highways Construction Archives exist in hard copy form only and are difficult to access.	N/A	N/A	Historic Drainage Assets
LB of Tower Hamlets	TOW_4O_NoData.txt	Updated SFRA which may include this data - see Item 4D	N/A	N/A	Ordinary Watercourses
LB of Tower Hamlets	TOW_5A_NoData.txt	In draft with Emergency Planning Team and expected to be referred to Defra at end of summer.	N/A	N/A	Multi-Agency Flood Plan
LB of Tower Hamlets	TOW_5B_NoData.txt	LBTH has a generic Major Emergency Plan which should also cover this.	N/A	N/A	Severe Weather Plan
LB of Tower Hamlets	TOW_5C_NoData.txt	None	N/A	N/A	Community Flood Plan
LB of Tower Hamlets	TOW_5D_NoData.txt	None known of.	N/A	N/A	Flood Management Plan
LB of Tower Hamlets	TOW_5E_NoData.txt	None	N/A	N/A	Scrutiny Panel Report
LB of Tower Hamlets	TOW_5F_NoData.txt	See Item 5A	N/A	N/A	Emergency Flood Plan
LB of Tower Hamlets	TOW_5G_NoData.txt	See item 4C	N/A	N/A	Surface Water Management Plan
LB of Tower Hamlets	TOW_5H_NoData.txt	See Item 1C.	N/A	N/A	Road Gulley Cleaming
LB of Tower Hamlets	TOW_5I_NoData.txt	Highways maintenance regime and timetable custodian is Margaret Cooper.	N/A	N/A	Asset Maintenance
LB of Tower Hamlets	6A_Tower_Hamlets_LDS.pdf	Local Development Scheme (please note that consultation periods for the DPDs has now moved from September 2010 to November 2010). Local Development Scheme contains LDF in Core Strategy. Awaiting Inspectors report following Examination in Public.	Consultation periods for the DPDs has now moved from September 2010 to November 2010	2	LDF Process
LB of Tower Hamlets	6B_Core_Strategy_Submission.zip	Submission version of Core Strategy- adoption to take place in September 2010.	Submission version - adoption to take place in September 2010.	2	Core Strategy Development Plans

Appendix B – Asset Register Recommendation

Introduction

The Flood and Water Management Act (FWMA) 2010, require that each Lead Local Flood Authority (LLFA) has a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The FWMA requires that the register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.

As of the 6th April 2011, all LLFAs will need to maintain a register. Defra have determined the legal characteristics of the register and records, this is provided in Table B1 below:

	Register	Record
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 FWMA 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.	

Table B1. Asset Register Requirements

Source: Defra, 2011 Lead Local Flood Authority Duty to Maintain a Register)

The creation of the asset register was outside of the scope of the Drain London project and is the responsibility of the LLFA. It is recommended that the LLFAs utilise a risk-based approach to the creation of the register, and begin recording structures or features which are considered the have the greatest influence on flooding. This appendix highlights assets and methods for their capture within the register and should be utilised as a guideline only.

Review and Recommendations

As part of the Drain London project, a review of the London Borough (LB) of Tower Hamlets's asset information was undertaken and recommendations have been put forward as to how best to fulfill the requirements of the Flood and Water Management Act 2010.

LB of Tower Hamlets's existing asset management system has been reviewed against the following criteria:

- Level 1 – The borough knows where their assets are, what they look like and what condition they are in. Register system may take the form of a spreadsheet or hard copy records.

- Level 2 – The borough is aware of the 'Local Authority Flood Risk Asset Tool' currently being produced by the EA / Defra. Their register is GIS based (basic proprietary system only) or uses a highways based asset management system database. Their register captures information generally aligned with guidance provide by the Tool and the EA NFCDD system where practical. They know where their assets are and carry out reactive maintenance of significant structures as required.

- Level 3 – The borough has a detailed understanding of Asset Registers as required by the Flood and Water Management Act. Their register system accurately replicates the 'Local Authority Flood Risk Asset Tool' data standards and related NFCDD structures to an attribute level. Their register is GIS based (advanced proprietary or bespoke system) or is completely integrated with an existing asset management system. They know where their assets are and carry out periodic maintenance on the structures using a risk based priority system.

LB Tower Hamlets provided limited asset information as part of the Drain London Tier 1 'data collection' exercise and based on the current review of the asset register appears to be Level 1.

In order to achieve a 'Level 3' status, it is recommended that the Council obtain and maintain the information identified within Table B2. If any additional information is required by the Council, then it is recommended that where possible this is incorporated into a Geographical Information System (GIS) system (MapInfo, ArcGIS, AutoCAD etc) and captured within a relevant Council database.

Data	Format	Recommendations
Highway flooding and drainage records – including location and serviceability of road gulley's.	GIS	Compile and maintain: • GIS layer of Highway flooding • GIS Layers of drainage network flooding. • GIS layer of gullies with serviceability state; • Where possible hyperlink imagery of flooding and anectodatl information from external sources (newspapers, websites, blogs etc)
Drainage network information – sewers (surface, foul, combined), culverts, drains (surface water, highway), gullies, ditches, other open drainage channels	GIS	Compile and maintain GIS layers of: • Sewers (surface, foul, combined) • Culverts from PDFs • Drains (surface water, highway) • Gullies • Ditches • Other open drainage channels Include hyperlinked imagery of necessary information to improve identification in the field.
Local Authority led flood risk improvement schemes	Database and GIS	Maintain a living document which records all such scheme details and contact details. Map locations of the scheme including hyperlinks to photos, design drawings, and pre and post construction information including imagery during rainfall events and any information recorded during the schemes operational life.

Data	Format	Recommendations
SUDS schemes information (Council adopted SUDS)	GIS and Database	Maintain a living document which records all Council adopted scheme details and contact information. Map locations of the scheme(s) including hyperlinks to photos, design drawings, and pre and post construction information including imagery during rainfall events and any information recorded during the schemes operational life. A copy of the maintenance management plan should be hyperlinked within the GIS layer and database.
SUDS schemes information (Privately owned SUDS schemes)	GIS and Database	Hyperlink development application information within the GIS system including: • Flood Risk Assessments, Feasibility Studies, Detailed Drainage Studies, etc; • Hyperlinks to photos, design drawings, and pre and post construction information - including imagery during; construction, rainfall events and any information recorded during the schemes operational life. • Approved maintenance management plan; • This should also capture the development connection point and any other relevant drainage information. When available, include operational phase information and any field results.
Pond and lake information (not included as SUDS)	Database and GIS	Keep a living document which records all details of these features along with a GIS layer detailing asset (name, purpose, maintenance) and location information.
Critical local asset records (assets which are known to, or have the potential to flood)	GIS	Compile GIS layer of Critical local asset records. Include hyperlinks to images of these assets for easy field identification.
Historic sewer records (if any)	GIS	Inquire if any specific flood records can be made are available from Thames Water. Where available, include drawings/photos of historical events and compile a GIS layer/database of historic sewer records available. Where images are available this should be hyperlinked linked within the GIS system.
Historic construction records of drainage assets	GIS	Locate and create GIS layer of plans and drawings relating to foul and surface water drainage. Where possible these should be hyperlinked within the GIS system,.
Capacity and condition of 'ordinary' watercourses essential to operation of the urban drainage systems, including culverted watercourses and flow models (where they exist).	GIS	Compile GIS layer of capacity and condition of 'ordinary' watercourses. Include hyperlinked images of key structures and features (possibly walls, spillways etc) of the watercourse.

Data	Format	Recommendations
New development drainage studies and supporting information	Database	Collate new development drainage studies and supporting information. Hyperlink development application information within the GIS system (including Flood Risk Assessments, Detailed Drainage Studies, Private development SUDs schemes etc) including post development connection and drainage information. When available, include operational phase information and any field results.
Road gulley cleaning/ maintenance records	Database	Create record and hyperlink imagery (where appropriate).of key gullies prone to flooding

Table B2 – LLFA Asset Register Recommendations

Appendix C1 – Surface Water Modelling

Introduction

Capita Symonds has constructed eight TUFLOW hydraulic models across the London Boroughs in Group 4. The extents of the models have generally been based upon catchment boundaries and not borough boundaries to limit the amount of cross-boundary interaction between models. This was carried out to limit the dependency of one model on the results of another. Consequently, the model results for each borough are divided over a number of models and in some cases have been modelled by more than one consultant. The following table outlines the models that cover the London Borough of Tower Hamlets, along with the name of the final model, percentage coverage of the Borough by each model, and the names of any other Boroughs falling within the model extent. Figure 1 shows the extent of the models listed.

Consultant	Model Name	Naming Convention (100 year Flood Event)	Borough Coverage	Other Boroughs covered by the Model
Capita Symonds	Tower Hamlets	DLT2_G4TH_0100R_026.tcf	98%	Newham Hackney Islington
Halcrow	A3	Group3_5m_3hr_100yr_a3_200.tcf	2%	City of London Islington Camden City of Westminster

Table 1: Model coverage for the London Borough of Tower Hamlets

The naming convention has generally been derived to reference the tier of work, the name of the model, the flood event being modelled and the version number. A standard naming convention was not adopted for all models built for the Drain London project, hence different conventions may have been adopted by other consultants.

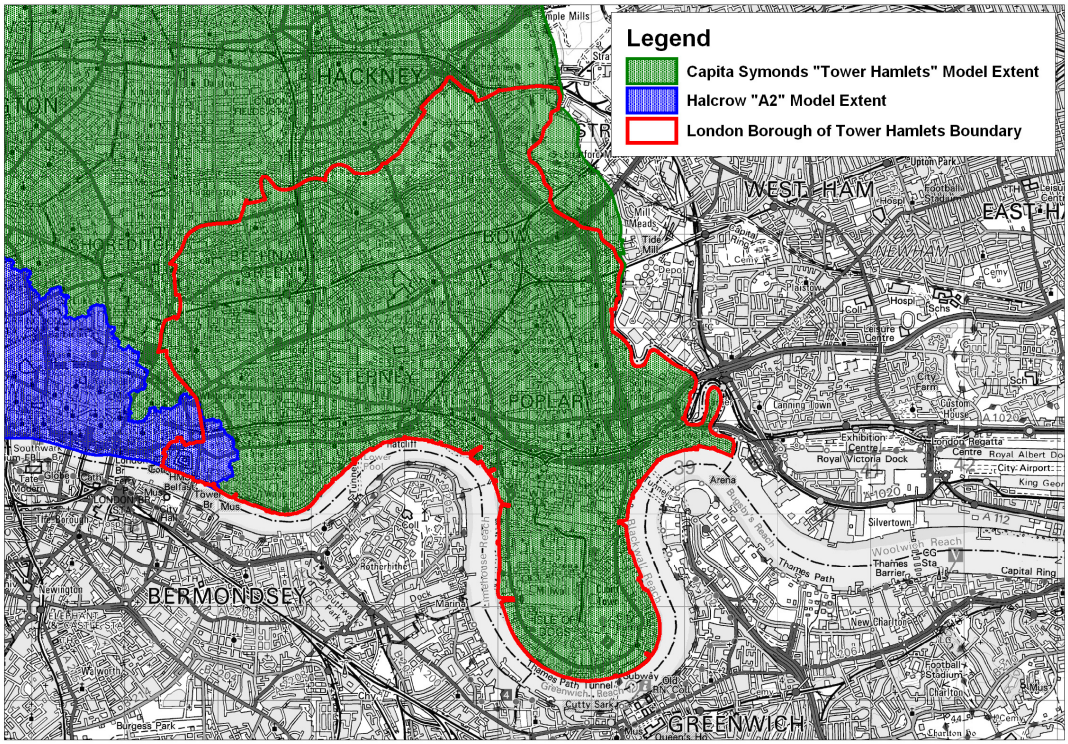

Figure 1: Model coverage for the London Borough of Tower Hamlets

Software Version

All models have been run using TUFLOW build 2010-10-AA-iDP as agreed by all Drain London consultants using the TUFLOW software. The "Tower Hamlets" model was run on the 64bit version of this build to take advantage of the faster simulation times and more advanced handling of larger models.

Model Parameters

All hydraulic models have been constructed following the guidance outlined in the Drain London: Data and Modelling Framework V1.0 (December 2010). The following sections of this appendix describe in more detail how this guidance was applied and where amendments or additions were made.

Direct Rainfall Methodology

The Drain London modelling was designed to analyse the impact of heavy rainfall events across each London Borough by assessing flow paths, velocities and catchment response. The Drain London Data and Modelling Framework specified that the direct rainfall method should be used in the modelling approach. This method incorporates conservative allowances for the drainage network and infiltration. The following key assumptions were made to generate the model input:

- Initial Loss – None
- Infiltration Loss – None
- Allowance for Drainage System – A constant value of 6.5mm/hr was applied
- No aerial reduction factor applied
- 'Summer' profile was used

To comply with the Drain London framework requirements rainfall inputs were generated at a standard 10km grid square resolution. As specified in the framework guidance hyetographs for the following rainfall events were generated:

- 1 in 30 year
- 1 in 75 year
- 1 in 100 year
- 1 in 100 year plus climate change (+30%)
- 1 in 200 year

Total rainfall depths at each 10km grid centroid for all required return periods were extracted from the FEH CD-ROM (v3) Depth Duration Frequency (DDF) model. A comparison between the peak rainfall depths in adjacent 10km grid squares was completed to confirm the suitability of the 10km grid resolution for modelling purposes. The difference in total rainfall depths between the grid centroids for 10km grid squares was mostly less than 5%, with the maximum difference being 17%, which suggests that the 10km grid data is suitable for use in the study.

Critical duration is a complex issue when modelling large areas for surface water flood risk. The critical duration can change rapidly even within a small area, due to the topography, land use, size of the upstream catchment and nature of the drainage systems. The ideal approach would be to model a wide range of durations. However, this is not always practical or economic when modelling large areas using 2D models which have long simulation times – such as within the Drain London study.

A high level investigation was undertaken to understand the effect of rainfall event duration on the Drain London Study area using a rapid modelling technique. The intention of the investigation was to show variation in critical duration across the study area and thus identify whether it was possible to identify single critical durations for each sub-model. The study used the 1 in 100year hyetographs for 1, 3, 6 and 12 hour durations along with a simplified terrain model to route overland flow. The key result was that critical duration is highly variable across surface water catchments – but the influence was not sufficiently significant to justify considering multiple event durations within the Drain London Study. Therefore, a single duration of 3hrs was selected for all model runs to ensure result consistency and comparability across the Greater London area. It is strongly recommended that an analysis of possible result sensitivity to duration is considered for future studies.

Grid Size

All models within the boundary of the London Borough of Tower Hamlets have been constructed with a 5m grid size, within the recommended range detailed in the Data and Modelling Framework. This grid size was chosen as it represented a good balance between the degree of accuracy (i.e. ability to model overland flow paths along roads or around buildings) whilst maintaining reasonable model run ("simulation") times. For example, refining the grid size from a 5m grid to a 2m grid is likely to increase the model simulation time from 21 hours to approximately 11 days.

Structures

Structures within the study area were generally modelled in 2D, an approach consistent with the strategic nature of the Drain London project. Structures modelled in 2D include those on watercourses and underpasses or culverts within the floodplain. The structures were modelled by using the ZSHP function in TUFLOW which allows the user to specify the object width representing the structure opening. Invert levels were determined by inspecting the LiDAR DTM with widths of structures either measured on site visits, from Google Maps, or from the LiDAR DTM.

The limitations of modelling structures in 2D, rather than as a 1D element, are that the width of the structures is limited by the grid size (i.e. structure width is a multiple of the grid size). The depth of water within the structure can also be over-estimated as rainfall is allowed to enter the structure from above and not just through the entrances of the structure. For this reason, only short structures (e.g. generally less than 40m) have been modelled in 2D.

A 1D modelling approach was therefore chosen for longer and more complex structures. These included structures such as the Limehouse Link Tunnel. The dimensions of these structures were estimated using the same method as for 2D structures. The roughness value for each structure was selected from the list of materials values agreed amongst all Drain London consultants. All structures modelled in 1D are listed in Table 2.

In some cases, the length of the tunnel was significant or the exit of the tunnel was in another London Borough or model (i.e. Blackwall Tunnel). In these situations, only the entrance of the structure was modelled and a 1D free-flow (stage vs time) boundary was attached to the downstream end. This approach has been agreed amongst all Drain London consultants. As the modelling of these structures has been simplified, the model results at these locations should be verified by undertaking more detailed modelling, particularly for critical structures.

Node Label	NGR	Location Description	Modelled Length (m)	Roughness
S002_1*	536120, 180930	Western entrance of Limehouse Link Road	77	0.02
S002_2*	537310, 180700	Eastern entrance to Limehouse Link Road, adjacent to West India Dock North	43	0.02
S002_3+	536850, 180600	Westbound connection into Limehouse Link Road	51	0.02
S002_4+	536850, 180580	Eastbound connection into Limehouse Link Road	59	0.02
S003*	535920, 180890	Eastern entrance of Rotherhithe Tunnel	130	0.02
S011+	537990, 178390	DLR tunnel from Mudchute towards south	40	0.02
S012+	538430, 180780	Northern entrance to western branch of Blackwall Tunnel	77	0.02
S013_1	537040, 180400	Westferry Road southbound tunnel beneath Westferry Circus	141	0.02
S013_2	537020, 180390	Westferry Road northbound tunnel beneath Westferry Circus	150	0.02
S014	533530, 182430	Eastern entrance to London Underground tunnel into Liverpool Street	147	0.05
S015	534100, 182190	London Underground	265	0.05

Node Label	NGR	Location Description	Modelled Length (m)	Roughness
		tunnel west from Shoreditch station		
S016	534460, 182110	London Underground tunnel on section between Shoreditch and Whitechapel stations	126	0.05
S017	534760, 181800	London Underground tunnel connecting to Whitechapel station from north and south	251	0.05
S017+	534880, 181650	London Underground tunnel south of Whitechapel station, beneath Cavell Street	47	0.05
S019+	537040, 182740	London Underground tunnel west of Bow Road station	67	0.05
S020	538890, 181082	East India Dock Road tunnel	311	0.02
S021+	534590, 185520	Entrance to National Rail tunnel north of Hackney Downs station, beneath Hackney Downs	54	0.05
S022	534580, 181990	London Underground tunnel on section between Shoreditch and Whitechapel stations	98	0.05
S023+	534830, 181870	London Underground tunnel east of Whitechapel (Central line)	52	0.05
S024	534470, 181750	London Underground tunnel west of Whitechapel (Central line)	67	0.05
S025	536600, 184780	East Cross Route Tunnel	300	0.02

Table 2: List of Structures modelled in 1D in the Borough of Tower Hamlets
* Only the entrance to the structure has been modelled as the low point is the middle of the tunnel and therefore water would enter the tunnel and then pond. This is represented by modelling both entrances for a short length.
+ Only the entrance has been modelled as the tunnel's exit is located outside of the model extents.

Adjustments to Topography

When reviewing the model's representation of the LiDAR DTM, it was observed in some locations of new development that excavation pits had been captured by the DTM whereas aerial photos showed buildings. Where this occurred in critical areas of the model or where the pits were particularly large, these were manually filled in to match the elevation of surrounding areas.

Building Footprints

Building footprints have been largely represented in the model as outlined in the Data and Modelling Framework. In situations where the polygon representing the building was large or long, the use of a single elevation to represent the floor level resulted in parts of the building being raised metres above the surrounding ground level. This can therefore misrepresent the potential for the building to flood. In these cases, the building 'polygon' was assigned a varying elevation such that the finished floor level remained 100mm above the ground level across the area of the polygon.

Runoff Coefficients

The runoff coefficients applied to the hydraulic models were in line with those stated in the Drain London Data and Modelling Framework. The runoff coefficients were applied to the rainfall profiles in order to represent the varying level of infiltration on each surface, therefore altering the input data directly.

Formal and Informal Defences

A GIS layer containing defences from the Environment Agency's NFCDD dataset was provided. These defences have been included in all models. Where additional data was provided by the Borough or informal defences such as walls were observed on site or through Google Maps, these were included in the model where it was thought that their presence would influence surface water flowpaths. The defacto defences are listed in Table 3.

Type of Defence	NGR	Description of Location
Railway embankment	534200, 185650	West side of Hackney Marshes
Brick Wall	533650, 182160	Adjacent to London Underground Line (Central) east of Liverpool Street Station

Table 3: List of Structures modelled in 1D in the Borough of Tower Hamlets

Model Boundaries

There are no 2D downstream boundaries applied to the "Tower Hamlets" model as these were not deemed necessary. Tidal/Fluvial defences are located along southern and eastern extents of the model, preventing surface water from flowing out of the model and into the River Roding and the River Thames.

1D downstream boundaries applied to structures as detailed in the previous section of this report, use a stage vs. time relationship, or HT boundary. A constant water level lower than the downstream invert level was specified to allow for a limitless volume of water to exit the structure.

Cross-Boundary Issues

In some cases, it was not possible to avoid interaction with a neighbouring model due to the nature of the topography. The "Tower Hamlets" model is one such model and it receives an inflow from the neighbouring "Haringey" model. The location of the cross-boundary is within the Hackney Borough north of the Stoke Newington train station. Initial model results from "Haringey" showed that water flowing southwards along the railway line continued into the "Tower Hamlets" model. To ensure that the flowpath is represented correctly, results from the "Haringey" model are extracted for each of the five return periods modelled. This is then read into the "Tower Hamlets" model as an inflow using a flow vs. time relationship (a QT boundary). As the inflow is located over 3km from the Tower Hamlets Borough boundary, any changes to this inflow are unlikely to affect the model results within the Borough.

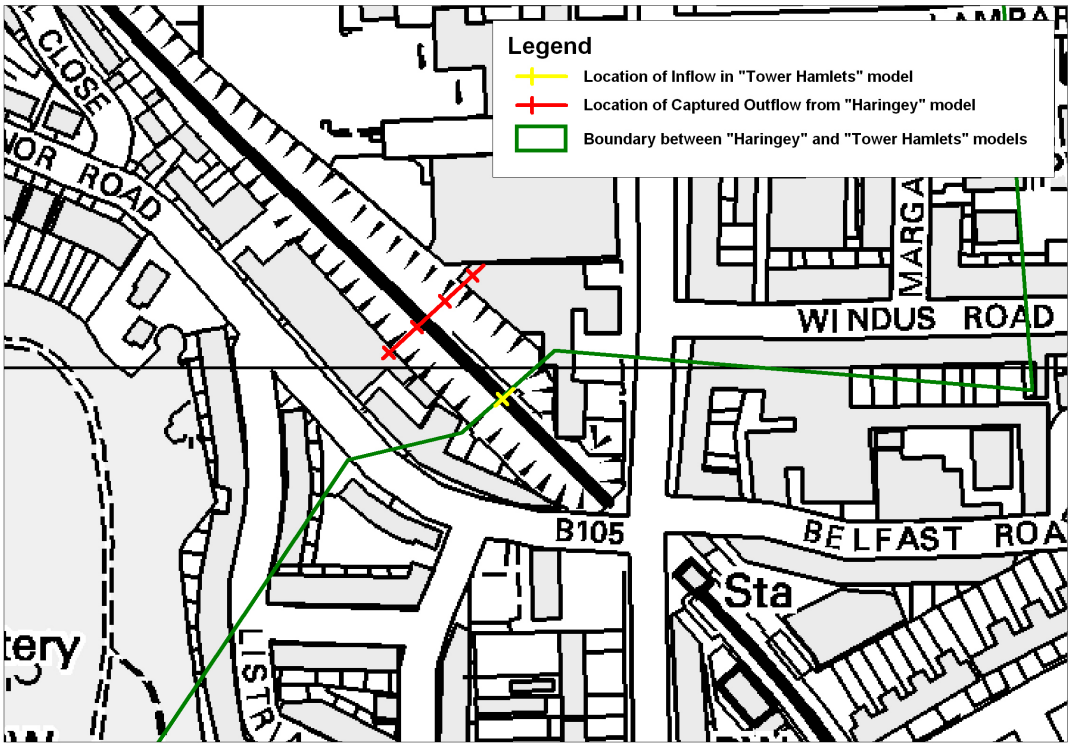

Figure 2: Cross boundary between “Haringey” and “Tower Hamlets” models

Simulation Time

All models were initially run for six hours in compliance with the Data and Modelling Framework document. The models were then assessed to determine whether this duration was suitable for each specific model. This was carried out by viewing the model results for the final few timesteps. The results were checked to determine if water depths were still increasing significantly, and whether new flowpaths were forming or existing flowpaths still propagating. If either of these conditions were found to exist, the simulation time was extended for a further hour after which the checks were repeated until none of the conditions were satisfied. The simulation times for each of the models within the London Borough of Tower Hamlets have been listed below in Table 4:

Model Name	Model Simulation Time (hrs)
DLT2_G4TH_0100R_026.tcf	7
Group3_5m_3hr_100yr_a3_200.tcf	6

Table 4: Model simulation times

Sensitivity Testing

The sensitivity of the model results to changes in drainage loss was tested. This was carried out for all models on the 1 in 200 year return period flood event. The original drainage loss of 6.5mm/hr was adjusted by +/-25% giving values of 8.125mm/hr and 4.875mm/hr to be used for the analysis. The two sensitivity test results were compared with the baseline results by producing a depth difference grid. This output shows the difference in depth as a result of the change in drainage loss. The model results are deemed to be sensitive to changes in the

tested parameter, if the percentage change in depth is greater than the percentage change in the parameter.

As a whole, the “Tower Hamlets” model was not found to be sensitive to changes in drainage loss. Changes in maximum depth were less than 25% compared to the baseline results. A number of intermittent locations in the model did show a larger change in depth. These were generally located in areas where there are sudden changes in elevation, i.e. at railway cuttings.

Model Stability

Assessing the stability of a model is a critical step in understanding the robustness of a model and its ability to simulate a flood event accurately. Stability in a TUFLOW model can be assessed by examining the cumulative error (or mass balance) of the model as well as the warnings outputted by the model during the simulation.

As can be seen in Figure 3 below, the cumulative error of the Tower Hamlets model is generally within the recommended range of +/-5%. High values are reported at the beginning of the rainfall event when the model cells first wet then settle down for the remainder of the simulation.

Approximately 20-30 warning messages are outputted for the “Tower Hamlets” model through the simulation for each of the five flood events. The warnings relate to areas of poor convergence, or in other words, where TUFLOW has had trouble finding a solution. The warnings were found to be spatially varied and non-persistent in time, which is a relatively common occurrence in these types of models. As the warnings were not found to repeatedly occur, these have a negligible impact on the overall model results and the model is considered fit for purpose.

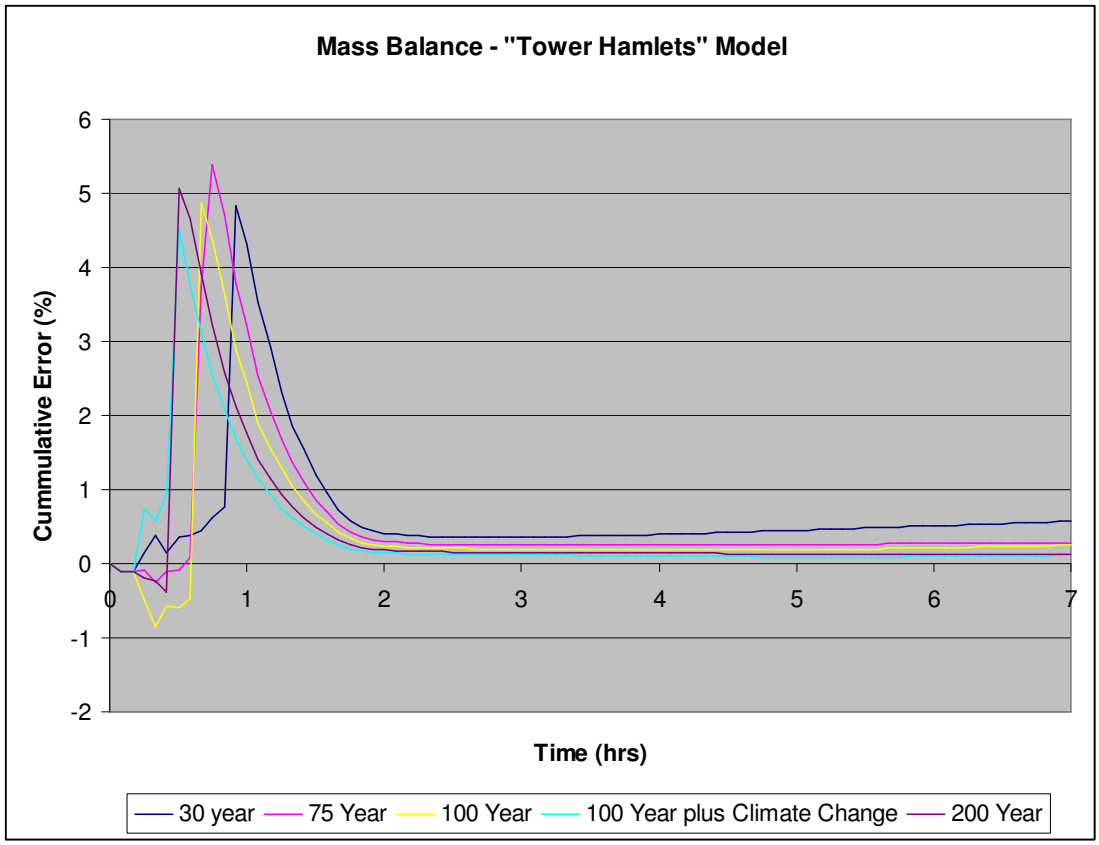

Figure 3: Mass Balance of Tower Hamlets Model

Conclusions and Recommendations

The hydraulic models constructed for Phase 2 of the Drain London project represent a strategic approach to identify areas at risk of surface water flooding. It represents a significant refinement on the previously available information on surface water flooding in Tower Hamlets. The models and their mapped results should only be used after a thorough review of this technical appendix and the Drain London Data and Modelling V1.0 (December 2010). Recommendations for future improvements to the models include (but are not limited) to the following:

- Explicitly model the existing drainage network in key areas of risk, as opposed to a London wide assumption on drainage capacity;
- Inclusion of survey data for critical structures;
- Inclusion of river flows and channel capacity (where applicable);
- Reduction in model grid size in key areas of risk;
- Testing of different storm durations;
- Inclusion of defacto defences outside of the scope of the Drain London project (e.g. assets identified through the Asset Register process); and
- The use of better quality or more up to date topographic information particularly in areas of recent development

Appendix C2 – Groundwater

Introduction

As part of the Drain London project Drain London Tier 1 consultants commissioned Jacobs/JBA to produce a dataset referred to as the Increased Potential Elevated Groundwater (iPEG) maps. The assessment was carried out at a Greater London scale. The iPEG mapping assists in identifying areas which have an increased potential to experience groundwater flooding. The iPEG map shows those areas within the borough where there is an increased potential for groundwater to rise to within 2m of the ground surface. When groundwater rises to this level water may be able to enter below ground structures such as basements and communications networks and continue rising to cause surface water flooding. The iPEG map includes an assessment of the potential groundwater to rise in both consolidated aquifers and from superficial permeable deposits (unconsolidated aquifers). The map also includes those areas close to rivers which are underlain by permeable superficial deposits where groundwater may rise to elevated levels driven by high water levels in the river.

Methodology

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 described below aims to identify only those areas in which there is the greatest potential for this to happen.

Four data sources have been utilised to produce the increased Potential for Elevated Groundwater map. These data sources are the:

- 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.

To produce the iPEG map for consolidated aquifers, an area was defined as having increased potential for elevated groundwater levels if at least two of the three mapping techniques listed above produced a corresponding area. For the permeable superficial deposits, only Band 1 Very High of the BGS and the TE2100 data were used as this was judged to best represent the hazard.

A description of each of the four data sets and how it was used in the production of the iPEG map is summarised in Table 1 below. The iPEG map should be viewed with careful consideration of the strengths and disadvantages of each of the four data sets.

Table 1 Summary of Data Used in the Production of the iPEG Map

	BGS Groundwater Flood Susceptibility Map	Jacobs Groundwater Emergence Map	JBA Groundwater Flood Map	Jacobs TE2100 Groundwater Maps
Mechanisms considered / hydrogeological coverage	Clearwater flooding through all consolidated aquifers and groundwater flooding through Permeable Superficial Deposits (PSD)	All major consolidated aquifers	Unconfined Chalk and Permeable Superficial Deposits	Groundwater emergence in Permeable Superficial Deposits in hydrological continuity with river levels.
Methodology	• Identify from geology where groundwater flooding could not occur • For all other areas, produce a groundwater level surface from National Groundwater Level data, modified to best represent groundwater flooding • Compare the groundwater level surface with the DTM and determine susceptibility to groundwater flooding based on depth to groundwater	Three scenarios: • Where flooding was reported and groundwater contours were available, groundwater emergence zones were defined such that they encompassed incidents of observed flooding. • Where no flooding was reported or no data supplied, but groundwater contours were available, then groundwater emergence zones were based on generalised aquifer properties and observation borehole levels. • Where no groundwater contour information was available, river network classified by BFIHOST was used to identify susceptible areas	For the Chalk maps: • Develop water level – frequency relationships at available boreholes • Extrapolate this relationship to un-gauged locations • Compare water level surface with DTM for mapped events	• Identify from geology areas of permeable superficial deposits • Identify mean water level in the Thames Estuary (and tidal watercourses) which will drive the groundwater head • Determine likely distance from the estuary (and tidal watercourses) over which groundwater levels could be influenced • Identify areas where the groundwater level could rise to the level in the estuary and be within 2m of the ground surface

	BGS Groundwater Flood Susceptibility Map	Jacobs Groundwater Emergence Map	JBA Groundwater Flood Map	Jacobs TE2100 Groundwater Maps
Data used in the production of the maps	BGS 1:50 000 geological mapping, with classifications of permeability, NextMap 5m DTM, National Groundwater Level data on a 50m grid.	50m resolution IHDTM; groundwater contour data from EA and BGS for all major aquifer units from various dates; borehole level data; recorded observations of groundwater flooding from 2000/1.	Borehole records from the EA; 5m DTM from Infoterra and 1:625 000 scale geological mapping	BGS 1:50 000 geological mapping, LiDAR data at 2m resolution and information on mean water levels and defence crest heights.
Strengths	• Considers consolidated and superficial aquifers • Based on National Groundwater Level data • Calibrated on winter 2000/1 observations of flooding • Provides number of classes of susceptibility to indicate sensitivity • Could select only highest susceptibility bands	• Calibrated on winter 2000/1 observations of flooding	• Provides explicit representation of 1 in 100 chance outline • Provision of up to three event probabilities could enable sensitivity testing • Calibrated on winter 2000/1 observations of flooding	• Considers an important mechanism not considered by other methods • Important mechanism in east London.
Disadvantages	• Outlines are not explicitly linked to event probabilities • Maps may indicate overly-large areas as susceptible to groundwater flooding	• Does not consider PSD • Outlines are not explicitly linked to event probabilities • Regional scale	• PSD map based on 1:50k background.	• Determination of distance from estuary over which groundwater levels could be influenced could be improved • Could consider an upward slope on groundwater levels away from the estuary

How to Use and Interpret the Map

The increased Potential for Elevated Groundwater map shows those areas within the borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface.

Groundwater may become elevated by a number of means:

- Above average rainfall for a number of months in Chalk outcrop areas;
- Shorter period of above average rainfall in permeable superficial deposits;
- Permeable superficial deposits in hydraulic continuity with high water levels in the river;
- Interruption of groundwater flow paths; and
- Cessation of groundwater abstraction causing groundwater rebound.

With the exception of groundwater rebound which is not covered, the iPEG map will identify those areas most prone to the mechanisms described above. The map shows those areas considered to have the greatest potential for elevated groundwater. Additional areas within the London Boroughs have permeable geology and therefore could also produce elevated groundwater levels. However, to produce a realistic map, only where there is the highest degree of confidence in the assessment are the areas delineated. This ensures resources are focused on the most susceptible areas. In all areas underlain by permeable substrate, groundwater should still be considered in planning developments.

Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas.

For this reason within iPEG areas, locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the iPEG map should not be used as a “flood outline” within which properties at risk can be counted. Rather it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so what would be the major flow pathways that water would take.

Appendix G – Spatial Planning Information Pack

Background

PPS 25 sets out national planning guidance for development in relation to flood risk. It takes a risk based approach and categorises land uses into different vulnerabilities, which are appropriate to different flood zones.

PPS 25 applies to all forms of flood risk, however, surface water, groundwater and ordinary watercourse flood risks are generally less well understood than fluvial or coastal flood risk. In part this is due to the much faster response times of surface water flooding, a perception that the impacts are relatively minor and the highly variable nature of influences, e.g. storm patterns, local drainage blockages, interactions with the sewer system.

However climate change models are predicting more frequent heavy storms and there is emerging evidence that this is already happening. It is also clear from the flooding that occurred in several parts of England in summer 2007 that surface water flooding can have major impacts. In the heavily urbanised area of London, the risks are significant and it is important that appropriate consideration is given to these risks when new development is proposed.

The planning system is a key tool in reducing flood risk, and with this additional information, this can apply to the surface water risk as well as fluvial and tidal risk.

Since April 2011, London Boroughs have been given the roles of Lead Local Flood Authorities (LLFAs) by the Flood and Water Management Act 2010. This means that each borough has new duties. The Planning Department has an important role to play in delivering these new duties and must ensure that it forms part of authority wide co-ordination of the LLFA role.

Whilst this document is titled a SWMP, it also identifies flood risk at ordinary watercourses and has been adapted to include consideration of groundwater flood risk through the identification of a map showing “Increased Potential for Elevated Groundwater (iPEG).

The Greater London Authority will examine the 33 SWMPs across London to update the Regional Flood Risk Appraisal during 2012.

Using the SWMP to update the borough SFRA

The SFRA for the LB of Tower Hamlets contains very little information on historic analysis of surface water, groundwater and ordinary watercourse flood risk. Only one groundwater record has been recorded, located in Mile End.

The mapping within this SWMP (Figures 13 to 17 in Appendix D) shows some areas that are vulnerable to extensive deep accumulations of water (>0.5m), these area have a high certainty of flooding during extreme storms and the damage occurring is likely to be significant. The mapping also shows some small areas of potentially deep (>0.5m), these area may have particular risks associated with them, but may also occur due to irregularities in mapping and modelling. The mapping also shows areas of shallower flooding (<0.5m), some isolated and some more extensive flooding. Maps show general flow directions and approximate velocities (in the form of ‘hazard’ maps) as even relatively shallow water flowing a high velocities can be a threat to life and can cause damage.

The production of this SWMP will be a significant addition of new/updated data. Therefore, in due course, this should trigger a review of the SFRA. The SFRA should consider these risks in the following ways:

- Large areas of deep (>0.5m) flooding should be shown as Local Flood Risk Zones, unless there is evidence to suggest that these risks have been mitigated, for example by high capacity drainage or pumping infrastructure.
- Small, isolated areas of deep (>0.5m) flooding should be investigated to determine how likely they are to be at flood risk but do not need to be shown if there is no significant risk.
- Large areas of shallower flooding should be identified as Local Flood Risk Zones if they pose a significant risk, but do not need to be shown if the risks are relatively minor.
- Smaller isolated areas of shallower flooding should generally not be identified as Local Flood Risk Zones, unless there is a particular significant risk associated with that area, as it must be expected that most areas will be affected to some extent by rainwater.
- Routes of fast flowing water may be considered as Local Flood Risk Zones if they pose a significant risk.
- Areas of Increased Potential for Elevated Groundwater, should be shown where they are likely to pose a significant risk of flooding or where they are likely to affect the nature of future development, especially for the design and use of sub-surface spaces.

Identifying an area as a Local Flood Risk Zone, should mean that it is then be treated in a similar way to Environment Agency Flood Zone 3, namely that a Flood Risk Assessment is required and measures should be taken to reduce the likelihood and impact of any flooding.

Where a Critical Drainage Area contributes significant amounts of surface water to a Local Flood Risk Zone, the SFRA should identify this and suggest strict application of sustainable drainage measures in line with the London Plan Sustainable Drainage Hierarchy.

Using the SWMP to update policies in Development Plan Documents

Ideally the review of the borough SFRA should be a pre-cursor to any significant change to the Core Strategy and development control policies. Therefore reference to the SFRA should automatically update the approach to local flood risks. Where the SFRA has not been updated, the review of Development Plan Documents should consider the same steps outlined above for the SFRA review.

Using the SWMP to influence major areas of redevelopment

Where major development areas are proposed, either in the London Plan or within the Core Strategy DPD, these should be examined for:

- Local Flood Risk Zones that affects the area
- Increased Potential for Elevated Groundwater
- Contribution of run-off to Local Flood Risk Zones beyond the actual redevelopment area.

Given the large scale of major developments, it is unlikely that the Local Flood Risk would prevent redevelopment taking place, but it may affect the location, uses, design and resilience of the proposals. Therefore, a Flood Risk Assessment needs to be undertaken and it should consider:

- the location of different types of land use within the site(s)
- the layout and design of buildings and spaces to take account of flood risk, for example by dedicating particular flow routes or flood storage areas
- measures to reduce the impact of any flood, through flood resistance/resilience measures/materials

- incorporating sustainable drainage and rainwater storage to reduce run-off to adjacent areas
- linkages or joint approaches for groups of sites, possibly including those in surrounding areas

Using the SWMP to influence specific development proposals

Where development is proposed in an area covered wholly or partially by a Local Flood Risk Zone, this should trigger a Flood Risk Assessment, as already required under PPS25.

Whilst some small scale developments may not be appropriate in high risk areas, in most cases it will be a matter of ensuring that the Flood Risk Assessment considers those items listed under major developments above and also considers some or all of the following site specific issues:

- Are the flow paths and areas of ponding correct, and will these be altered by the proposed development?
- Has the site been planned sequentially to keep major surface water flow paths clear?
- Has exceedance of the site's drainage capacity been adequately dealt with? Where will exceedance flows run off the site?
- Could there be benefits to existing properties at risk downstream of the site if additional storage could be provided on the site?
- In the event of surface water flooding to the site, have safe access to / egress from the site been adequately considered.
- Have the site levels been altered, or will they be altered during development? Consider how this will impact surface water flood risk on the site and to adjacent areas.
- Have inter-dependencies between utilities and the development been considered? (for example, the electricity supply for building lifts or water pumps)

Specific Locational Considerations

Within the LB of Tower Hamlets, the following major redevelopment areas have already been identified.

Opportunity Area	Local Flood Risk
Lower Lee Valley	• Fluvial River Lee and River Thames • Surface Water: Road underpasses (A12, A102, B125) and DLR tracks • Groundwater: Vicinity of Bromley
Millenium Quarter and Crossharbour	• Tidal: River Thames • Surface Water: Tiller Road/Westferry Road and area around Launch Street.
Wapping	• Fluvial/Tidal: River Lee and River Thames • Surface Water: Around Pennington Street and Reardon Street. • Groundwater: Vicinity of St George in the East
Fish Island	• Fluvial: River Lee • Surface Water: White Post Lane, Hackney Wick • Groundwater: near Bow
Bethnal Green North	• Groundwater: whole of opportunity area
Bishopsgate Goodsyard	• Surface Water: Area south of Sclater Street • Groundwater: parts of opportunity area

Opportunity Area	Local Flood Risk
Wood Wharf	• Tidal: River Thames • Surface Water: Vicinity of Westferry Circus • Groundwater: parts of opportunity area
Ocean Estate	• Groundwater: parts of opportunity area

Table G-1: Specific Locational Considerations

Mapping Checklist

Table G-2 below indicates the SWMP maps located in Appendix D which are of potential use to spatial planning, and indicates which maps may be suitable for replacing existing SFRA maps:

Issue	SWMP maps	Consider replacing existing SFRA maps?
Surface water flood risk	Figures 13 to 22	Yes – more detailed methodology to that used for the SFRA.
Increased potential for elevated groundwater	Figure 10	Yes – more detailed methodology to that used for the SFRA.
Infiltration SUDs suitability map	Figure 11	Yes – provides a consistent initial infiltration SUDs screening process for all London Boroughs, but does not replace on-site assessments.
Recorded incidents of sewer flooding	Figure 9	Yes – similar method (based on postcode sector) but brings the records up-to-date to June 2010.

Table G-2: SWMP maps of potential use to spatial planners

Appendix H – Resilience Forum and Emergency Planner Information Pack

Background

Presently, surface water flooding is less well understood than other sources of flooding, partly because surface water events tend to happen and disperse quickly meaning that there is a lack of accurate and consistent records and partly because they are not tied to readily identifiable features such as rivers or the sea. Therefore this SWMP offers an opportunity to communicate up to date information about locations at risk from surface water flooding to those with an interest. Responses in an emergency will be informed by known surface water flooding locations, especially near public buildings and major transport routes and important infrastructure.

The purpose of this information pack is to assist in communicating surface water flood risk to the London Local Resilience Forum, and Emergency Planners within the London Resilience Partnership to enable them to ensure that incident management plans are updated based on the improved understanding of surface water flooding. SWMP mapping outputs and knowledge will be used to:

- Update Community Risk Registers (CRR);
- Update Multi-Agency Flood Plans (MAFP).

This pack is presented as a Frequently Asked Questions (FAQ) document and contains information that addresses the following points:

1. How can SWMP outputs improve Community Risk Registers?
2. How can SWMP outputs improve Multi-Agency Flood Planning?
3. How do SWMP outputs compliment the Flood Forecasting Centre's Extreme Rainfall Alert (ERA)?
4. Examples of Good Practice

In updating Multi-Agency Flood Plans, as well as the neighbouring boroughs of City of London, Hackney, and Newham, the LB of Tower Hamlets also have a responsibility to partner with other key stakeholders and risk management authorities, who share the responsibility for decisions and actions. Ideally, the informal relationships established within the context of the Drain London programme should be formalised to ensure clear lines of communication and continued mutual cooperation through the development of a Memorandum of Understanding. This should include appropriate aspects for Surface Water Flood Risk Management.

The Central London Local Resilience Forum (LRF) is one of six London Forums, bringing together the London Boroughs of City of London, Kensington & Chelsea, Lambeth, Southwark, Tower Hamlets, and Westminster. The Forum is responsible for overseeing the local implementation of the policy set by the London Local Resilience Forum and ensuring that all organisations work together in planning for emergencies. The Central LRF creates a 'community risk register' of assessed risks that the Council and other responders must take into account when planning for emergencies and planning for business continuity events. As well as local authorities, membership of the Central London LRF include representatives from emergency services and government agencies.

1. How can SWMP outputs improve Community Risk Registers?

Community Risk Registers (CRR) are prepared by Category 1 responders and are required as part of the Civil Contingencies Act (CCA) 2004. The CCA requires that Category 1 responders undertake risk assessments and maintain these risks in a CCR. In this context risks are defined as events which could result in major consequences, and they include risks from flooding.

Outputs from SWMP can be used to reduce the uncertainties associated with assessing the likelihood and impact of surface water flooding (see Community Risk Register HL18 for more information on current risk assessment). SWMP presents an opportunity for the identification of vulnerable sites and populations which may be at increased risk, and allows for risk-based prevention or mitigation actions to be taken.

2. How can SWMP outputs improve Multi-Agency Flood Plans?

Multi-Agency Flood Plans (MAFP) are specific emergency plans which should be developed by LRFs, to deliver a coordinated plan to respond to flood incidents. MAFPs recognise the need for specific flooding emergency plans, due to the complex nature of flooding and the consequences that arise. Guidance on producing a MAFP is available at http://www.ukresilience.gov.uk/media/ukresilience/assets/flooding_ma_planning_guidance_0208.pdf.

Outputs from SWMPs should inform the development of, or update, the MAFP.

The SWMP surface water mapping should be used as an initial indicator of a possible risk. A Flood Risk Assessment at a site shown as being at risk of surface water flooding should consider:

- Impacts on flood receptor sites
- The degree of receptor vulnerability
- In the event of surface water flooding to the site, has safe access to / egress from the site been adequately considered?

The table below indicates the SWMP maps which are of potential use to emergency planning, and indicates which maps may be suitable for updating existing MAFP maps:

Issue	SWMP maps	Consider updating existing MAFP maps?
Surface water flood risk	Figures 13 to 22	Yes – more detailed methodology to that used for the MAFP.
Increased potential for elevated groundwater	Figure 10	Yes – more detailed methodology to that used for the MAFP.

Table H-1: SWMP maps of potential use to emergency planners

3. How do SWMP outputs compliment the Flood Forecasting Centre's Extreme Rainfall Alert (ERA)?

In 2008 the Met Office and the Environment Agency set up the Flood Forecasting Centre to provide services to emergency and professional partners. The Flood Forecasting Centre provides an Extreme Rainfall Alert (ERA) service to Category 1 and Category 2 responders. The ERA is issued at county level and is used to forecast and warn for extreme rainfall that could lead to surface water flooding, particularly in urban areas. It is designed to help local response organisations manage the impact of flooding via two products:

1. Guidance – issued when there is a 10% or greater chance or extreme rainfall;
2. Alert – issued when there is a greater than 20% chance of extreme rainfall.

The ERA cannot provide site-specific real-time surface water flood forecast, but does offer a county level alert of impending rainfall. The alert is based on the probability of rainfall occurring, rather than being a definitive forecast.

Surface water flooding has very short lead times and is hard to predict in real time because local topography and drainage infrastructure affect the direction of runoff and location of flooding. However, the assessment carried out as part of this SWMP study has taken an important step towards the likely flow pathways and locations of ponding of surface water. Used in parallel with the ERA, this can be used to improve emergency planning and responses for surface water flooding events.

4. Examples of Good Practice for Emergency Planners

- **Ensure that a programme of engagement on flood risk awareness is initiated within the Borough.** Meet with key corporate communications teams to agree an approach to social change, education and awareness raising inline with the needs of the Borough.

- **Build trust -** Public and stakeholder trust in authorities through **long term, transparent engagement.**

    - Ensure there are key messages in the that encourage attitude and behaviour change with the public. This will help to address misconceptions that flooding results from a failure on someone's part.

    - Educate the public to help them better understand where responsibilities lie, changes they can make to their own lifestyles, and actions they can take to physically reduce personal flood risk.

    - Encourage communities towards creating their own community action/response plans to support wider ownership of risk and responsibilities

    - Consider holding face to face interviews with at -risk families and groups to better inform your Community Risk Register. This will help both you and them to better understand risk and plan to manage it.

    - Establish a **common baseline for flood data** and information in line with EA requirements. Set up a Borough '**One-Stop Shop'** to enable efficient information consolidation and data sharing. This will support efficient planning and updating of the MAFP.

    - **Develop a surface water flooding response plan with vulnerable receptors as external partners**. Vulnerable receptors could include hospitals, schools and care homes. Identify these through Emergency Planning and other relevant forums and build into stakeholder engagement. This will assist with prioritisation decisions. For example 'early warning' processes, appropriate measures, funding and resourcing.

    - Link the actions from the SWMP directly to the **Flood Risk Management Strategy** for the Borough such that a programme of work is visible.

    - Link with the Planning Department's **Strategic Flood Risk Assessment** (SRFA) to ensure that Emergency Planners are involved in land use decisions for new development.

- Create a key facts and 'what to do' section for surface water flooding in **emergency handbooks**. Provide easy- to- reach contact points, and regularly update your website

- Work with other agencies, such as the **Environment Agency flood alert/warning schemes**, in the interests of cost effectiveness and good communication - but still own the responsibility for your borough. Use others' information to reinforce your own process.