3. Phase 2: Risk Assessment

3.1 INTERMEDIATE ASSESSMENT

3.1.1 The aim of the Phase 2 Risk Assessment is to identify the sources and mechanisms of surface water flooding across the study area which will be achieved through an 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 at differing scales of detail. Table 3-1 defines the three potential levels of assessment within a SWMP. The Drain London project has specified the production of one SWMP for each London Borough based on their entire administrative areas. This SWMP therefore 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, 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 5000 properties at risk across the Borough[5], 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 which may require

[5] National Rank Order of Settlements Susceptible to Surface Water Flooding Defra 2009

more detailed assessment. The methodology used for this SWMP is summarised below. Further detail of the methodology is provided in Appendix C.

- A Direct Rainfall approach using TuFLOW software has been selected whereby rainfall events of known probability are applied directly to the ground surface and are routed overland to provide an indication of potential flow path directions, velocities and areas where surface water will pond.
- 2-dimensional pluvial modelling has been supported by hydraulic field visits undertaken in conjunction with the Royal Borough of Kingston upon Thames staff.
- The outputs from the pluvial modelling are verified (where possible) against historic surface water flood records.

3.2 Risk Overview

Mapping of Surface Water Flood Risk

3.2.1 The mapping shown within this report is intended to identify broad areas which are more likely to be vulnerable to surface water flooding. This allows the Royal Borough of Kingston upon Thames and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

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

3.2.3 It should be noted that these maps only show the predicted likelihood of surface water flooding (this includes flooding from drains, small watercourses and ditches that occurs in heavy rainfall in urban areas) for defined areas. Due to the coarse nature of the source data used, the maps are not detailed enough to define risk for individual addresses. Individual properties therefore may not always face the same chance of flooding as the areas that surround them.

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

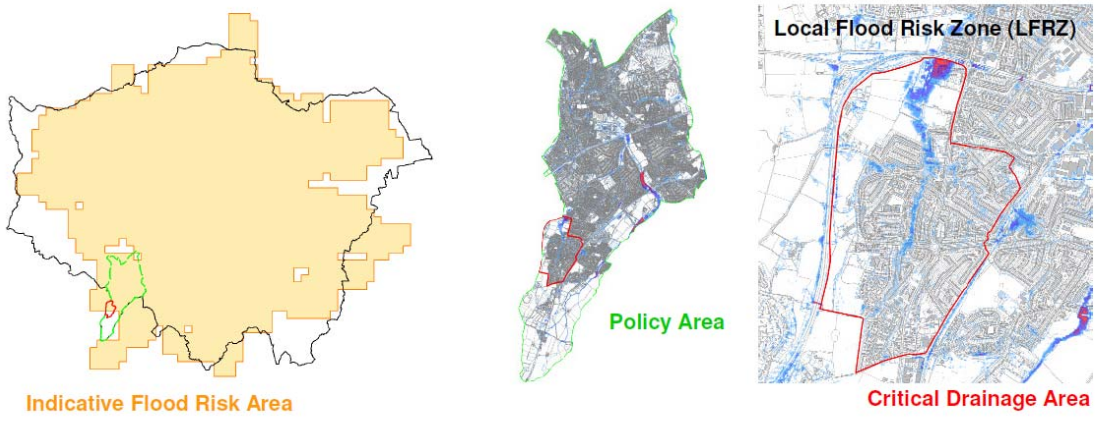
3.2.5 The Borough Council and the Drain London Tier 1 and Tier 2 Consultants will not be liable if the maps by their nature are not as accurate as might be desired, or if they are misused or misunderstood despite our warnings. For this reason we are unable to guarantee that the maps will always be completely accurate or up to date.

Summary of Definitions

3.2.6 Figure 3-1 provides a summary of the terminology used throughout this SWMP; the following sections provide a definition of each area. To avoid confusion and ensure clarity of scale, the hierarchy of definitions is summarised as follows, from smallest to largest:

1. Local Flood Risk Zone (LFRZ, managed at the local scale);
2. Critical Drainage Area (CDA, containing one or more Local Flood Risk Zones – managed at the local scale);
3. Policy Areas (PA, containing one or more Critical Drainage Areas and covering the entire Borough);
4. Flood Risk Area (as defined by the EA / Defra Indicative Flood Risk Areas – an area approximately covering the entire Greater London Area and managed at a strategic scale).

Figure 3-1 Example of Flood Risk Area, Policy Area, CDA and LFRZ



Local Flood Risk Zones

3.2.7 For the purpose of the SWMP, a LFRZ is defined as:

'Discrete areas of flooding that affect houses, businesses or infrastructure'.

3.2.8 A LFRZ is defined as the actual spatial extent of predicted flooding in a single location. Related LFRZs can be grouped together as a Critical Drainage Area or left in isolation and considered within the larger Policy Areas.

Critical Drainage Areas

3.2.9 A Critical Drainage Area (CDA) is defined as:

'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.'

3.2.10 CDA units are larger than LFRZs and denote an area or catchment where mitigation measures may be implemented to reduce flooding experienced in the LFRZ. CDA units should be used for site specific detailed planning and capital works schemes and may contain one or more LFRZs.

Policy Areas

3.2.11 A Policy Area is defined as:

'A discrete area within an administrative area where appropriate planning policy can be applied to manage flood risk.'

3.2.12 Policy Areas contain one or more CDAs and cover the entire study area. Policy Areas are primarily based on hydrological catchments but may also accommodate geological concerns and other factors as appropriate. Policy areas may be used to provide guidance on general policy across the study area e.g. the use of soakaways in new development. Due to the similarity of geology across the study area, there is only one Policy Area defined for the Royal Borough of Kingston upon Thames which follows the Borough boundary.

Indicative Flood Risk Areas

3.2.13 Indicative Flood Risk Areas are defined by the Environment Agency / Defra definition primarily for the purpose of Preliminary Flood Risk Assessment preparation. The Indicative Flood Risk Area covers the entire Greater London Areas and is managed at a strategic scale.

3.3 Surface Water Flooding

Mechanism of Flooding

3.3.1 Surface water flooding is caused as a result of high intensity rainfall, often short duration summer storms such as those experienced in the Royal Borough of Kingston upon Thames in July 2007. These storm events can generate runoff which flows over the surface of the ground and ponds in low lying areas before entering a watercourse or sewer. It often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with the additional flow. Surface water flooding is known as pluvial flooding.

3.3.2 No single organisation has overall responsibility for surface water flooding with different aspects of the drainage system falling to either The Highway Authority (in this case Royal Borough of Kingston upon Thames), Thames Water, riparian owners and Transport for London (red routes including the A3).

Pluvial Modelling

3.3.3 The Environment Agency commissioned national scale surface water modelling, resulting in the preparation of the Flood Map for Surface Water (FMfSW) which identified areas at risk of flooding during the 3.3% AEP (1 in 30 annual probability) and 0.5% AEP (1 in 200 annual probability) rainfall events.

Figure D1 – EA Flood Map for Surface Water

3.3.4 In order to continue developing an understanding of the causes and consequences of surface water flooding in the study area, intermediate level hydraulic modelling has been undertaken for a suite of five rainfall event probabilities. This hydraulic modelling has been designed to provide additional information where local knowledge is lacking and forms a basis for future detailed assessments in areas identified as high risk.

3.3.5 A Direct Rainfall approach using Tuflow software has been selected whereby rainfall events

of known probability are applied directly to the ground surface and is routed overland to provide an indication of potential flow path directions, velocities and areas where surface water will pond. A full methodology of the hydraulic modelling undertaken is included in Appendix C.

3.3.6 Figures 3.2.1 and 3.2.2 show the modelling results for the Royal Borough of Kingston upon Thames for the rainfall event with a 1% AEP (1 in 100 annual probability of occurring in any year). Figures for the other modelled return periods are included in Appendix D.

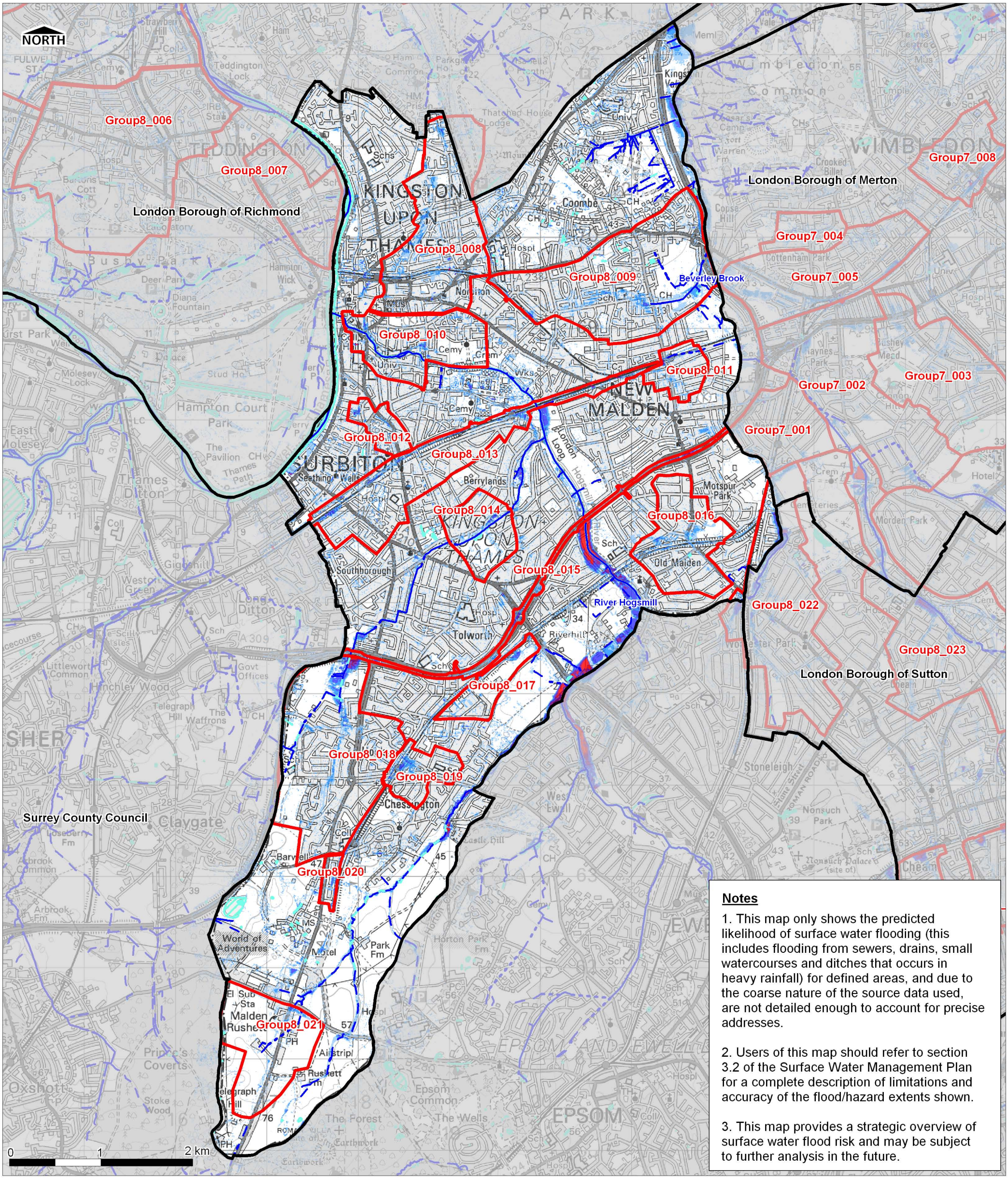
Figure 3.3.1 – Surface Water Flood Depth (1% AEP)
Figure 3.3.2 – Surface Water Flood Hazard (1% AEP)

Figure D6 – Surface Water Flood Depth (1 in 30 annual probability 3.3% AEP)
Figure D7 – Surface Water Flood Hazard (1 in 30 annual probability 3.3% AEP)
Figure D8 – Surface Water Flood Depth (1 in 75 annual probability 1.3% AEP)
Figure D9 – Surface Water Flood Hazard (1 in 75 annual probability 1.3% AEP)
Figure D10 – Surface Water Flood Depth (1% AEP plus climate change)
Figure D11 – Surface Water Flood Hazard (1% AEP plus climate change)
Figure D12 – Surface Water Flood Depth (1 in 200 annual probability 0.5% AEP)
Figure D13 – Surface Water Flood Hazard (1 in 200 annual probability 0.5% AEP)

3.3.7 A summary of the suggested use for each mapped output is provided in Table 3-2.

Table 3-2 Modelled Return Periods and Suggested Use

Modelled Return Period	Suggested use
3.3% AEP Probability of occurrence is 1 in 30 years	Current standards required Thames Water sewers to accommodate rainfall event with a 3.3% AEP or less, however the capacity of existing sewers is likely to be lower. This layer will identify areas that are prone to regular flooding and could be used by highway teams to inform maintenance regimes.
1.3% AEP Probability of occurrence is 1 in 75 years	In areas where the likelihood of flooding is 1.3% or greater insurers will not guarantee to provide cover to property should it be affected by flooding. This GIS layer should be used to inform spatial planning; if property can not be guaranteed insurance, the development may not be viable.
1% AEP Probability of occurrence is 1 in 100 years	Can be overlaid with Environment Agency Flood Zone 3 GIS layer to show areas at risk under the same event from both sources. Can be used to advise planning teams.
1% AEP plus 30% climate change	PPS25 requires that the impact of climate change is fully assessed. Reference should be made to this flood outline by the spatial planning teams to assess the sustainability of developments.
0.5% AEP Probability of occurrence is 1 in 200 years	To be used by emergency planning teams when formulating emergency evacuation plans from areas at risk of flooding.



Notes

1. This map only shows the predicted likelihood of surface water flooding (this includes flooding from sewers, drains, small watercourses and ditches that occurs in heavy rainfall) for defined areas, and due to the coarse nature of the source data used, are not detailed enough to account for precise addresses.

2. Users of this map should refer to section 3.2 of the Surface Water Management Plan for a complete description of limitations and accuracy of the flood/hazard extents shown.

3. This map provides a strategic overview of surface water flood risk and may be subject to further analysis in the future.

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Borough Administrative Boundary
- Critical Drainage Area
- Permanent Water Bodies
- Main River
- Ordinary Watercourse
- Culverted Watercourse

Flood Depth

- <0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- >1.5m

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Royal Borough of Kingston upon Thames

Surface Water Management Plan

Surface Water Depth (m) 1 in 100 Chance of rainfall event occuring in any given year (1% AEP)

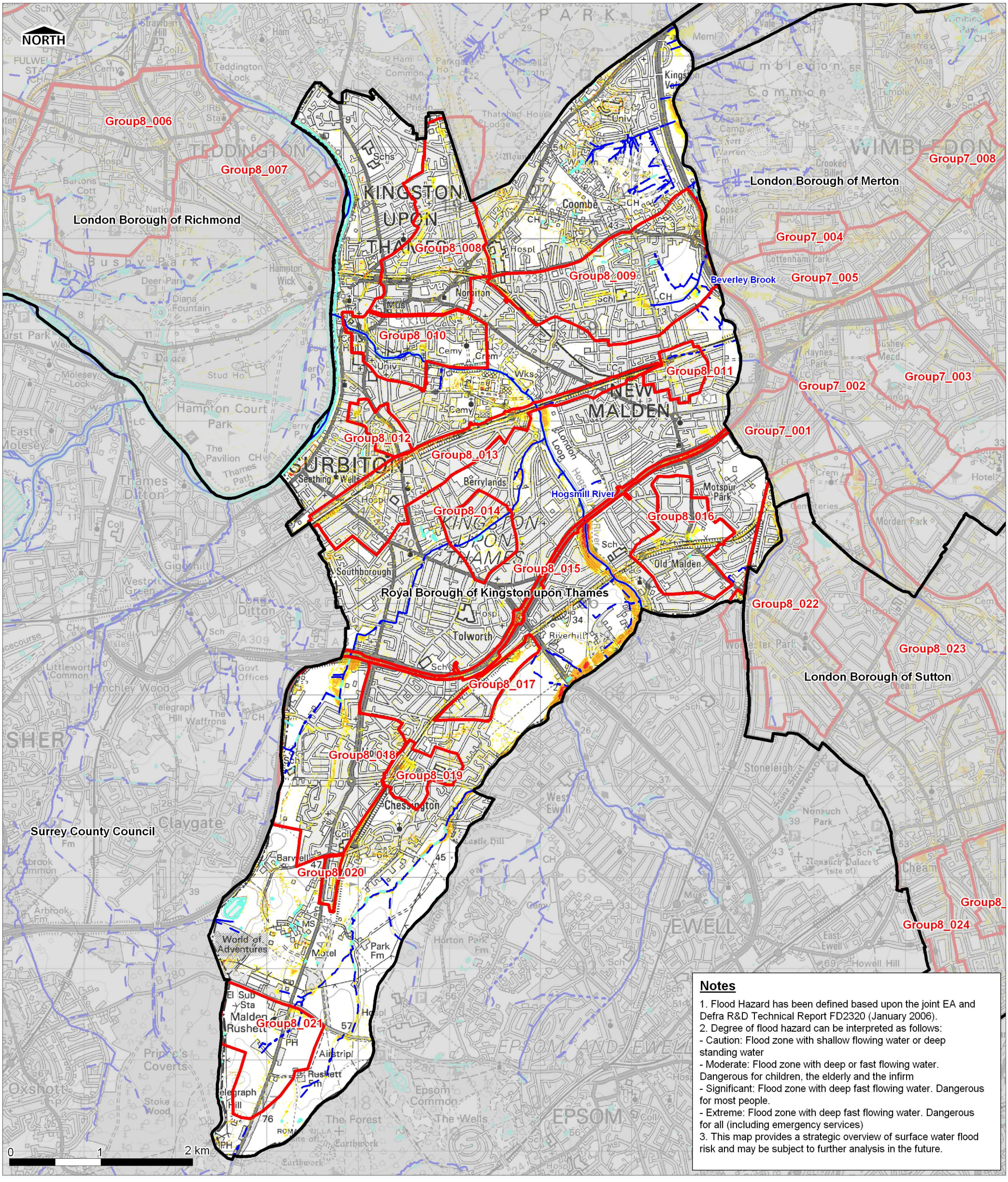
Consultants
CAPITA SYMONDS Flood Risk Management
Scott Wilson
URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

Drain London Programme Board Members

Environment Agency · Thames Water · LONDON COUNCILS · GREATERLONDONAUTHORITY

Scale at A3	Date	Drawn by	Approved by
1:40,000	20/07/2011	D.SKILTON	E.CRAVEN

FIGURE 3.3.1



Notes

1. Flood Hazard has been defined based upon the joint EA and Defra R&D Technical Report FD2320 (January 2006).
2. Degree of flood hazard can be interpreted as follows:
- Caution: Flood zone with shallow flowing water or deep standing water
- Moderate: Flood zone with deep or fast flowing water. Dangerous for children, the elderly and the infirm
- Significant: Flood zone with deep fast flowing water. Dangerous for most people.
- Extreme: Flood zone with deep fast flowing water. Dangerous for all (including emergency services)
3. This map provides a strategic overview of surface water flood risk and may be subject to further analysis in the future.

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Borough Administrative Boundary
- Critical Drainage Area
- Permanent Water Bodies
- Main River
- Ordinary Watercourse
- Culverted Watercourse

Flood Hazard

- <0.75 Caution (Very low hazard)
- 0.75 - 1.25 Moderate (Danger for some)
- 1.25 - 2.0 Significant (Danger for most)
- <2.0 Extreme (Danger for all)

Royal Borough of Kingston upon Thames

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:40,000	20/07/2011	D.SKILTON	E.CRAVEN

Surface Water Flood Hazard Rating
1 in 100 Chance of rainfall event occuring in any given year (1% AEP)

Consultants
CAPITA SYMONDS Flood Risk Management
Scott Wilson
URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

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FIGURE 3.3.2

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HISTORICAL SURFACE WATER FLOODING

3.3.8 The Royal Borough of Kingston upon Thames has provided records of roads and broad locations which experienced flooding during the July 2007 floods. These incidents have been geo-referenced and mapped over the modelling results in Figure D2 (Appendix D).

3.3.9 The key impacts and consequences of recent (last 10 years) heavy rainfall events are outlined below:

- A social work team needed to be re-housed for two months following the flooding of their offices
- Residential properties often flooded
- Residents of Council accommodation have required temporary and permanent relocation following flooding
- Severe traffic disruptions, particularly around Kingston town centre's one-way traffic system
- Kingston town centre businesses lose revenue due to disruption of traffic
- Manhole cover blown off main sewage main flooding a park in New Malden and forcing it to be closed for six months. This cost Thames Water approximately £240,000.
- Intensity of rainfall has caused damage to Council property including electrical damage costing approximately £80,000 to one Council building
- Scouring of the banks of the Hogsmill River because of high water levels requiring repair

Figure D2 – Surface Water Flood Depth (1% AEP) & Recorded Surface Water Flood Incidents

3.4 ORDINARY WATERCOURSE FLOODING

MECHANISMS OF FLOODING

3.4.1 Ordinary watercourse flooding includes flooding from small open channels and culverted urban watercourses[6]. These small channels often receive most of their flow from inside the urban area and perform an urban drainage function.

Figure 3.4.1 – Watercourses, Flood Zones and Fluvial Flood Incidents

3.4.2 In September 2002 the Royal Borough of Kingston upon Thames commissioned Jacobs to complete an Asset Survey of the Ordinary Watercourses within their Borough boundary. This study found that the combined reach of the channel lengths of ordinary watercourses within the Borough (including Pachesham Stream, Lambeth Stream, Keswick Avenue Drain, Bonesgate Stream and Surbiton Stream) was approximately 12.5km. The characteristics of the watercourses are described in Table 2-A of the Asset Survey, reproduced below.

[6] These watercourses will frequently be ordinary watercourses (within the responsibility of local authorities) but may also be designated Main River (with responsibility of the Environment Agency).

Table 3-3 Characteristics of Ordinary Watercourses within the Royal Borough of Kingston upon Thames

Agency reach name	RBK Reach Name	Total reach length	Length within the Borough (m)	Catchment Area (km^2)
Pachesham Stream	N/A	3325	400	3.9*
Lambeth Stream (culvert)	N/A	2371	882	1.08
Keswick Ave. Drain	N/A	1188	1188	1.49
Bonesgate Stream	Trib.2	4516	4516	8.26
Surbiton Stream	Trib.1	6001	5567	9.38

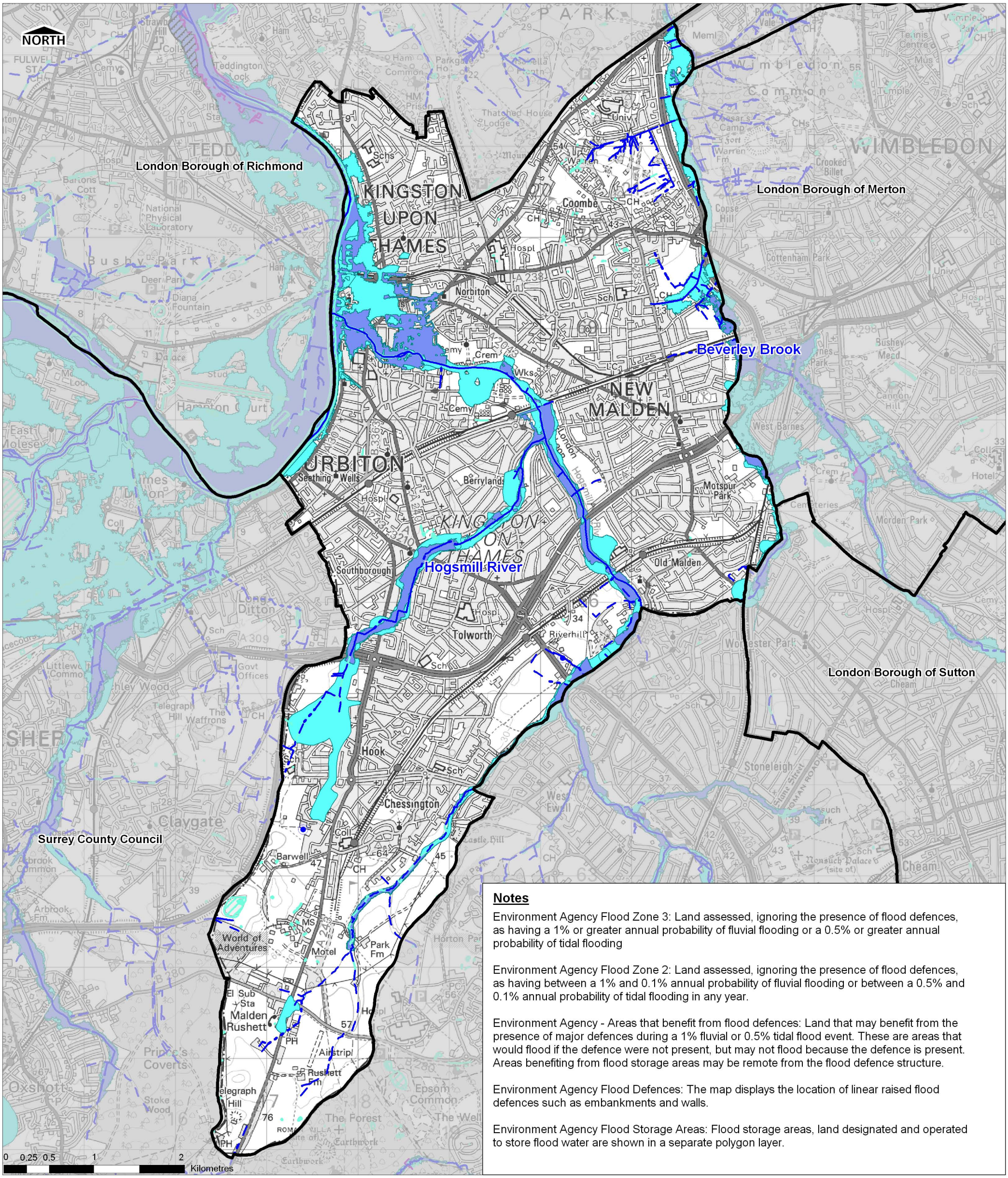
**The Pachesham Stream drains approximately 0.82km^2 within the Borough, however the total catchment is 3.9km^2.*

RESPONSIBLE ORGANISATIONS

3.4.3 The Environment Agency has responsibility over flooding from designated Main Rivers, however the responsibility for maintenance of small open channels and culverted urban watercourses which are not designated as 'main river' falls to the Royal Borough of Kingston upon Thames and riparian owners who own land on either bank i.e. Royal Borough of Kingston upon Thames is only responsible for ordinary watercourses where land on either bank is in council ownership, or where historical agreements have been made.

3.4.4 Responsibilities as riparian owner are to:

- Pass flow on without obstruction, pollution or diversion affecting the rights of others;
- To accept flows through your land even if caused by inadequate capacity downstream;
- Maintain the bed and banks of the watercourse (including trees and shrubs growing on the banks) and for clearing any debris, natural or otherwise even if it did not originate from your land;
- Watercourses and their banks must not be used for the disposal of any form of garden or other waste;
- Failure in carrying out these responsibilities could result in possible civil action;
- Local Authorities have certain permissive powers to undertake flood defence works and powers for enforcement under the Land Drainage Act 1991 and Public Health Act on watercourses which have not been designated as main rivers.



Notes

Environment Agency Flood Zone 3: Land assessed, ignoring the presence of flood defences, as having a 1% or greater annual probability of fluvial flooding or a 0.5% or greater annual probability of tidal flooding

Environment Agency Flood Zone 2: Land assessed, ignoring the presence of flood defences, as having between a 1% and 0.1% annual probability of fluvial flooding or between a 0.5% and 0.1% annual probability of tidal flooding in any year.

Environment Agency - Areas that benefit from flood defences: Land that may benefit from the presence of major defences during a 1% fluvial or 0.5% tidal flood event. These are areas that would flood if the defence were not present, but may not flood because the defence is present. Areas benefiting from flood storage areas may be remote from the flood defence structure.

Environment Agency Flood Defences: The map displays the location of linear raised flood defences such as embankments and walls.

Environment Agency Flood Storage Areas: Flood storage areas, land designated and operated to store flood water are shown in a separate polygon layer.

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Borough Administrative Area
- Flood Zone 2
- Flood Zone 3
- Main River
- Ordinary Watercourse
- Culverted Watercourse
- Areas Benefiting fro Flood Defences
- Permanent Water Bodies
- Flood Storage Area
- Defences
- Fluvial Flooding Incidents

Royal Borough of Kingston upon Thames

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:40,000	20/07/2011	D.SKILTON	E.CRAVEN

Environment Agency Flood Map and Fluvial Flood Incidents

Consultants
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Scott Wilson
URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

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FIGURE 3.4.1

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