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London Borough of Hammersmith and Fulham Strategic Flood Risk Assessment

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Executive Summary

Introduction

This report is a Strategic Flood Risk Assessment (SFRA) for London Borough of Hammersmith and Fulham (LBHF). This SFRA is an update to the LBHF SFRA (2010) and has been prepared in accordance with current best practice, the National Planning Policy Framework (NPPF) and its accompanying Flood Risk and Coastal Change Planning Practice Guidance (PPG). It utilises a number of new datasets that were not available at the time of the 2010 SFRA, including the 2014 Surface Water Management Plan (SWMP), Areas Susceptible to Groundwater Flooding (AStGWF) mapping and revised breach analysis using the Environment Agency Thames Tidal Breach Modelling Study completed in 2015.

The SFRA is a study to assess present and future flood risk to the Borough from all sources and assess the impact that development will have on flood risk. It enables LBHF to select and develop sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on existing site allocations within the Borough but also sets out the procedure to be followed when assessing additional sites for development in the future. The SFRA will assist LBHF in making the spatial planning decisions required to inform the Local Plan.

Flood Risk in Hammersmith and Fulham

A thorough review of existing information and additional modelling work were used to identify the level of flood risk from all sources present within the Borough. The SFRA identified that the most significant sources of flood risk within the LBHF are surface water, sewer and groundwater flooding. There is also tidal flood risk corresponding to a failure in the River Thames tidal defences.

Sewer and Surface Water Flood Risk

Sewer and surface water flooding are particularly problematic within LBHF, which has experienced significant problems historically and during the most recent heavy rainfall events of July 2007. The 2014 SWMP outlines the predicted surface water flood risks across the Borough, identifies Critical Drainage Areas (CDAs) and provides a surface water management strategy. Figure 7 (Appendix B) shows the spatial distribution of sewer flooding events for the Borough, provided by Thames Water. Thames Water have stated that the areas which have in the past been affected by such flooding should not be seen as areas to avoid future development and that the reverse is also true - that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure discharge capacity exists or can be provided and that flood risk is not increased.

As sewer and surface water flood risk are significant, it is recommended that LBHF take an active role in future strategic surface water management plans for London, plan for future emergencies, and provide guidance to residents on how they can mitigate against the impacts of these types of flooding.

Groundwater Flood Risk

The majority of the southern half of the study area is at high risk of groundwater flooding from superficial deposits overlying the London Clay bedrock. Figure 14 (Appendix B) provides an overview of groundwater flood risk in the Borough. It is essential that groundwater flood risk is assessed in relation to any development, particularly within areas identified in this SFRA as being at medium or high risk of groundwater flooding. Groundwater flood risk must also be considered when designing Sustainable Drainage Systems (SuDS), in particular the potential impact of increased infiltration SuDS on properties further down gradient.

Tidal Flood Risk

The tidal flood risk predicted within the LBHF (with the presence of the River Thames tidal defences) was determined by the Environment Agency Flood Zone Maps. Tidal flood risk is extensive, but at present the LBHF is defended against predicted events up to and including the 0.1% Annual Exceedance Probability (AEP) tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard from a breach or during an overtopping scenario if climate change predictions are correct and the defences are not raised. There is a low risk of fluvial flooding within LBHF.

Future Planning and Development Control

The SFRA also contains:

- An initial review of flood risk at each of LBHF's preferred future development sites;
- Recommended policies to aid the Council in managing the flood risk within the LBHF;
- An outline of requirements for detailed Flood Risk Assessments (FRAs); and
- Advice on Sustainable Drainage Systems (SuDS) and mitigation measures to consider as part of a development proposal.

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1. Introduction

1.1 Overview

A Strategic Flood Risk Assessment was completed on behalf of the Royal Borough of Kensington and Chelsea (RBKC, August 2009) and the London Borough of Hammersmith and Fulham (LBHF, June 2010).The SFRA was developed in line with the now superseded Planning Policy Statement 25 – Development and Flood Risk (DCLG, 2006)[1]. The SFRA was developed to inform the LBHF Local Development Framework (LDF).

Capita URS (URS are now known as AECOM) were commissioned in 2013 to update the SFRA and to produce a separate SFRA document for each borough. This is the SFRA report for LBHF and contains analysis of flood risks and planning implications and recommended policies for the Borough.

The 2010 SFRA has largely been retained; however several updates and reviews were carried out. The following summarises the scope of works for this updated document:

- Identify policy updates since 2010, in particular the introduction of the National Planning Policy Framework (NPPF, March 2012), the Flood Risk and Coastal Change Planning Practice Guidance (PPG, March 2014) and revisions to LBHF Local Plan policies;
- Identify updates related to new information available from the LBHF Surface Water Management Plan (SWMP); and
- Review and update new data sources.

The release of Planning Policy Statement 25: Development and Flood Risk in December 2006 (PPS25, 2006) emphasised the responsibility that Local Planning Authorities (LPAs) have to ensure that flood risk is understood and managed effectively using a risk-based approach as an integral part of the strategic planning process. PPS25 encouraged LPAs to undertake SFRAs and to use their findings and those of other studies to inform strategic land use planning. The National Planning Policy Framework (NPPF) document replaced the suite of Planning Policy Statements, including PPS25, on 27 March 2012. The NPPF states:

> *"A Strategic Flood Risk Assessment is a study carried out by one or more planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of climate change, and to assess the impact that changes or development in the area will have on flood risk".*

The NPPF and its accompanying Flood Risk and Coastal Change Planning Practice Guidance (PPG) maintain the requirement to apply a risk-based, sequential approach to the location of development in order to avoid flood risk to people and property. The key difference for flood risk policy compared to PPS25 is that the NPPF gives Local Authorities a wider remit to interpret and implement local policies. This makes the SFRA process all the more important in establishing suitable, reasonable and practical local development policies to manage local flood risk.

Following the recently updated Environment Agency (EA) River Thames breach results Capita were commissioned in 2015 to update the breach analysis and mapping outputs of the LBHF SFRA.

1.2 SFRA Objectives

In keeping with guidance presented in the NPPF and the PPG, the objectives of this SFRA update are to:

1. Identify the extent of all Flood Zones.
2. Determine the actual flood risk in Flood Zone 3 given the presence of defences.
3. Identify the rapid inundation zone (RIZ) resulting from defence failure.
4. Identify the effect of flood defence failure, including extent, depth and velocity of flooding.

[1] Planning Policy Statement 25: Development and Flood Risk, December 2006.

5. Assess the potential increase in flood risk resulting from climate change for all sources of flooding.
6. Establish the flood risk to proposed development sites within the delineated NPPF zones.
7. Determine the effect of an increase in surface water drainage as a result of the proposed development sites and highlight any areas where the drainage system is known to be inadequate.
8. Supplement current policy guidelines and provide a straightforward risk based approach to development control in the local area.
9. Provide a reference document which all parties involved in planning and flood risk can reliably turn to for initial advice.

Note that the above objectives remain the same as those in the 2010 SFRA, with the exception of updating to account for policy changes. The potential impact of growth on future flood risk is a key driver for development of the SFRA and for the SFRA to provide a consistent and robust evidence base for assessment of new development.

1.3 Study Area

The study area (refer to Figure 1-1) encompasses the administrative boundary of the London Borough of Hammersmith and Fulham.

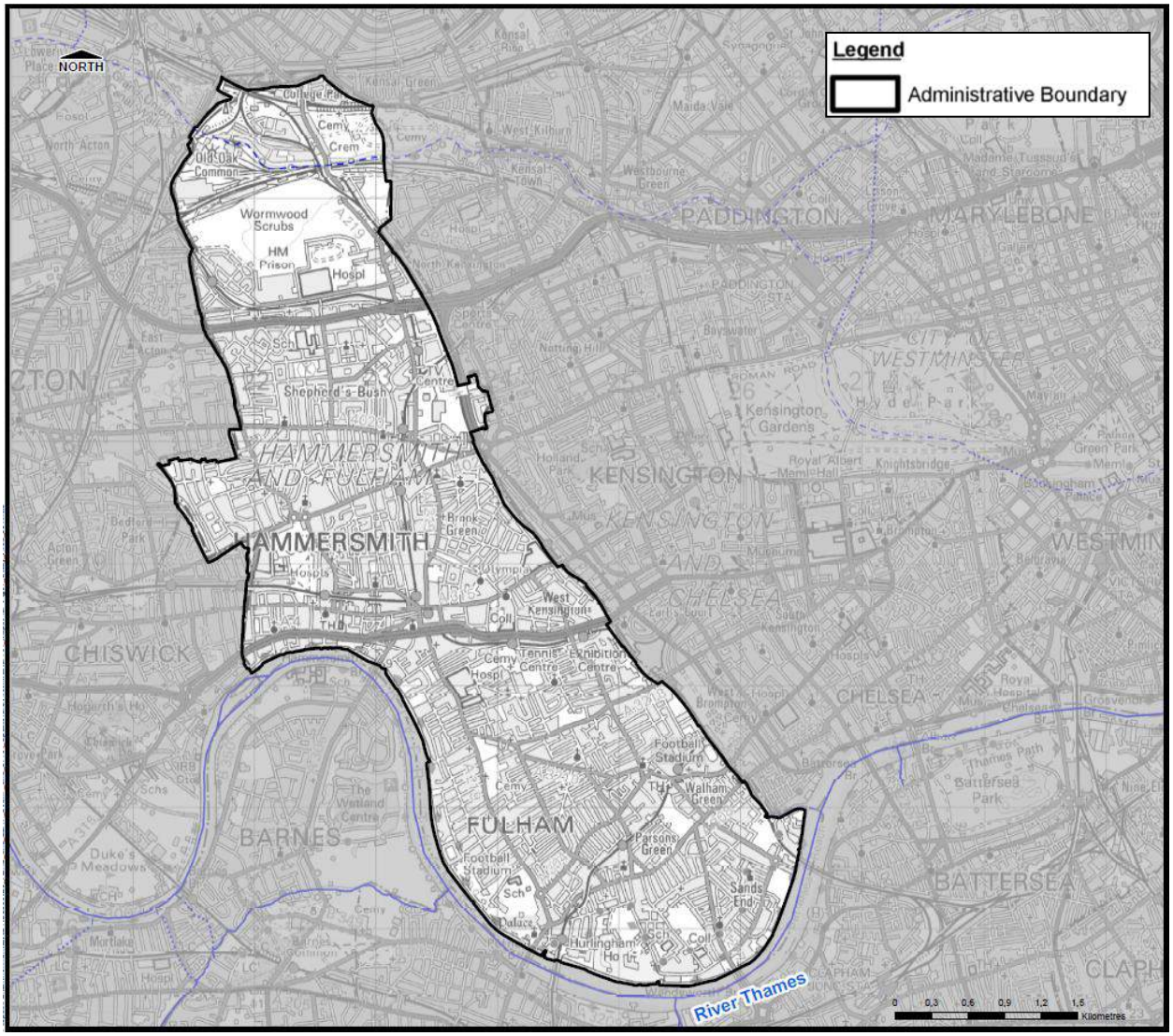

Figure 1-1: LBHF Borough Boundary

1.3.1 The Tidal Thames

The River Thames is primarily tidally dominated through London and the most severe flood risks come from tidal surges. Teddington is the normal tidal limit although high fluvial flows can affect parts of west London and extreme surges can impact areas upstream of Teddington. The tidal Thames floodplain is currently defended through a combination of raised banks and barriers, the most important being the Thames Barrier at Woolwich. There are also eight other major barriers, 36 major industrial floodgates, 400 minor moveable structures and 337 km of tidal walls and embankments[2].

These defences provide protection against tidal flooding to an estimated 1 in 1000 year standard for 2030 (as estimated when the defences were originally designed), which equals a less than 0.1% chance of flooding each year. So far the rate of sea level rise has not exceeded that expected and the defences are thus currently providing a greater level of protection than originally projected for 2030 (for a 1 in 1000 year event).

The Thames Barrier does not eliminate normal tidal movements and thus high water levels can be reached in the river that, without the river walls and banks, would flood lower lying parts of Hammersmith and Fulham. These are similar to the areas shown on the Environment Agency's Flood Zone maps, which represent a scenario where the area is undefended.

The Environment Agency published the Thames Estuary 2100 (TE2100) Plan in November 2012. This sets out their recommendations for flood risk management for London and the Thames Estuary through to the end of century and beyond. The plan puts the need for climate change adaptation at its core. It primarily looks at tidal flooding, though other sources of flooding including high river flows as a result of heavy rainfall and surface water flooding are also considered.

The River Thames is strongly influenced by tides along the LBHF boundary. For any given tide the peak river levels are also influenced by fluvial flows, although this influence is often small in comparison.

1.3.2 Flood Risks

The LBHF is at a risk of flooding from a number of sources, the nature of which differs significantly. Flood risk can be considered in terms of probability of occurrence and consequence.

The probability of flooding from the tidal River Thames is small, but the consequences are potentially high due to high flows causing rapid inundation of low lying areas and therefore increasing the potential threat to life. The last major flood from the River Thames in the area occurred in 1928 and resulted in a number of people being killed within basement properties. Flood protection within the study area has improved, but this risk cannot be removed completely. This threat is considered further in Chapter 5.

The two possibilities for flooding from the River Thames are:

- A major failure of a defence wall due to breaching; and
- Failure of the Thames Barrier and consequent overtopping of a defence wall (subject to climate change).

[2] Lavery, S and Donovan, B (2005) Flood Risk Management in the Thames Estuary looking ahead 100 years. Phil Trans. R. Soc, 1455-1474

Surface water flooding due to intense rainfall overwhelming the capacity of the sewer system is much more likely than flood defence failure, but would have localised impacts and a less severe threat to life. Failure of water mains or small temporary defences is also more likely than flood defence failure, though would have less of an impact on the Borough. The central and southern parts of the Borough are also highly susceptible to groundwater flooding. Groundwater flooding poses a risk to basements, ground floor properties and assets held below ground level, and can also cause inundation of roads and overflowing of sewers and drains. The risk to life associated with groundwater flooding is low. Other possible sources of flood risk include the Grand Union Canal, in the north of the Borough.

Figure 1-2 (below) displays the Flood Risk Zones and defence locations within the study area.

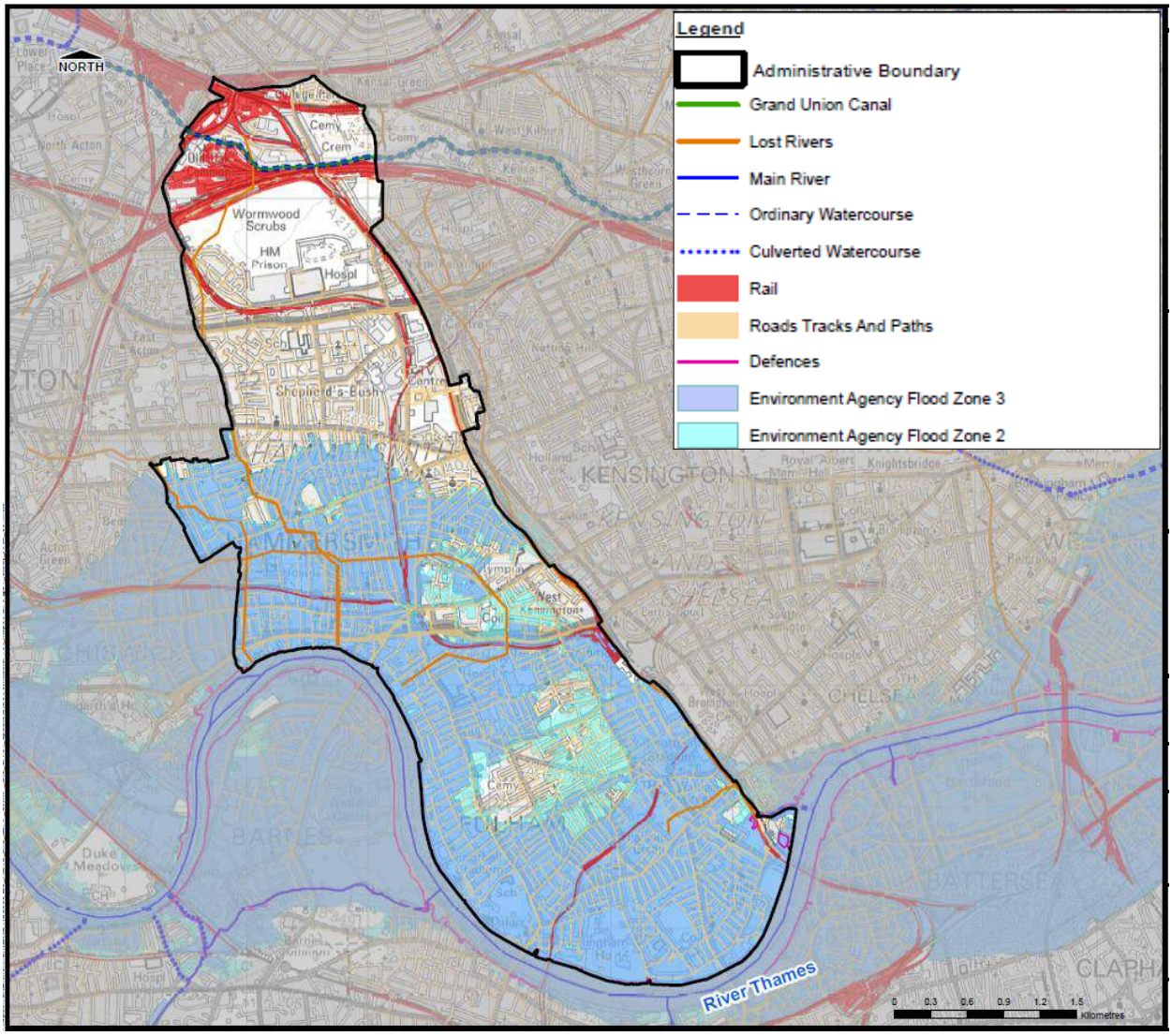

Figure 1-2: Flood Zones and Defence Locations within the Study Area

Figure 1-3 (below) displays the surface water model output depths for a 1 in 100yr event with an allowance for climate change, obtained from the LBHF Surface Water Management Plan (SWMP), and the Critical Drainage Areas (CDAs) defined in the same report.

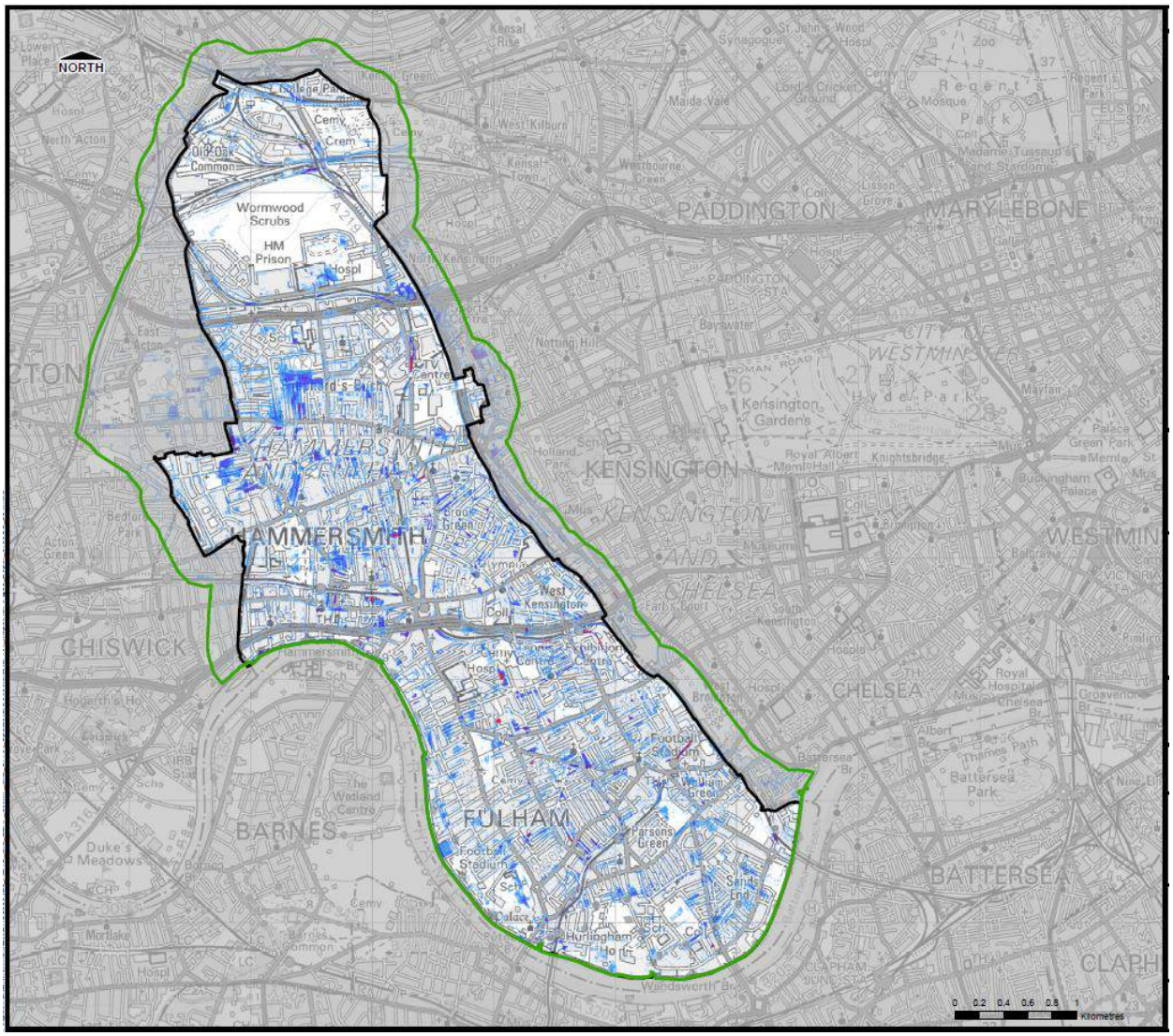

Figure 1-3: 1 in 100yr + Climate Change Surface Water Flood Depths and Critical Drainage Areas

2. Strategic Flood Risk Assessment Overview and Approach

2.1 Overview of the SFRA Process

The SFRA is a planning tool that can be used to inform the spatial planning process. The SFRA should be used to refine the information relating to the areas within LBHF which may flood, taking into account all sources of flooding and climate change. This information should form the basis of LBHF's future flood risk management policies. In addition the SFRA has informed the development of Local Plan policies and provides the information to enable the Exception Test to be applied during the site allocation and development control process.

In line with NPPF guidelines, site allocations should be made outside of the tidal or fluvial flood risk areas defined by Flood Zones 2 and 3 (i.e. located within Zone 1) wherever possible. If there are no reasonably appropriate Flood Zone 1 sites, allocations should be made in Zone 2 first, considering flood risk vulnerability of land uses. Only where there are no reasonably available sites in Flood Zone 1 or 2 should Zone 3 allocations be made. In order to demonstrate that there are no lower risk sites available the Sequential Test needs to be carried out. As a Borough-wide Sequential test has been undertaken by LBHF, the requirement for a Sequential Test can be considered to have been fulfilled for all locations within the Borough, and site-specific Sequential Tests for proposed developments within the Borough are not considered necessary. For further information see Section 2.1.1. The Exception Test should be used, where allowed, to justify allocations or developments in high risk areas where the need to develop is considered exceptional.

The SFRA provides some indication of deliverability of a proposed development and hence whether a proposed development site should be considered in more detail in terms of flood risk. Risk is defined as a function of both probability of an event occurring and the consequences should that event take place. When considering the residual risk associated with the failure of a flood defence, consideration must be given to both overtopping (subject to climate change) and the structural integrity of the defence. To assess residual risk, it is necessary to model the consequence of a breach in, or the overtopping of, the flood defences in an event with a 0.5% chance of occurring each year (1 in 200 year event). Generally, the worst case scenario will coincide with a failure of the defences at the peak of the flood event. A two dimensional inundation model (which has the ability to predict depth, velocity and hazard) of the defended area is required to examine the impact of either a breach failure or overtopping during the design event. The extent of inundation behind the defence can then be identified, and the depth and velocity of flow (within the inundated area) monitored over time throughout the duration of the event.

In addition to tidal flood risk, sources of flooding including groundwater, overland flow and drainage systems must also be considered when planning development. Although explicit consideration of these sources of flooding is not a requirement for flood zone allocation, local drainage issues have the potential to cause substantial damage and distress. When considering development proposals, known drainage and surface water problems need to be taken into account. These are particularly pertinent in the LBHF, where there are considerable areas at high risk of surface water, sewer and/or groundwater flooding.

All sources of flood risk including tidal, groundwater, overland flow and sewer flood risk must be considered when planning development. When considering development proposals, known drainage and surface water problems must be taken into account.

2.1.1 Sequential Test

The NPPF sets out the requirement for a sequential approach, recommending that LPAs use a risk based approach to development planning. The Environment Agency Flood Zone Map provides the basis of the test, in which sites at lower flood risk are identified and prioritised in order of flood risk vulnerability and their safety, in order to assist in allocation for development. A further level of analysis may be required where development is planned behind or adjacent to existing defences in order to test the sustainability and robustness of the mitigation measures. This SFRA provides LBHF with Flood Zone classifications for all locations identified for development, as well as the information required to classify future allocations.

When allocating or approving land for development in flood risk areas, LPAs are expected to demonstrate that there are no suitable alternative development sites located in lower flood risk areas. The LBHF Core Strategy (October 2011) states that most of the Borough is at risk of some form of flooding, noting that the part of the Borough which lies within Flood Zone 1 (in the north) is at risk from sewer and surface water flooding. As such, the Council considers it unreasonable to restrict development in the Borough to this area only. The Council therefore considers that the Sequential Test permits the consideration of all sites for development, subject to meeting the requirements of the Exception Test and a completion of an appropriate site specific Flood Risk Assessment. As a Borough-wide Sequential test has been undertaken by LBHF, the requirement for a Sequential Test can be considered to have been fulfilled for all locations within the Borough, and site-specific Sequential Tests for proposed developments within the Borough are not considered necessary.

The Environment Agency has statutory responsibility and must be consulted on all development applications allocated with medium and high risk zones, including those in areas with critical drainage problems and for any development on land exceeding 1 hectare outside Flood Zones 2 and 3. In these circumstances, the Environment Agency will require the Council to demonstrate that there are no reasonable alternatives, in lower flood risk categories, available for development. Where appropriate, the Exception Test is to be applied.

The LBHF Core Strategy permits the consideration of all sites for development, subject to meeting the requirements of the Exception Test and completion of an appropriate site specific FRA. Developers are not required to apply the Sequential Test to individual developments.

2.1.2 Exception Test

The NPPF explains where and for what type of development the Exception Test needs to be applied. For the Exception Test to be passed:

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

Where the Exception Test is required, it should be applied as soon as possible to all sites allocated for development, and all planning applications other than for minor development. Both elements of the Exception Test have to be passed before development is allocated or permitted. In some situations, for

certain types of development, it is not appropriate to use the Exception Test to justify development. For example, development which is highly vulnerable to flooding (e.g. a hospital) cannot be justified within the high risk zone through the use of the Exception Test. The situations where it is necessary and appropriate to apply the Exception Test are outlined in Table 2-1.

Table 2-2 provides a description of the flood risk vulnerability classification for various development types.

Table 2-1: Flood Risk vulnerability and flood zone 'compatibility'

Flood Risk Vulnerability Classification	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	x*	Exception Test Required	✓
Zone 3b	Exception Test Required	✓	x*	x*	x*

Key

✓ Development is appropriate

x Development should not be permitted

* LBHF policy varies from the NPPF Table in that development in all vulnerability classes is permitted in Flood Zone 3, subject to the Exception Test being fulfilled.

Zone 1: All land uses listed above are appropriate in this zone.

Zone 2: Water-compatible, less vulnerable and more vulnerable land uses and essential infrastructure are appropriate in Zone 2. Highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.

Zone 3a: Water-compatible and less vulnerable uses of land are appropriate in Zone 3a. Highly vulnerable uses should not generally be permitted in this zone; however LBHF policy varies from NPPF guidance and allows more vulnerable land use developments if the Exception Test is passed. More vulnerable and essential infrastructure uses should only be permitted in Zone 3a if the Exception Test is passed.

Zone 3b: According to NPPF guidance, only water-compatible uses and the essential infrastructure that has to be there should be permitted in Zone 3b. Essential infrastructure in this zone should pass the Exception Test and be designed and constructed to meet a number of flood risk related targets. Less vulnerable, more vulnerable and highly vulnerable uses should not generally be permitted in Zone 3b; however LBHF policy varies from NPPF guidance and allows development in all vulnerability classes subject to the Exception Test being fulfilled.

Table 2-2: Flood Risk vulnerability classification

Essential Infrastructure	• Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use[3] • Installations requiring hazardous substances consent[4]. Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations that require coastal or water-side locations, or need to be located in other high flood risk areas. In these instances the facilities should be classified as "essential infrastructure".[5]
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste[6] • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.[7]
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable" classification and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).

[3] For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.

[4] See the Planning Practice Guidance for Hazardous Substances:
http://planningguidance.planningportal.gov.uk/blog/guidance/hazardous-substances/planning-for-hazardous-substances/
www.communities.gov.uk/publications/planningandbuilding/circularplanningcontrols

[5] In considering any development proposal for such an installation, local planning authorities should have regard to planning policy on pollution in the NPPF.

[6] For definition see the Planning Practice Guidance for Waste at:
http://planningguidance.planningportal.gov.uk/blog/guidance/waste.

[7] See footnote 2.

Water compatible development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Notes to Table 2-2:
a. This classification is based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on Flood Risks to People (FD2321/TR2)[8]and also on the need of some uses to keep functioning during flooding.
b. Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.
c. The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

2.2 SFRA Approach

This SFRA was undertaken in two stages, the approach to each stage of the SFRA is as follows:

2.2.1 Stage 1

Data Collection

A critical phase in the project delivery is the collection and review of existing information. A summary of data sources used in this assessment is provided below:

- Sites likely to be developed.
- Historical records of flooding including cause and extent.
- Known and perceived flood risk areas, including Flood Zone Maps and details of flood risk areas associated with groundwater and surface water drainage issues including CDAs.
- Catchment topography LiDAR (Light Detection and Ranging) data and Ordnance Survey (OS) Mapping.
- Existing investigations for the River Thames.
- Current flood risk management strategies including details of flood defence assets.

[8] See website for further details:
https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCIQFjAA&url=http%3A%2F%2Fsciencesearch.defra.gov.uk%2FDocument.aspx%3FDocument%3DFD2321_3436_TRP.pdf&ei=W0PrVISbDYXYOOe6gfAF&usg=AFQjCNHHGie6pNSdrv0tpGLCD3QxNlHfnQ&bvm=bv.86475890,d.ZWU

- Hydrometric data.
- Sewer map and surface water modelling results from the SWMP.
- DG5 Sewer Flooding Records.
- Groundwater flood risk data including geological maps.

Assessment of Flood Risk

The primary objective is to assess and categorise flood risk from all sources within the study area. In general, the following considerations have been addressed as part of the flood risk assessment process:

- Identification of known and/or perceived flood risk areas, including the nature of the flooding problem (e.g. river, canal, sewer, groundwater flooding; surface water flooding and local under-capacity drainage; culvert blockage), providing the initial 'filter' for key flood risk issue areas within the district.
- Review of current Environment Agency Flood Zone Map to provide an initial definition of High Risk Zone 3.
- Review of CDAs provided in the LBHF SWMP and identification of critical floodplain areas.
- Identification of significant structures (bridges, culverts, embankments, outfalls etc) that will influence local hydraulics.
- Identification of formal and informal flood defences that reduce flooding to development and regeneration areas.
- Definition of areas subject to development pressure and/or regeneration.
- The hazard associated with rapid inundation following failure of existing defences, breaching and overtopping has been identified (where relevant) and modelled (where possible).

Review of Climate Change and Land Use Impacts

Consideration has been given to the implications of wider land management practices on flood risk in the area. The delineation of Flood Zones 2 and 3, coinciding with the 1 in 1000 year (0.1% AEP) and 1 in 200 year (0.5% AEP) events respectively, has been used as an indication of how flood risk may alter laterally as a result of climate change. Where existing river models were available, further interrogation of modelling results has been used to determine more accurately the potential impact of climate change and land use change on design levels. Surface water modelling outputs from the LBHF SWMP, shown in Figures 3 and 4 (Appendix B), have taken into account climate change predictions by applying increased rainfall in the model.

2.2.2 Stage 2

This involves identifying those areas in the Borough that fall within Flood Zones 1, 2 and 3. LBHF have put forward 18 development areas. The individual sites are overlain onto the defined flood risk zones (refer to Figure 10 in Appendix B) and reviewed with respect to the degree of flood risk predicted to impact them. The filtering process used to categorise these sites is summarised in Table 2-3 overleaf. In addition to review of flood zones, which provide information on tidal flood risk only, surface water, groundwater and reservoir inundation datasets are reviewed in order to reflect the actual flood risk to the sites from all sources.

Table 2-3: Flood Zones and Development

Sites within Flood Zone 1: Sites located outside the 'medium' and 'high' flood risk areas (Flood Zones 2 and 3 respectively). The NPPF considers areas within Flood Zone 1 to be at little or no risk of fluvial or tidal flooding. Flood risk zones are defined by the Environment Agency's Flood Zone Maps.	 Preferred location for development (least risk and greatest range of compatible land uses)
Sites within Flood Zone 2: Sites located outside the high flood risk zone 3 but wholly or partially located within the medium Flood R Zone 2.	
Sites within Flood Zone 3a: Previously developed or undeveloped areas wholly or partially located within high Flood Zone 3a.	Development less/not acceptable (highest risk and least range of compatible land uses)
Sites within Flood Zone 3b: Sites located wholly or partially within the functional floodplain. These are areas where water has to flow or be stored in times of flood.	

Planning Review of Sites within Flood Zones 1 and 2

Recommendations for the future management of development and redevelopment sites in 'low' to 'medium' flood risk areas are provided to meet the requirements of national planning guidance and regional and local flood risk policy.

Planning Review of Sites within Flood Zone 3

Consideration has been given to the actual risk posed to individual sites in 'high' flood risk areas (Flood Zone 3) and recommendations for development allocations have been made. Development constraints within these areas are dependent on the strategic importance and requirement for development (within a planning context).

Recommendations for the future management of development within the 'high' Flood Risk Zone have been provided on a site-by-site basis to meet the requirements of the NPPF, as well as regional and local flood risk policy.

Detailed Assessment Requirements and Exception Test

In order to assist LBHF in determining whether housing and employment requirements can be met, without affecting existing areas of medium to high flood risk, detailed assessments have been carried out at a number of sites. At these sites the potential impact and feasibility of generic mitigation measures have been considered. Where necessary sites have been assessed to determine what is required to pass part b of the Exception Test.

Establishment of Guidance for LPA and Developers at Planning Application Stage

Concise and pragmatic guidance has been developed to assist the Council and developers to ensure that the outcomes and recommendations of the SFRA are followed through to the planning application and implementation stage.

It is imperative to ensure that the requirements placed upon developers at the planning application stage are robust and fit for purpose. Similarly, the ownership, roles and responsibilities of the LPA, Environment Agency and Thames Water as appraisal bodies must also be clearly understood to ensure that the intent of the SFRA and planning process are not lost.

LBHF as a Lead Local Flood Authority (LLFA) is only responsible for the management of Local Flood Risk. Local flood risk is defined as surface water flooding, ordinary watercourse flooding and groundwater flooding. This area of responsibility is defined by the Flood and Water Management Act 2010.

3. The Planning Framework

3.1 Introduction

The purpose of this section of the report is to identify and outline those high level documents which have to be taken into account in preparing this SFRA. The documents which have been reviewed include the London Plan together with national planning legislation and Local Plan policies and guidance.

3.2 National Planning Guidance

Flood and Water Management Act 2010

The Flood and Water Management Act 2010 places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. The Act and Regulations together set out the requirements and targets Local Authorities need to meet, including:

- Taking an active role leading flood risk management as LLFAs.
- Cooperating with other relevant authorities to manage local flood risk.
- Setting a duty to investigate flood incidents and report upon them.
- Maintaining an 'Asset Register' of assets that have a significant influence on local flood risk.
- Designating 'features' that have a significant influence on local flood risk.
- Regulating works on 'ordinary watercourses'.
- Developing and implementing Local Flood Risk Management Strategies (LFRMS).
- Providing support to the LPA, acting as the statutory consultee on the delivery of SuDS techniques where necessary.

The Flood and Water Management Act also clarifies three key areas that influence development:

- Sustainable drainage (SuDS) - the Act makes provision for a national standard to be prepared on SuDS. Developers will be required to obtain LPA approval for the SuDS in accordance with the Non-Statutory Technical Standards for sustainable drainage systems as part of the planning application process.
- Flood risk management structures - the Act enables the Environment Agency and Local Authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent.
- Permitted flooding of third party land – In exceptional circumstances, the Environment Agency and Local Authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

The Flood and Water Management Act places a responsibility on the LBHF to manage and lead on local flooding issues in the Borough, including co-operating with other relevant authorities and regulating Sustainable Drainage Systems.

National Planning Policy Framework (2012)

The National Planning Policy Framework[9] was issued in March 2012 and outlines the national policy including on development and flood risk assessment. This replaced with immediate effect national policy including Planning Policy Statement 25 – Development and Flood Risk.

The NPPF requires Local Plans to be supported by a Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources. Advice should be sought from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities. Planners should use the Sequential Test as the primary decision making tool, and if this is passed and it is deemed necessary to place development in higher flood risk zones, apply the Sequential Approach to steer vulnerable development within the red line boundary to areas at lowest risk of flooding.

National Planning Policy Guidance

The Technical Guidance to the National Planning Policy Framework[10] has been superseded by the Planning Practice Guidance Flood Risk and Coastal Change[11] (April 2015) which sets strict tests to protect people and property from flooding. All local planning authorities are expected to follow the PPG. Where these tests are not met, national policy is clear that new development should not be allowed. The main step to be followed is designed to ensure that development is directed to the lowest risk of flooding (the Sequential Test). Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. This is in accordance with paragraph 101 of the NPPF.

The National Planning Practice Guidance document provides guidance on how the local planning authorities should:

- Assess flood risk;
- Avoid flood risk; and
- Manage and Mitigate flood risk and coastal change.

There is also information on the requirements to consult the Environment Agency, on the role of lead local flood authorities and on flood risk in relation to minor developments. In addition, NPPF provides information on the application of the Sequential and the Exception Tests in the preparation of a Local Plan.

The April 2015 update to the practice guidance provides additional guidance on SuDS, including:

- The importance of SuDS;
- When SuDS should be considered;
- The SuDS discharge hierarchy;
- Factors a local authority will address when considering SuDS as part of a planning application;
- When SuDS are inappropriate and relevant flood risk consultees;
- Applicability of Defra's Non-statutory Technical Standards for Sustainable Drainage Systems;
- Design and construction cost considerations;
- Operation and maintenance considerations; and
- Where to go for further SuDS advice.

As part of the April 2015 update, the practice guidance provides details on the parties responsible for assessing the suitability of SuDS practices. As per paragraph 084 from the practice guidance:

The decision on whether a sustainable drainage system would be inappropriate in relation to a particular development proposal is a matter of judgement for the local planning authority. In making this judgement the local planning authority will seek advice from the relevant flood risk management bodies, principally

[9] National Planning Policy Framework (DCLG, 2012)

[10] Technical Guidance to the National Planning Policy Framework (DCLG, 2012)

[11] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

the lead local flood authority, including on what sort of sustainable drainage system they would consider to be reasonably practicable.

Non-statutory Technical Standards for Sustainable Drainage Systems, March 2015

This document, published by the Department for Environment, Food and Rural Affairs, sets out non-statutory technical standards for sustainable drainage systems. The non-statutory technical standards should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

Non-statutory technical standards are provided for the following items:

- Flood risk outside the development;
- Peak flow control;
- Volume control;
- Flood risk within the development;
- Structural integrity;
- Designing for maintenance considerations; and
- Construction.

LBHF will offer adoption for all new SuDS Features that meet the LBHF SuDS Adoption Criteria, set out within the LBHF SuDS Design and Adoption Guide[12]. All Major planning applications will need to set out who will be responsible for maintaining and inspecting the drainage system for the lifetime of the development and include a detailed SuDS maintenance plan.

[12] http://connect.woking.public-i.tv/document/Item_5___Adoption_of_Sustainable_Drainage_Systems___SUDS___19_March_2015.pdf

3.3 Regional Policy Drivers

The London Plan

The London Plan is the overall strategic plan for London, setting out an integrated economic, environment, transport and social framework for the development of London over the next 20 to 25 years. Since the London Plan was adopted in 2004 there have been several revisions to the Plan, with the most recent revisions published in 2015. At the time of writing, an Examination in Public of the Draft Further Alterations to the London Plan (FALP) is ongoing. The London Plan contains a series of objectives identified by the Mayor of London. The overarching objective of the plan is to promote sustainable development. The London Plan indentifies five sub regions (Central London, North, East South and West). LBHF is identified as being within the West London sub region. The London Plan also has a number of policies, some of which have recently been revised in the REMA document. The policies relevant to this SFRA include:

Policy 5.11 Green Roofs

Major development proposals should be designed to include roof and site planting, especially green roofs and walls where feasible, to deliver as many of the following objectives as possible:

- Adaption to climate change.
- Sustainable urban drainage.
- Mitigation of climate change.
- Enhancement of biodiversity.
- Accessible roof space.
- Improvements to appearance and resilience of the building.
- Growing food.

Policy 5.12 Flood Risk Management

Strategic -The Mayor will work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost effective way.

Planning decisions - Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the PPG over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 Plan and Catchment Flood Management Plans.

Developments which are required to pass the Exception Test set out in the NPPF and the PPG will need to address flood resilient design and emergency planning by demonstrating that:

a) The development will remain safe and operational under flood conditions.

b) A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions.

c) Key services including electricity and water will continue to be provided under flood conditions.

d) Buildings are designed for quick recovery following a flood.

Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourse and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way.

Policy 5.13 Sustainable Drainage

Planning decisions - Development should utilise Sustainable Drainage Systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1) Store rainwater for later use.
2) Use infiltration techniques, such as porous surfaces in non-clay areas.
3) Attenuate rainwater in ponds or open water features for gradual release.
4) Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5) Discharge rainwater direct to watercourse.
6) Discharge rainwater to a surface water sewer/drain.
7 Discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of the Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

Sustainable Design and Construction: The London Plan Supplementary Planning Guidance

The Supplementary Planning Guidance (SPG) was published in April 2014. The document seeks to provide additional information to support the implementation of the London Plan. The guide seeks to identify a series of standards and measures to promote sustainable development around the themes of resource management, adapting to climate change and pollution management, principally land, air, noise, light and water.

With regard to water pollution and flooding, the SPG identifies the following essential standards:

- All developments on greenfield sites must maintain greenfield runoff rates. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate.
- Developments should utilise SuDS unless there are practical reasons for not doing so. The aspiration is to deliver SuDS schemes that provide multiple benefits, in addition to reducing flood risk.
- A range of return periods up to and including the 1 in 100 year plus climate change critical storms (an additional 20-30%) should be assessed.

The guidance provides a helpful introduction to the various methods of SuDS which can be applied and adopted as part of a development proposal.

3.4 Local Planning Policy

The Core Strategy Adopted October 2011

The Local Plan includes the Core Strategy (adopted October 2011), the Development Management Local Plan (adopted July 2013) and Planning Guidance Supplementary Planning Document (July 2013).

The Core Strategy DPD is the overarching document of the LDF and sets out the Borough's long term vision for land use. The Core Strategy highlights that the risk of flooding from the River Thames and from surface water flooding are key issues in Hammersmith and Fulham and that they have to be taken into account when planning new development in the Borough. Proposed changes to the Local Plan recognise the importance of groundwater flood risk in the Borough.

Policy CC2 Flooding

Water and Flooding

The Council will expect all development to minimise current and future flood risk and the adverse effects of flooding on people. In particular:

- All development at risk of flooding should be subject to a site specific flood risk assessment, appropriate to the scale and type of development.
- Development within the High and Medium Residual Risk areas should assess the type and severity of flood risk and manage the residual flood risks.
- Contributions from development proposals will be required to assist in mitigation and/or relief measures which will reduce the overall risk of flooding.
- Development adjoining the river will be expected to maintain the integrity of river defences and set development back in order to allow the maintenance and improvement of the defences.

In addition, the Council will strive to reduce the risk of flooding from surface water and foul water and its contribution to fluvial flooding by requiring development proposals to include appropriate sustainable drainage systems and systems to reduce the amount of water discharged to the foul water drainage.

Development Management Local Plan Policy DM H3

Reducing water use and the risk of flooding

The Council will require developments to reduce the use of water and minimise current and future flood risk and the adverse effects of flooding on people by implementing the following measures:

- All new build, changes of use and conversions from a less to a more vulnerable use should assess the risk of flooding from all sources, in particular tidal, surface water and sewer flooding. Where there is a risk of flooding, a site specific Flood Risk Assessment (FRA) will be required in accordance with the guidance in the LBHF SFRA;
- Prior to undertaking an FRA, the developer needs to address the requirements of the NPPF and, where applicable, to carry out parts a and b of the Exception Test. Evidence that the Exception Test has been passed will need to be included in the FRA;
- All developments in the Borough will be required to incorporate Sustainable Drainage Systems (SuDS) to reduce both the volume and speed of surface water run-off unless there are practical reasons for not doing so;
- Developments will be expected to achieve greenfield run-off rates and at least 50% attenuation of undeveloped site's surface water run-off at peak times, and where possible to achieve 100% attenuation;

- New self-contained basement flats will not be permitted in areas where there is a medium to high risk of flooding and no satisfactory means of escape can be provided;

- All new development should include water efficient appliances. In addition, major developments and high water use developments should include other measures such as rainwater harvesting and grey water re-use; and

- All new development proposals will be required to demonstrate that there is sufficient water and wastewater infrastructure capacity both on and off site to serve the development or that any necessary upgrades will be delivered ahead of the occupation of development.

Development Management Local Plan Policy DM A8

Basement accommodation and lightwells

New basement accommodation in existing dwellings will be permitted where:

- It does not extend beyond the footprint of the dwelling and any approved extension (whether built or not);

- There is no adverse impact on the amenity of adjoining properties and on the local natural and historic environment; and

- It does not increase flood risk from any source.

All other new or extended accommodation below street level should be designed to minimise the risk of flooding to the property and nearby properties from all sources of flooding. To minimise the risk of sewer flooding, developments will be required to provide active drainage devices.

Where there is a medium to high risk of fluvial flooding and no satisfactory means of escape can be provided, new self contained basement flats will not be permitted.

Planning Guidance Supplementary Planning Document Policy 1

Flood Risk Assessment

Planning applications must provide supporting information in line with the requirements of this SPD to show that appropriate consideration has been given to all forms of flood risk. Where necessary, a drainage strategy and information on proposed mitigation measures should be provided. There may need to be consultation with the Environment Agency and Thames Water.

Information should be included on proposed sustainable drainage measures and any ongoing management requirements, in consultation with the Environment Agency and Thames Water where necessary, to show compliance with Development Plan policies on sustainable drainage. Any approved drainage measures shall thereafter be retained and maintained in accordance with the approved details.

Local Plan: Proposed Groundwater Text

LBHF has proposed changes to the Local Plan, currently in the draft stage. The proposed text is as follows:

“There is an increased potential for elevated groundwater in some parts of the borough, mainly to the south of Goldhawk Road.

Groundwater needs to be taken into account where new basement construction or extensions are planned to ensure that any new development does not increase flood risk either on-site or by impacting on groundwater flows to the detriment of neighbouring properties. Policy HO11 on basements and light wells sets out further requirements in this respect”

The Core Strategy states that the Council will expect all development to minimise current and future flood risk and the adverse effects of flooding on people. Planning applications must provide supporting information to show that appropriate consideration has been given to all forms of flood risk.

The Environment Agency's Thames Estuary 2100 Project

The Thames Estuary 2100 Project was established by the Environment Agency in 2002 with the aim of developing a strategic flood risk management plan for London and the Thames Estuary through to the end of the century. The project primarily looks at tidal flooding, though other sources of flooding (including high river flows as a result of heavy rainfall and surface water flooding) are considered.

The key driver for the project was to consider how tidal flood risk was likely to change in response to future changes in climate and people and property in the floodplain. Additional to this was an understanding that many of the existing flood walls, embankments and barriers were getting older and would need to be raised or replaced to manage rising water levels.

The plan divided the estuary into 23 geographical areas, known as policy units. Each policy unit has been assessed to determine the appropriate level of flood risk management.

It confirms that the source of flooding is:

- Tidal from the River Thames upstream of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled), flood depths up to 3 meters if the Thames Barrier were to fail.
- Risk from pluvial and urban drainage sources.

LBHF is within Action Plan Zone 1 "West London", and is in Policy Unit "Hammersmith". The Policy is "*P5: to take further action to reduce flood risk beyond that required to keep pace with climate change".*

The Environment Agency's vision for the Hammersmith policy unit is to enhance the already attractive environment in this area by providing defence improvements that are designed in a sensitive way and blend with the surroundings whilst achieving policy P5. The vision also includes greater local and institutional awareness of the flood risk, which should influence emergency planning, land use planning and new development.

Thames Water Five-Year Plan for 2015 to 2020

The Thames Water Five-Year Plan for 2015 to 2020[13] states that Thames Water intends to:

- Reduce risk of internal flooding to 1,799 properties, protecting them from a 1 in 30 year storm. This aims to "benefit many homes in... Hammersmith and Fulham";
- Ensure that new housing developments do not increase the risk of flooding for existing customers;
- Investigate reducing groundwater entering sewers at fourteen locations; and
- Promote more widespread use of sustainable drainage in their region to reduce dependence on the drainage network.

[13] Summary of our five-year plan (2014) Thames Water. Available at: http://www.thameswater.co.uk/about-us/17481.htm [Accessed 21st August 2014]

In addition, the Thames Tideway Tunnel is being constructed to upgrade London's sewer system.

Surface Water Management Plan (SWMP)

A Surface Water Management Plan (SWMP) was completed in April 2015. The document is a plan which outlines LBHF's preferred surface water management strategy and includes consideration of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 1000 probability of occurrence in any given year (1% Annual Exceedance Probability, AEP). A review of the results demonstrate that 7,059 residential properties and 899 non-residential properties in the Borough could be at risk of surface water flooding of greater than 0.1m depth during a 1% AEP rainfall event. Of those, 845 residential properties and 64 non-residential properties could be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event.

Preliminary Flood Risk Assessment

A Preliminary Flood Risk Assessment (PFRA) was completed in July 2011 as part of the wider Drain London project which involved the delivery of a Surface Water Management Plans (SWMP) – modelled at an intermediate level – and PFRA for each of the 32 London Boroughs and the Corporation of the City of London. The PFRA has been undertaken to assist LBHF to meet its duties as an LLFA, with the delivery of the first stage of the Flood Risk Regulations (2009).

The PFRA is a high level screening exercise that compiles information on significant local flood risk from past and future floods, based on readily available and derivable information. The study has not identified any past floods that are considered to have had significant harmful consequences. Future flood risk from extreme events is estimated to be high in the LBHF.

4. Data Collection

4.1 Flood Zone Maps

The Environment Agency Flood Zone Maps show the extents of the 1 in 200 year return period tidal flood event (an event with a 0.5% chance of occurring each year) and 1 in 1000 year tidal event (an event with a 0.1% chance of occurring each year). They were prepared using a methodology based on modelling of the estuary and two dimensional (2D) flood routing using ground data based on LiDAR.

The Environment Agency Flood Zone Maps do not take account of flood defences and, therefore, represent a theoretical maximum extent of tidal flooding. The actual extent of flooding is mitigated by flood defences. Therefore, the Environment Agency Flood Zone Maps provide a worst case assessment of the extent of flooding and are consistent with the NPPF, which categorises flood risk ignoring the effects of defences. Figure 1-2 shows the extent of Flood Zones 2 and 3 across the Borough.

4.2 Flood Defences

As discussed above, the Environment Agency Flood Zone Maps do not take account of the presence of flood defences. The NPPF states that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding, and therefore sites within these areas must be assessed with respect to the adequacy of the defences.

The tidal Thames is defended to a 1 in 1000 year standard (protection against an event with a 0.1% chance of occurring each year), by a series of walls, embankments, flood gates and barriers, with the Thames Barrier being the major protection for the study area. The statutory defence level (the level to which the defences must be maintained) within the study area is 5.41m downstream of Putney Bridge and 5.54m upstream.

The location and condition of all flood defences within the Borough has been provided by the Environment Agency via the National Fluvial and Coastal Defence Database (NFCDD). Table 4-1 shows how condition is rated by the Environment Agency.

Table 4-1: NFCDD Condition Ratings

Condition Rating	Condition	Condition Description
1	Very good	Fully serviceable
2	Good	Minor defects
3	Fair	Some cause for concern. Requires careful monitoring
4	Poor	Structurally unsound now or in the future
5	Very Poor	Completely failed and derelict

4.3 Breach Modelling

Thames Estuary (TE2100) Plan

The Thames Estuary 2100 (TE2100) Plan[14] sets out the EA recommendations for flood risk management for London and the Thames Estuary until 2100. The plan has a strong emphasis on climate change adaptation, using the latest climate science to understand climate change impacts in the Thames Estuary.

TE2100 tidal data provided by the Environment Agency includes extreme water levels (0.5% AEP event) in the Thames for the present day (2012)[15] and future years (up to 2065 and 2100 including climate change). The data also includes present day defence levels and the levels to which defences should be raised in order to defend against the extreme water levels for 2100 (including climate change).

Tidal Data

Table 4-2 shows the TE2100 Extreme Water Levels (mAOD) for the tidal Thames Figure 4-1 the node locations. A comparison of the Thames Tidal Joint Probability Extreme Water Level Model data (2008) and the TE2100 data (2012) shows that the 2008 data provides a higher water level for all nodes within close proximity to the LBHF. The TE2100 data also shows an increase in level between 2012 and 2100, whereas the 2008 data shows a decrease in water level between 2005 and 2107. The TE2100 data should be considered more reliable as the study takes into account a significant amount of climate change research undertaken by Met Office Hadley Centre and other key organisations.

Table 4-2: TE2100 Extreme Water Levels (mAOD) for the Tidal Thames

Scenario	0.5% Annual Probability of Exceedance for node 2.19
Present day (2012)	5.03
Future (up to 2065 including climate change)	5.64
Future (up to 2100 including climate change)	5.93

Scenario	0.5% Annual Probability of Exceedance for node 2.20
Present day (2012)	5.01
Future (up to 2065 including climate change)	5.63

[14] Thames Estuary 2100: TE2100 Plan (2012) Environment Agency

[15] "Present day" is the reference used in the original study and refers to 2012, not to the "present day" at the time of this SFRA update (2016).

Scenario	0.5% Annual Probability of Exceedance for node 2.20
Future (up to 2100 including climate change)	5.92

Scenario	0.5% Annual Probability of Exceedance for node 2.21
Present day (2012)	4.96
Future (up to 2065 including climate change)	5.60
Future (up to 2100 including climate change)	5.89

Scenario	0.5% Annual Probability of Exceedance for node 2.22u
Present day (2012)	4.49
Future (up to 2065 including climate change)	5.58
Future (up to 2100 including climate change)	5.88

Scenario	0.5% Annual Probability of Exceedance for node 2.23
Present day (2012)	4.93
Future (up to 2065 including climate change)	5.57
Future (up to 2100 including climate change)	5.87

Scenario	0.5% Annual Probability of Exceedance for node 2.24 / 2.24au / 2.24ad
Present day (2012)	4.92

Scenario	0.5% Annual Probability of Exceedance for node 2.24 / 2.24au / 2.24ad
Future (up to 2065 including climate change)	5.56
Future (up to 2100 including climate change)	5.85

Scenario	0.5% Annual Probability of Exceedance for node 2.25
Present day (2012)	4.90
Future (up to 2065 including climate change)	5.54
Future (up to 2100 including climate change)	5.84

Scenario	0.5% Annual Probability of Exceedance for node 2.26
Present day (2012)	4.89
Future (up to 2065 including climate change)	5.54
Future (up to 2100 including climate change)	5.84

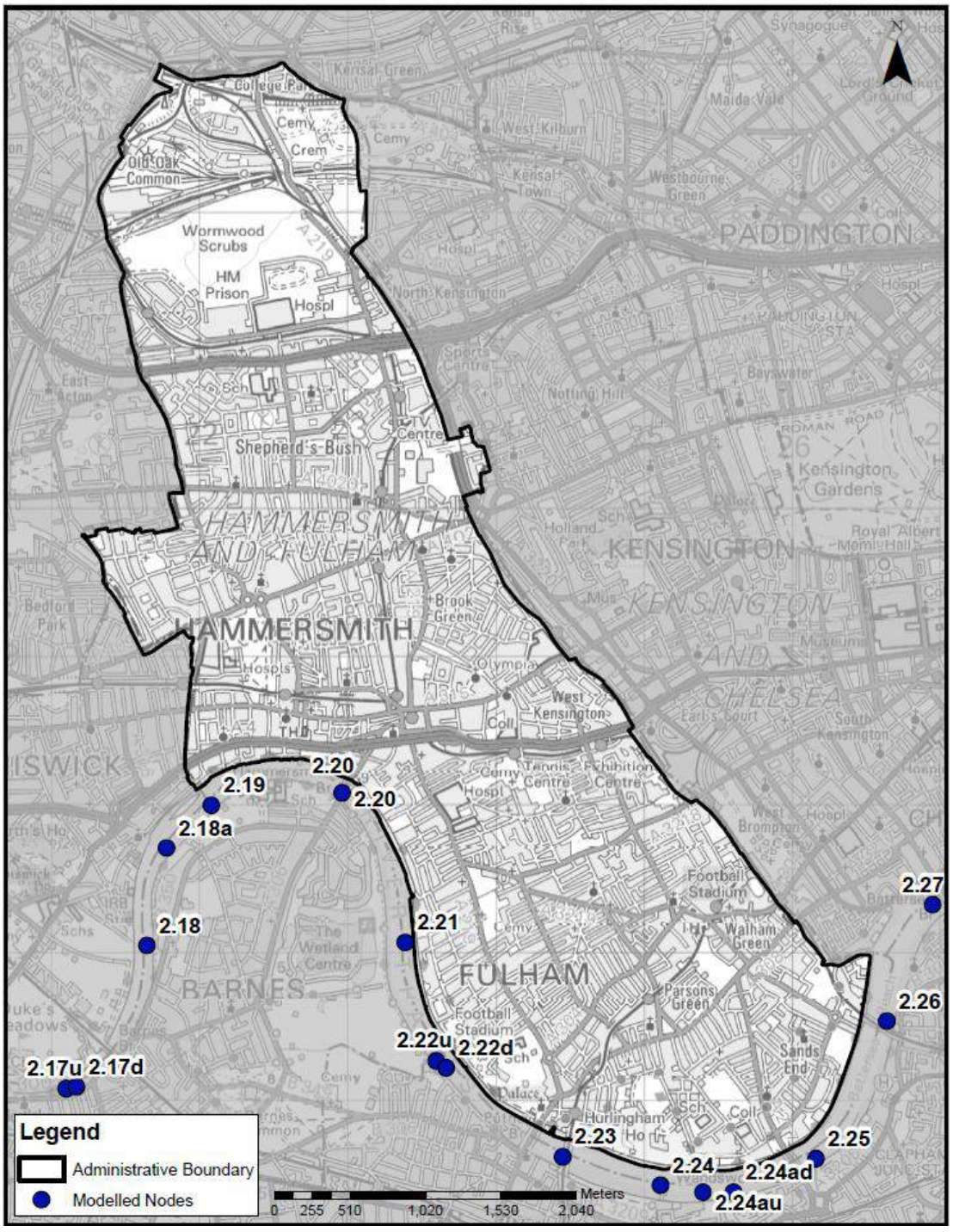

Figure 4-1: Flood Model Node Locations

4.4 Flooding from other sources

Surface Water

The LBHF Surface Water Management Plan (SWMP), completed in April 2015, provides additional surface water flood risk data and model outputs that were not available at the time of the original SFRA. The SWMP outlines the Borough's preferred surface water management strategy and includes consideration of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall. The SWMP is the most recent and comprehensive study

of surface water flood risk for LBHF. Surface water model outputs completed for the SWMP and CDAs defined within with SWMP were reviewed for the SFRA update.

Sewer

Updated sewer flood risk information provided in the SWMP and updated historical sewer flooding records provided by Thames Water were utilised to assess sewer flood risk in this SFRA.

Groundwater

The following groundwater flood risk and modelling studies have been completed since the release of the original SFRA, and have informed this updated SFRA: Increased Potential for Elevated Groundwater Maps (GLA 2011); Environment Agency Areas Susceptible to Groundwater Flooding Map (EA 2012); and ESI Groundwater Flood Risk Map Version 1.1 (ESI 2014).

4.5 Topography

Remotely sensed ground level data (LiDAR) was made available for use in the SFRA by the Environment Agency. This information is in the form of a land surface level grid with a 1m grid resolution. The nominal vertical accuracy of LiDAR data is typically ±0.25 m. LiDAR data is available for most of the Borough and has been utilised. Figure 2 (Appendix B) shows the topography of the study area.

4.6 Lost Rivers

Lost Rivers were once tributaries of the River Thames before they became culverted or converted into sewers. There are three Lost Rivers in the study area; one forms the Borough boundary line with RBKC (Counters Creek) and the other two are located in the west of the Borough at Stamford Brook and Parr's Ditch.

Counters Creek rose near Kensal Green cemetery and flowed roughly straight in a south-south-east direction passing close to the present sites of Olympia, Earl's Court and Stamford Bridge. It would have passed under the bridge carrying the King's Road and have continued to the River Thames as Chelsea Creek[16] (which is still visible). In the early 19th century Counters Creek, south of Olympia, was converted into the Kensington Canal, but was later bought and drained by the West London Railway Company to build a rail line extension. The stream now runs underneath the railway line in the Counters Creek Sewer.

Stamford Brook encompasses the streams draining into the River Thames at Hammersmith. The eastern stream rose west of Wormwood Scrubs; the western stream flowed down to Ravenscourt Park, where they joined to flow out to the River Thames at Hammersmith Creek. Stamford Brook was covered and made a sewer in the late 19th century.

Parr's Ditch was possibly artificial, rather than a river, to divide the parishes of Hammersmith and Fulham, it remained open until 1876 when it was converted to a sewer.

4.7 Historical Flooding

Historical flooding events and issues have been identified and assessed utilising a number of information sources. These include the Environment Agency, LBHF, Thames Water, London Fire Brigade, Transport for London and Network Rail. Figure 6 (Appendix B) provides an overview of historical flood incident data for the Borough.

[16] Barton, N (2000) The Lost Rivers of London. Historical Publications Limited, chpt 4, p.43-48.

Surface Water Flooding

As part of the development of the SWMP, LBHF provided a GIS dataset of recorded flooding incidents, predominantly from the July 2007 flood event. These are the only historical surface water flooding records held by the Council. These records are shown in Figure 6 (Appendix B). In many cases the historic flooding information provided is anecdotal and does not include records of flood depth or cause of flooding.

The most recent significant flood event occurred during July 2007, when intense periods of rainfall exceeded the capacity of existing drainage systems, causing significant overland flow and ponding of surface water in low lying areas. Many areas were affected including properties in Sands End, Parsons Green, Fulham, Brook Green and the Cathnor Park area.

Other significant flood events held by LBHF include:

- A storm on the night of the May 30th 1979 resulted in a surcharge of the sewer system locally around Vera Road (SW6) and Tadmore Street (W12). This caused a number of basement properties to flood.
- In recent times there has been regular surcharging of the sewer on the north side of Shepherds Bush Green, sufficient to cause flooding to the old public toilets which is now a nightclub.
- On July 20th 2007 the Borough suffered surface water flooding as a consequence of heavy prolonged rainfall with 148 calls being made to LBHF's Emergency Planning Team.

Sewer Flooding

Thames Water was able to provide information regarding sewer flooding events over the past ten years on a broad scale. The information was provided on postal area basis; no specific information was provided as Thames Water consider that providing customers' addresses is not in accordance with data protection requirements. **Error! Reference source not found.** shows the number of properties flooded by overloaded sewers within LBHF over the past ten years. For a more detailed review of sewer flooding, refer to the LBHF SWMP.

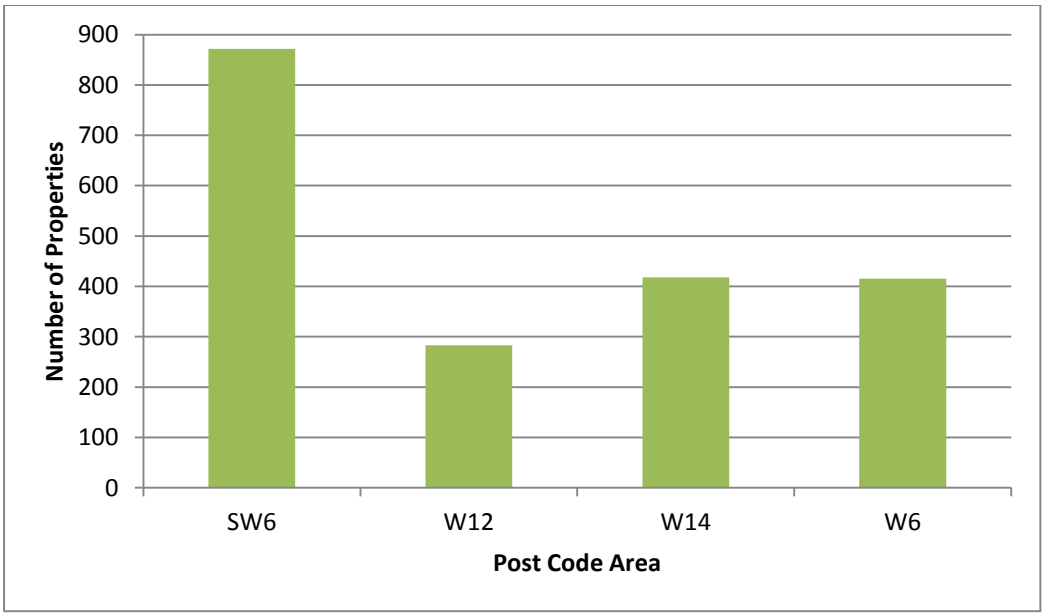

Figure 4-2: Number of properties flooded by overloaded sewers over the last 10 years

Historic Tidal Flooding Records

The Environment Agency does not have a record of the extent of tidal flooding within LBHF. Table 4-3 indicates the levels recorded during extremely high tides in London.

Table 4-3: Observed water levels (mAOD) at Hammersmith Bridge during high tides

	7 Jan 1928	13 Feb 1938	1 Mar 1949	1 Feb 1953	10 Dec 1965	19 Jan 1975	12 Jan 1978	31 Dec 1978
Hammersmith Bridge	5.16	5.15	5.17	5.33	5.02	5.11	5.3	5.37

The following is an account of how LBHF was affected by the 1928 flood event in London:

> "The flooding at Hammersmith Bridge reached a depth of five feet (approximately 1.5 metres). There was widespread dislocation; phones were cut off, cars damaged and stranded, roads blocked by fallen debris. In all fourteen people died in the 1928 floods, most of them in their beds, including young female servants in the downstairs quarters of wealthy property owners in the Westminster and Chelsea areas."[17]

There has been no major flooding from the River Thames within LBHF since the 1930 Flood Act when, following the 1928 flood event, the level of the defences were raised.

[17] Milne, A (1982) London's Drowning. Thames Methuen, chpt 1, p17.

5. Flood Risk in the London Borough of Hammersmith and Fulham

5.1 Introduction

The guidance detailed below has been developed to provide a clear, concise and consistent means of assessing the feasibility and sustainability of sites and to determine appropriate flood risk mitigation measures where required. The framework will aid LBHF and others in assessing flood risk associated with allocations and potential development sites. It will also provide an evidence base for the flood risk related policies in the Council's Local Plan. Although now replaced by the NPPF, the PPS25 Practice Guide still contains useful guidance and examples of flood risk management which can be used to manage flooding within LBHF. However, it should be noted that defences do not eliminate the risk, only reduce the frequency of flooding.

The NPPF aims to direct development to lower flood risk sites wherever possible. "Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere"[18]. The LBHF Core Strategy (October 2011) states that due to the high risk of flooding throughout the Borough, from a range of sources including tidal and surface water, the Sequential Test permits the consideration of all sites for development, subject to meeting the requirements of the Exception Test and a completion of an appropriate site specific FRA. Therefore, the Sequential Test does not need to be repeated for proposed developments.

Table 2-1, Chapter 2, highlights the type of development considered appropriate for each Flood Zone. This table highlights whether a development is permitted in a specific Flood Zone, whether the development is permitted but only when the Exception Test is passed, and whether a site specific FRA is required to support a planning application. It must be noted that this SFRA does not preclude the need for site specific FRAs.

This chapter will present the guidance for Flood Zone 3b; Flood Zone 3a (including defended, public safety and rapid inundation, and the feasibility of flood risk mitigation); Flood Zone 2; and Flood Zone 1. It will then discuss issues relating to flood risk from other sources.

5.2 NPPF Flood Zones

The extent of the Flood Zones within the LBHF can be seen in Section 1, Figure 1-2 and at a larger A3 scale in Figure 1 (Appendix B). In the LBHF the Flood Zones correspond to tidal flood risk from the River Thames.

Flood Zone 1 – Low Probability

Flood Zone 1 is the area outside of Flood Zone 2. For LBHF this is mainly the area north of Uxbridge Road and comprises 40% of the Borough. Flood Zone 1 equates to a tidal or fluvial flood event with less than a 0.1% chance of occurring each year (1 in 1000 year event).

In accordance with the PPG Table 3, all development (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) is permitted in Flood Zone 1. All development proposals must consider the following about the sites:

- Their vulnerability to flooding from other sources as well as from river and sea flooding, including surface water, sewer and groundwater sources.

[18] The National Planning Policy Framework, March 2012

- Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.

The LBHF Local Plan (including the Core Strategy, the Development Management Local Plan and Planning Guidance Supplementary Planning Document) and the London Plan lay out clear guidelines for surface water runoff requirements, which must be strictly adhered to within any development proposal. Chapter 3 provides additional detail on these policies.

Flood Zone 2 – Medium Probability

Flood Zone 2 covers an area similar to that of Flood Zone 3 (discussed overleaf) with a few areas where the zone extends further (e.g. the Dawes Road area and West Kensington). The percentage coverage of this flood zone within LBHF is 7%. Flood Zone 2 equates to a tidal flood event which has between a 0.1% and 0.5% chance of each year (between a 1 in 1000 and 1 in 200 year event).

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed.

All development proposals must consider the following information about the sites:

- Their vulnerability to flooding from other sources as well as from river and sea flooding, including surface water, sewer and groundwater sources.
- Their vulnerability to flooding from all sources over the lifetime of the development.
- Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water run-off, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property.
- A demonstration that residual risks of tidal or fluvial flooding are acceptable (after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resilient and resistant design, escape / evacuation (access and egress), effective flood warning and emergency planning).

Flood Zone 3a – High Probability

Flood Zone 3 covers approximately 53% of the Borough; much of the area south of the Uxbridge Road is Flood Zone 3. Flood Zone 3 equates to a tidal flood event with a greater than a 0.5% chance of occurring each year (1 in 200 year event).

PPG Table 3 (reproduced within Section 2, Table 2-1) states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the Sequential Test. According to PPG Table 3, highly vulnerable development is not permitted, with essential infrastructure and more vulnerable development required to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

PPG advocates that developers and Local Authorities should implement the following policy aims:

- Reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques.
- Relocate existing development to land in zones with a lower probability of flooding.
- Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Regeneration of land or change in land use behind existing defended areas in the Flood Zone 3 (has this been defined) will continue to require a more detailed assessment of the flood risk (i.e. whether the scale of risk is worth taking), and how sustainable and effective the mitigation measures would be (i.e. whether the risk could be managed).

An assessment of the actual risk within Flood Zone 3 is required where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones. For development to proceed it must also be shown that the development will not increase flood risk elsewhere. Due to the high risk of flooding from sources including tidal, surface water, sewer and groundwater within LBHF, highly vulnerable developments will be considered provided the criteria above and the provision of a suitable FRA are satisfied.

Flood Zone 3b (Functional Floodplain) – High Probability

Whilst prior to the development of London there would have been large areas of land close to the river that regularly flooded, within the Borough there is now only a very small area of functional floodplain, associated with the small section of Chiswick Mall which falls within the LBHF boundary.

Although not strictly 'floodplain' the tidal foreshore exposed each tide should be protected as this plays an important role in the functioning of the tidal Thames.

5.3 Assessment of Residual Risk

The guidance to the NPPF deals with managing residual flood risk.

Paragraph 16 of the NPPF states that, “residual risks are those remaining after applying the sequential approach and taking mitigating actions.” It states that:

> *"It is the responsibility of those planning development to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed”.*

It is the developer’s responsibility to demonstrate how (in planning terms) this can be achieved and how the residual risks will be managed. A clear distinction between commercial flood standards of protection and management of loss of life should be explored in the FRA. A greater reliance on flood warning may be required, which is not always a tangible alternative to accepting a lower standard of protection.

The study area is a defended area, and is considered to be an area of floodplain where the defences substantially (but not necessarily completely) mitigate the flood risk associated with the event which has a 0.5% chance of occurring each year (1 in 200 year return period).

Within defended areas, tidal flood risk is primarily associated with overtopping and breach of defences (and localised flooding associated with drainage systems in some locations). These risks are related to the likelihood (standard of protection and structural integrity of defences) and consequences of flooding (depth, speed and duration of flooding, and land use within defended area).

The consequences of defence overtopping or failure (breach) can be estimated using flood inundation modelling and mapping. This has been undertaken at a number of locations within the Borough and is detailed in Section 5.4.

5.4 Breach Analysis

The Thames Barrier is designed to be robust and reliable and the Environment Agency maintains and operates the barrier to ensure that the level of protection is maintained. The barrier gates are routinely operated and there is a high degree of redundancy in terms of power supply and hydraulic systems. The Thames Barrier has been closed in response to tidal conditions over 170 times since it became operational in 1982 without any problems arising and thus has proved reliable in practice. The Thames Barrier is only closed in response to high tidal surges (though it has also on occasion been used to reduce high level levels in Teddington and Richmond during fluvial flood events) and thus even with the barrier operating as intended, the predicted peak tide levels can be significantly above the ground level in LBHF. The river walls therefore provide an important defence and a source of residual risk arises from a breach in the flood defence wall.

Existing Environment Agency breach models were used to analyse the flood extent and hazard associated with defence breaches at eight locations within LBHF. The Environment Agency determined suitable breach locations by identifying areas that could be susceptible to a risk from a breach of the defences. It should be noted that this is only an indication as it fails to account for the possibility of human interference with the defence. Examples of human interference include vehicle impact, ship impact and excavation behind defences. The effects of these events on the defence are not always noticed immediately, and the defence may appear fine but later collapse under the pressure of a rising tide. It is not possible to quantify the probability of a defence wall failure, but the probability will be greater than that of a highly engineered and managed defence such as the Thames Barrier.

For the breach analysis it was assumed that the Thames Barrier will not fail but will be used more often in the future as sea levels rise and other actions being studied by the TE2100 are brought into effect.

In the model, a 35 hour tidal sequence is run through the breach, spanning 3 tidal peaks. The breach is ‘open’, adopting the designated sill level throughout the simulation. Different assumptions concerning timing of breach and barrier closure in the event of a breach upriver of the Thames Barrier) would affect the volume of water inundating the floodplain. The extent of flooding at each time step will be different depending on the assumption of the breach.

For this study, only one peak is being modelled for different timesteps, therefore the Environment Agency advised (on the 21st of December 2015) that two assumption were modelled; firstly the breach occurs before the highest peak and secondly the breach occurs near or at the top of the highest peak on the rising limb. Modelling both assumption helps to account for this uncertainty and provides an upper and lower estimate for each time step in regards to extent and depth (refer to Figures 8-1-1 to 8-9-2 in appendix B).

5.4.1 Approach to Breach Analysis

The Environment Agency used 1D/2D linked models to model flood defence breaches for 113 locations along the River Thames (eight of them are within LBHF). The identified breaches were modelled using ISIS spill units linked to 2D TUFLOW floodplain models to create 1D/2D linked models. This approach provides significant benefit compared to the method applied in the previous study (2011/12), in that it allows easy update of hydraulic model breach characteristics (breach sill level, width, weir coefficient and formation over time) without the time-consuming need to change multiple TUFLOW files. This will allow future users to readily test new defence specific breach characteristics.

The 1D models consist of two HT boundary nodes and one spill unit. The spill unit contains the breach width and elevation; the full breach dimensions remain consistent from the start to the end of the simulation. One HT boundary is linked to the design water level time series generated by the 1D Thames river model. The other HT boundary is linked to the 2D TUFLOW floodplain model via the 1D_nd_point and 2D_bc_sx_line shape files.
Flow across the breach location is calculated in the ISIS 1D model and the generated flow hydrograph is transferred into the TUFLOW floodplain model via a TUFLOW 2D BC SX line. The width of the 2D BC SX line corresponds to the breach width (20 or 50m). Floodplain inundation is then simulated by the 2D TUFLOW model.

The elevation of the 2D_bc_sx_line is set equal to the breach sill level. The 2D_bc_sx_line is situated at the lowest elevation point within the breach buffer zone which is an enclosed circle with a radius equal to the breach width (20m or 50m). To prevent model instability, cells directly adjacent to the 2D_bc_sx_line are set to be the same as breach sill level using a 2D_Zplg_Breach shape file. Figure 5-1 summarises the various important inputs of the 1D-2D model setup.

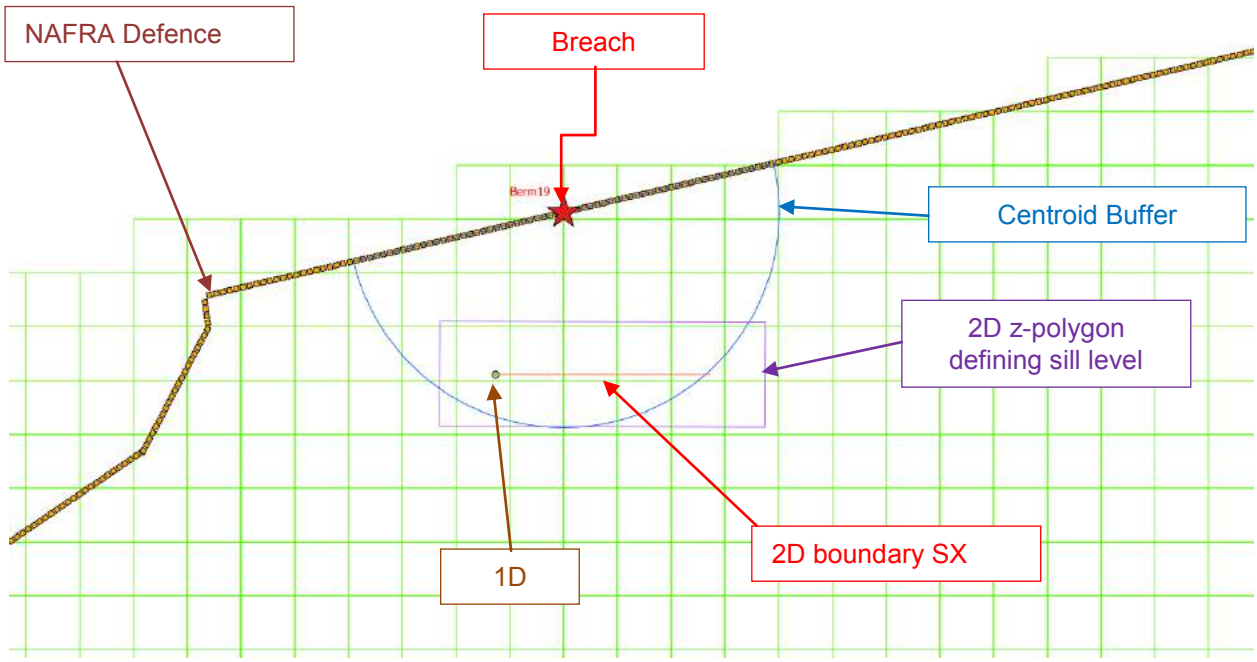

Figure 5-1: Important inputs for the 1D-2D TUFLOW model

5.4.2 Breach Locations

The Environment Agency selected breach locations based on defence condition and ground level behind the defence wall. The breaches remain open for one tidal cycle before being closed. This assumes that (temporary or permanent) repairs would be carried out within hours of the breach occurring. The breaches are represented by a drop from the statutory defence level to the level of the land behind the defence. The breaches are 20m wide, a standard width for hard defences. Table 5-1 indicates the breach locations and elevations in the Environment Agency model, and the top level of the existing defences (crest levels) based on Environment Agency NFCDD data. Breach locations are shown in Figure 5-2 overleaf.

Table 5-1: Modelled Levels (m AOD) for the Tidal Thames

Breach	Location	Width (m)	Defence Crest Level (mAOD)	Breach Sill Level (mAOD)
Ham 1	NGR 521995, 178130	20	5.57	4.68
Ham 2	NGR 522551, 178285	20	5.88	4.02
Ham 3	NGR 522890, 178210	20	5.60	4.26
Ham 4	NGR 523377, 177538	20	6.04	4.24
Ham 5	NGR 523442, 177082	20	6.03	3.43
Ham 6	NGR 523658, 176377	20	5.69	3.17
Ham 7	NGR 524226, 175845	20	5.69	2.80
Ham 8	NGR 524981, 175558	20	5.41	2.35
Ham 9	NGR 176878, 176878	20	5.41	4.70

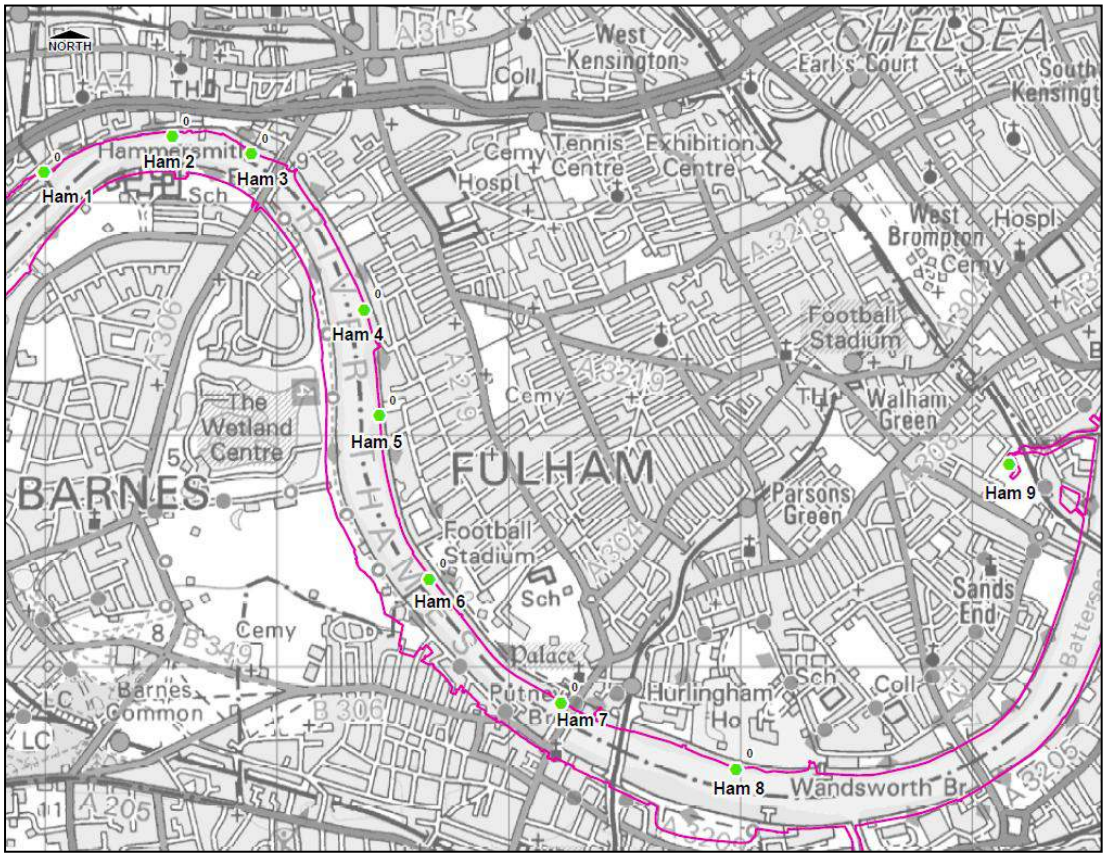

Figure 5-2: Breach Locations

5.4.3 Chelsea Creek Breach

Breach Ham 9 corresponds to Chelsea Creek, which lies along the border of LBHF and RBKC. It was determined that a breach of the defences at Chelsea Creek may lead to flooding within LBHF, and it was therefore decided to model a breach at this location. The region directly to the west of Chelsea Creek,

within LBHF, is currently undergoing significant residential development, which will include a network of canals. The modelled breach was extended along the length of the canal which joins Chelsea Creek, determined from the site plan, in order to more accurately represent the breach. This modelling has utilised the latest TE2100 flood level as this was deemed to be the best available data at the time of modelling.

5.4.4 Overtopping Analysis

Overtopping of the defence walls is unlikely given the operation of the Thames Barrier. However, in the unlikely event of non-closure of the barrier, overtopping could occur. The likelihood of overtopping can be estimated by comparison of modelled water levels and defence crest levels. The TE2100 present day extreme water level for node 2.20 is 5.01mAOD, which is below the crest level of all defences in LBHF, indicating that overtopping of the defences is highly unlikely.

The TE2100 future dataset takes into account the effects of climate change. The future (up to 2100) extreme water level for node 2.20 is 5.92mAOD, which exceeds the current defence crest level of all breaches except Ham 4 and Ham 5, indicating that overtopping could occur at this tidal level at most of the breach locations. Review of the TE2100 study information provided by the Environment Agency indicates that the defences at breach locations Ham 1 to Ham 7 should be raised to 6.40mAOD and the defence at Ham 8 should be raised to 6.35mAOD, which would mean that overtopping does not occur at the extreme tidal level currently predicted. Based on this assumption no overtopping scenarios have been modelled for the LBHF.

5.5 Climate Change

A comparison between the TE2100 present day and future (up to 2100 including climate change) extreme water levels for a 1 in 200 year tidal event indicate a significant increase in the River Thames tidal peak in the region of the LBHF. At node 2.20, used in the breach model, the extreme water level is estimated to increase from the present day level of 5.01mAOD to a level of 5.92mAOD by 2100.

5.6 Residual Risk Classification

For allocations where a development site is close to flood defences, consideration must be given to the risk to public safety (risk to life). Development should not be sited where it could cause or increase risk to public safety and/or the structural integrity of buildings and infrastructure. Consideration of the depth of flooding, rate of inundation and safe access/egress is required to assess these risks. This assessment is applicable to areas at residual risk of flooding, that is, risk from breach or overtopping. Environment Agency guidance suggests that all development should have a dry access and egress in the 1 in 200 year event (the event with a 0.5% chance of occurring each year). Greater depths may be permitted where elevated access/egress to safe ground is provided.

DEFRA has produced a classification to determine the Flood Hazard to People as a function of depth and velocity. The following text explains how the Flood Hazard rating has been incorporated into the Residual Risk Classification. Figure 15 (Appendix B) shows the residual risk classifications for the Borough based on the breach model outputs.

Residual risk classifications should be used as a basis for determining whether an area is at risk of tidal flooding due to a breach in River Thames defences. However, it should be noted that these provide only an indication as the possibility of human interference with defences is not accounted for.

Table 5-2: Residual FD2320 Flood Hazard to People as a function of Depth and Velocity

d × (*v*+0.5) + *DF*	Degree of Flood Hazard	Description
< 0.75	**Low**	Caution *"Flood zone with shallow flowing or deep standing water"*
0.75 - 1.25	**Moderate**	Dangerous for some (e.g. children) *"Danger: flood zone with deep or fast flowing water"*
1.25 - 2.5	**Significant**	Dangerous for most people *"Danger: flood zone with deep fast flowing water"*
> 2.5	**Extreme**	Dangerous for all *"Extreme Danger: flood zone with deep fast flowing water"*
DF is a debris factor. For urban areas it is recommended that DF=0 for depth <0.25m and DF=1 for depth > 0.25m		

The Rapid Inundation Zone (RIZ) can be defined as the area that a flood will cover within half an hour of a breach occurring. The RIZ is often the area which suffers the highest depths and velocities. For allocations within an RIZ, consideration must be given to the risk to public safety associated with access and egress from properties. Examining the simulated progression of a number of breaches, it was found that within 30 minutes, the extent of a breaching could reach an area of approximately 50m - 300m from where the failure occurs, which is in line with a number of other studies. This area in proximity to the river is thus potentially at high risk and is classed as an RIZ.

A simplified residual risk classification to delineate risk within Flood Zone 3a was derived (Table 5-3) taking account of DEFRA's work on Flooding Hazards to People (DEFRA/ Environment Agency Flood Risk to People FD2320/TR2, Dated 2008) which gives consideration to both the depth of water and speed of flow that can affect people and the possible impact the proximity of a site to the river during a sudden surge of water resulting from the failure of a defence.

The Hazard Classification takes account of a debris factor and it is believed that this can increase significantly above a depth of 0.25m. The high residual risk classification is thus chosen to indicate the areas that could be dangerous to people and incorporates the RIZ and FD2320 Hazard categories equivalent to moderate, significant and extreme flood hazard.

Table 5-3: Residual Flood Risk Classification within Flood Zone 3

Classification	Criteria
HH: High	Areas within the RIZ with a water depth greater than 0.25m. Areas outside the RIZ with a water depth of greater than 0.6m. Areas within the RIZ with no safe (dry) access or egress.
MH: Medium	Areas within RIZ with a water depth of less than 0.25m. Areas outside the RIZ with a water depth less than 0.6m.
LH: Low	Areas which has not been classified as medium or high risk but are still within the Environment Agencies Flood Zone 3.

The medium residual risk classification is equivalent to low to moderate flood hazard incorporating areas within the RIZ and with water depths of less than 0.25m. Outside the RIZ velocities were generally lower than 0.75m/s therefore depths with less than 0.6m are seen as low or medium hazard.

The low residual risk part of Flood Zone 3 is that area that is not predicted to be affected by the breaching considered but could potentially be affected if breaches were not closed within the time assumed.

The location of high velocities is dependent on the location of the breach. The modelled velocities for the limited number of simulated breaches cannot therefore give a full picture of Flood Hazard. In reality high velocities can be generated due to local features not picked up in the LiDAR or the grid used for flood modelling. For example, flow into a basement may be a high hazard if it occurs rapidly without warning.

5.7 Sewer Flooding

Sewer Flood Risk Assessment

Based on customer privacy and legal issues, there was not enough detailed data available from Thames Water to provide a detailed map for sewer flooding within LBHF. Thames Water have provided details of sewer flooding on a postal area basis. Figure 7 (Appendix B) utilises this data and provides an overview of the spatial distribution of sewer flooding events in the Borough. A review of this map shows a significant number of sewer flooding incidents throughout the Borough. The LBHF SWMP provides a more detailed analysis of sewer flood risk in the Borough, including information on Counters Creek, a former watercourse that now forms part of the sewer system, and on the drainage network.

Sewer Flood Risk and Climate Change

As the drainage network in the LBHF is primarily combined, the sewer flood risk is intrinsically linked to the surface water flood risk. Based on current knowledge and understanding, the effects of future climate change are predicted to increase the intensity and likelihood of summer rainfall events, which may result in increased frequency of combined sewer surcharge, in the absence of improvements in capacity or function of the existing network. The effect of climate change on surface water flood risk was accounted for in the LBHF SWMP, for which model outputs were produced for a 1 in 100 year event with an allowance for climate change, applied as additional rainfall. The model does not account for increased load due to population increase; nor does it account for improvements to the drainage network.

Impacts of Sewer Flooding

The impact of sewer flooding is usually confined to relatively small localised areas but, because 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.

Management of Sewer Flood Risk

Responsibility for management of the drainage network in the Borough is shared between Thames Water, Network Rail and Transport for London. As the LLFA, LBHF should work with the relevant authorities to minimise sewer flood risk in the Borough. In particular, LBHF should work closely with Thames Water and other relevant stakeholders to identify opportunities for integrated management of surface water and sewer flood risk across the Borough.

Thames Water have elected to install anti-flood pumps (known as ‘FLIPs’) on private drains in areas particularly susceptible to sewer flooding. The LBHF SWMP provides recommendations for drainage network maintenance and improvement measures in the Borough.

Thames Water have stated that the areas which have in the past been affected by sewer flooding should not be seen as areas to avoid future development and that the reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure capacity exists within both the on and off site network, or can be provided as part of a site's redevelopment

LBHF should work with Thames Water and other relevant stakeholders to identify opportunities for integrated management of surface water and sewer flood risk across the Borough.

5.8 Surface Water Flooding

Surface Water Flood Risk Assessment

A Surface Water Management Plan (SWMP) was completed in April 2015. The document is a plan which outlines the Borough's preferred surface water management strategy and includes consideration of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

The chief mechanisms for flooding in the London Borough of Hammersmith and Fulham can be broadly divided unto the following categories:

- *Runoff from higher topography* - The areas of greatest flood depths tend to be at the base of the steeper land to the north of the Borough.
- *Localised surface water runoff* - Within the central and southern parts of the Borough, surface water flooding tends to be a result of localised ponding of surface water.
- *Sewer Flooding* - Areas where extensive and deep surface water flooding is likely to be the influenced by sewer flooding. Where the sewer network has reached capacity and surcharged, this will exacerbate the flood risk in these areas.
- *Low Lying Areas* - Areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding.
- *Railway Cuttings* - Four stretches of mainline railway track (in cuttings) are susceptible to surface water flooding and, if flooded, will impact services that pass across the Borough; and
- *Railway Embankments* - Discrete surface water flooding locations along the up-stream side of the raised network rail embankments where water flows are interrupted and ponding can occur.

Figure 3 and Figure 4 (Appendix B) show the LBHF SWMP model outputs for surface water flood risk and hazard for the 1 in 100 year rainfall event, with an allowance for climate change. Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 200 probability of occurrence in any given year (0.5% Annual Exceedance Probability, AEP). A review of the results demonstrate that 8,545 residential properties and 1,210 non-residential properties in the LBHF could be at risk of surface water flooding of greater than 0.1m depth during a 0.5% AEP rainfall event. Of those, 2,057 residential properties and 205 non-residential properties could be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. A review of these statistics coupled with local knowledge of the study area indentifies that the following CDAs are at greatest risk of significant flooding (greater than 0.5m deep) from the 0.5% AEP rainfall event:

- LBHF_04: Brook Green.
- LBHF_03: Askew Road.
- LBHF_05: Paddenswick Road.

- LBHF_06: Kings St/Hammersmith.
- LBHF_12: Sands End.

Within the LBHF, the risk of surface water flooding is present across much of the central and southern extent of the Borough. The areas to the centre of Hammersmith (LBHF_05: Paddenswick Road and LBHF_06: Kings St/Hammersmith), Brook Green (LBHF_04: Brook Green) and Askew Road (LBHF_03: Askew Road) are at particular risk of deeper flooding (>0.5m).

Surface Water Flood Risk and Climate Change

Based on current knowledge and understanding, the effects of future climate change are predicted to increase the intensity and likelihood of summer rainfall events, meaning surface water flooding may become more severe and more frequent in the future. The effect of climate change on surface water flood risk was analysed in the LBHF SWMP, for which model outputs were produced for a 1 in 100 year event with an allowance for climate change, applied as additional rainfall.

Impacts of Surface Water Flooding

Pluvial flooding can affect all forms of the built environment, including:

- Residential, commercial and industrial properties;
- Amenity and recreation facilities; and
- Infrastructure, such as roads and railways, electrical infrastructure, telecommunication systems and sewer systems.

This type of flooding 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, this type of flooding tends not to have consequences as serious as other forms of flooding, such as flooding from rivers; however it can still cause significant damage and disruption on a local scale.

Management of Surface Water Flood Risk

The LBHF SWMP (2014) provides detailed Borough-wide and CDA-specific surface water flood risk management options for LBHF. Surface water flood risk is a large scale issue, present throughout London Boroughs and it is recommended that LBHF continues in an active role in future strategic surface water management plans for London in liaison with the Greater London Authority and Thames Water.

LBHF should continue in an active role in future strategic surface water management plans for London in liaison with the Greater London Authority and Thames Water.

5.9 Groundwater Flooding

Groundwater flooding is water originating from sub-surface permeable strata which emerges from the ground, either at a specific point (such as a spring) or over a wide diffuse location, and inundates low lying areas. 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. Flooding from groundwater tends to be long in duration, developing over weeks or months and continuing for days or weeks.

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 emerging at the surface.
- Inundation of drainage infrastructure.
- Inundation of low-lying property (basements).

Geology

A geological map for the study area is provided in Figure 11 (Appendix B) reproduced from the British Geological Survey (BGS) 1:50,000 scale geological series. The bedrock is predominantly London Clay. Superficial deposits of sand and gravel (Kempton Park Gravel Formation) overlie the London Clay across the southern extent of the Borough (Goldhawk Road towards the River Thames).

Superficial deposits of clay and silt (Langley Silt Member) overlie the London Clay across the area between Westway (A40) and Goldhawk Road, and around the area of Brook Green and Hammersmith Road.

The London Clay is overlain with superficial gravels in the lower part of the Borough. These permeable gravels outline the historic floodplain of the River Thames and may contain a perched water table. If, following heavy rainfall, the water table within this gravel layer rises, localised groundwater flooding may occur in excavations and basements. Along the route of 'lost' rivers, springs and rivulets which would have usually joined the streams may still flow, as such finding their way underground, probably along the original course of the stream[19].

Groundwater Flood Risk Assessment

The data sources listed below have been reviewed to produce an overall interpretation of groundwater flood risk in the study area.

- Increased Potential for Elevated Groundwater Maps (GLA 2011).
- Environment Agency Areas Susceptible to Groundwater Flooding Map (EA 2012).
- ESI Groundwater Flood Risk Map Version 1.1 (ESI 2014)

The information sources listed above were reviewed as part of this study.

Table 5-4 summarises the content of each source and how it has been used within the risk assessment.

Table 5-4: Review of Available Groundwater Information

Source	Summary	Risk Assessment Application
EA Areas Susceptible to Groundwater Flooding (AStGWF) Map	This data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge.	This provides an overview of proportional area that is at high or very high risk of groundwater flooding. The categories are as follows:  <25% (low)  ≥25%<50%(moderate)  ≥ 50% <75% (high)  >=75% (very high)

[19] Barton, N (1992) The Lost Rivers of London. Historical Publications Limited, chpt 10, p 134.

Source	Summary	Risk Assessment Application
EA Groundwater Flooding Database	Use of records provided within the Draft Tier 2 SWMP (2011).	Review of predicted and known groundwater risk locations.
GLA Increased Potential for Groundwater Flooding Map	This map was produced for the Drain London Tier 2 project and shows those areas where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface.	This provides additional detail on areas at risk of groundwater flooding at greater spatial resolution than the AStGWF map.
ESI Groundwater Flood Risk Map Version 1.1	This map is based on a 50m resolution groundwater model. Likelihood is ranked according to whether flooding is expected to occur at a site due to extreme groundwater levels, estimated to have a return period of 1 in 200 years.	LBHF have access to this data, and the mapping has been compared to the other groundwater flood risk datasets in order to better understand groundwater flood risk in the Borough. However, licensing rules do not permit reproduction or distribution of the mapping in this SFRA.

ESI Groundwater Flood Risk Map

The most recent dataset available for use in the LBHF SFRA is the ESI Groundwater Flood Risk Map (Version 1.1, 2014). This is based on a 50m resolution groundwater model for Scotland, England and Wales. The ESI Groundwater Flood Risk Map is the most detailed dataset available for assessment of groundwater flood risk within LBHF due to its 50m resolution and clear categorization of risk. However, licensing restrictions do not permit reproduction or distribution of this data. It is recommended that LBHF officers refer to this dataset when considering planning applications.

If more detailed data relating to the risk of groundwater flooding is required, it is recommended that the reader contact the British Geological Survey (BGS) in order to obtain the BGS Groundwater Flooding Susceptibility Maps, which cover consolidated aquifers (chalk, sandstone etc., termed ‘clearwater’ in the data attributes) and superficial deposits. Within this dataset susceptibility to flooding is classified into the following categories; very low, low, moderate, high and very high and is not restricted to identifying the risk with 1km square grids. The dataset does not take account of the chance of flooding from groundwater rebound.

Areas Susceptible to Groundwater Flooding

The latest Environment Agency dataset for assessing groundwater flood risk in the study is the Areas Susceptible to Groundwater Flooding (AStGWF) map, shown in Figure 5-3. This map uses underlying geological information to infer groundwater flood susceptibility. A review of the AStGWF map highlights that the southern half of the study area is highly susceptible to groundwater flooding.

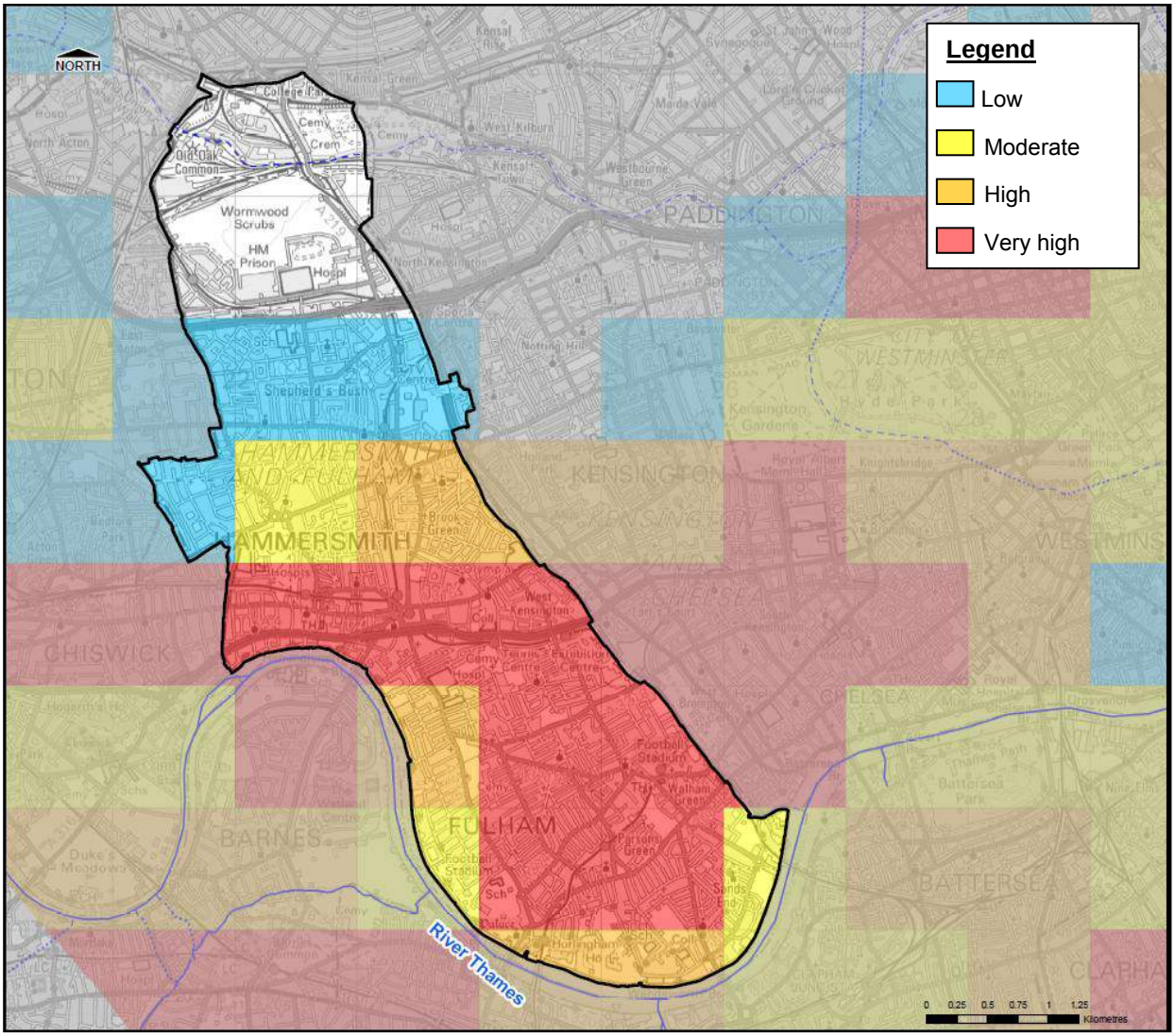

Figure 5-3: Environment Agency Areas Susceptible to Groundwater Flooding

Potential for Elevated Groundwater

Large areas within the Drain London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface.

The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map which was created as part of the Drain London Tier 2 project (reproduced within Figure 5-4 overleaf):

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

The mapping technique used aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment. The Increased Potential for Elevated Groundwater map shows those areas within the London Borough Hammersmith and Fulham where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface.

Figure 5-4 shows that within Borough there is no increased potential for elevated groundwater within the bedrock (consolidated aquifers). With respect to permeable superficial deposits, there is increased potential for elevated groundwater in the central and south eastern areas of the Borough. In areas with an increased potential for groundwater, basements, buildings below ground level, buried surfaces and other assets held below ground level are vulnerable to flooding from groundwater. This can also lead to inundation of roads, commercial, residential and amenity areas as well as flooding of ground floors of buildings and overflowing of sewers and drains.

This dataset represents the best publicly accessible dataset available for use in this SFRA and should be referred to when preparing FRAs within the Borough. This mapping shows an increased potential for groundwater flooding throughout a large proportion of the area south of Goldhawk Road and in two areas north of that. As such, it is of key importance that groundwater flood risk be considered prior to development in these areas, and FRAs in these regions should take into account the risk from groundwater flooding. Although a large area in the north of the catchment has been determined to be at negligible risk of groundwater flooding, it is important to note that increased recharge due to infiltration SuDS may increase groundwater flood risk down gradient. It is also important to consider the impact of high groundwater levels on surface water flooding, as high groundwater levels can lead to reduced infiltration which will subsequently increase the risk of surface water flooding.

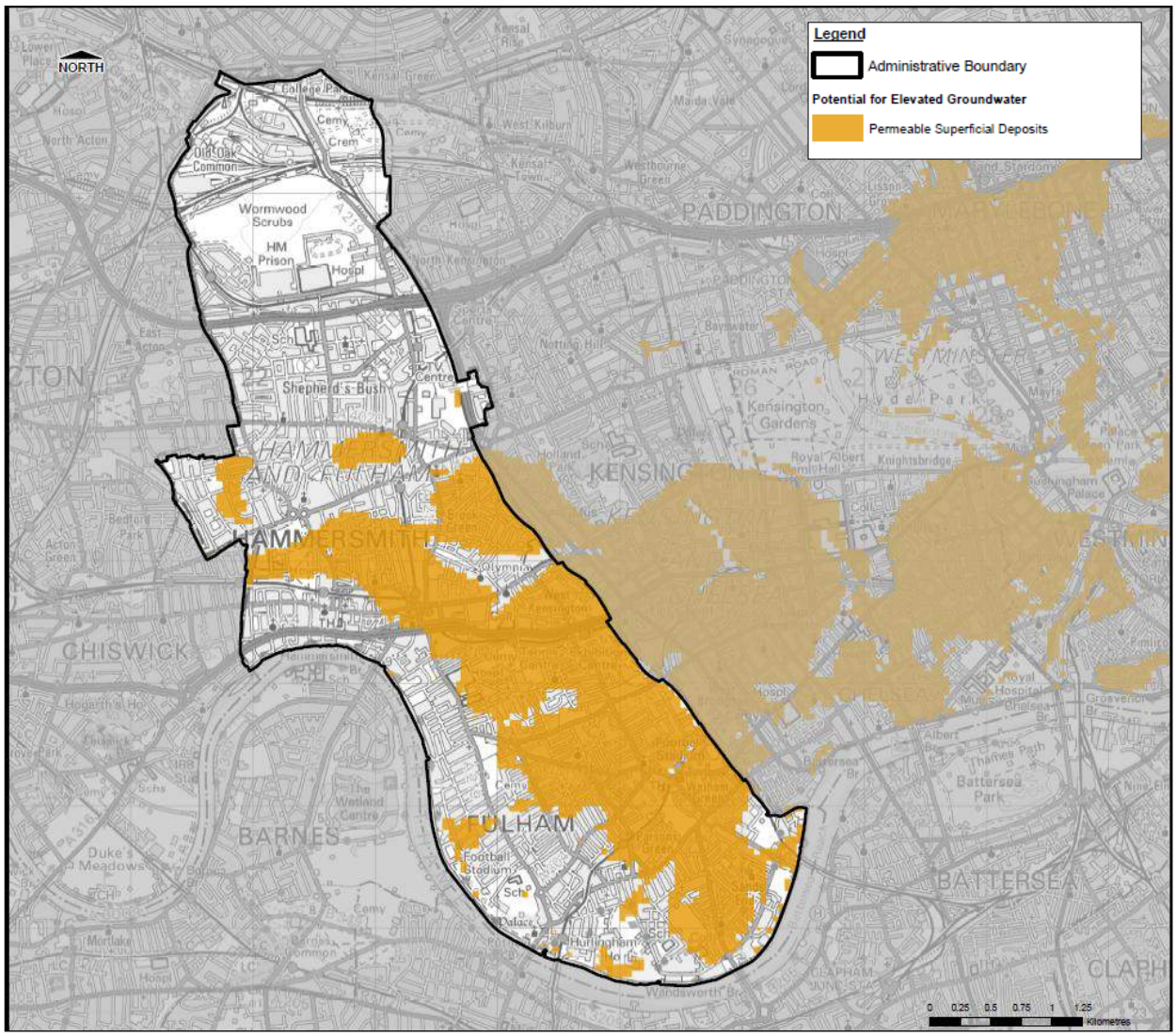

Figure 5-4: Increased Potential for Elevated Groundwater

The Increased Potential for Elevated Groundwater Map should be used in the initial scoping stages to determine whether a location is at potential risk of groundwater flooding; however it should not be used as a substitute for detailed site-specific evaluation of groundwater flood risk. LBHF should also utilise the ESI Groundwater Flood Risk Map when considering planning applications.

Groundwater Flood Risk and Climate Change

The impact of climate change on groundwater levels is highly uncertain. The UK Climate Impact Programme (UKCIP) model indicates that, in future, winters may be generally wetter and summers substantially drier across the UK. The greater variability in rainfall could mean more frequent and prolonged periods of high or low water levels. The effects of climate change on groundwater in the UK therefore may include increased frequency and severity of groundwater-related floods. It should be noted that although winter rainfall may increase the frequency of groundwater flooding incidents, the potential of drier summers and lower recharge of aquifers may counteract this effect.

Impacts of Groundwater Flooding

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.

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

Groundwater Flood Risk Management

Management is highly dependent upon the characteristics of the specific situation. The costs associated with the management of groundwater flooding are highly variable. The implications of groundwater flooding should be considered and managed through development control and building design. Possible responses include:

- Raising property ground or floor levels or avoiding the building of basements in areas considered to be at risk of groundwater flooding.
- Provide local protection for specific problem areas such as flood-proofing properties (such as tanking, sealing of building basements, raising the electrical sockets/TV points etc.)

- Replacement and renewal of leaking sewers, drains and water supply reservoirs. Water companies have a programme to address leakage from infrastructure, so there is clear ownership of the potential source.
- Major ground works (such as construction of new or enlarged watercourses) and improvements to the existing surface water drainage network to improve conveyance of floodwater from surface water of fluvial events through and away from areas prone to groundwater flooding.

Most options involve the management of groundwater levels. It is important to assess the impact of managing groundwater with regard to water resources, and environmental designations. Likewise, placing a barrier to groundwater movement can shift groundwater flooding from one location to another. The appropriateness of infiltration based drainage techniques should also be questioned in areas where groundwater levels are high or where source protection zones are close by.

Infiltration SuDS

Improper use of infiltration Sustainable Drainage Systems (SuDS) could lead to contamination of the superficial deposit or bedrock aquifers, leading to deterioration in aquifer quality status or groundwater flooding / drainage issues. However, correct use of infiltration SuDS is likely to help improve aquifer quality status and reduce overall flood risk.

The Environment Agency provides guidance on infiltration SuDS at the following website:

http://www.rtpi.org.uk/media/12399/suds_a5_booklet_final_080408.pdf

These documents should be considered by developers and their contractors, and by the Councils when approving or rejecting planning applications. Other reference materials for the UK can be located on the CIRIA website http://www.ciria.org http://www.wsud.org/ and the professional community website http://www.susdrain.org/resources/ which provides resource links and SuDS case studies.

The areas that may be suitable for infiltration SuDS exist where there is a combination of high ground and permeable geology. However, consideration should be given to the impact of increased infiltration SuDS on properties further down gradient. An increase in infiltration and groundwater recharge will lead to an increase in groundwater levels, thereby increasing the susceptibility to groundwater flooding at a down gradient location. This type of analysis is beyond the scope of the current report, but it could be as significant problem where there is potential for perched water tables to develop. Figure 5-3 provides the summary outputs of the Infiltration SuDS Map across LBHF.

Due to the underlying geology the suitability for incorporating infiltration SuDS measures is largely uncertain and developers will need to undertake infiltration tests to confirm the suitability of utilising these SuDS measures. Developers must ensure that their proposed drainage designs comply planning policies and with the available Environment Agency and Thames Water guidance.

Source protection zones (SPZs) should be considered when applying mitigation measures, such as SuDS, which have the potential to contaminate the underlying aquifer. Restrictions on the use of infiltration SuDS apply to those areas within SPZs. There are no SPZs in the Borough.

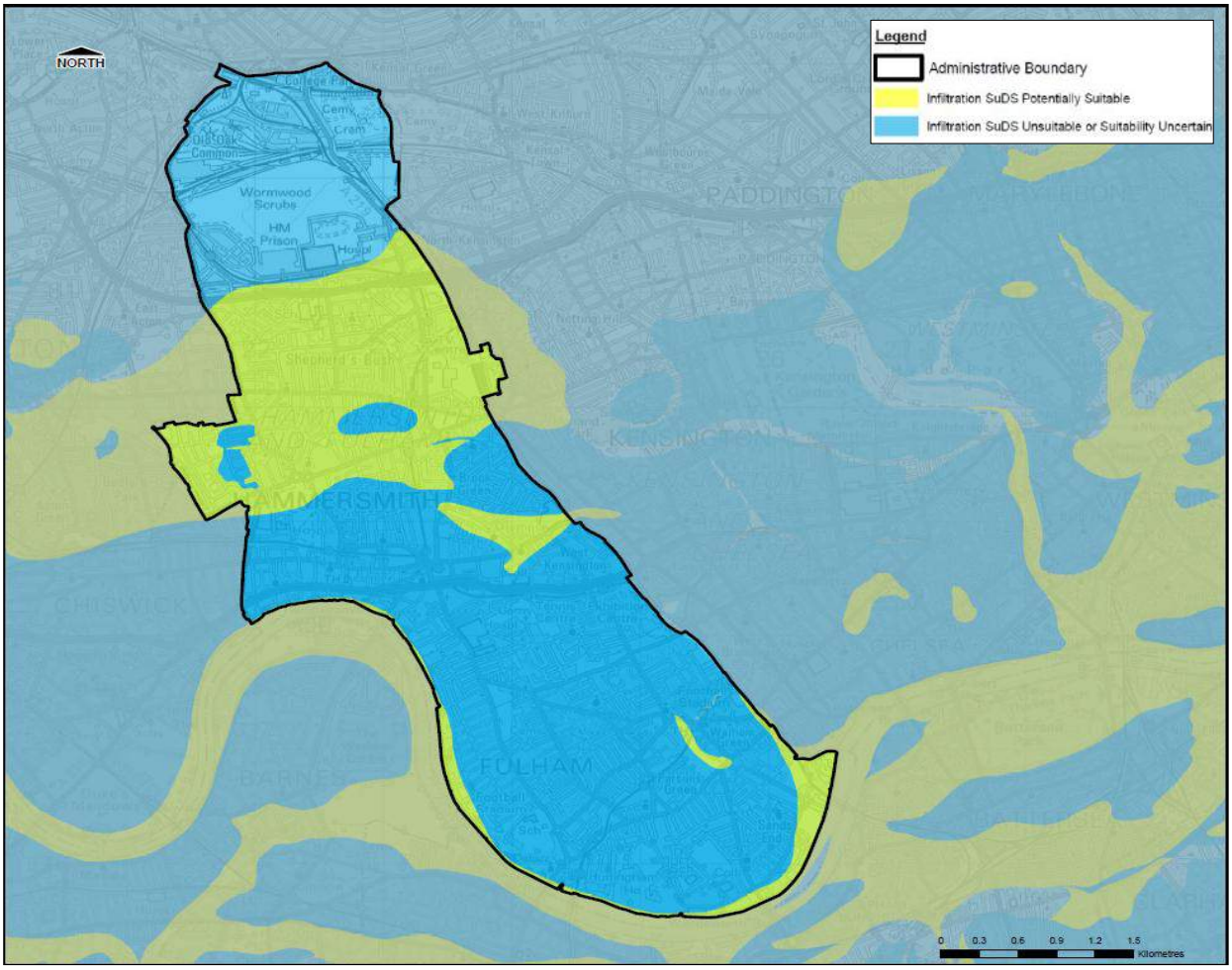

Figure 5-5: SuDS Suitability Mapping – Infiltration Suitability

Grand Union Canal

The Grand Union Canal traverses the north of the Borough. Along the length of the canal there are a few embanked parts, however most of the canal follows the land contour and thus there are very few places where failure of the canal bank is a risk to the Borough. It is more likely that the canal will act as a conveyor of flow in an extreme event, and it is likely to convey flow out of the Borough due to the topography. Figure 1 (Appendix B) shows the location of the canal within the Borough.

Flood Risk from areas outside the Borough

Due to the topography of the Borough there is a risk of receiving surface runoff and combined sewer flows from the neighbouring Boroughs of Kensington and Chelsea, Ealing, Brent and Hounslow. A risk to LBHF also arises from flood waters travelling along the underground tube network into Earls Court Station and from there entering the tube network within the Borough. It is unlikely that the waters would be deep enough to emerge from the network into the streets; nevertheless this disruption to the underground tube network would be significant. It is important that Borough Councils consider not only potential flood risk within their own Borough posed by development, but also the potential for increased risk in neighbouring Boroughs.

Flooding due to failure of the defences along the River Thames at its frontage in Kensington and Chelsea and Hounslow are unlikely to travel into the Borough.

Flood Risk to areas outside the Borough

Flooding within Hammersmith and Fulham poses a possible flood risk to the neighbouring Boroughs of Kensington and Chelsea and Hounslow as a result of a breach in the defences near the borders. The risk from LBHF arises from the breach flood waters spreading out and crossing the border. There is also the potential for surface water to flow overland into the RBKC at several underpasses along the Borough boundary, as well as into Hounslow and Ealing. It is essential that the Council considers not only potential flood risk within the LBHF posed by development, but also the potential for increased risk in neighbouring Boroughs.

5.10 Critical Infrastructure at Risk of Flooding

Critical infrastructure is infrastructure which would be critical in the event of an emergency. Figure 5A-1, Figure 5A-2 and Figure 5A-3 (Appendix B) show the critical infrastructure at risk of tidal or surface water flooding within the Borough. Critical infrastructure at flood risk within the Borough include fire, police and ambulance stations, hospitals, telephone exchanges, tube stations, a council depot and main roads (including the A4).

Table 5-5 overleaf provides a summary of flood risk for critical infrastructure in the Borough. The only critical infrastructure shown to be as risk of residual flooding from the River Thames is Putney Bridge Underground Station, which is located within 150m of the River Thames. A number of the critical infrastructure properties are within regions at increased potential for groundwater flooding, and are therefore at risk of groundwater flooding. There is also a surface water flood risk to a number of the properties, although it must be notes that the SWMP model outputs on which these were based is not detailed enough to define risk for individual properties.

In addition, LBHF SWMP states: “railway and tube lines that are below ground level but are not covered are shown to have flood depths in excess of 1.5m. The nature of the railway lines does suggest a greater susceptibility to surface water flooding, however no account has been made for drainage within these areas. Therefore the degree of flooding should not be considered realistic.” Critical infrastructure which falls into this category is marked ‘*’.

Critical infrastructure bodies/organisations are recommended to integrate flood resilience measures and establish Emergency Flood Plans if not done so already as part of their business continuity plans. This will ensure that critical services can continue to function should the site be impacted by flood waters. Critical infrastructure providers should liaise with the council’s Emergency Planning Team to ensure an integrated approach to flood response as outlined in the Multi-Agency Flood Plan.

Table 5-5: Summary of Flood Risk for Critical Infrastructure

Critical Infrastructure Classification	Name	Groundwater Flood Risk	Surface Water Flood Risk	Tidal Flood Risk
Data Source				
		Increased Potential for Elevated Groundwater dataset	Surface water modelling for the 1 in 100 year rainfall event with an allowance for climate change (LBHF SWMP)	Breach Modelling re-run as part of the update to the SFRA
Hospital	Queen Charlotte's Hospital	Low Risk	Moderate Risk	Low Risk
	Hammersmith Hospital	Low Risk	Moderate to High Risk	Low Risk
	Charing Cross Hospital	Low Risk	Low to Moderate Risk	Low Risk
Ambulance Station	Hammersmith Ambulance Station	At Risk	Low to Moderate Risk	Low Risk
Fire Station	Hammersmith Fire Station	At Risk	Moderate Risk	Low Risk
	Fulham Fire Station	At Risk	Low Risk	Low Risk
Council Depot	Bagley Road Depot	At Risk	Low Risk	Low Risk
Police Stations	Shepherd's Bush Police Station	Low Risk	Low Risk	Low Risk
	Hammersmith Police Station	At Risk	Moderate Risk	Low Risk
	Fulham Police Station	At Risk	Low Risk	Low Risk
Railway Stations	Imperial Wharf Railway Station	Low Risk	High Risk	Low Risk
	Kensington Olympia Railway Station	At Risk	Moderate to High Risk*	Low Risk
	Shepherd's Bush Train Station	Low Risk	Moderate Risk	Low Risk
Underground Stations	East Acton	Low Risk	Low Risk	Low Risk
	White City	Low Risk	Moderate to High	Low Risk

			Risk*	
	Shepherd's Bush (Hammersmith and City)	Low Risk	Low to Moderate Risk	Low Risk
	Shepherd's Bush (Central)	Low Risk	Low Risk	Low Risk
	Goldhawk Road	Low Risk	Low to Moderate Risk	Low Risk
	Ravenscourt Park	Low Risk	Moderate Risk	Low Risk
	Hammersmith (Hammersmith and City)	At Risk	Low Risk	Low Risk
	Hammersmith (District and Piccadilly)	At Risk	Low Risk	Low Risk
	Baron's Court	At Risk	High Risk*	Low Risk
	West Kensington	At Risk	High Risk*	Low Risk
	Fulham Broadway	At Risk	Low Risk	Low Risk
	Parson's Green	At Risk	Low Risk	Low Risk
	Putney Bridge	At Risk	Low Risk	High Residual Risk
	Kensington Olympia	At Risk	Moderate to High Risk*	Low Risk

6. Proposed Development Sites

This section provides a summary of flood risk for 18 strategic development sites as defined by the LBHF from the Strategic Housing Land Availability Assessment (SHLAA). The assessment considers flood risk from all sources based on the strategic scale information collated for this SFRA. Figure 10 (Appendix B) provides an overview of the site locations within the Borough.

This assessment does not remove the need for planning applications to be supported by a detailed flood risk assessment where appropriate. As stated in Chapter 2, it is recommended that developers consult the Environment Agency, LBHF, Thames Water, the Rivers and Canal Trust and the Port of London Authority (where required) early in the development of site proposals to agree appropriate measures, informed by more detailed analysis where necessary.

Table 6-1: Summary of Flood Risk for 18 Strategic Development Sites

Site Reference (refer to Figure 10 in Appendix B for as overview of site locations)	Site Name	NGR	Size of site (ha)	Flood Zone	Surface Water (Pluvial)	Groundwater	Artificial Sources	Residual Risk	Summary of Risk
		Data Source							
		Approximate based on H&F strategic site information		EA Flood Zones	Surface water modelling for the 1 in 100 year rainfall event with an allowance for climate change (LBHF SWMP)	Increased Potential for Elevated Groundwater dataset	EA Reservoir Inundation Mapping which shows areas at risk of flooding from large reservoirs (> 25,000 m3)	Breach Modelling re-run as part of the update to the SFRA	
1	BBC TV Centre (Plot B)	523186, 180541	5.5	1	Small areas of ponding associated with a moderate (danger for some) and significant (danger for most) hazard rating on site. Surface water flooding to Wood Lane access to site.	Low Risk. Site underlain by Langley Silt Member superficial deposits.	Low Risk from a reservoir breach. The Paddington Branch of the Grand Union Canal is located 1.3km to the north of the site. The canal does not appear to be embanked and no breach modelling for the section is available.	Low Risk	Due to the size of the site (greater than 1ha) a flood risk assessment will be required to support a planning application and should focus on the management of surface water. There would be no requirement for the site to pass the Sequential or Exception Test as it is located in Flood Zone 1 (lowest risk of flooding).
2	Former Dairy Crest Site - Aviva-Helical Bar	523400, 180963	4.9	1	Small areas of ponding associated with a moderate (danger for some) hazard rating and small area in south west corner associated with significant (danger for most) hazard rating.	Low Risk. Site underlain by Langley Silt Member superficial deposits.	Low Risk from a reservoir breach. The Paddington Branch of the Grand Union Canal is located 1.3km to the north of the site. The canal does not appear to be embanked and no breach modelling for the section is available.	Low Risk	Due to the size of the site (greater than 1ha) a flood risk assessment will be required to support a planning application and should focus on the management of surface water. There would be no requirement for the site to pass the Sequential or Exception Test as it is located in Flood Zone 1 (lowest risk of flooding).
3	M&S	523482, 180765	4.2	1	Area of deep ponding associated with a significant (danger for most) hazard rating in the south west of the site adjacent to Wood Lane.	Low Risk. Site underlain by Langley Silt Member superficial deposits.	Low Risk from a reservoir breach. The Paddington Branch of the Grand Union Canal is located 1.3km to the north of the site. The canal does not appear to be embanked and no breach modelling for the section is available.	Low Risk	Due to the size of the site (greater than 1ha) a flood risk assessment will be required to support a planning application and should focus on the management of surface water. There would be no requirement for the site to pass the Sequential or Exception Test as it is located in Flood Zone 1 (lowest risk of flooding).
4	Shepherd's Bush Market	523207, 179829	1.9	3	Areas of ponding are associated with a moderate (danger for some) and significant (danger for most) hazard rating.	Northern part of site is underlain by Kempton Park Gravel Formation and shown to be at risk from groundwater flooding. The southern area is underlain by the Langley Silt Member and not shown to be at risk.	Low Risk	Low Risk	The site is partly located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address management of surface water and groundwater on site.

Site Reference (refer to Figure 10 in Appendix B for as overview of site locations)	Site Name	NGR	Size of site (ha)	Flood Zone	Surface Water (Pluvial)	Groundwater	Artificial Sources	Residual Risk	Summary of Risk
		Data Source							
		Approximate based on H&F strategic site information		EA Flood Zones	Surface water modelling for the 1 in 100 year rainfall event with an allowance for climate change (LBHF SWMP)	Increased Potential for Elevated Groundwater dataset	EA Reservoir Inundation Mapping which shows areas at risk of flooding from large reservoirs (> 25,000 m3)	Breach Modelling re-run as part of the update to the SFRA	
5	Earls Court 2 / TFL Depot	524895, 178271	19.2	3	Areas of deep ponding on the tracks are associated with an extreme (danger for all) hazard rating. Elsewhere on site ponding is associated with a moderate (danger for some) and significant (danger for most) hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	Low Risk	The site is located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address management of surface water and groundwater on site.
6	Seagrave Road Car Park	525413, 177839	3.0	3	Small areas of ponding are associated with a moderate (danger for some) hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	Low Risk. Breach modelling for the SFRA is shown to impact only a small part of the site near the south eastern boundary.	The site is fully located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address management of surface water and groundwater on site.
7	1-9 Lillie Road	526177, 176180	0.7	3	Areas of ponding are associated with a moderate (danger for some) and significant (danger for most) hazard rating on site. The eastern site boundary is formed by the railway cutting associated with an extreme (danger for all) hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	Low Risk	The site is fully located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address management of surface water and groundwater on site.
8	Watermeadow Court	526183, 176196	0.5	3	Small and shallow area of ponding associated with a very low hazard rating.	The site is underlain by the Kempton Park Gravel Formation and alluvium. The northern part of the site is shown to be at risk from groundwater flooding.	Low Risk	Breach modelling for the SFRA has been undertaken approximately 1.4km to the west and is not shown to impact the site. As the site borders the River Thames tidal defences, it is recommended that the need for site specific breach modelling is assessed as part of a detailed FRA.	The site is fully located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address management of surface water and groundwater on site. Assessment of the need for site specific breach modelling is recommended as part of the FRA.

Site Reference (refer to Figure 10 in Appendix B for as overview of site locations)	Site Name	NGR	Size of site (ha)	Flood Zone	Surface Water (Pluvial)	Groundwater	Artificial Sources	Residual Risk	Summary of Risk
		Data Source							
		Approximate based on H&F strategic site information		EA Flood Zones	Surface water modelling for the 1 in 100 year rainfall event with an allowance for climate change (LBHF SWMP)	Increased Potential for Elevated Groundwater dataset	EA Reservoir Inundation Mapping which shows areas at risk of flooding from large reservoirs (> 25,000 m3)	Breach Modelling re-run as part of the update to the SFRA	
9	Currys and PC World	525796, 175658	1.2	3	Small and shallow area of ponding associated with a very low hazard rating.	Low Risk. The site is underlain by alluvium.	Low Risk	Breach modelling for the SFRA has been undertaken approximately 0.8km to the west and is shown to impact only a small part of the site. It is recommended that the need for site specific breach modelling is assessed as part of a detailed FRA.	The site is fully located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application. Assessment of the need for site specific breach modelling is recommended as part of the FRA.
10	Riverside Studios/Queens Wharf	523118, 178147	0.6	3	No significant surface water flooding issues have been identified. The site is associated with a very low hazard rating.	The site is underlain by the Kempton Park Gravel Formation and alluvium. The southern part of the site is shown to be at risk from groundwater flooding.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	There is a residual risk of flooding from a breach of the River Thames tidal defences to a small area in the west of the site during the 1 in 200 year return period event. Flooding is associated with a moderate hazard (danger for some).	The site is fully located in Flood Zone 3. In accordance with the NPPF guidance, 'Water Compatible' and 'Less Vulnerable' land uses are appropriate with in Flood Zone 3a, 'Essential Infrastructure' and 'More Vulnerable' land uses require the Exception Test to be passed. 'Highly Vulnerable' land uses are not appropriate within Flood Zone 3a. A detailed flood risk assessment will be required to support a planning application and must address the management of surface water and groundwater on site. Assessment of the need for site specific breach modelling is recommended as part of the FRA.
11	Junction of Western Avenue and Old Oak Road	521657, 180868	0.2	1	There are small areas of ponding associated with a moderate (danger for some) hazard rating.	Low Risk. The site is underlain by the Langley Silt Member	Low Risk	Low Risk	The site is located in Flood Zone 1, all uses of land are appropriate in this zone.
12	Olympia Multi-storey Car Park Maclise Road	524208, 179299	0.5	2 & 3	No significant surface water flooding issues have been identified. The site is associated with a very low hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	Low Risk	The site is partially located in Flood Zones 2 & 3. The site layout plan should locate development in the areas of lowest flood risk within the site. A flood risk assessment will be required to support a planning application and must address the management of groundwater on site.
13	6-12 Gorleston Street	524387, 178769	0.1	1	One small area of ponding on the north east boundary associated with a moderate (danger for some) hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	Low Risk	Low Risk	The site is located in Flood Zone 1, all uses of land are appropriate in this zone.
14	22 Bute Gardens And 11 - 17 (odd) Wolverton Gardens	523531, 178737	0.2	2	An area of ponding in the north west boundary is associated with a moderate (danger for some) hazard rating.	The site is underlain by the Kempton Park Gravel Formation and shown to be at risk from groundwater flooding.	Low Risk	Low Risk	The site is located in Flood Zones 2. A flood risk assessment will be required to support a planning application and must address the management of surface water and groundwater on site.

Site Reference (refer to Figure 10 in Appendix B for as overview of site locations)	Site Name	NGR	Size of site (ha)	Flood Zone	Surface Water (Pluvial)	Groundwater	Artificial Sources	Residual Risk	Summary of Risk
		Data Source							
		Approximate based on H&F strategic site information		EA Flood Zones	Surface water modelling for the 1 in 100 year rainfall event with an allowance for climate change (LBHF SWMP)	Increased Potential for Elevated Groundwater dataset	EA Reservoir Inundation Mapping which shows areas at risk of flooding from large reservoirs (> 25,000 m3)	Breach Modelling re-run as part of the update to the SFRA	
15	Tent site, Lots Road	526218, 176884	0.4	1, 2 & 3	No significant surface water flooding issues have been identified. The site is associated with a very low hazard rating.	Low Risk. The site is underlain by alluvium.	Low Risk	As the site borders the River Thames tidal defences, it is recommended that assessment of the need for site specific breach modelling is undertaken as part of a detailed FRA.	The site is partially located in Flood Zones 2 & 3. The site layout plan should locate development in the areas of lowest flood risk within the site (Flood Zone 1). A flood risk assessment will be required to support a planning application. Assessment of the need for site specific breach modelling is recommended as part of the FRA.
16	Favourite public house, 27 St Ann Road	523900, 180362	0.1	1	One small area of ponding is associated with a moderate (danger for some) hazard rating.	Low Risk. The site is underlain by the Langley Silt Member	Low Risk	Low Risk	The site is located in Flood Zone 1, all uses of land are appropriate in this zone.
17	77-89 Glenthorne Road	522846, 178736	0.1	2 & 3	Small areas of ponding is associated with a moderate (danger for some) hazard rating.	Low Risk. The site is underlain by the Kempton Park Gravel Formation.	The maximum flood extents from a reservoir breach scenario of the Queen Mary and Queen Mother Reservoirs (located over 15km to the west of the site) extend as far as the site.	Low Risk	The site is partially located in Flood Zones 2 & 3. A flood risk assessment will be required to support a planning application and must address the management of surface water on site.
18	BBC Media Village	523160, 180861	1.4	1	Shallow areas of ponding on site associated with a low hazard rating and small areas associated with a moderate (danger for some) hazard rating on site.	Low Risk. The site is underlain by the Langley Silt Member	Low Risk from a reservoir breach. The Paddington Branch of the Grand Union Canal is located 1.3km to the north of the site. The canal does not appear to be embanked and no breach modelling for the section is available.	Low Risk	Due to the size of the site (greater than 1ha) a flood risk assessment will be required to support a planning application and should address the management of surface water. There would be no requirement for the site to pass the Sequential or Exception Test as it is located in Flood Zone 1 (lowest risk of flooding).

7. Future Planning and Development Control

The SFRA is the basis upon which initial planning decisions with regard to flooding are made. The Council are required to prioritise the allocation of land for development in ascending order from Flood Risk Zones 1 to 3. However, as development becomes necessary because of lack of suitable Zone 1 space, or for socio-economic reasons, then it is necessary to consider development allocations in higher risk zones. Where development is allocated within the medium flood risk zone (Zone 2) or high flood risk zone (Zone 3), the NPPF requires the Council to demonstrate that there are no reasonable alternative development sites in lower flood risk zones. As stated in Section 2.1.1, the Council has previously conducted the Sequential Test for the entire Borough and therefore no further application of the Sequential Test is required. It may be necessary to apply the Exception Test, and the situations where it is necessary and appropriate to apply this are outlined in Table 3 of the PPG, and in Chapter 2, Table 2-1 of this report. The table indicates where developments could be allowed, rejected or subject to the Exception Test.

What does that mean for Sites within Zone 1?

From a tidal and fluvial flood risk perspective, all land uses are acceptable within Flood Zone 1. Flood risk is not considered to be a significant constraint to development and all land uses listed below are appropriate in this zone:

- Essential infrastructure;
- Highly vulnerable;
- More vulnerable;
- Less vulnerable; and
- Water compatible development.

Due to their potential impact on the local flood risk, a Flood Risk Assessment (FRA) will be required for all developments greater than 1 ha in size.

In addition, due to the risk of surface water and sewer flooding highlighted in the LBHF SWMP, an FRA will be required for all developments within identified CDAs. This will include further consideration of surface water drainage, a recommended approach to controlling surface water discharge and onsite mitigation measures that may be required, particularly where sewer capacity is limited.

The Flood Risk Assessment will be undertaken by the potential developer of the site. The Environment Agency and Thames Water will be able to advise potential developers as to their specific requirements on a site by site basis. The Council also provides advice in its Planning Guidance Supplementary Planning Document (SPD).

What does that mean for Sites within Zone 2?

Subject to the application of the Sequential Flood Risk Test[20], the NPPF specifies suitable types of development in Zone 2 as:

- Essential infrastructure;
- More vulnerable;
- Less vulnerable; and
- Water compatible development.

[20] Note that the Sequential Test has been completed by the Council for the entire Borough

Highly vulnerable development is subject to the Exception Test.

A Flood Risk Assessment will be required for all development in this zone. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels. Appendix A2 provides details of access and egress requirements.

A further level of analysis of the affects of a breach in or overtopping of the defences in an extreme event (usually the 0.5% AEP plus climate change) may be required if the site falls within an area which is classified as being at High or Medium Residual Risk in order to test the sustainability and robustness of the mitigation measures. Other flood risk constraints, such as incidents of localised flooding and other site specific considerations will need to be addressed. Site-specific Flood Risk Assessments will be undertaken by the developer of the site. Where required, the Environment Agency will be able to advise developers as to their specific requirements on a site by site basis. The council also provides guidance in its Planning Guidance SPD.

What does that mean for Sites within Zone 3a?

Subject to the application of the Sequential Flood Risk Test, the NPPF specifies suitable types of development in Zone 3a as:

- Less vulnerable; and
- Water compatible development.

Essential Infrastructure and More Vulnerable development are subject to the Exception Test. Highly Vulnerable development should not generally be permitted in this zone; however certain developments in this category may be permitted on a case-by-case basis if approved by the Council and the EA.

Any proposals for development within Flood Zone 3 will require developers to undertake a detailed site specific Flood Risk Assessment. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

Where the site falls within an area which is classified as being at High or Medium Residual Risk, the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.5% AEP plus climate change). It should be noted that constraints to development are likely to be significant and developers should seek advice from the Council, the Environment Agency and Thames Water as to the specific requirements for assessment.

Flood Zone 1: **An FRA is required for all developments greater than 1ha in size and/or within a Critical Drainage Area.**

Flood Zone 2: **All developments require a site-specific FRA. Highly vulnerable development is subject to the Exception Test.**

Flood Zone 3: **All developments require a site-specific FRA. Essential infrastructure and more vulnerable developments are subject to the Exception Test. Highly vulnerable development should not generally be permitted; however certain developments in this category may be permitted on a case-by-case basis if approved by the Council and EA, subject to meeting the requirements of the Exception Test and provision of a detailed FRA.**

Proposals in Flood Zone 2 or 3 should demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

8. Conclusion and Recommendations

The SFRA has identified that the significant sources of flood risk within the London Borough of Hammersmith and Fulham (LBHF) are surface water and sewer flooding, and the residual risk which arises from a possible failure in the River Thames tidal defences. There is also a high risk of groundwater flooding in the Borough.

Sewer and surface water flooding are particularly problematic, with the Borough experiencing significant problems historically and during the heavy rainfall events of 20th July 2007. Figure 3 (Appendix B) provides an overview of surface water flood risk in the Borough. It is recognised that this is a large scale issue and it is recommended that LBHF continues in an active role in future strategic surface water management plans for London in liaison with the Greater London Authority and Thames Water. This can now be supported by the results of the SWMP. Due to the interconnected nature of surface water and sewer flooding in the Borough, it is essential that LBHF work closely with Thames Water to identify opportunities for integrated surface water and sewer flood risk management.

There is a high risk of groundwater flooding throughout the central and south parts of the Borough, which must be considered not only in terms of its own risk, but also in terms of the increased surface water flood risk associated with high groundwater levels. Figure 14 (Appendix B) provides an overview of areas at increased potential for groundwater flooding. The Increased Potential for Elevated Groundwater should be used in the first instance to identify areas at potential groundwater flood risk.

Future climate change predictions imply that surface water, sewer and groundwater flooding will become more frequent; therefore the Council needs to plan for future emergencies, become proactive in mitigating against the risk, and provide guidance to residents on how they too can mitigate against the impacts of this type of flooding.

There is a risk of tidal flooding throughout a large proportion of the Borough, but at present Hammersmith and Fulham are fully defended against the 0.1% annual probability extreme tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard should a breach occur. Although a breach in the defences is not expected, this is a possibility that needs to be taken into account in planning. The SFRA has fully assessed the extent and variation of the residual risk remaining behind defences within the Borough. Figure 15 (Appendix B) shows the areas suffering residual risk and their classifications.

The Environment Agency released the Thames Estuary 2100 (TE2100) Plan in November 2012. The document sets out their recommendations for flood risk management for London and the Thames Estuary through to the end of century and beyond. The Plan puts the need for climate change adaptation at its core. It primarily looks at tidal flooding, though other sources of flooding including high river flows as a result of heavy rainfall and surface water flooding are also considered.

In the future, with sea level rise and climate change, the TE2100 plan predicts an increase in River Thames water levels within the Borough. It is thought unlikely that the Thames Barrier would fail to close during a significant tidal surge in the North Sea, but should this occur, the risks have been concluded to be low. This is based on the defences being raised to levels laid out in the TE2100 plan. If these defences are not raised to the identified levels, there is a severe risk of overtopping causing flooding to LBHF.

An analysis of the risk associated with defence breaches taking into account climate change has been undertaken within the Borough. These results indicate a significant increase in residual risk (both depth and hazard) as a result of the predicated climate change levels and should be considered within any future development applications.

Guidance has been given to the LPA on what types of development are suitable in each of these Flood Zones according to the NPPF. The LBHF Core Strategy demonstrates that the Sequential Test has been undertaken by LBHF on a Borough-wide level and determined that the Sequential Test permits the consideration of all sites for development, subject to meeting the requirements of the Exception Test and a completion of an appropriate site specific FRA. Therefore developers are not required to apply the Sequential Test to individual developments. It is essential that Flood Risk Assessments submitted with development proposals take into account the findings of this SFRA as well as the LBHF SWMP, and assess flood risk from all sources. Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels. Appendix A1 provides detailed guidance for the completion of detailed flood risk assessments and Appendix A2 provides guidance on mitigation measures.

Where the site falls within an area which is classified as being at High or Medium Residual Risk, the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.5% AEP plus climate change). It should be noted that constraints to development are likely to be significant and developers should seek advice from the Council, the Environment Agency and Thames Water as to the specific requirements for assessment.

Appendix A – Guidance documentation

Appendix A1 - Guidance for the Completion of Detailed Flood Risk Assessment

Introduction

In accordance with current planning policy guidance, the planning process discourages development in areas vulnerable to flooding. This SFRA is not intended to be a prescriptive document, but a planning tool to guide future development away from flood risk areas. Developers should refer to the SFRA and the NPPF when considering future planning applications. This appendix, A.1, will present the guidance for the developers on the requirements of a FRA for development in proposals in Flood Zones 1, 2, 3. The following appendix, A.2, provides guidance on how specific flood risk management issues can be achieved.

Prior to development, site specific flood risk assessments will need to be undertaken to ensure that all forms of flood risk at a site are fully addressed. An initial assessment of flood risk will be required for all proposed developments and change of use to establish that they have met the requirements for FRAs and flood risk reduction set out in Table 3 of the PPG.

An FRA will be required for proposed developments:

- that fall in the medium and high flood risk zones (Flood Zones 2 and 3).
- in Flood Zone 1 which are greater than 1 ha in size or within an identified Critical Drainage Area.

It is normally the responsibility of the applicant/developer to prepare a FRA, in consultation with the LPA. The SFRA cannot provide this level of site specific information.

The aim of a Flood Risk Assessment (FRA) is to demonstrate how flood risk to the development and flood risk to others, from all sources, will be managed now and in the future.

Flood Risk Assessments for proposed development in the LBHF should follow the approach recommended by:

- The Environment Agency (see its National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk in England);
- NPPF and PPG; and
- Local Plan policy and Planning Guidance Supplementary Planning Document.

Flood Risk Assessments for Flood Zones 2 and 3

A.1.1 Householder and Other Minor Extensions

Apart from habitable basements, domestic extensions within the curtilage of the dwelling (see General Permitted Development Order definition of, minor development') and non-domestic extensions with a footprint of less than 250m^2, proposals will not require a detailed FRA.

These applications should demonstrate that the risk of flooding from all sources has been assessed, including tidal, surface water, sewer and groundwater flooding.

The application should show either:

Floor levels within the proposed development set at no lower than existing levels AND, flood proofing of the proposed development has been incorporated where appropriate

Or;

Floor levels within the extension set at 300mm above the known or modelled 0.5% (1 in 200 chance each year) tidal and coastal flood. See:

https://www.gov.uk/planning-applications-assessing-flood-risk

And;

Consideration has been given to reducing the rate of run-off from the proposed development and/or from the site as a whole.

A.1.1.2 Change of use from a less to a more vulnerable use

Table 2 in the PPG classifies uses by their vulnerability to flooding. For example, most commercial buildings are less vulnerable than residential buildings and basement dwellings are more vulnerable than other residential uses. Therefore a FRA will be required where the ground floor and/or basement of a building in Flood Zone 2 or 3 changes from a use that is less vulnerable to one that is classified as 'more vulnerable' or 'highly vulnerable'. Similarly, an FRA will also be required in Flood Zone 3 where a use changes from a 'water compatible' use to a 'less vulnerable' use.

The FRA will need to show how any increase in vulnerability will be dealt with and in some cases the change of use may not be permitted.

A.1.1.3 Non-Major Development

Non-major developments are where the number of additional dwellings to be constructed, or to be created as a result of a conversion, is less than 10 and/or the site is less than 0.5ha, and for all other uses, where the floor space to be built is less than 1000sqm and/or where the site area is less than 1ha. Most developments in LBHF that fall into this category are small infill developments where the proposed development is constrained by the adjoining buildings and by the streetscape in the surrounding area. The FRA needs to balance the benefits of development against the flood risk to the development and should be appropriate to the scale of development and to the constraints of an infill site in relation to the mitigation measures that may be possible. The FRA must be undertaken by a suitably qualified professional.

Prior to undertaking a FRA the developer needs to address the requirements of the Exception Test (if applicable). Evidence that the Exception Test (where necessary), has been passed will need to be included in the FRA. The FRA should:

- Determine whether the development is at flood risk from any source (e.g. surface water, sewer, and groundwater), not just tidal flood risk. The details and maps provided in the SFRA identify possible areas at risk from all sources of flooding - these are not definitive. The LBHF SWMP should be referred to for further information on surface water and sewer flooding. Thames Water should be contacted to determine the risk of surface water and sewer flooding in the vicinity and to determine whether the proposed development will increase flood risk elsewhere. Each source of flooding will need further detailed investigation specific to the location being developed - see Section A.1.3 and A.1.4.

- Determine whether the development will be at flood risk from any source in the future as a result of climate change. (The effect of climate change on flooding from the River Thames was not found to be significant in this SFRA (see Sections 5.4); therefore it will be the effect of climate change on rainfall events which will be the primary focus).

- Assess the level of residual flood risk behind the flood defences. The SFRA identifies those areas that are at high and medium residual risk (Figures 8) and also estimates the speed of flooding from a number of possible breach locations. This does not mean that development in this area would necessarily be in an area of high or medium residual risk but rather that a more detailed study needs to be carried out at site specific level to prove that there is an appropriate level of understanding of flood risk related to the site. The site specific FRA should assess whether a detailed breach analysis is required. Where a detailed breach analysis is required see advice in Section A.1.3.

- Demonstrate that the development will be safe (see Section A.2.1.1 and A.2.4.2), without increasing flood risk elsewhere (A.2.1.2), and, where possible, will reduce flood risk overall (see Section A.2.1.3). Determine whether the development will increase flood risk elsewhere.

- Demonstrate the ability of the development to avoid increasing flood risk elsewhere (see Section A.2.1):

- Demonstrate how flood risk will be managed (see section A.2) and ensure any proposed flood risk management measures will be sufficiently funded so the site can be developed and occupied safely throughout its proposed lifetime.

- Demonstrate that where proposed developments are adjacent to the River Thames, they have been set back by 16m to allow for the future maintenance, replacement or repair of the Thames Tidal Defences. Where this is not feasible and setback is less than 16m, the FRA must prove that the EA have been consulted and agree on the reduced set back distance.

- Demonstrate that the development is compliant with national, regional and local policy.

- Ensure any proposed SuDS techniques and flood risk management measures will be sufficiently funded to enable them to be maintained and the site occupied safely throughout its proposed lifetime.

Further information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance Note 3:-
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311509/LIT_9186.pdf

Advice on making development safe, avoiding increase to flood risk elsewhere, and reducing flood risk overall are given in the following sections.

A 1.1.4 Major Development

Major developments will need to carry out a FRA in accordance with the advice in relation to non-major developments above, but in addition the FRA will need to consider the potential for more mitigation measures. All major developments within the high and medium residual risk zones should carry out a breach analysis, see advice in Section A.1.2.1.

Flood Risk Assessments for Flood Zone 1

Flood Risk Assessments are required where proposed developments within Flood Zone 1 are greater than 1ha in size or are within an identified Critical Drainage Area. The FRA must be undertaken by a suitably qualified professional and should be appropriate for the scale of development. The potential impact upon areas and receiving drainage systems, following the increase in runoff as a result of increase in impermeable area, needs careful consideration.

The FRA should:

- Determine whether the development is at flood risk from other sources now and in the future (e.g. surface water, sewer, and groundwater). (The details and maps provided in the SFRA identify possible areas at risk from all sources of flooding, these are not definitive. Each source of flooding will need further detailed investigation specific to the location being developed - see Section A.1.3 and A.1.4).

- Where flood risk from other sources is identified:

    - Demonstrate how flood risk will be managed.
    - Ensure that development is safe (see Section A.2.4.2);
    - Ensure that where possible flood risk is reduced overall; through sequential design, flood resilience, mitigation measures and the use of SuDS (see Section A.2).
    - Assess the impact of a proposed development upon surface water drainage following an increase in impermeable area, including the potential impact upon surrounding areas, and ensure that flood risk is not increased elsewhere (see Section A.2.1)
    - Recommend the approach to control surface water discharge
    - Ensure any proposed SuDS techniques and flood risk management measures will be sufficiently funded to enable them to be maintained and the site occupied safely throughout its proposed lifetime.
    - The FRA should then conclude with an assessment of the scale of the impact, and the recommended approach to controlling surface water discharge from a proposed development.
    - Further Information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance Note 1: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311502/LIT_9193.pdf and the PPG.

A.1.2.1 Developments <1ha

Proposed developments should include the appropriate application of sustainable drainage techniques so as to maintain, or preferably reduce the existing runoff and flood risk in the area.

How to Assess Tidal Flood Risk from a Breach

Where a site specific breach analysis is required (see Section A.1.1 above) the following information should be assessed.

Extreme tide levels in LBHF from the tidal Thames model should be obtained from the Environment Agency. The SFRA has shown using these water levels that LBHF is protected by well-maintained defences that will not overtop.

Consultation with the Environment Agency will be required to agree what breach location would cause the greatest water levels at the site. A detailed site-specific analysis should be carried out by a qualified professional and will involve:

- Locating appropriate breach locations and determining the relative dimensions to be modelled. The Environment Agency will be able to offer guidance on location of a breach, defence heights and proposed breach widths.
- 2D modelling of a breach in a defence for the tidal flood event with a 0.5% annual probability, including the impact of climate change. The breach should occur for a duration of two tide cycles.
- Extraction of detailed site specific data including depths, velocities, UK flood hazard index and speed of onset.

The depths, velocities and speed of onset can then be used to assess the risk to life and test the robustness of mitigation schemes. The FRA also should review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator.
NB: Although a breach analysis has been undertaken as part of the SFRA, it was on a broader scale and does not provide the site specific quantitative details required.

A.1.3 How to Assess Flood Risk from Other Sources

Flood risk from 'other sources' in LBHF is described in Sections 5.7, 0 and 5.9 of this SFRA.

Thames Water should be contacted for information relating to the risk of sewer flooding at the site. Figures 12 and 14 (Appendix B) should be used to assess the risk from groundwater flooding.

All developers should refer to Figures 3 and 4 (Appendix B) prior to submitting a planning application and use this information to assess whether the site may be susceptible to flooding from surface water. The site may be considered susceptible to surface water flooding if it is within 100m of a known surface water flooding incident or where surface water flood depth shown in Figure 3 (Appendix B) is 0.2m or deeper. In addition, the LBHF SWMP should be consulted to determine whether the site lies within a critical drainage area.

If the sources above indicate that the site may be at risk then the level of risk will need to be quantified in greater detail at the site by a qualified flood risk management professional using appropriate local data:

- The capacity of the existing drainage system and any planned improvements.
- The nature and behaviour of local aquifers.

After initial scoping, the need for drainage or groundwater modelling using appropriate software should be sensibly assessed depending on the severity of the problem. Any existing surface water flow routes (including routes that groundwater flooding takes overland) must be preserved by the development. Mitigation against the likely depths of flooding should be provided up to the 1% annual probability plus climate change event. Some suggested methods are given in Section A.2.3. The required precautionary climate change allowances for peak rainfall intensity are given in Table 2 of the Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal[21], and must be modelled for an FRA. These are: 5% added to peak rainfall intensity up to 2025, 10% to 2055, 20% to 2085 and 30% to 2115. The appropriate period for climate change assessment is the designed lifetime of the development.

[21] http://archive.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcd3climate.pdf

A1.4 Additional Consideration for Flood Risk Assessments

A.1.5.1 Basements /sub-basements

The content of the FRA will be similar to the above guidance with a specific focus on:

- Whether the site has a history of flooding (including groundwater, surface water and sewer flooding).
- Proposed ground levels, floor levels and threshold levels of any openings to the basement. These should be reviewed relative to groundwater levels taken from the nearest known borehole where the property is at risk of groundwater flooding.
- The distance of the proposed site from the River Thames, and the subsequent residual risk.
- Flood water levels adjacent to the basement and ground levels at street level.
- Time to onset of flooding and velocities, when assessing the risk to basements. In rapid inundation areas (i.e. low lying and or close to the tidal river (the River Thames) the onset of flooding can take place rapidly without much notice from a breach in the flood defences. The applicant should be aware of the high risk to life and property in these areas.
- The use of permanent (as speed of onset is fast and flood warning is not realistic) flood resistance measures e.g. secondary flood defences to the basement, barriers on doors etc;
- The use of flood resilient materials and design to aid rapid recovery;
- Evacuation plan to a location within the building, a safe refuge at a level above flood water level.
- Within the medium and high risk areas of Flood Zone 3 it is necessary to define residual risk. This may be determined by comparing proposed floor levels with the 1:200 year water level (including climate change) in the River Thames.
- This scenario may be refined by undertaking a site specific breach analysis to determine the flood risk at the site and for use in the design of the proposed development.
- In the case of extensions to basements the propagation of flooding may be ascertained from the 'Individual Breach Extents' shown in the SFRA Appendix B.
- Protection against flooding from sewage system.

A1.5.2 Drainage Capacity

The capacity of drainage infrastructure is often limited and is at or near capacity under existing conditions. Development that leads to increased peak runoff within the drainage catchments may lead to infrastructure capacity being exceeded, with the potential for increased flood risk. Development locations should be assessed to ensure capacity exists within both the on and off site network.

Thames Water have advised that:

"To ensure all future development is sustainable, detailed computer modelling of development sites will be carried out to identify infrastructure requirements once the exact location and scale of development is known. Development will not be allowed to precede the delivery of essential infrastructure, identified as part of this modelling. Development presents an opportunity to reduce peak run-off rates, if sustainable drainage measures are implemented."

Since the original SFRA was prepared, Thames Water have carried out an assessment of the Counters Creek Strategic Sewer and concluded that much of H&F is at risk of flooding if there is an intense storm within the Counters Creek catchment area. The catchment area extends to Camden and Brent.

This reinforces the need for developments to satisfy the drainage requirements outlined in Sections A.1.1 and A.1.2 for surface water management and the use of measures to reduce surface water run-off (Sections A.2.1.2 and A3). Contact should be made with Thames Water regarding foul water capacity and for any evidence of recent flooding.

A.1.5.3 Critical Infrastructure

Critical infrastructure is infrastructure which would be critical in the event of a flood. If critical infrastructure is to be located in flood risk areas an FRA must demonstrate that it has been designed to remain operational throughout the duration of a flood.

Appendix A2 Guidance on Mitigation Measures

A.2.1 Meeting Part 2 of the Exception Test

Where allocations remain in high risk flood zone 3, the development needs to meet part 2of the exception test:

> *A site specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.*

A.2.1.1 Safe access and egress

The requirements to ensure a development is 'safe' are outlined in appendix A.2.4.2.

A.2.1.2 Avoid increasing flood risk elsewhere

Developers should aim to achieve greenfield run off from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing, or at least not increasing, the amount of hard standing associated with existing homes.

Sustainable drainage techniques will be one of the keys to ensuring that long-term flooding risk is managed, particularly given the extent of hard surfaced area in London. The Mayor of London believes that managing London's surface water and combined sewer flooding/overflows should start with source control management - improving the permeability of the public realm through the incorporation of rainwater harvesting and sustainable drainage - before proceeding to enhanced drainage capacity. These techniques include permeable surfaces, storage on site, green roofs, infiltration techniques and even water butts. Many of these techniques also have benefits for biodiversity by creating habitat, and some can help to reduce the demand for supplied water (see also London Plan Policy 4A.11 Living roofs and walls).

To avoid increasing flood risk elsewhere developments will need to meet the following drainage requirements:

- Developers should aim to achieve greenfield run off from their site through the application of the London Plan drainage hierarchy (see Sections 3.3 and 3.4)
- Use of sustainable drainage systems (SuDS)
- Flow paths for surface water runoff that exceeds drainage capacities and breach flows are not disrupted.
- Defended Floodplain storage capacity should not be reduced, but, if necessary, compensated for on a level for level basis outside of the floodplain.
- If the site is adjacent to the river and defences, building works throughout the course of development should not increase the risk of the defences breaching.

A.2.1.3 Overall reduction in flood risk

For developments to reduce flood risk overall, they would need to make sure that:

- The site is designed sequentially (see appendix A.2.2).
- Flood resilience and mitigation measures are provided in response to identified flood risk (see Sections A.2.3 and A.2.4)
- Where appropriate, floor levels are raised 300mm above the 1 in 100 year climate change flood level (see appendix A.2.4.1).
- Adequate flood warnings and evacuation plans are in place (A.2.4.3)
- Where appropriate scheme layout and design contribute towards the strengthening of flood defences

A.2.2 Mitigation through Sequential Design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Future developments may take place in any of the three Flood Zones. Most large development proposals include a variety of land uses of varying vulnerability to flooding.

The NPPF Planning Policy Guidance states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. parking, recreational space) can be located in more high risk areas.

A.2.3 Mitigation against Surface and Sewer Flooding

Following the intense rain storm on the 20th July 2007 when LBHF suffered notable flooding. It is evident that flood risk from sewers and surface water is a major issue in the Borough. Current climate change predictions suggest that this type of intense rain storm is likely to become more frequent. The data provided by the councils about the 20th July event highlighted that the main problem was basements becoming flooded. Thames Water are responsible for the sewer network (the majority being combined sewer in this area) and have a program to reduce sewer flooding within the Borough. The sewer network cannot accommodate the more extreme rainfall events, consequently sewer and surface water flooding can occur. To mitigate against the effects of flooding from these extreme events the homeowner/developer can install permanent and temporary flood proofing measures.

A.2.3.1 Flood Resistance Measures

Flood resistant construction can prevent or minimise the entry of water to a building when there is flooding outside.

Temporary Flood Barriers are moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum, especially with much of the LBHF being conservation areas. On a smaller scale temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water. Temporary flood barriers do require property occupiers to pre-empt a flood event. Flooding from the sewerage systems in the Borough is primarily flash-flooding as a result of short duration, intense rainfall. With short lead times and no flood warning system in place for the sewerage systems, there are limitations to the value of temporary flood barriers to prevent property flooding from surface water or sewer flooding. The Environment Agency provides a list of manufacturers, with the Kitemark, of temporary defences on their website https://www.gov.uk/government/organisations/environment-agency

Permanent Flood Barriers can include built up doorsteps, rendered brick walls and toughened glass barriers. Even though LBHF contains conservation areas there are sympathetic permanent flood defences which could be installed.

The clear flood barrier is visually unobtrusive so as to not detract from the character of the area. Such clear flood barrier can also be installed behind railings. They would still need approval from the council's conservation officer.

Resistance to Sewer Flooding

Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains, within the property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. The CIRIA publication, 'Low cost options for prevention of flooding from sewers', provides further information.

Manhole covers within the property's grounds could be sealed to prevent surcharging. However, in densely urbanised areas of flat topography, sealing covers may simply move the flooding to adjacent properties. This option should only be considered following an assessment of the likely consequences during a sewer surcharge event.

Pumped Drainage: Some low-lying properties or basements many not be able to discharge by gravity to the foul/combined sewerage systems, and a pumped installation will be required. Even where a gravity discharge is possible, a pumped discharge can be installed if there is a risk of property flooding due to sewer surcharge. This is particularly true for basements. In some parts of the Borough, basement floor levels are below the soffit level of the public sewer. Advice should be sought from the Boroughs Building Standards officers and Thames Water Developer Services (Developer.Services@thameswater.co.uk or 0845 850 2777).

A.2.3.2 Flood Resilience Measures

Flood resilience reduces the consequences of flooding and increases the ability of people or buildings affected to recover from flooding.

When developing basements or property with a risk of flooding from other sources the following should be considered to make the building resilient to flooding:

- New electrical circuitry being installed at a higher level, with power cables being carried down from the ceiling rather than up from the floor level.
- Water-resistant materials for floors, walls and fixtures.

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA. The 2007 Communities and Local Government document 'Improving the Flood performance of New Buildings - Flood Resilient Construction' provides further details on resilience measures.

A.2.4 Mitigation against Residual Risks

The residual risks posed to the Borough as a consequence of the River Thames flood defence walls breaching require a different mitigation approach to that of surface and sewer flooding.

A.2.4.1 Raising Floor Levels

The raising of floor levels within a new development avoids damage occurring to the interior, furnishings and electrics in time of flood. Ideally floor levels should be raised to a height of 300mm above the water level occurring as a result of a flood defence breach during the 1 in 200 year plus climate change event (the event with a 0.5% chance of occurring each year plus a 20% increase for climate change). This 300mm height that the floor level is raised is referred to as the 'freeboard'.

It is however recognised that it may not be practical or economic to raise floor levels to a height that would avoid property damage, particularly for extensions and infill development, or for developments which require disabled access. Although the consequences of a breach would be severe the chances of a breach happening is low, compared to sewer or surface water flooding. Other mitigation measures may therefore need to be considered, particularly measures that would allow for the safe evacuation of the occupants of the property.

A.2.4.2 Safe Access and Egress

Safe access/egress in a flood event will minimise the impact upon the emergency services in the event of an evacuation. 'Safe' will be a function of depth and velocity of water surrounding the development and along access/egress routes, and also the time it takes for the flood to reach the site relative to the time it would take to evacuate the site. These details would be calculated as part of the site specific assessment (section A.1.1.1).

'Safe' access should remain dry for residential developments and 'more' and 'highly vulnerable' uses and should preferably be dry for other uses such as educational establishments and 'less vulnerable' land use classifications. Dry escape for residential dwellings should be available in the instance of a flood defence breach during the 1 in 200 year event (the event with a 0.5% chance of occurring each year) taking into account climate change.

Developments at Residual Flood Risk from failure of the Thames Tidal Defences will have to demonstrate that:

- 'Safe' access includes ability to escape to higher levels without having to pass through flood waters.
- A robust Flood Warning Plan is developed.
- For major highly vulnerable development and essential infrastructure safety will also need to be ensured through demonstration that a robust evacuation plan to dry land is developed.

The developer will be asked (if this is not already included in the FRA) to review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator. In this instance it needs to be demonstrated that depths and velocities of flood water will be acceptable to the 'risks to some' category of this calculator.

A.2.4.3 Flood Warning and Evacuation

The NPPF recommends that warning and evacuation arrangements should be in place for managing residual flood risks to developments behind river and coastal flood defences. All homes and businesses within Flood Zone 2 and 3 are eligible for the Environment Agency's Floodline Warnings Direct (FWD) service, and should be encouraged to sign up to it. However, currently in the SFRA area FWD is primarily used to alert the occupiers of properties with moveable dams to impending conditions. At present FWD is unlikely to have information of a breach in the flood defences until some while after it has occurred. Information on the availability of FWD can be obtained from the local Environment Agency office.

Safe access and egress for evacuation and the emergency services is required for any new development in high and medium residual risk zones. Safe dry access/egress in a flood event will minimise the impact upon the emergency services in the event of an evacuation.

Where significant new population is being added to a residual flood risk area formal consultation with the council's Emergency Planning team is required. Emergency/evacuation plans should be in place for all properties, large and small, at residual risk of flooding; those developments which house vulnerable people (i.e. care homes and schools) will require more detailed plans. Advice should be sought from the council's Emergency Planning Team when producing an emergency/evacuation plan for developments as part of an FRA. Detailed emergency/evacuation plans for developments should undertake consultation not only with the Council's Emergency Planning team but also the Emergency Services so they know what is expected of them in the event of an emergency.

The Local Authority is designated a category 1 responder under the Civil Contingencies Act 2004. In an event of an emergency coordination with the other category 1 responders (including the emergency services and the Environment Agency) is essential to guarantee the safety of residents. It is recommended that the London Borough of Hammersmith and Fulham review their Emergency Plan with respect to flooding, in light of the details provided in the SFRA and SWMP.

Appendix B Figures

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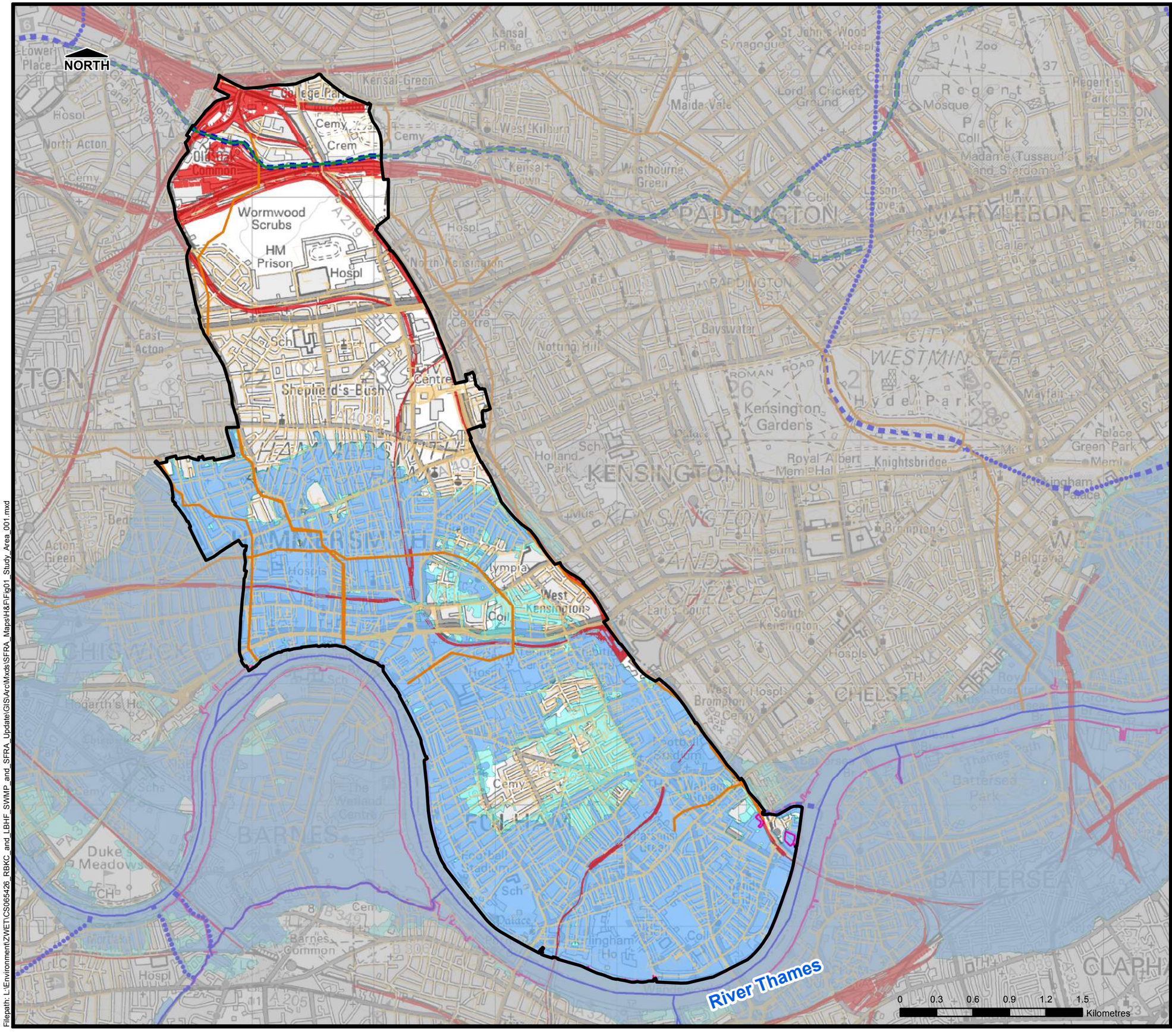

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Grand Union Canal
- Lost Rivers
- Main River
- Ordinary Watercourse
- Culverted Watercourse
- Rail
- Roads Tracks And Paths
- Defences
- Environment Agency Flood Zone 3
- Environment Agency Flood Zone 2

Notes

1. 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.
2. 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.
3. Environment Agency Flood Defences: The map displays the location of linear raised flood defences such as embankments & walls

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:30,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Study Area

Commercial in Confidence

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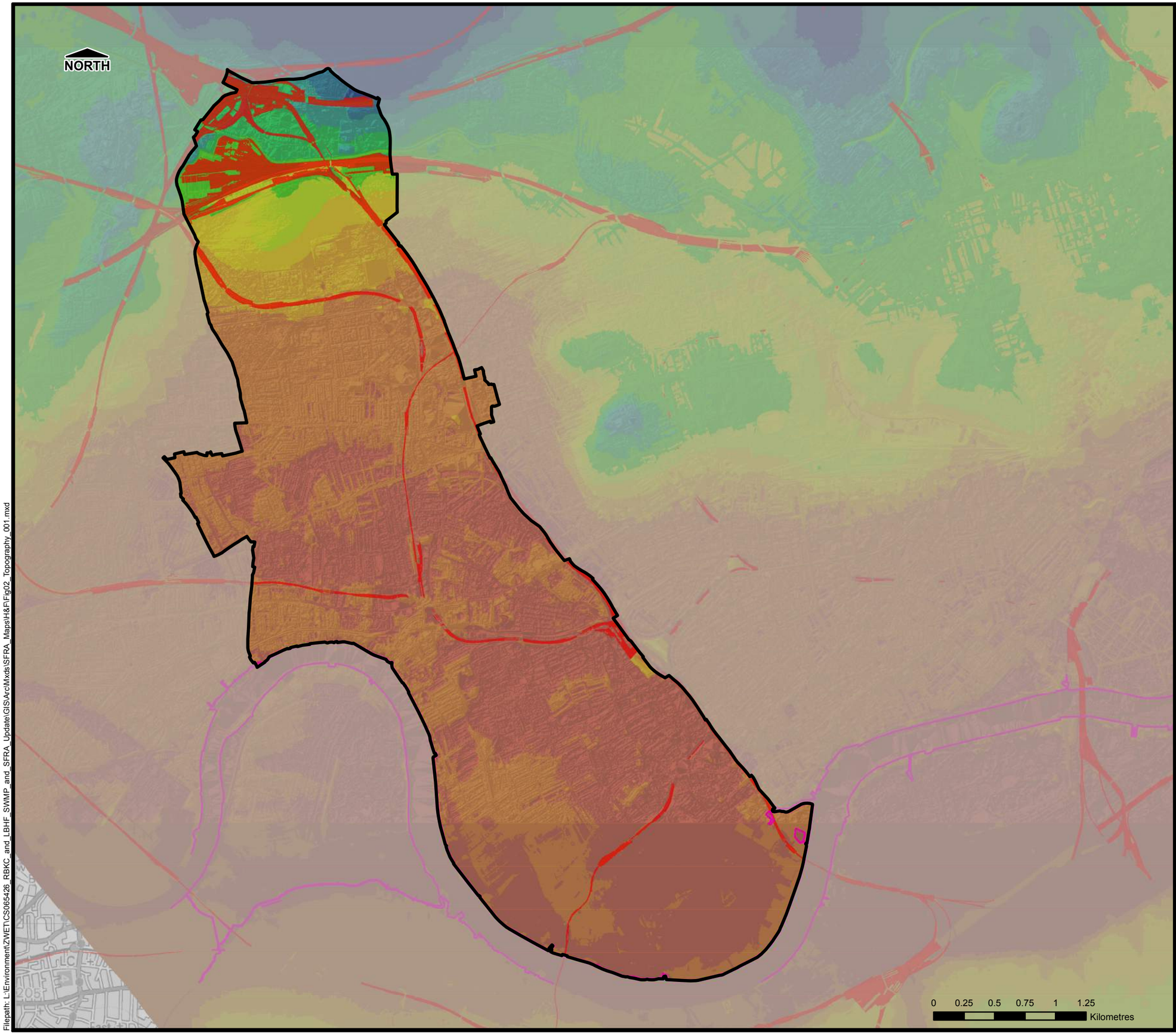
FIGURE 1

Filepath: L:\Environment\ZWET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&FFig01_Study_Area_001.mxd



Legend

- Administrative Boundary
- Defences
- Rail

Terrain Height (m)

0 - 5	25 - 30
5 - 10	30 - 35
10 - 15	35 - 40
15 - 20	40 - 45
20 - 25	45 - 50

Notes

1. Digitial Terrain Model is based on filtered data and therefore excludes buildings and vegetation.

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Topography

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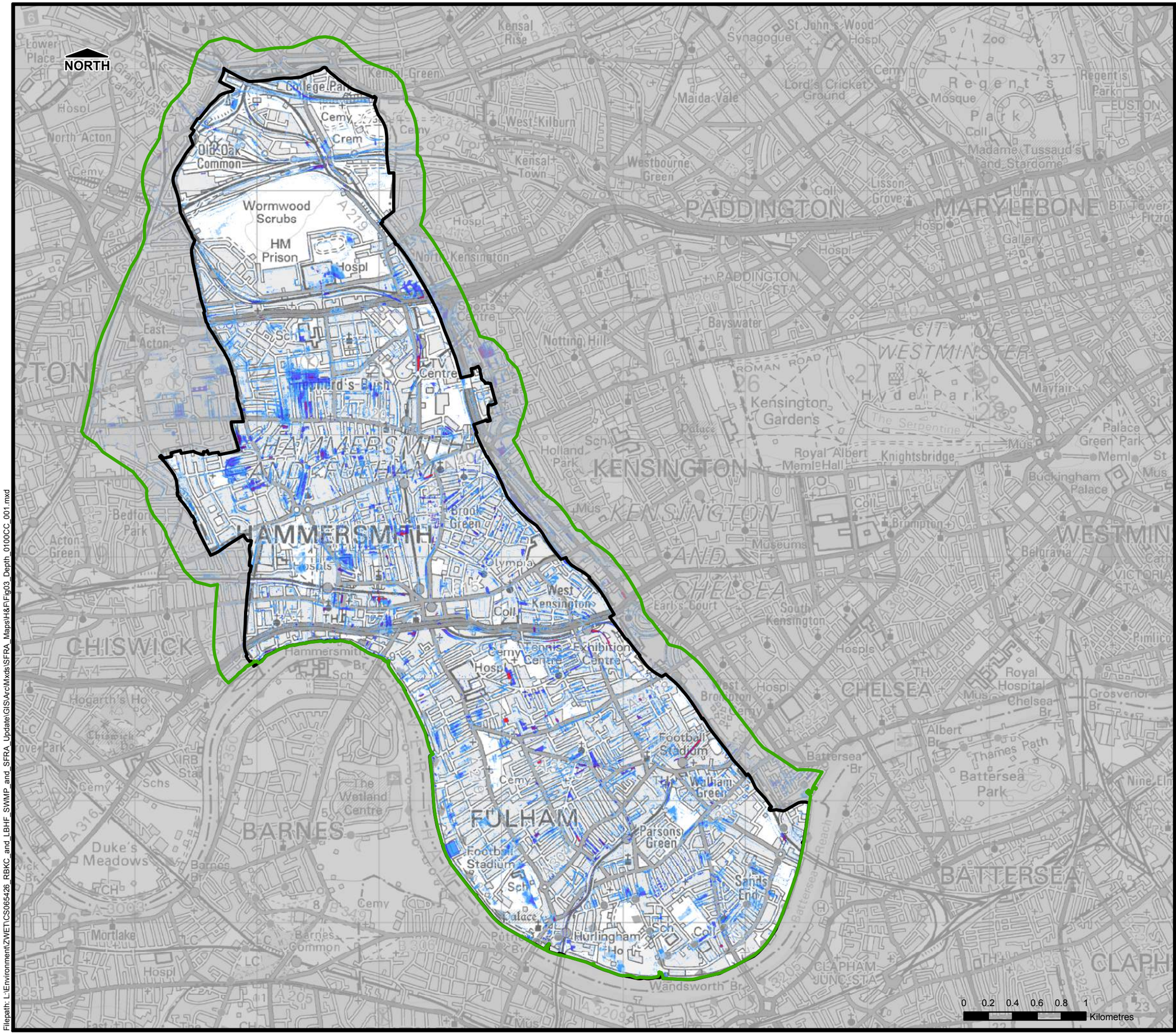
FIGURE 2

Filepath: L:\Environment\ZWET\CS\065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&FFig02_Topography_001.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Model Extent
- Administrative Boundary

Flood Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Surface Water
Flood Depth
1 in 100yr CC, 1.5hr duration
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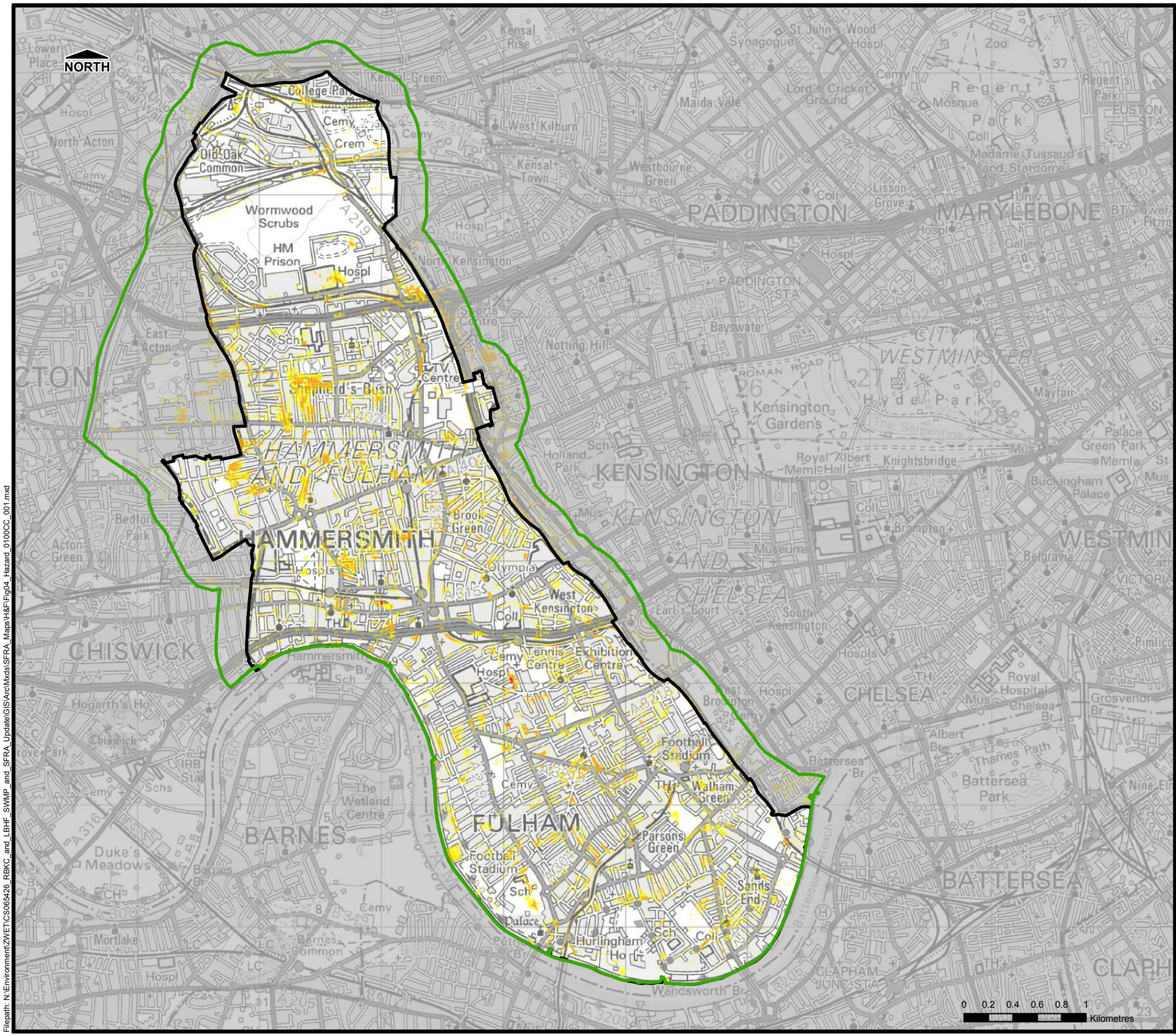
FIGURE 3

Filepath: L:\Environment\ZWET\CS\065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig03_Depth_0100CC_001.mxd



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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Model Extent
- Administrative Boundary

Flood Hazard

- Caution (Very Low Hazard)
- Moderate (Danger for Some)
- Significant (Danger for Most)
- Extreme (Danger for All)

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Surface Water
Flood Hazard
1 in 100yr CC, 1.5hr duration
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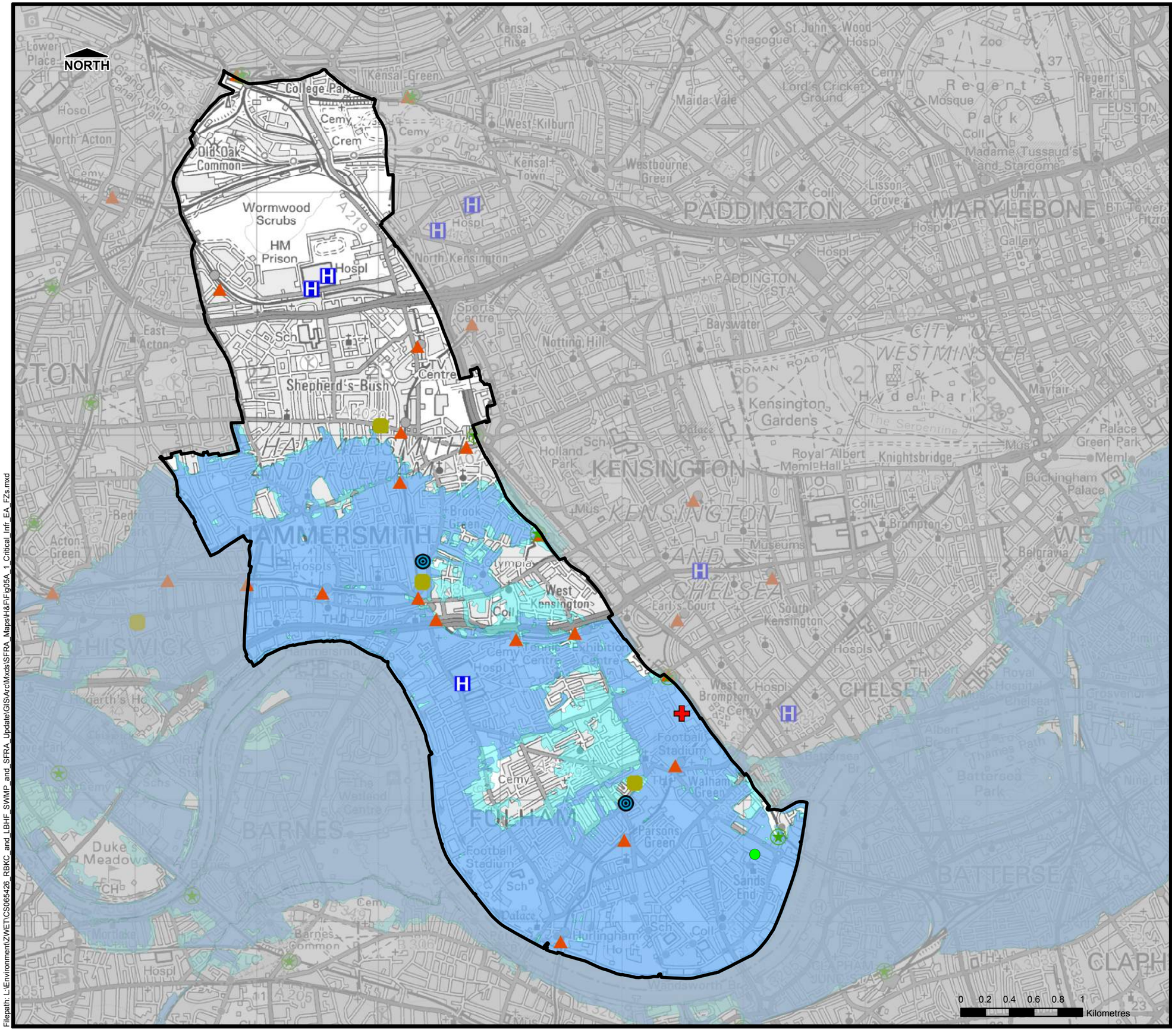
FIGURE 4



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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Environment Agency Flood Zone 2
- Environment Agency Flood Zone 3

Critical Infrastructure

- Council Depot
- Ambulance Stations
- Fire Stations
- Hospitals
- Police Stations
- Railway Stations
- Underground Stations

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Critical Infrastructure and Environment Agency Flood Zones
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FIGURE 5A-1

NORTH

0 0.2 0.4 0.6 0.8 1 Kilometres

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Legend

Administrative Boundary

Flood Depth (m)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- >1.5

Critical Infrastructure

- Council Depot
- Ambulance Stations
- Fire Stations
- Hospitals
- Police Stations
- Railway Stations
- Underground Stations

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Critical Infrastructure and Surface Water Flood Depth
1 in 100yr CC, 1.5hr duration
Commercial in Confidence

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FIGURE 5A-2

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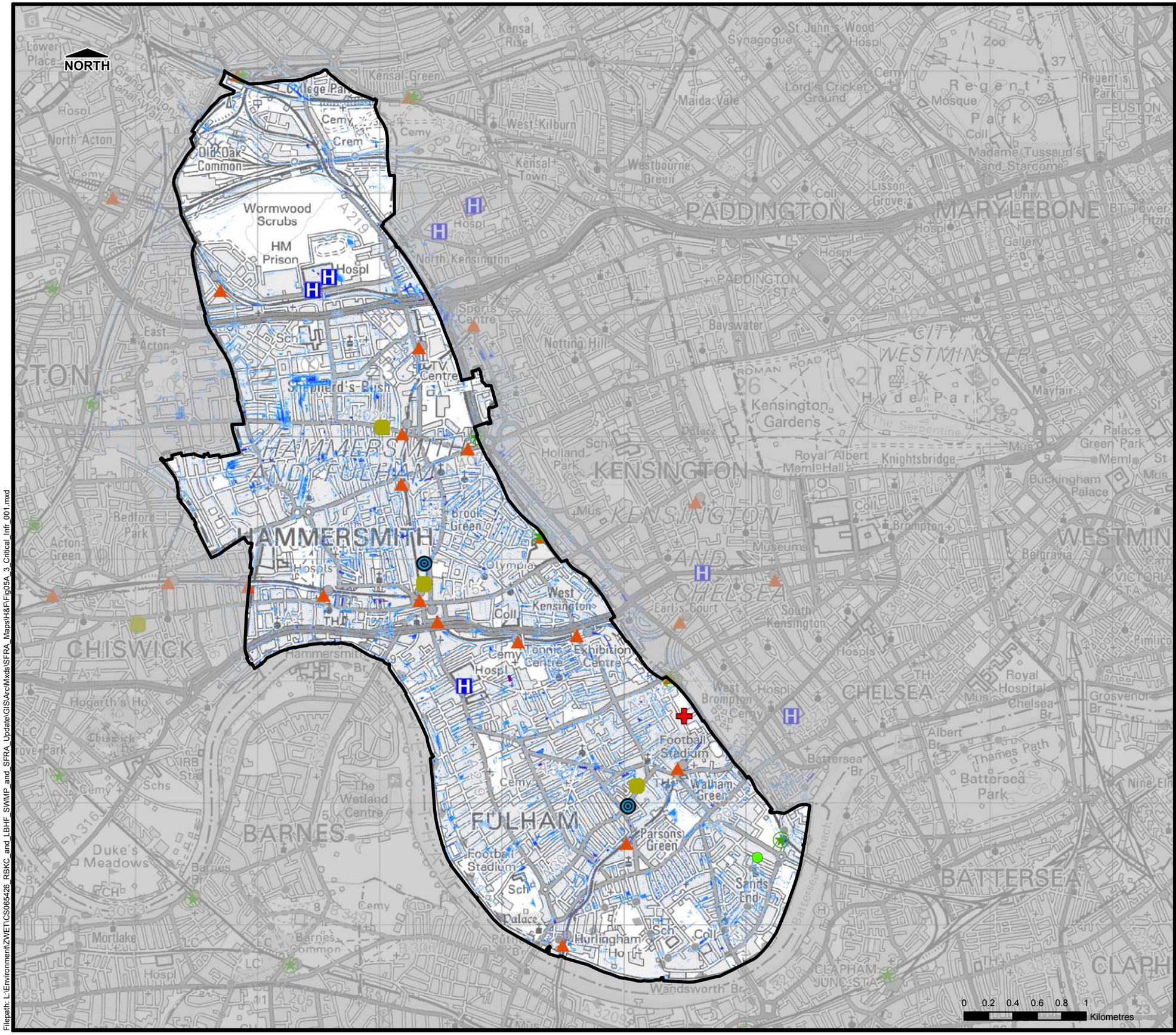

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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary

Flood Depth (m)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- >1.5

Critical Infrastructure

- Council Depot
- Ambulance Stations
- Fire Stations
- Hospitals
- Police Stations
- Railway Stations
- Underground Stations

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Critical Infrastructure and Surface Water Flood Depth 1 in 30yr, 1.5hr duration Commercial in Confidence

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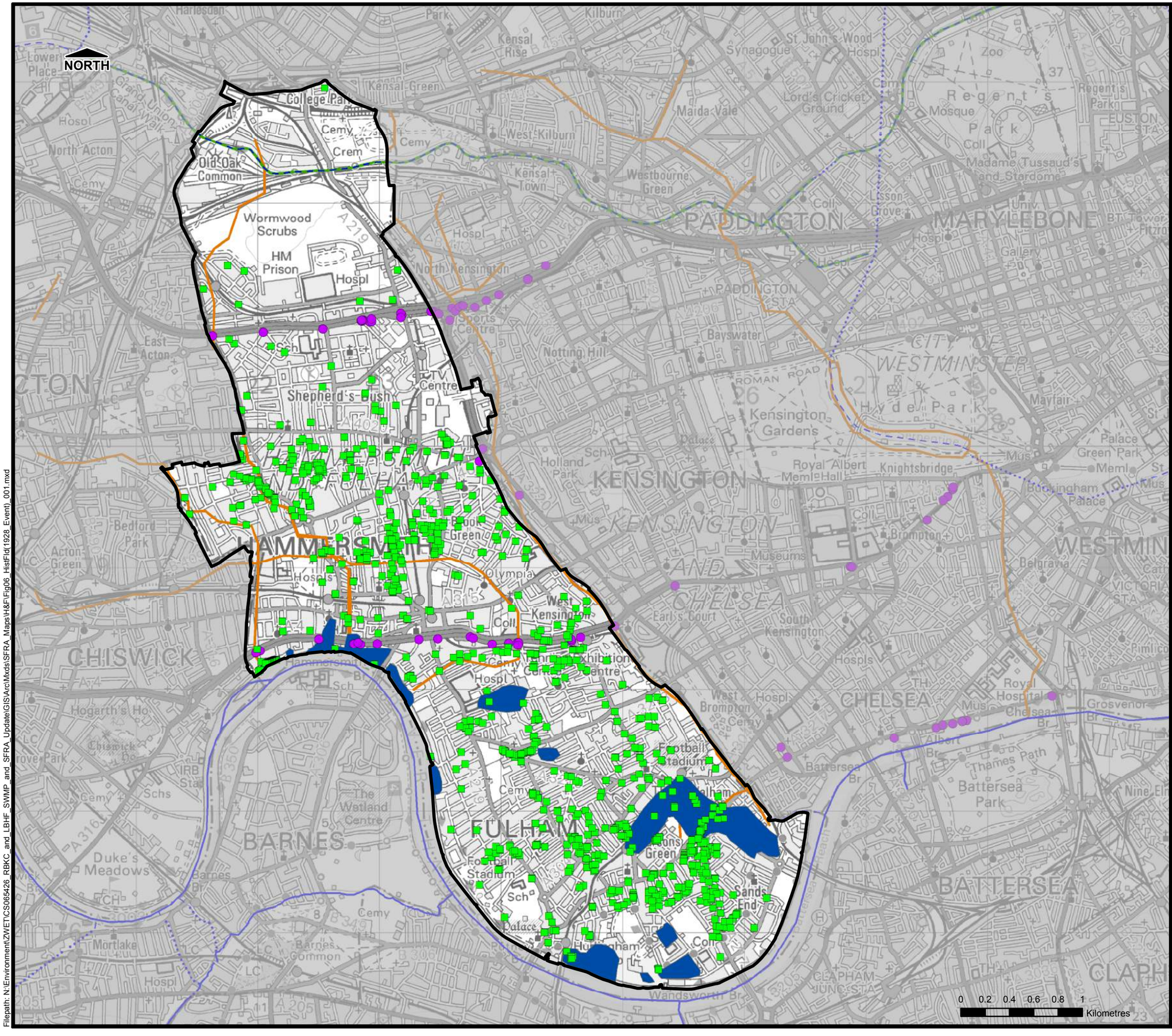
FIGURE 5A-3



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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Main River
- Ordinary Watercourse
- Culverted Watercourse
- Grand Union Canal
- Lost Rivers
- Flood Incidents (LBHF)
- Flood Incidents (Transport For London)
- Historic Flood Event (1928)

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Historical Flooding Overview

Commercial in Confidence

Consultant

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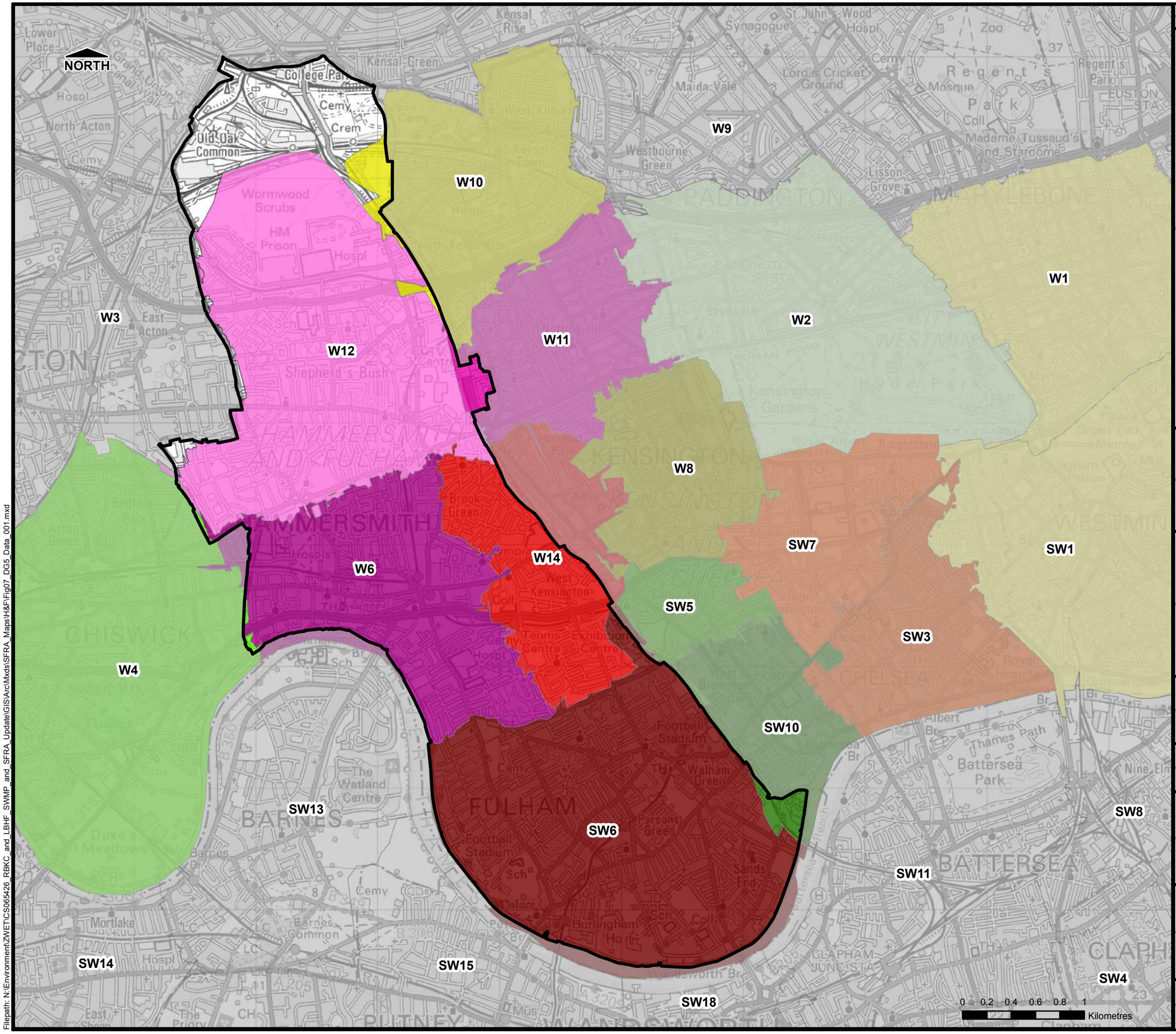
FIGURE 6



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

Administrative Boundary

No. of Sewer Flood Records

0	50	283
2	53	310
4	99	415
12	103	418
38	146	872

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Recorded Incidents of Sewer Flooding

Commercial in Confidence

Consultant

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FIGURE 7

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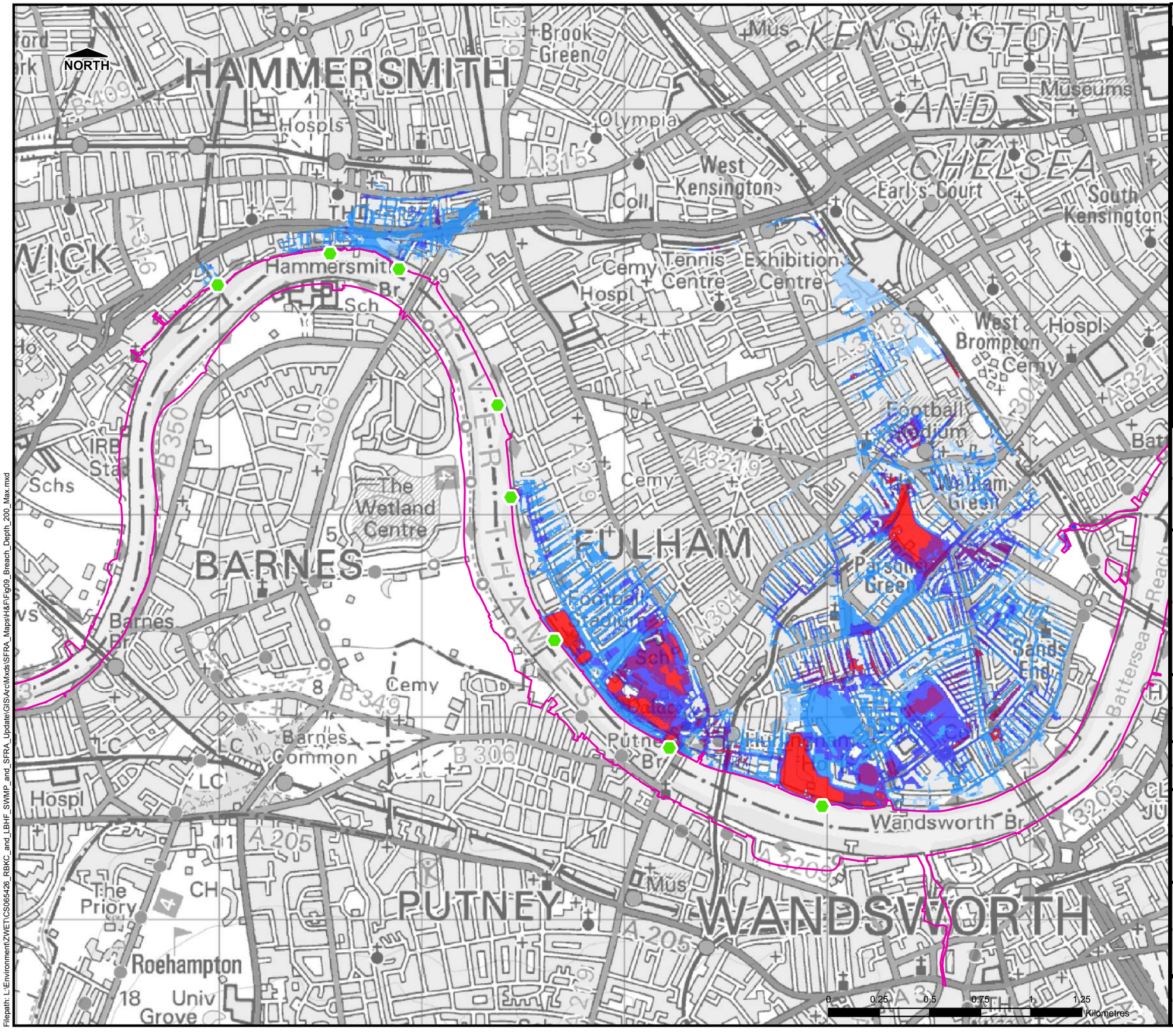

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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Notes

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Tidal Breach Depth (Maximum)
1 in 200yr event

Commercial in Confidence

Consultant

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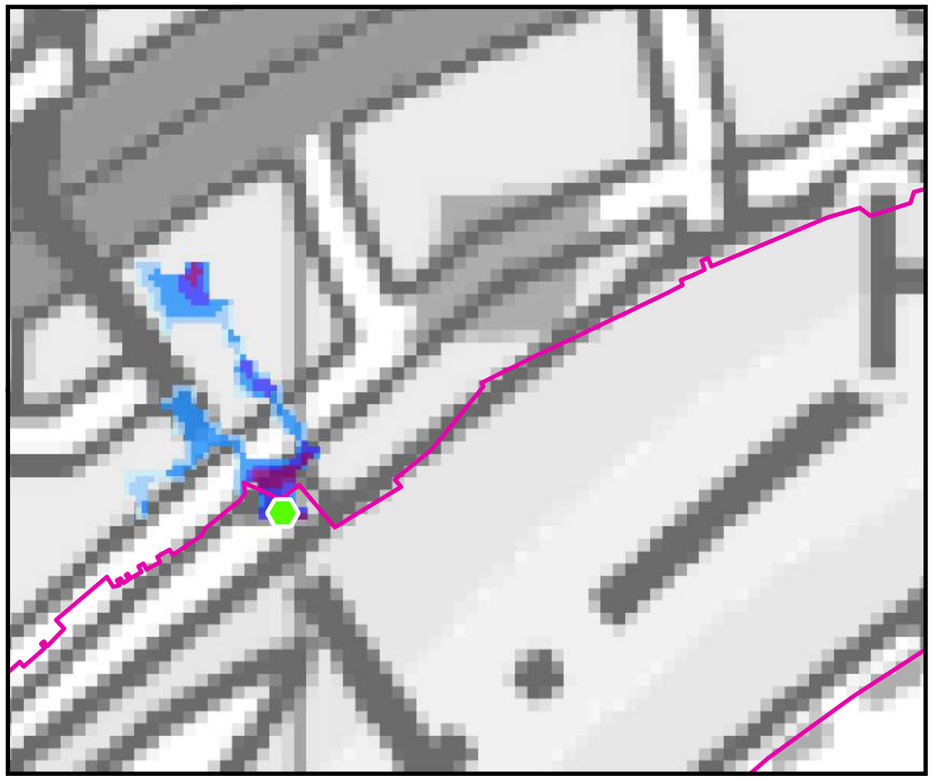
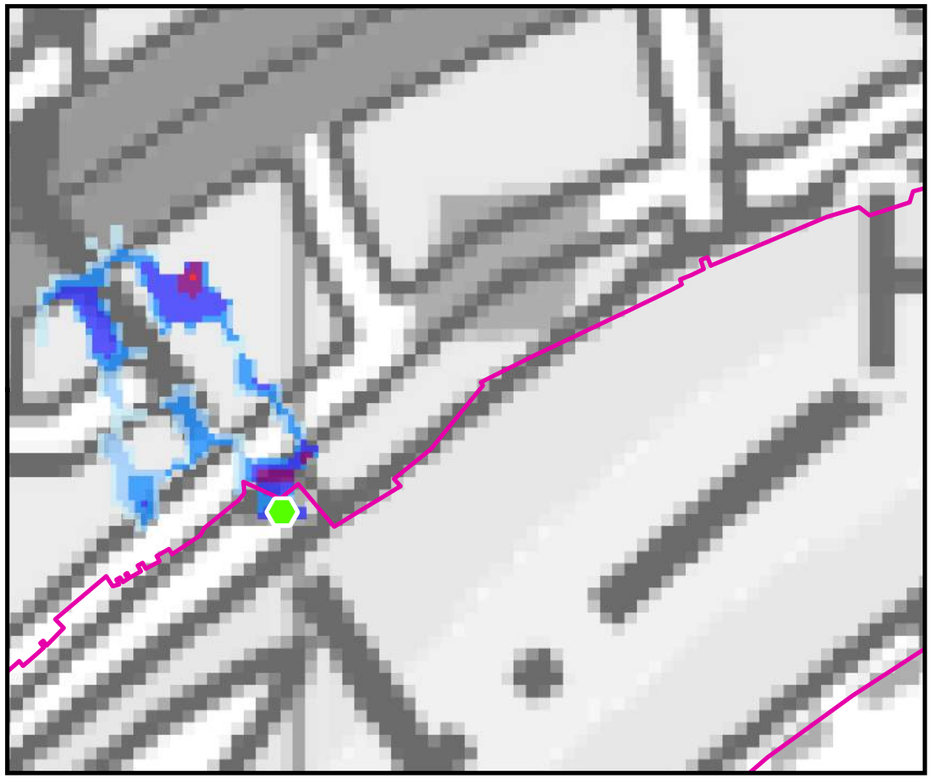
FIGURE 8

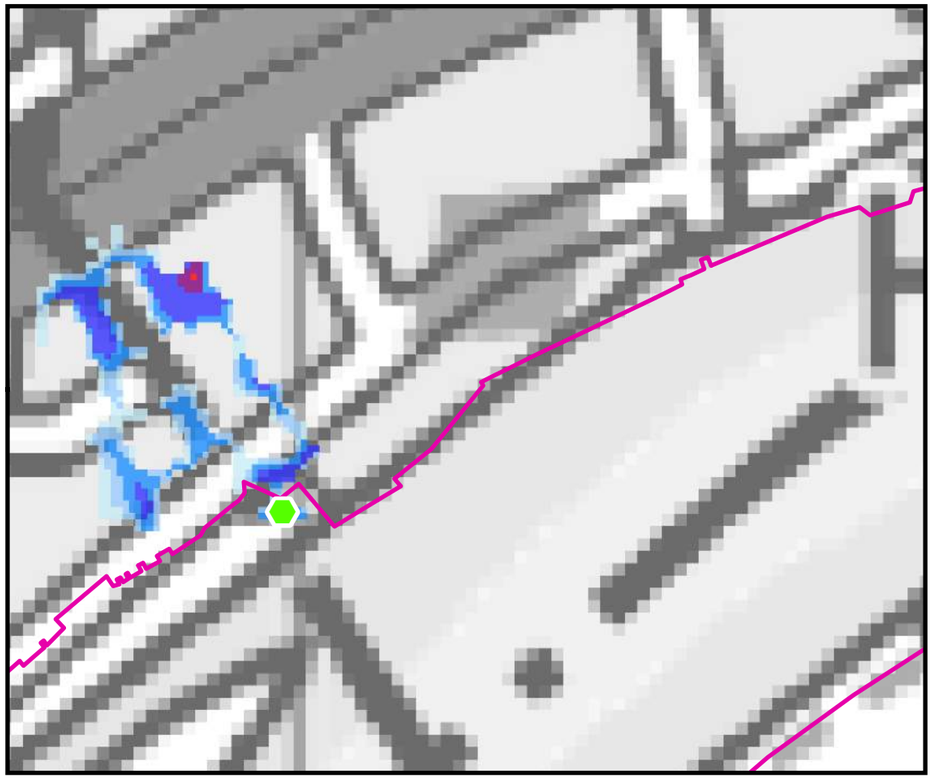
Time After Breach = 0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.02 0.04 0.06 0.08 0.1
Kilometres

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_1_1_Ham1_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:2,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham1
1 in 200yr Event
Commercial in Confidence

Consultant

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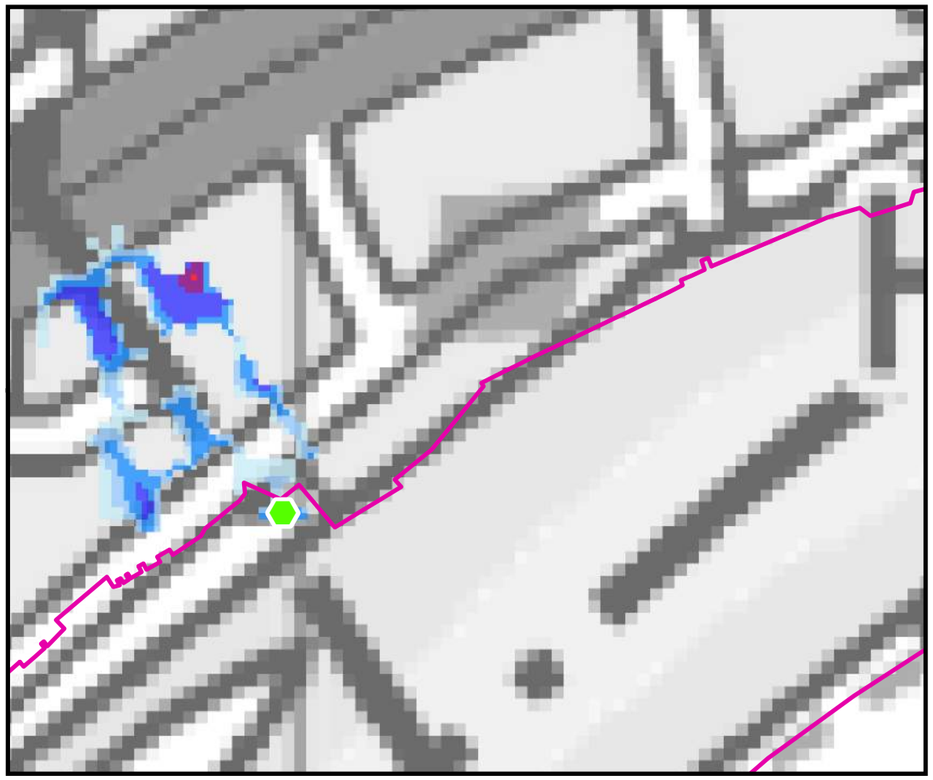
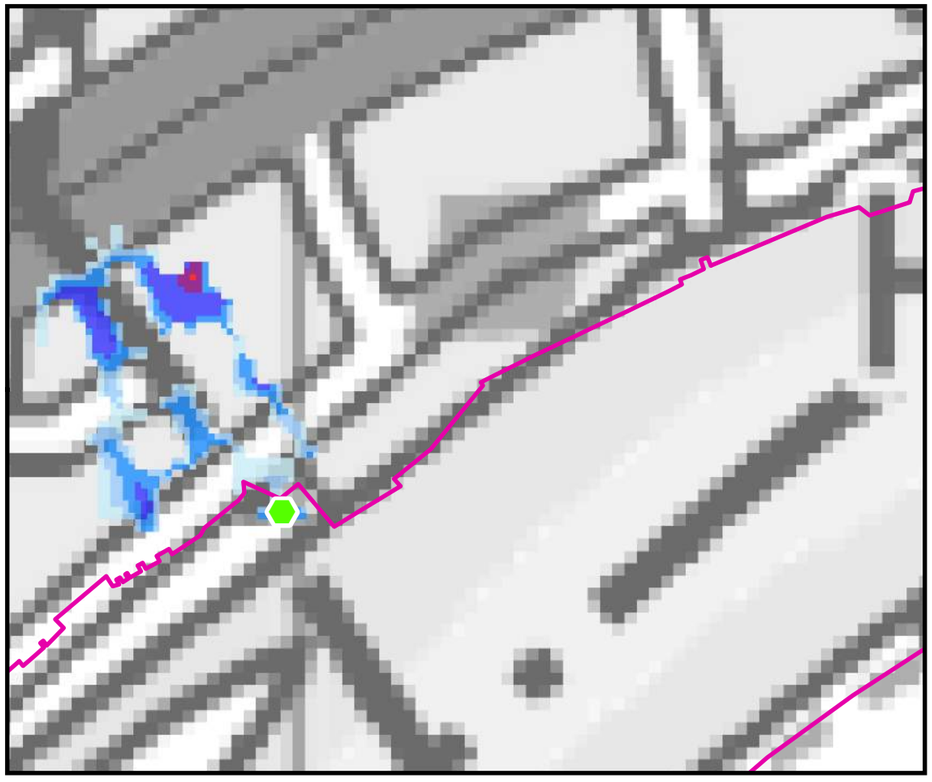
FIGURE 8.1.1

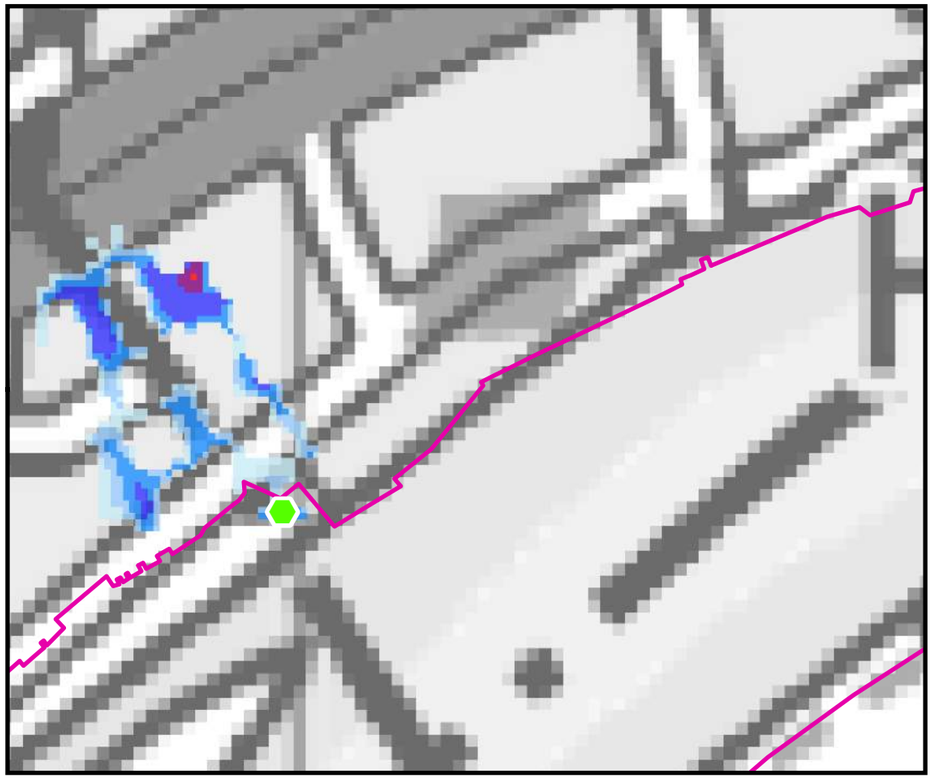
Time After Breach = 3.0hrs



Time After Breach = 4.0hrs



Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.02 0.04 0.06 0.08 0.1
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:2,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham1
1 in 200yr Event
Commercial in Confidence

Consultant

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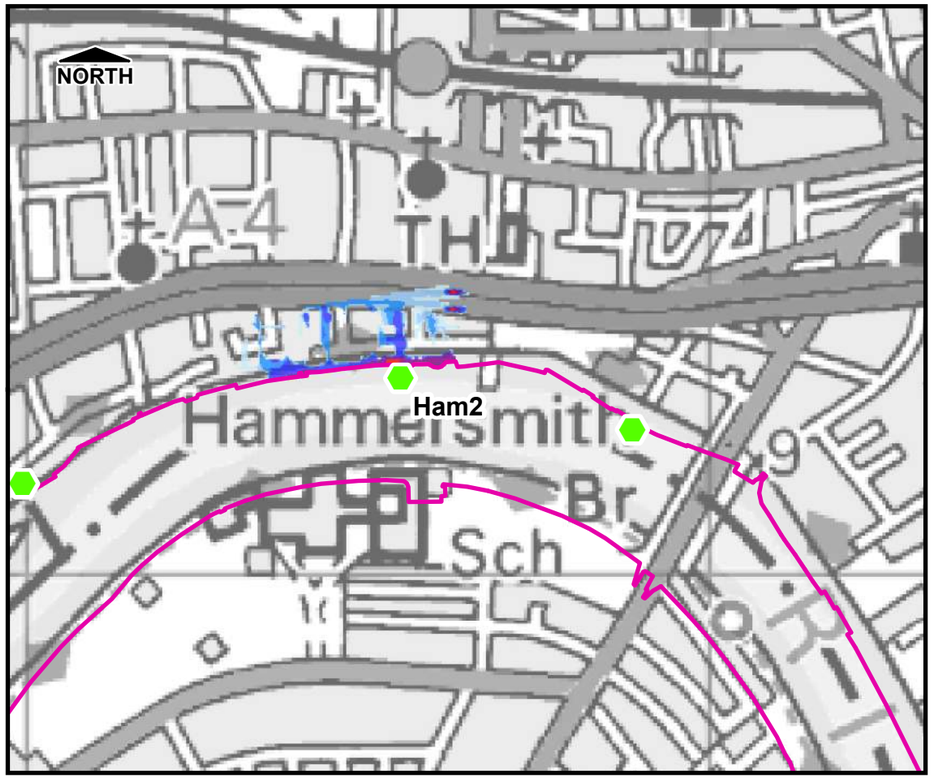
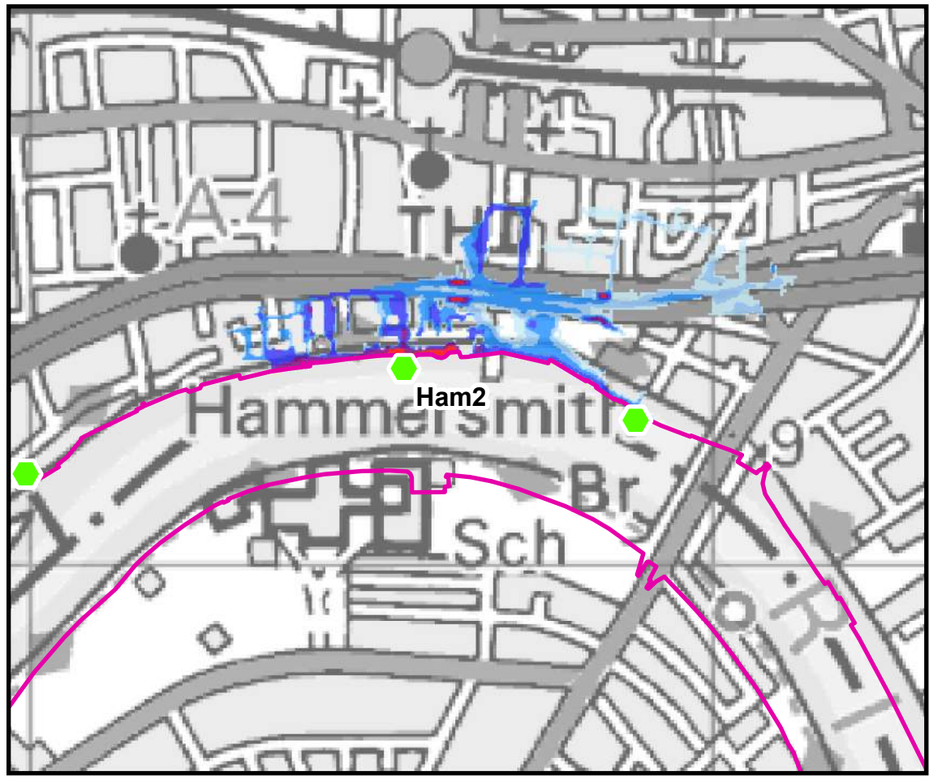
London
EC2V 7NQ

FIGURE 8.1.2

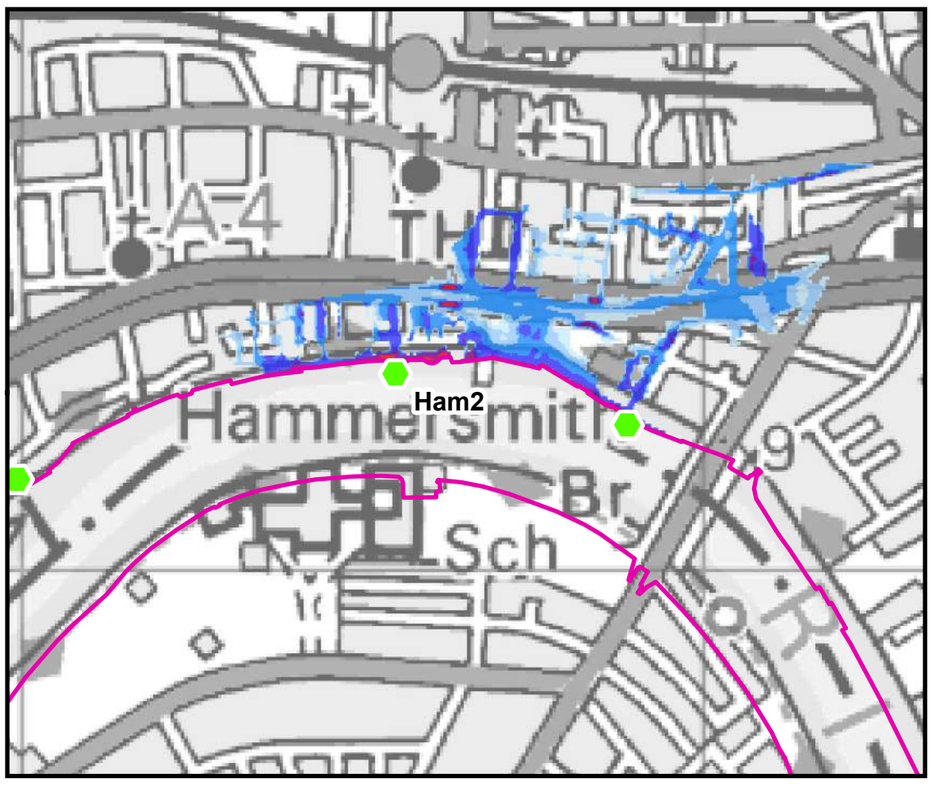
L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_1_2_Ham1_Depth_200_001.mxd



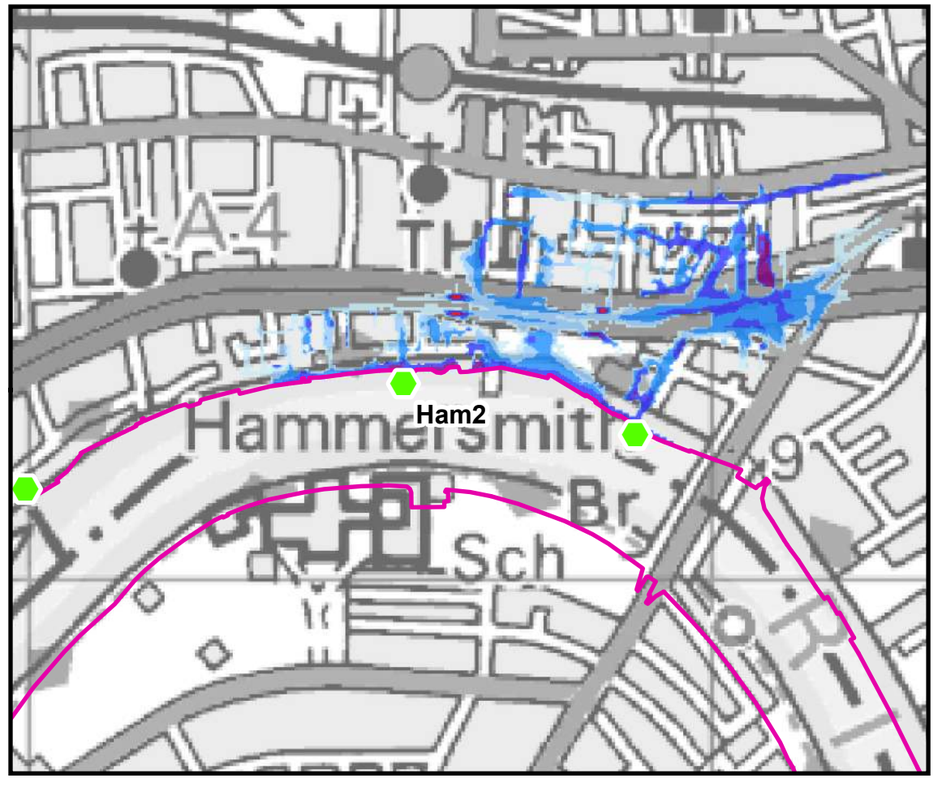
Time After Breach = 0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.075 0.15 0.225 0.3 0.375
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:9,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham2
1 in 200yr Event
Commercial in Confidence

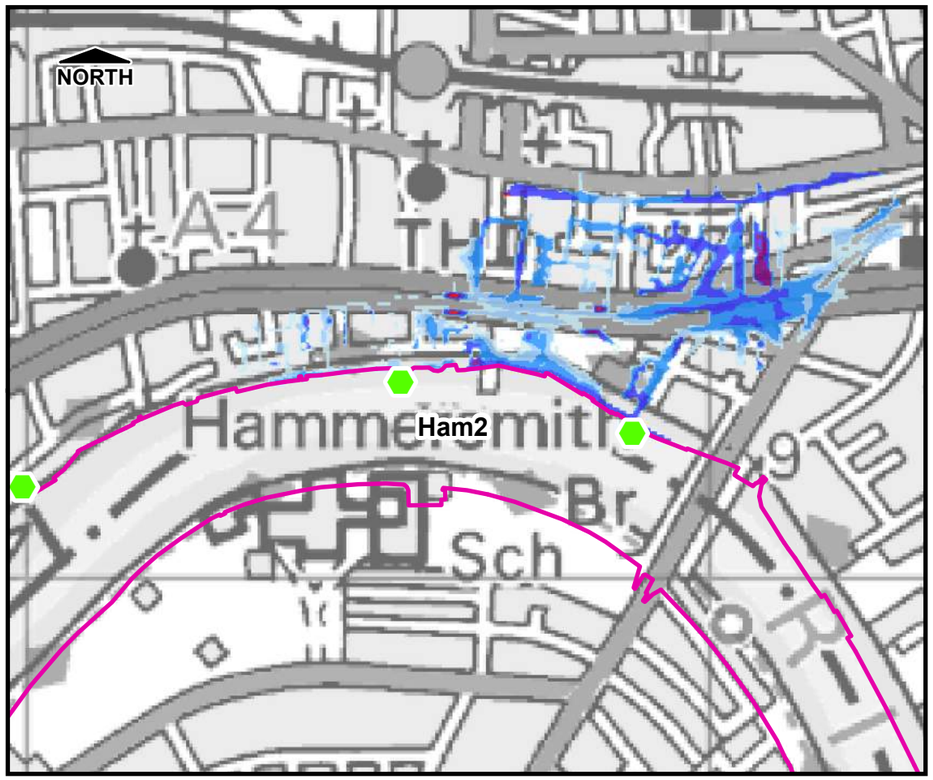
Consultant

CAPITA | AECOM

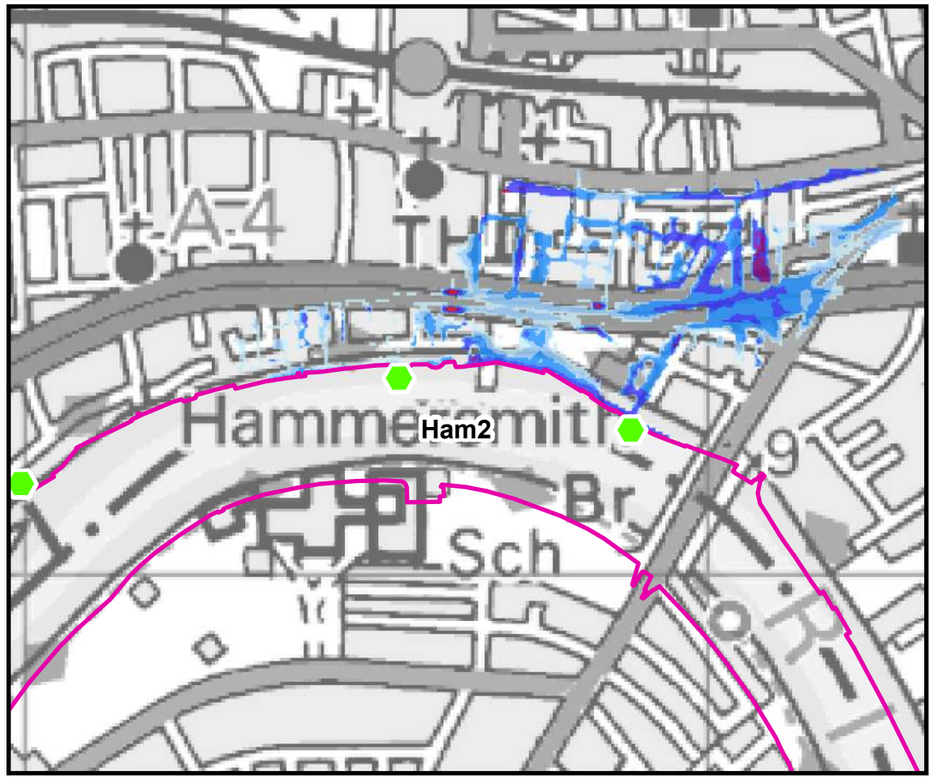
Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.2.1

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_2_1_Ham2_Depth_200_001.mxd



Time After Breach = 3.0hrs



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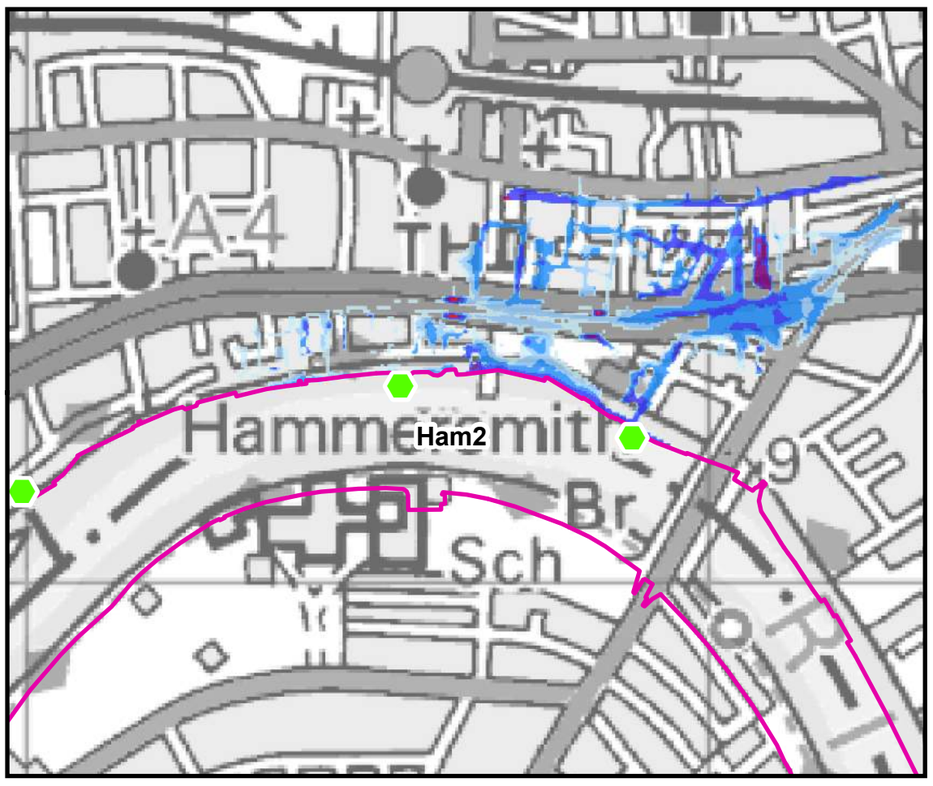
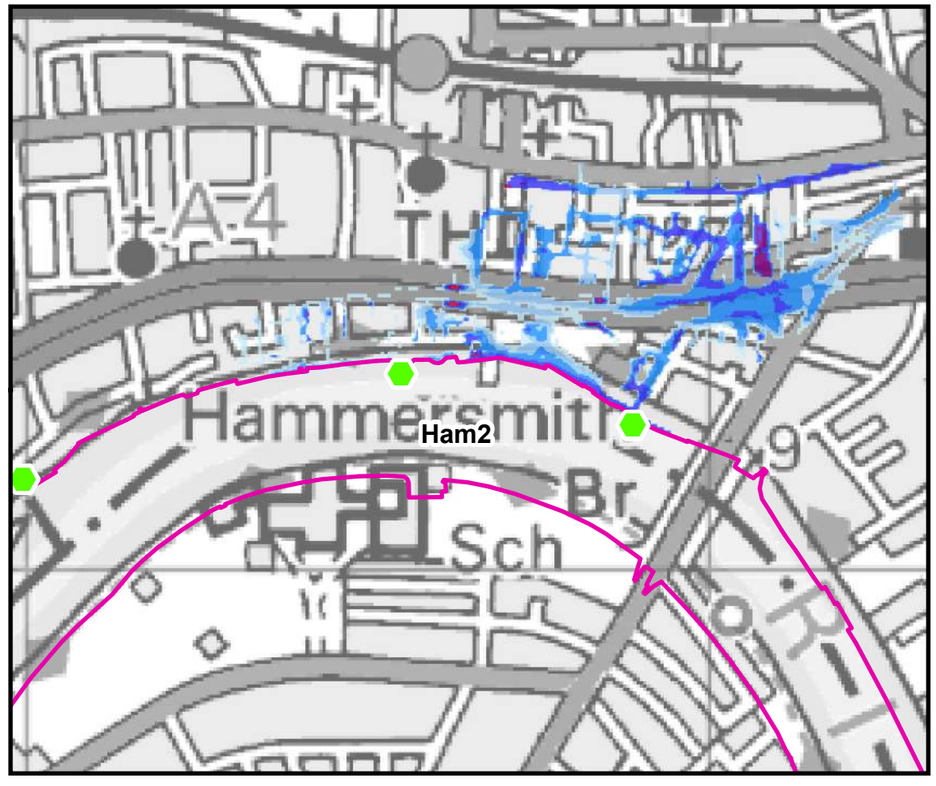


Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.075 0.15 0.225 0.3 0.375
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:9,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham2
1 in 200yr Event
Commercial in Confidence

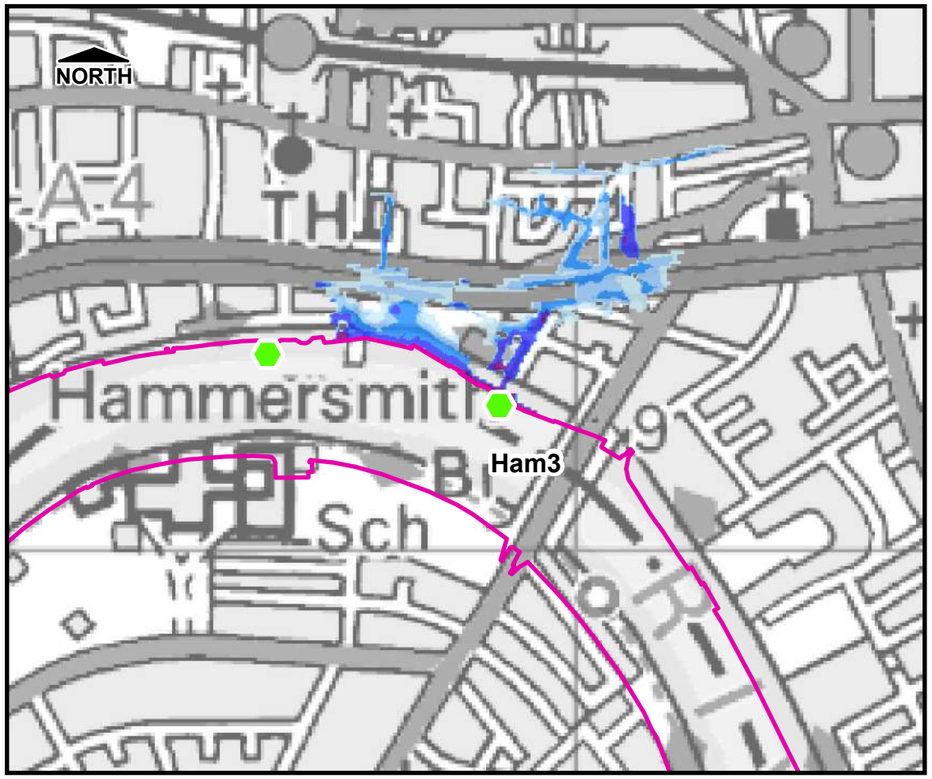
Consultant

CAPITA | AECOM

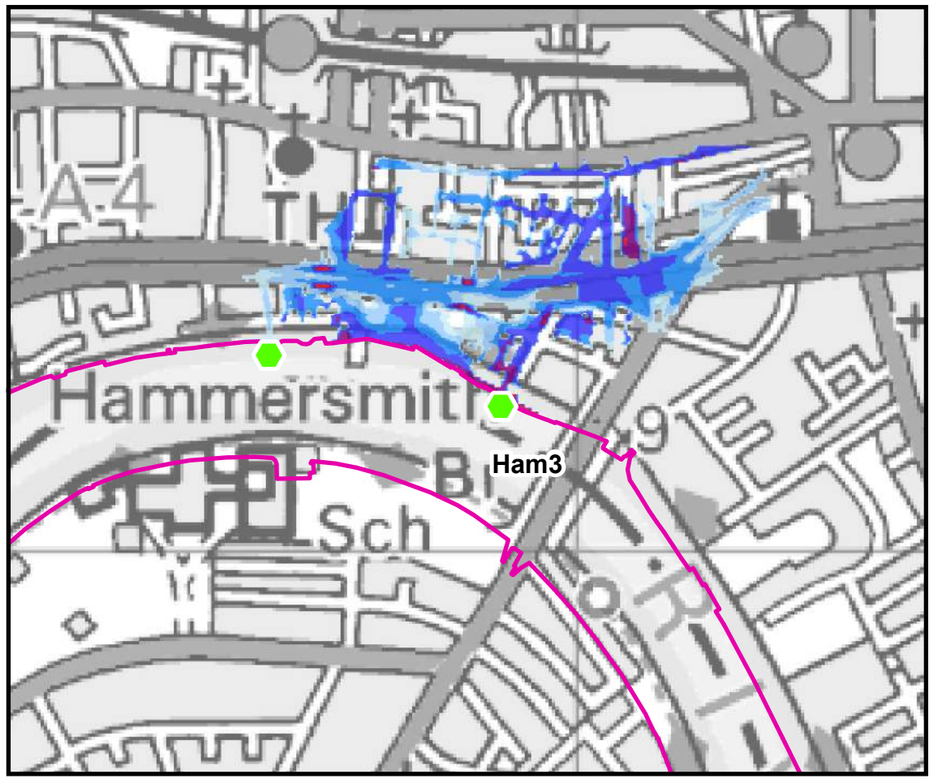
Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.2.2

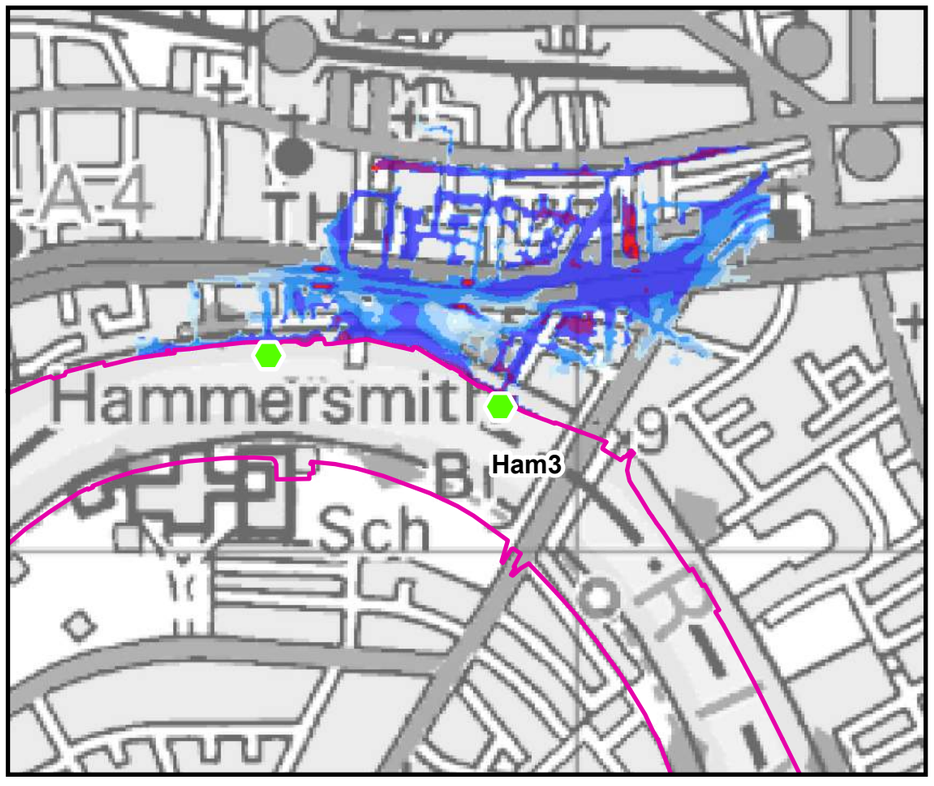
L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_2_2_Ham2_Depth_200_001.mxd



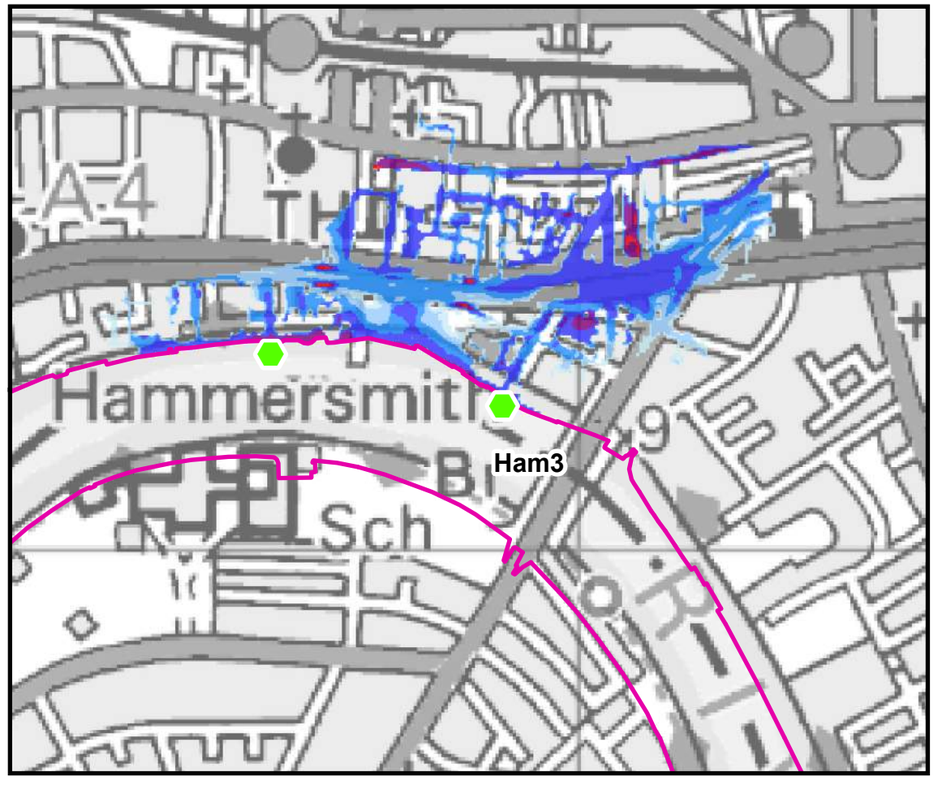
Time After Breach = 0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.075 0.15 0.225 0.3 0.375
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:9,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

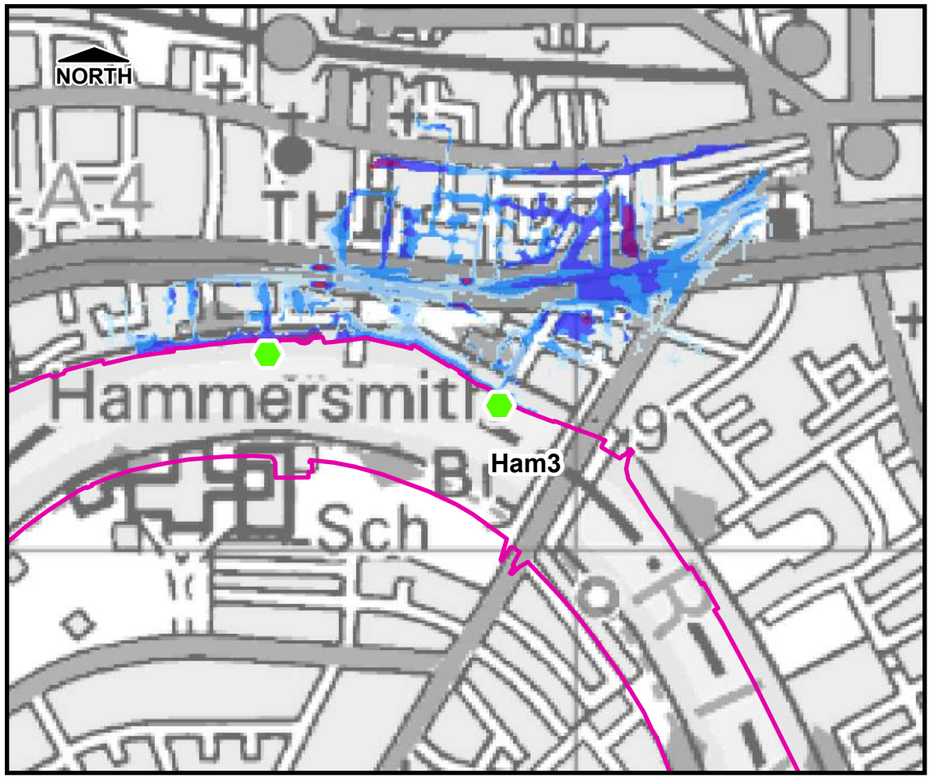
Tidal Breach Depth
Breach Location Ham1
1 in 200yr Event
Commercial in Confidence

Consultant

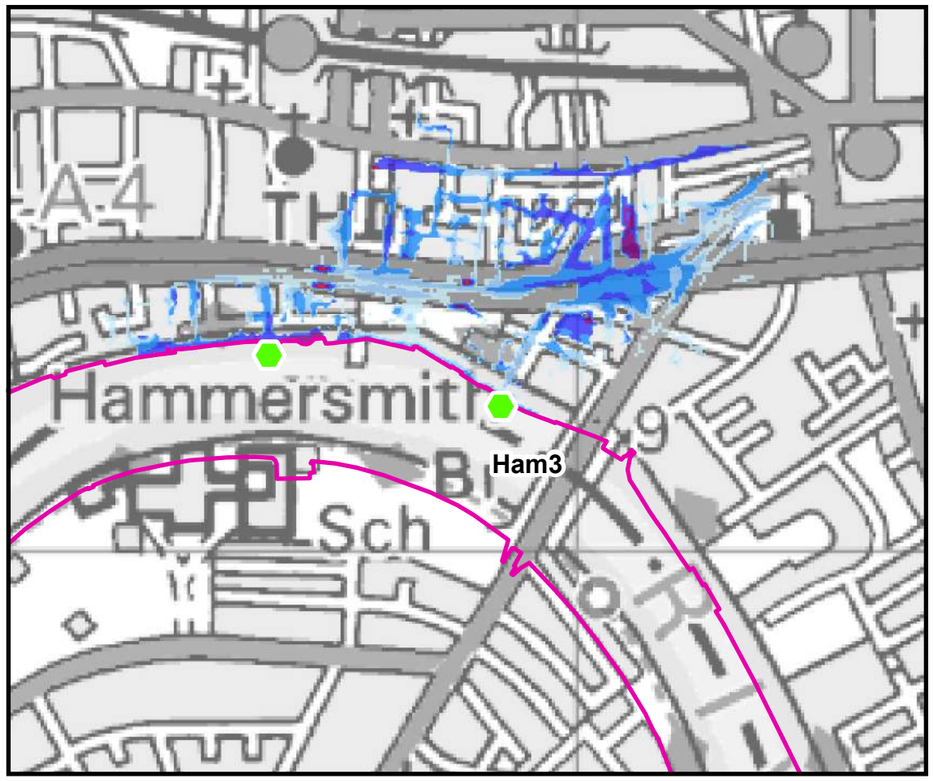
CAPITA | AECOM
Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.3.1

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_3_1_Ham3_Depth_200_001.mxd

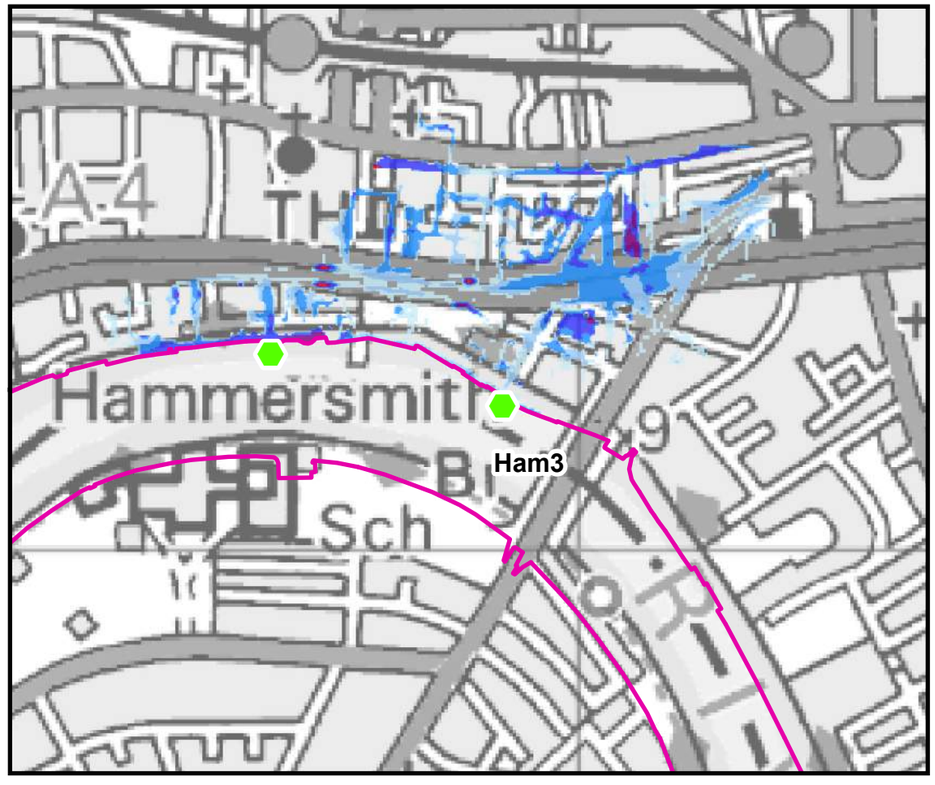


Time After Breach =3.0hrs



Time After Breach = 4.0hrs

Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.08 0.16 0.24 0.32 0.4
Kilometres

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_3_2_Ham3_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:9,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

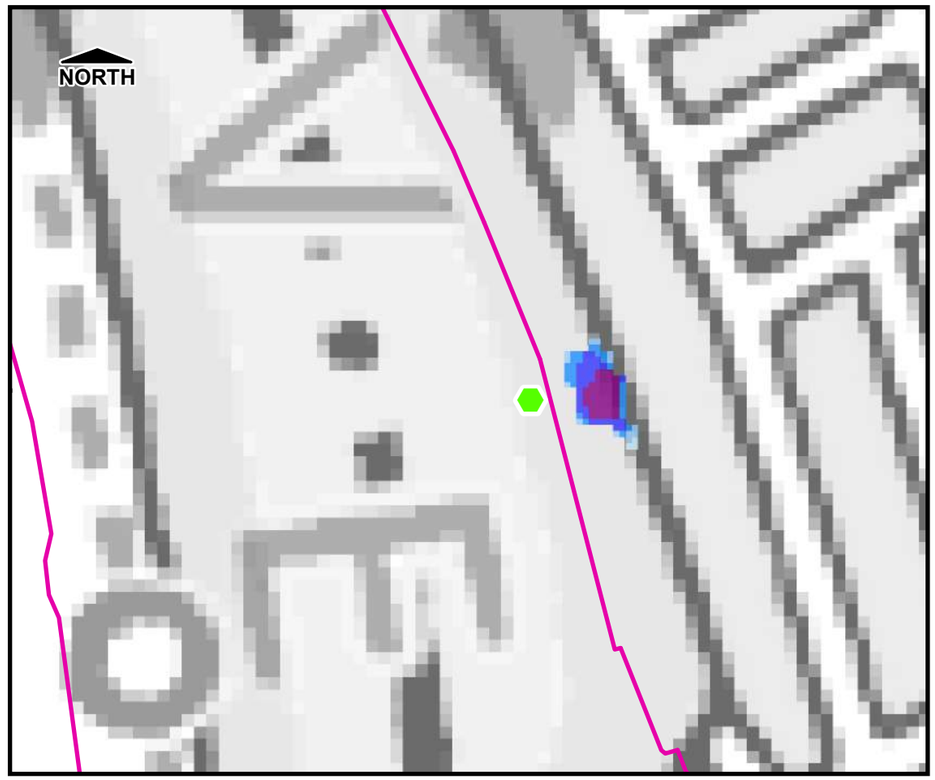
Tidal Breach Depth
Breach Location Ham3
1 in 200yr Event
Commercial in Confidence

Consultant

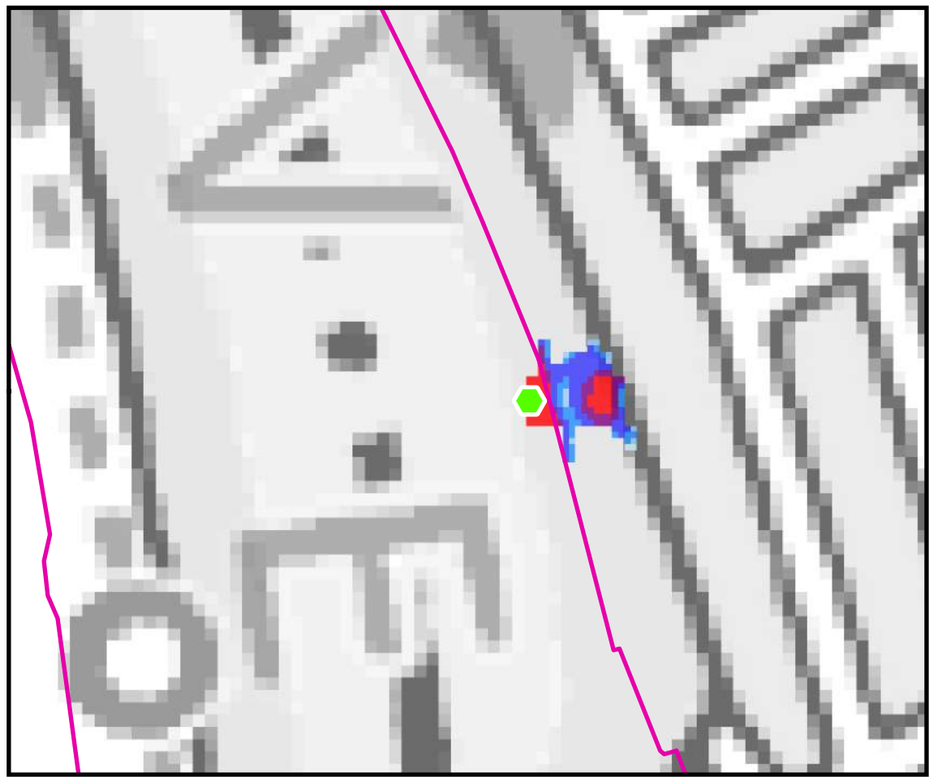
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

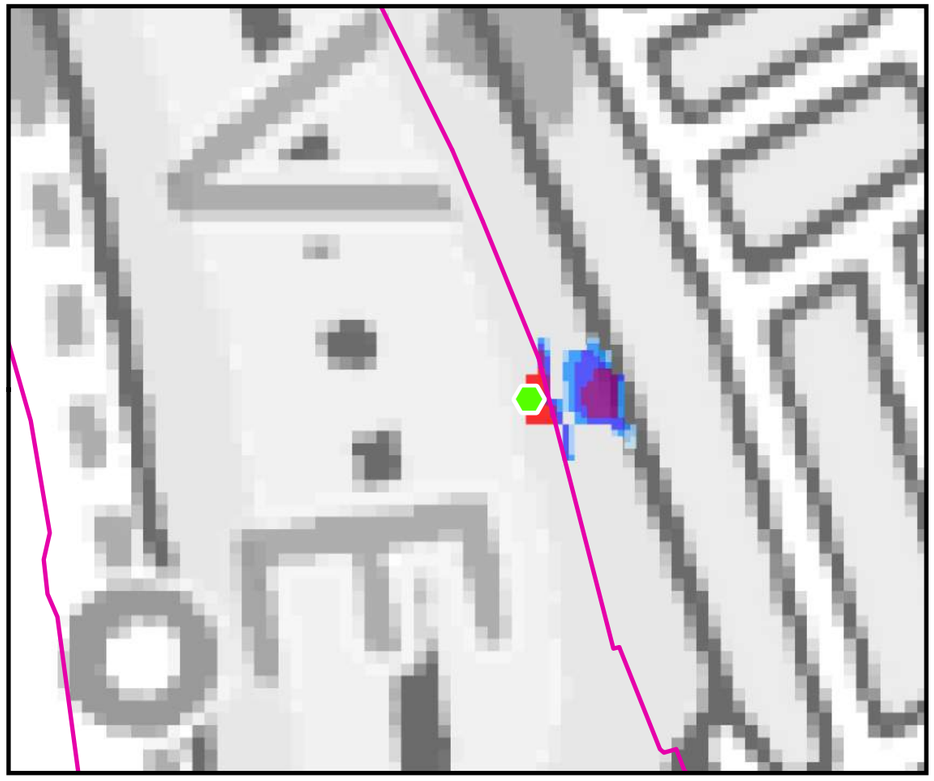
FIGURE 8.3.2



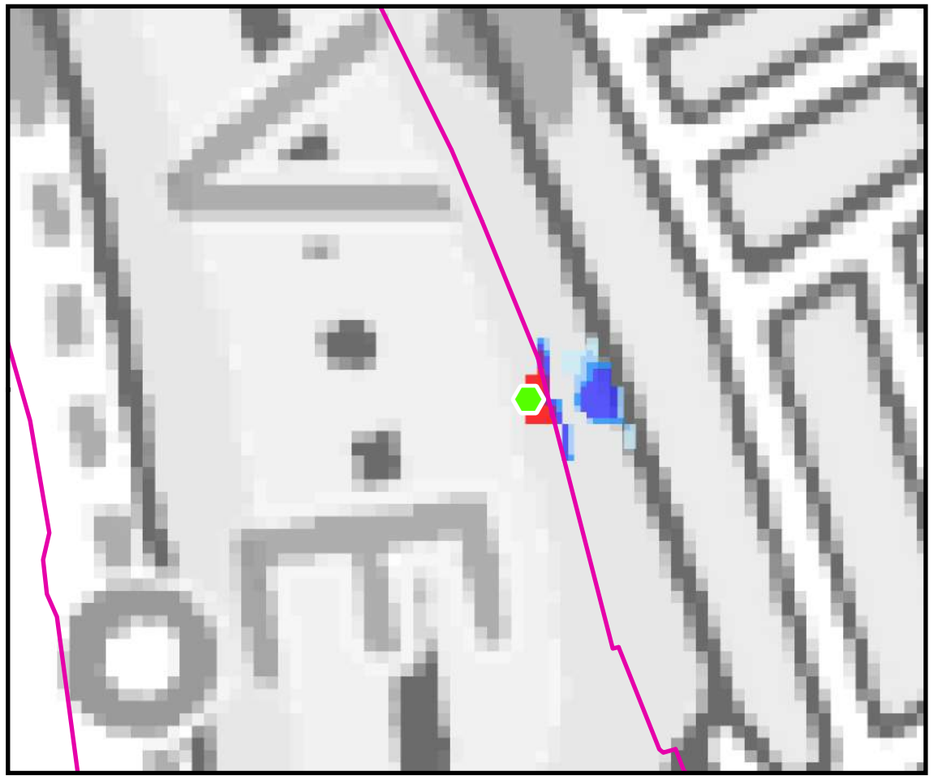
Time After Breach =0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.02 0.04 0.06 0.08 0.1
Kilometres

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&F\Fig8_4_1_Ham4_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:2,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

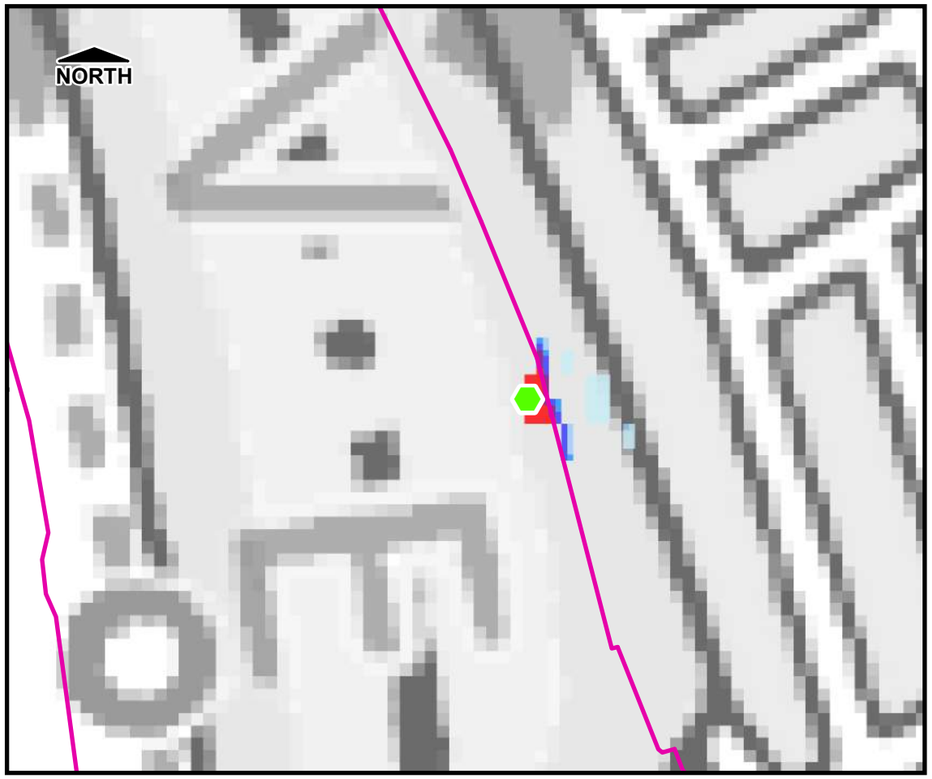
Tidal Breach Depth
Breach Location Ham4
1 in 200yr Event
Commercial in Confidence

Consultant

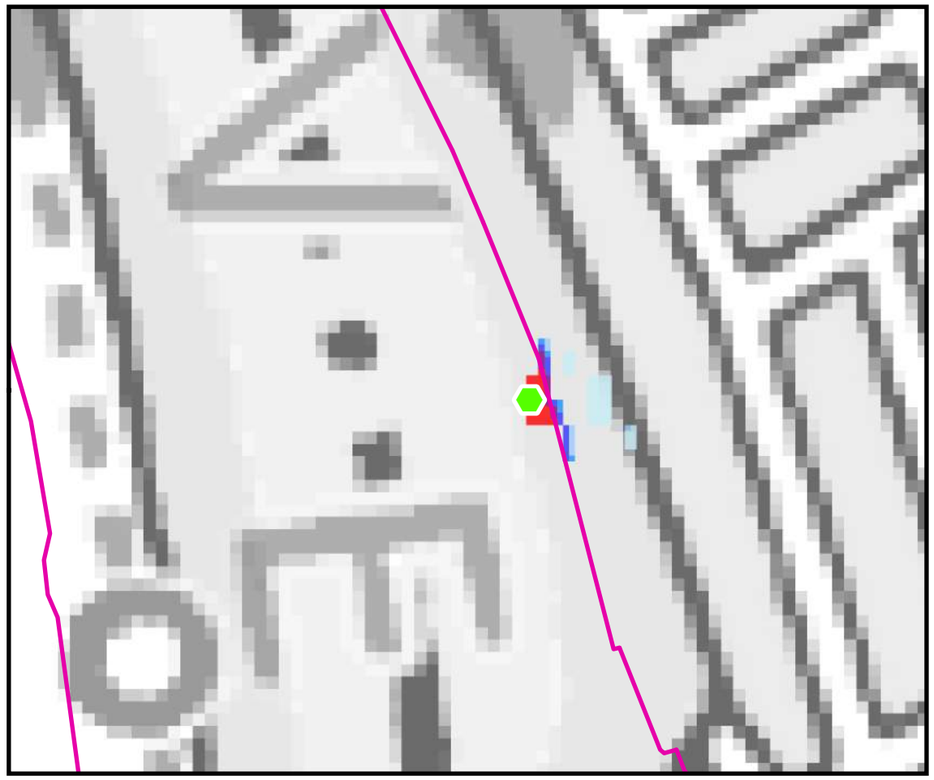
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

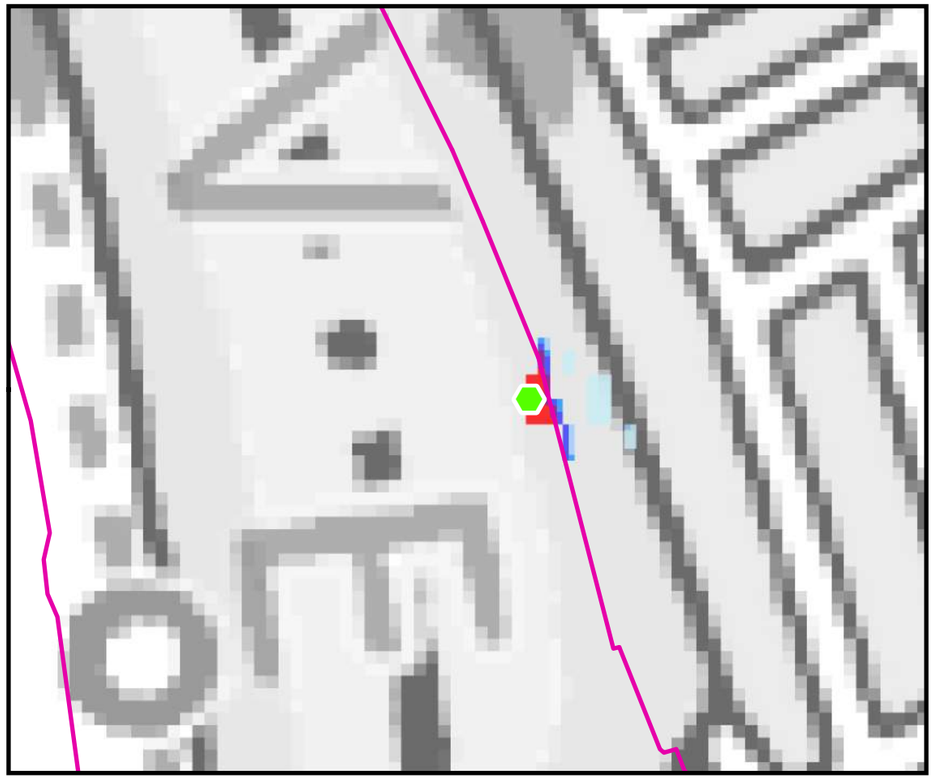
FIGURE 8.4.1



Time After Breach =3.0hrs



Time After Breach = 4.0hrs



Time After Breach = 5.0hrs

Time After Breach = 6.0hrs

0 0.02 0.04 0.06 0.08 0.1
Kilometres

L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&F\Fig8_4_2_Ham4_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:2,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

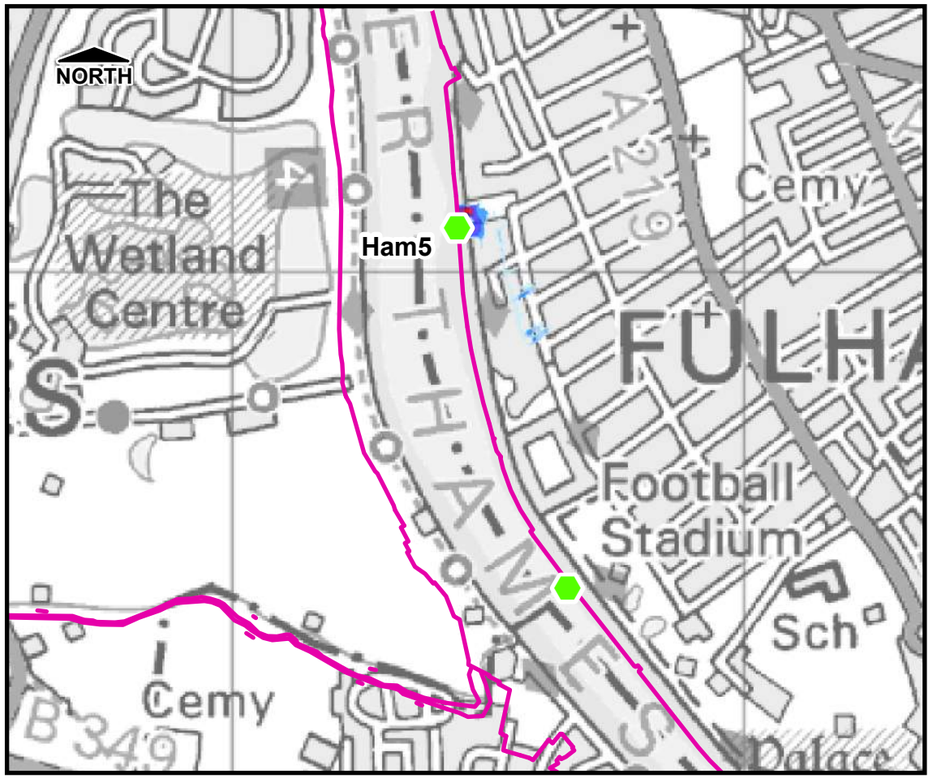
Tidal Breach Depth
Breach Location Ham4
1 in 200yr Event
Commercial in Confidence

Consultant

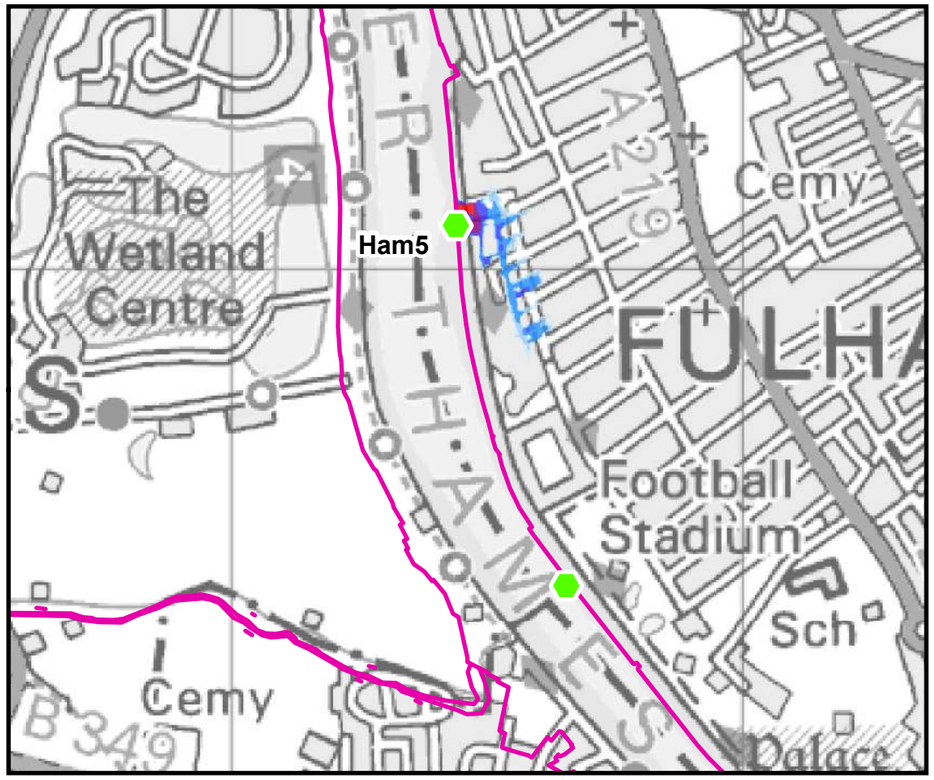
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

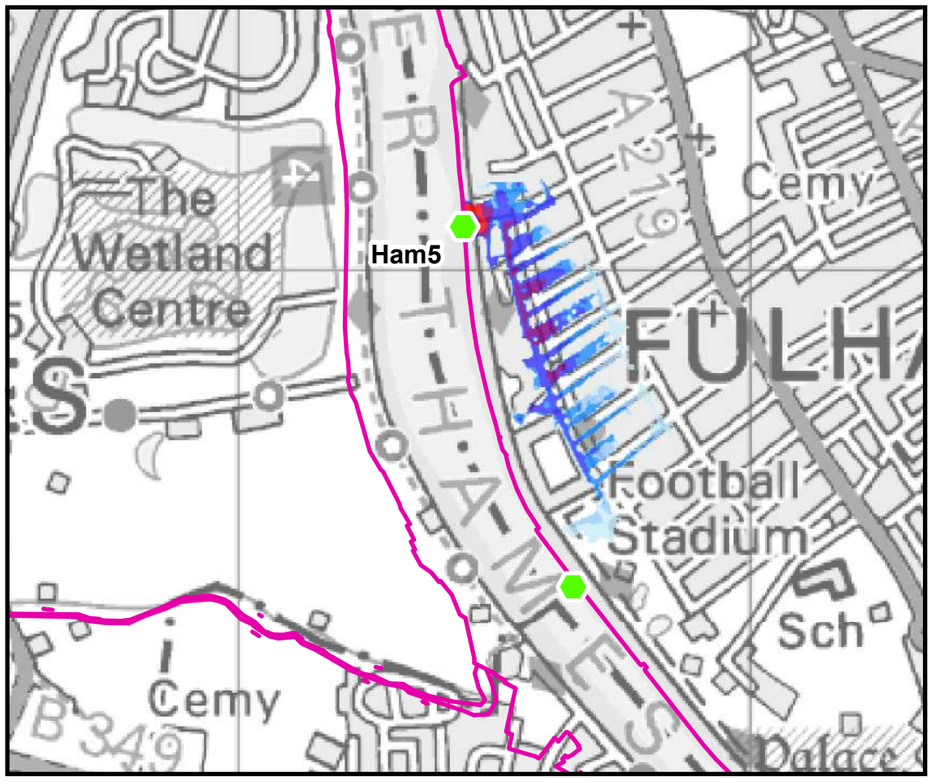
FIGURE 8.4.2



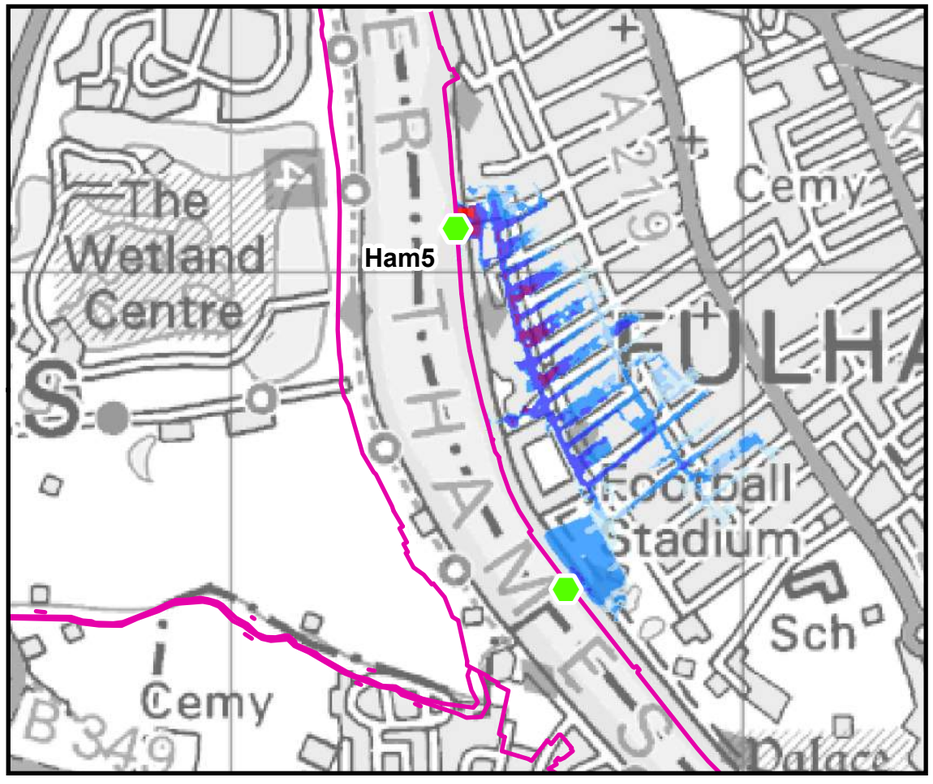
Time After Breach = 0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.09 0.18 0.27 0.36 0.45
Kilometres

L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIM\xds\SFRA_Maps\H&F\Fig8_5_1_Ham5_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:12,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

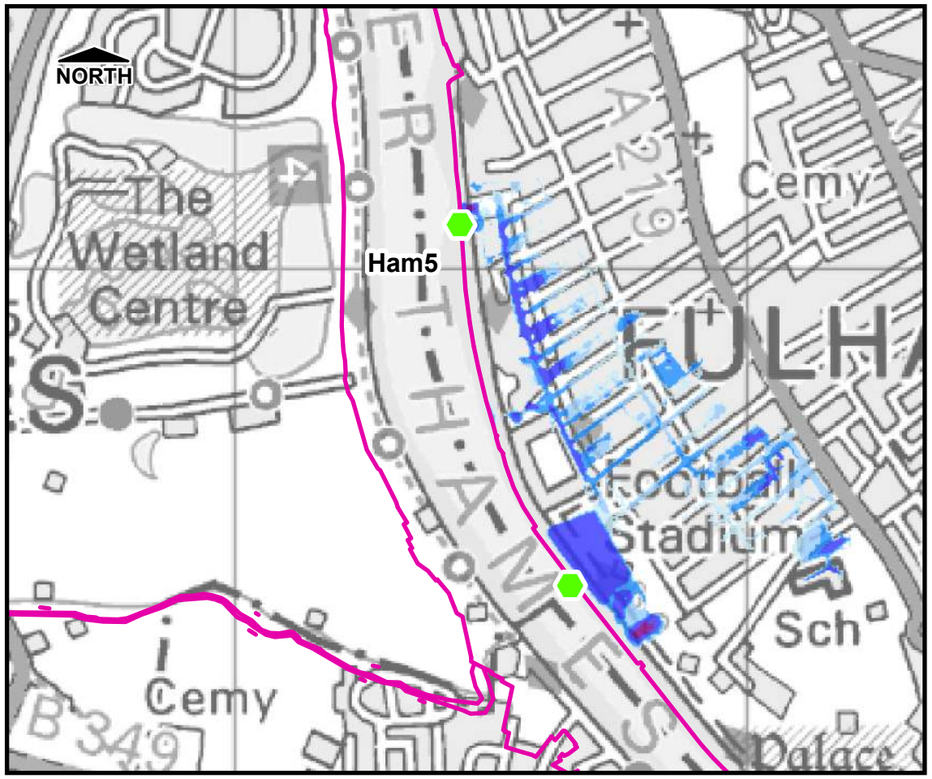
Tidal Breach Depth
Breach Location Ham5
1 in 200yr Event
Commercial in Confidence

Consultant

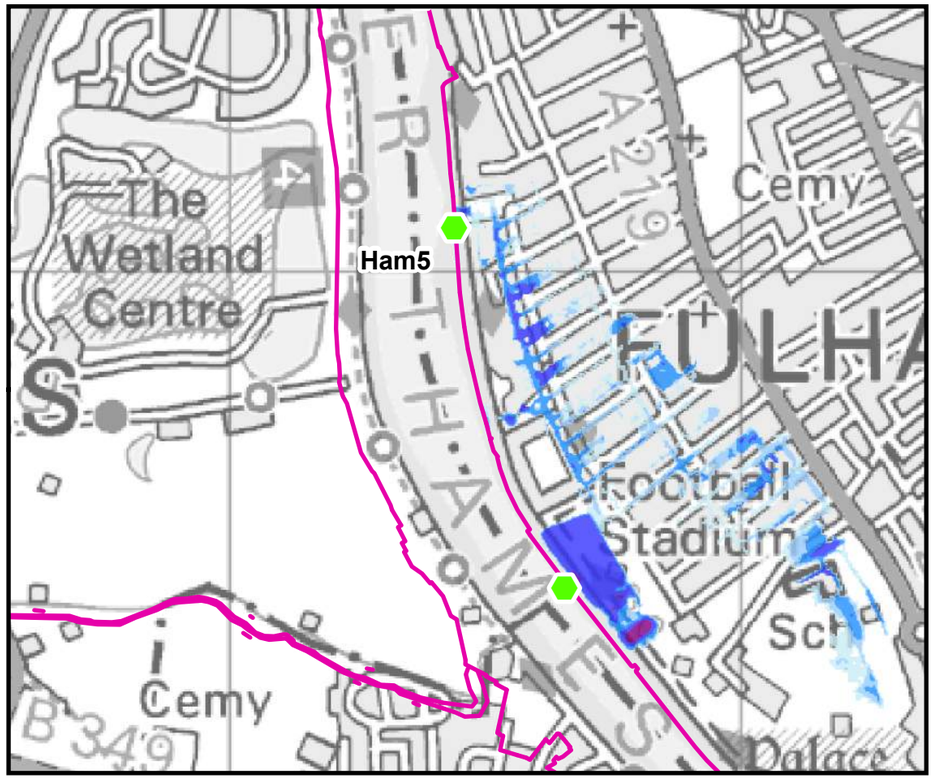
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

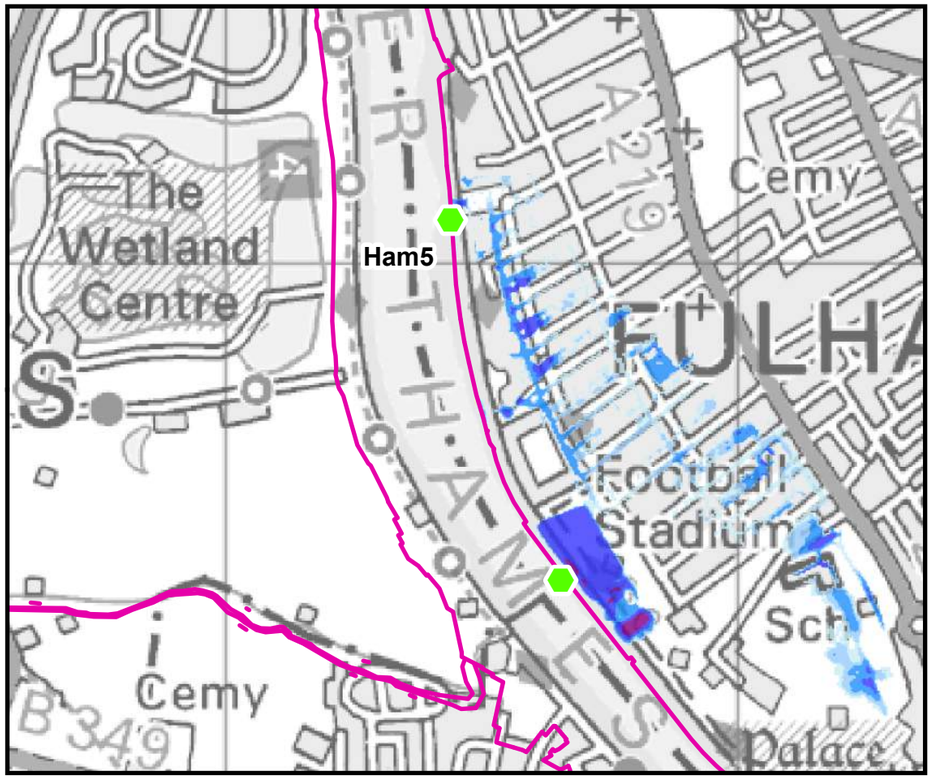
FIGURE 8.5.1



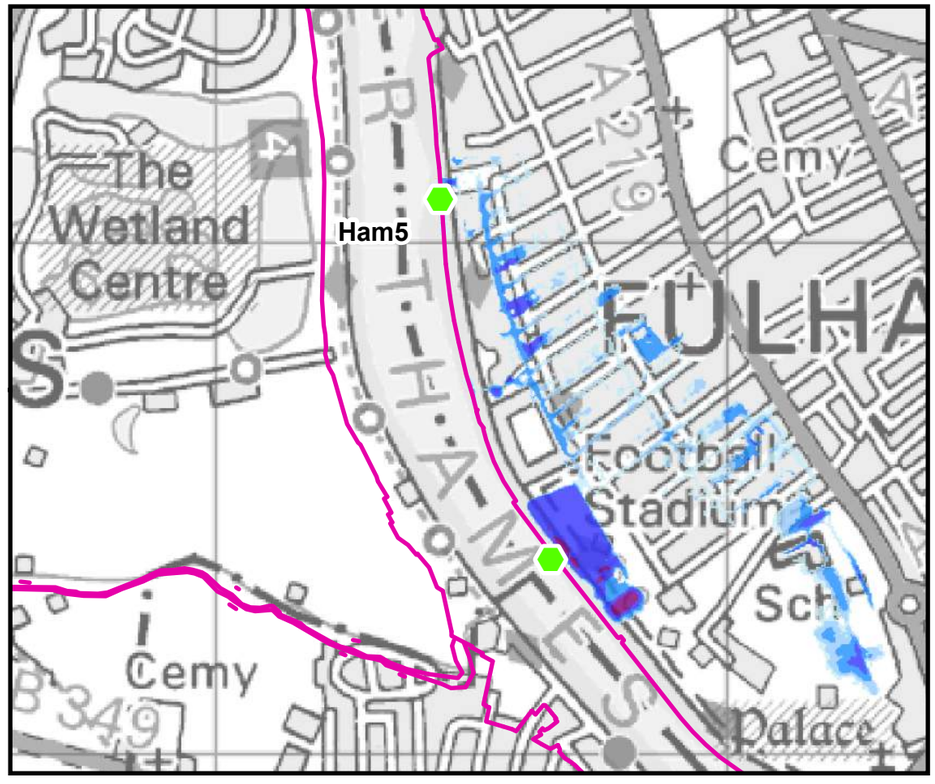
Time After Breach = 3.0hrs



Time After Breach = 4.0hrs



Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.09 0.18 0.27 0.36 0.45
Kilometres

L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_5_2_Ham5_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:12,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

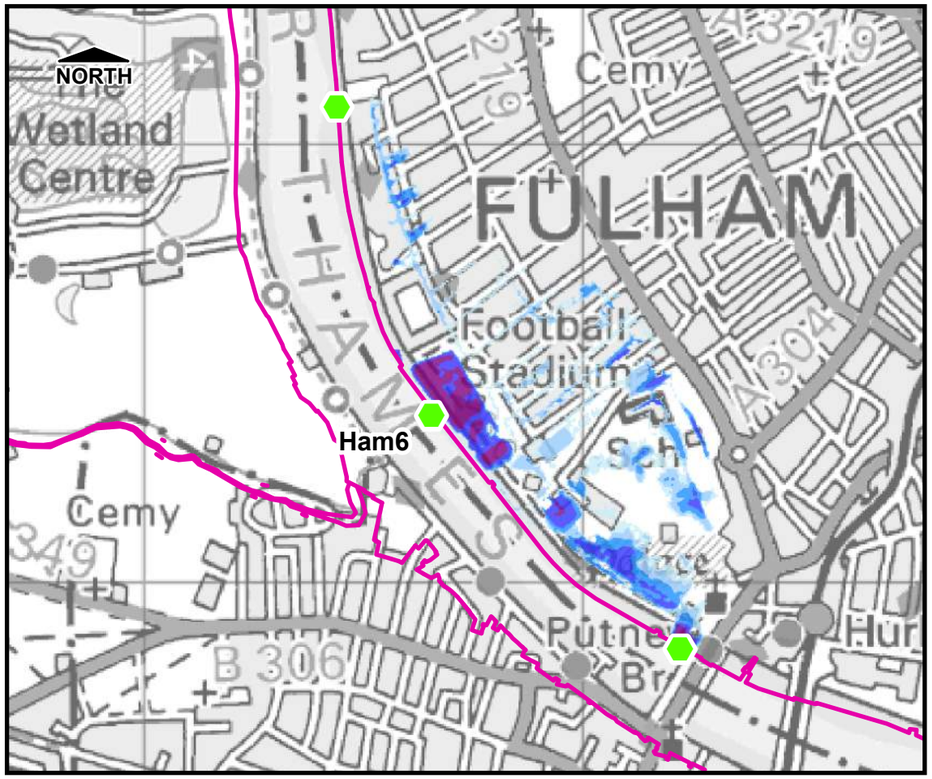
Tidal Breach Depth
Breach Location Ham5
1 in 200yr Event
Commercial in Confidence

Consultant

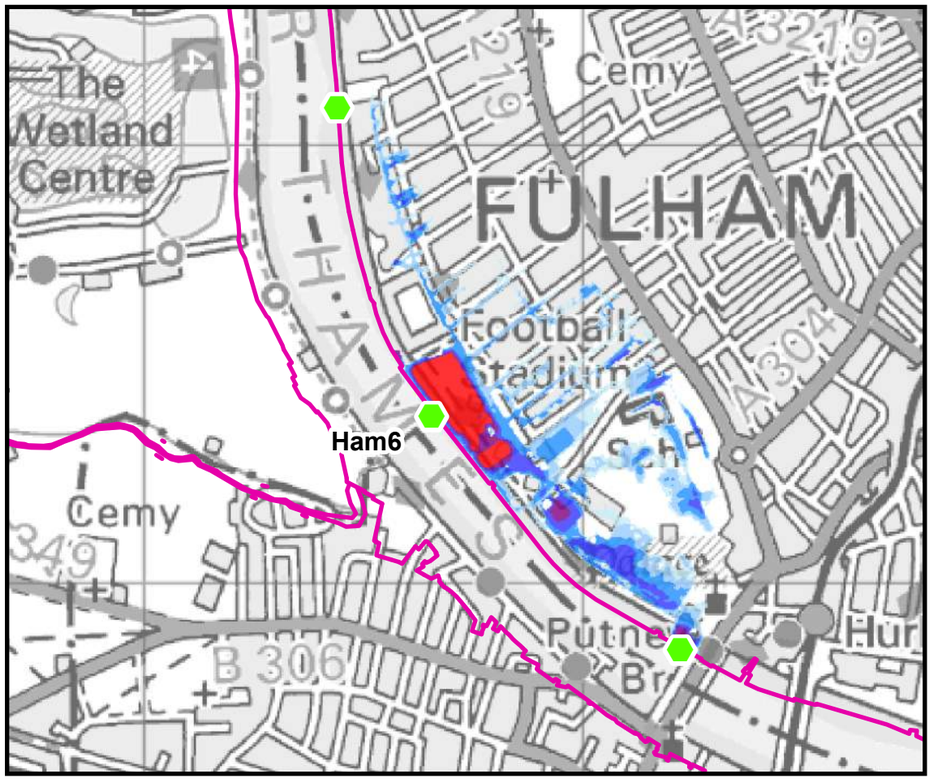
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

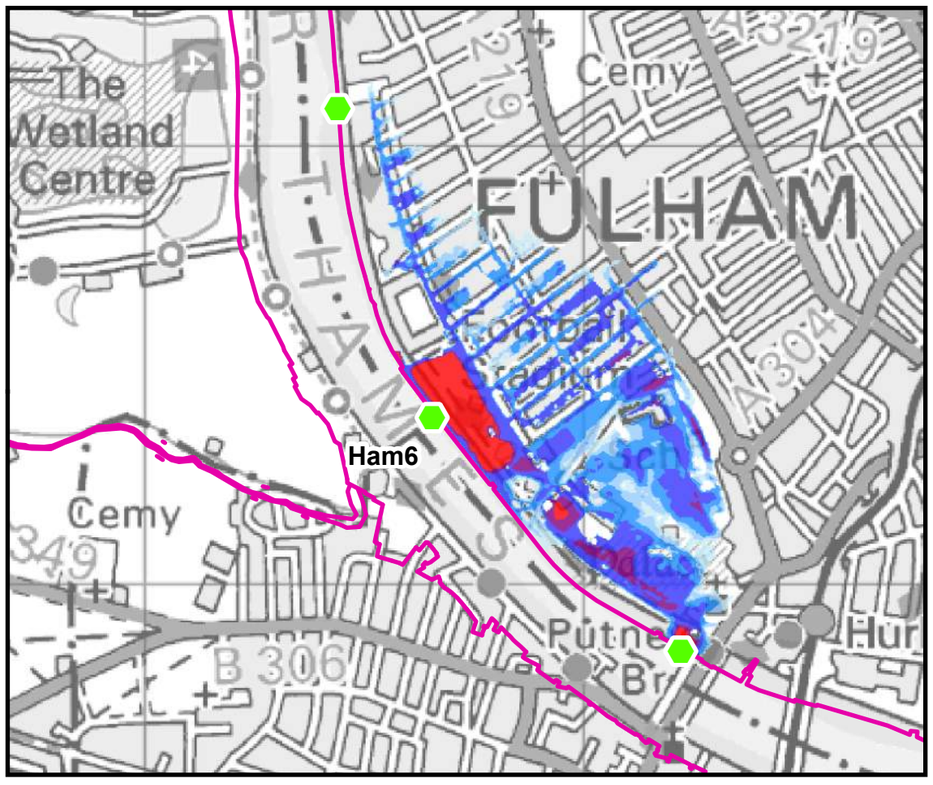
FIGURE 8.5.2



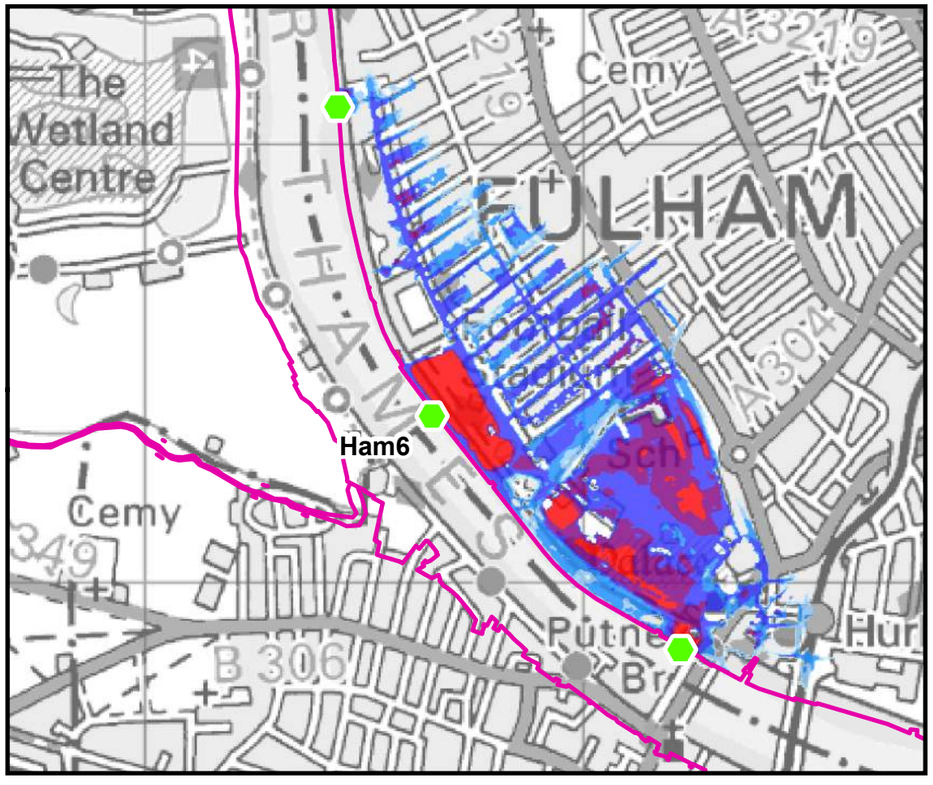
Time After Breach = 0.5hrs



Time After Breach = 1.0hrs



Time After Breach = 1.5hrs



Time After Breach = 2.0hrs

0 0.09 0.18 0.27 0.36 0.45
Kilometres

L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_6_1_Ham6_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:14,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

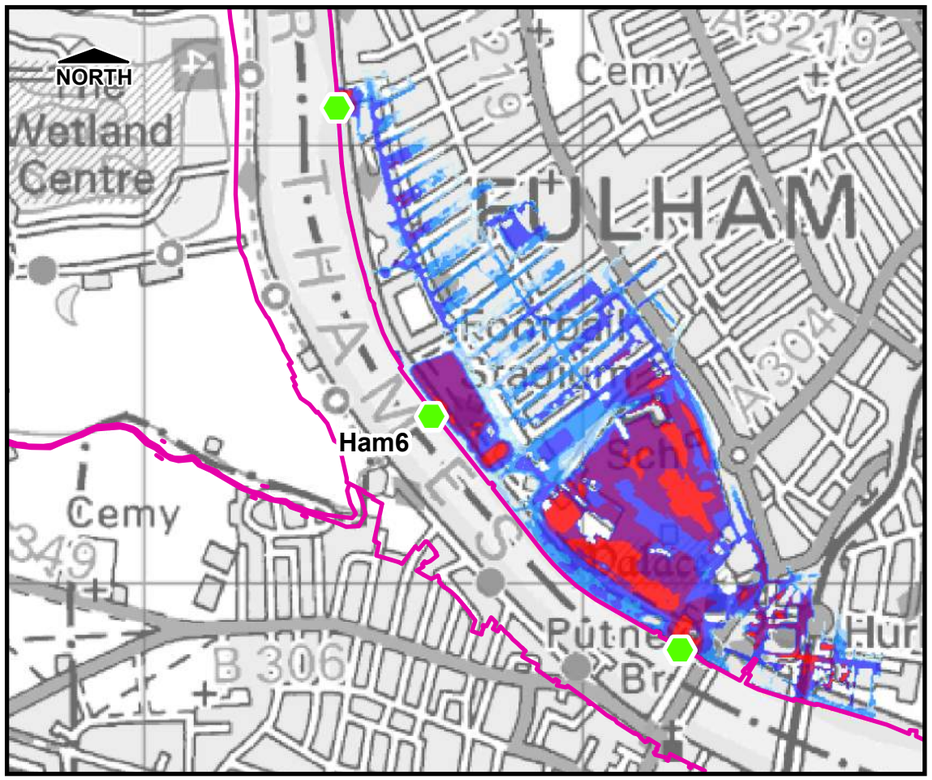
Tidal Breach Depth
Breach Location Ham6
1 in 200yr Event
Commercial in Confidence

Consultant

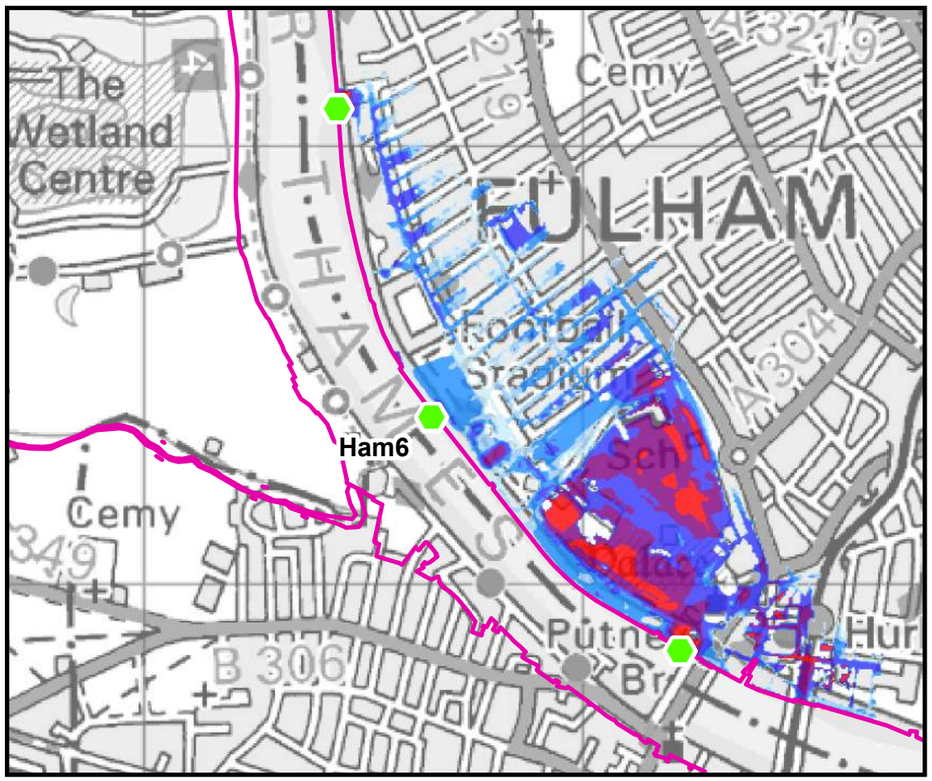
CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.6.1



Time After Breach = 3.0hrs



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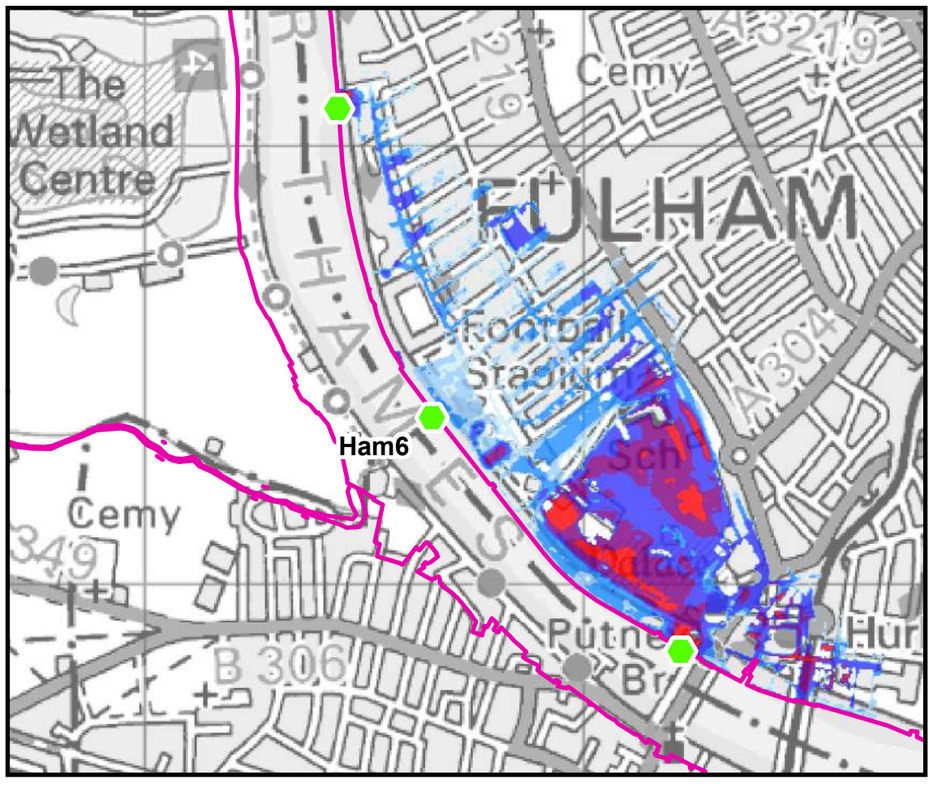
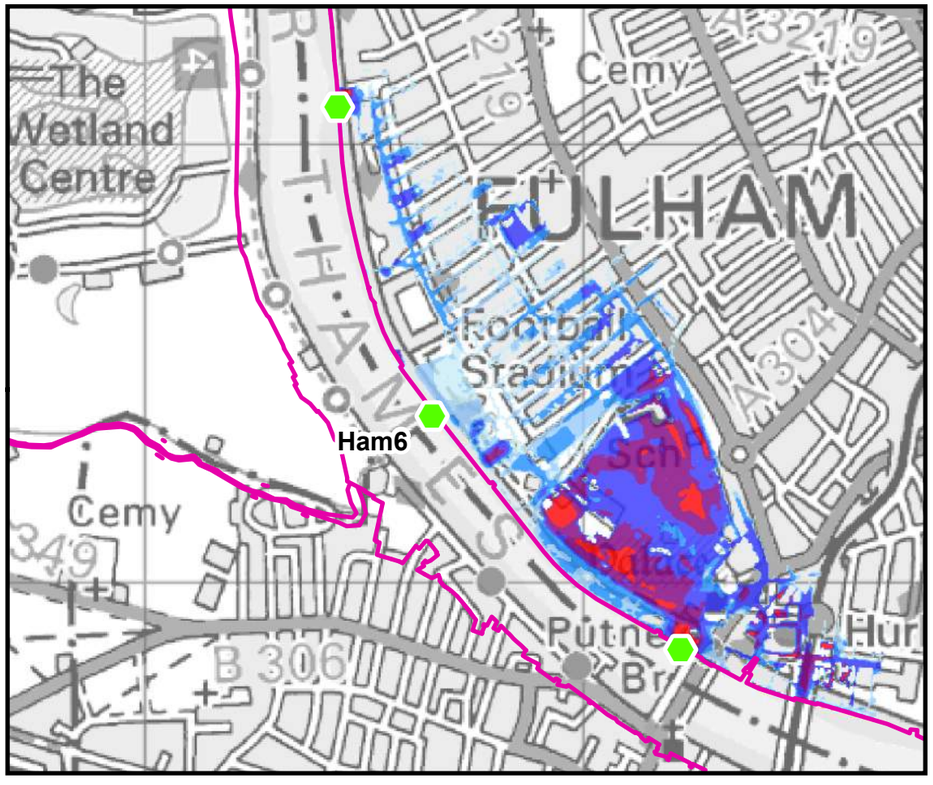


Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.09 0.18 0.27 0.36 0.45
Kilometres

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_6_2_Ham6_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:14,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

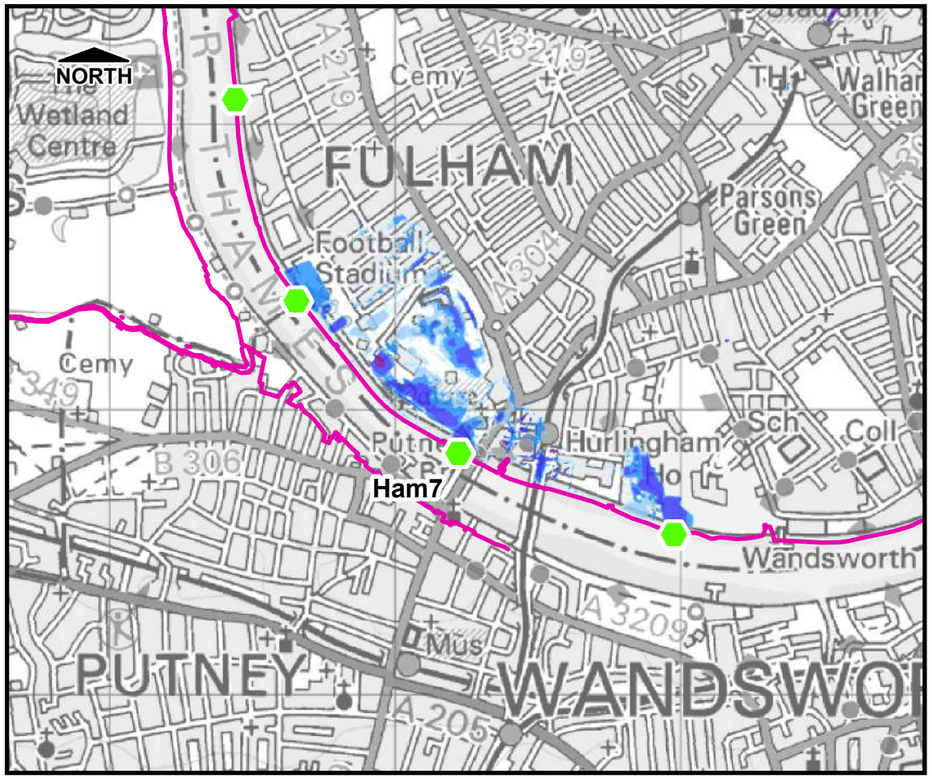
Tidal Breach Depth
Breach Location Ham6
1 in 200yr Event
Commercial in Confidence

Consultant

CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.6.2



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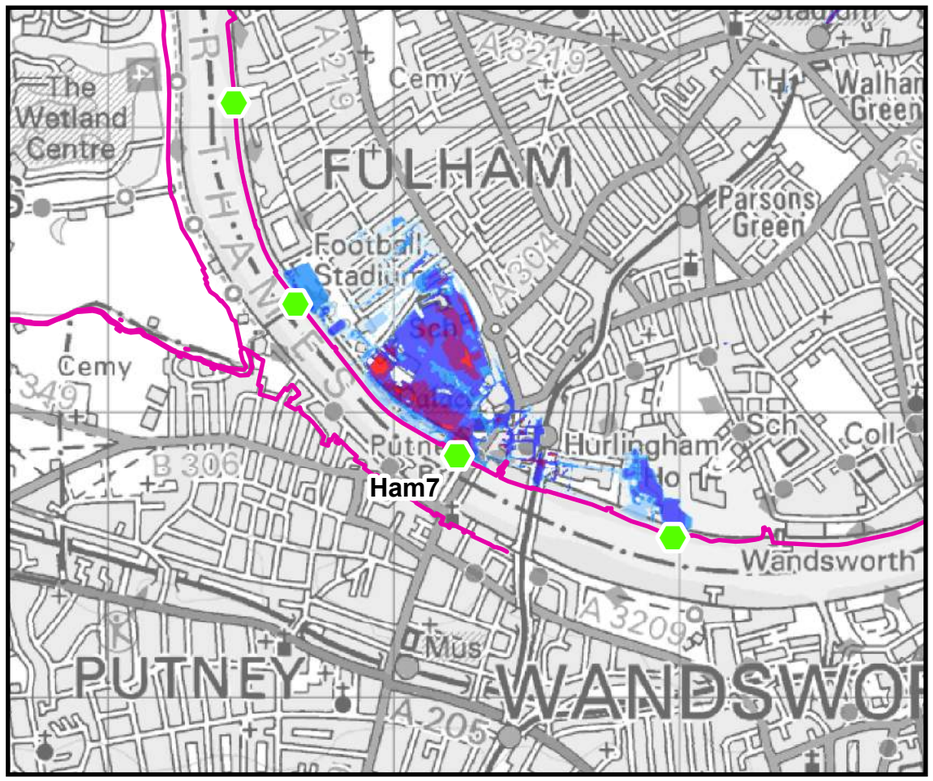

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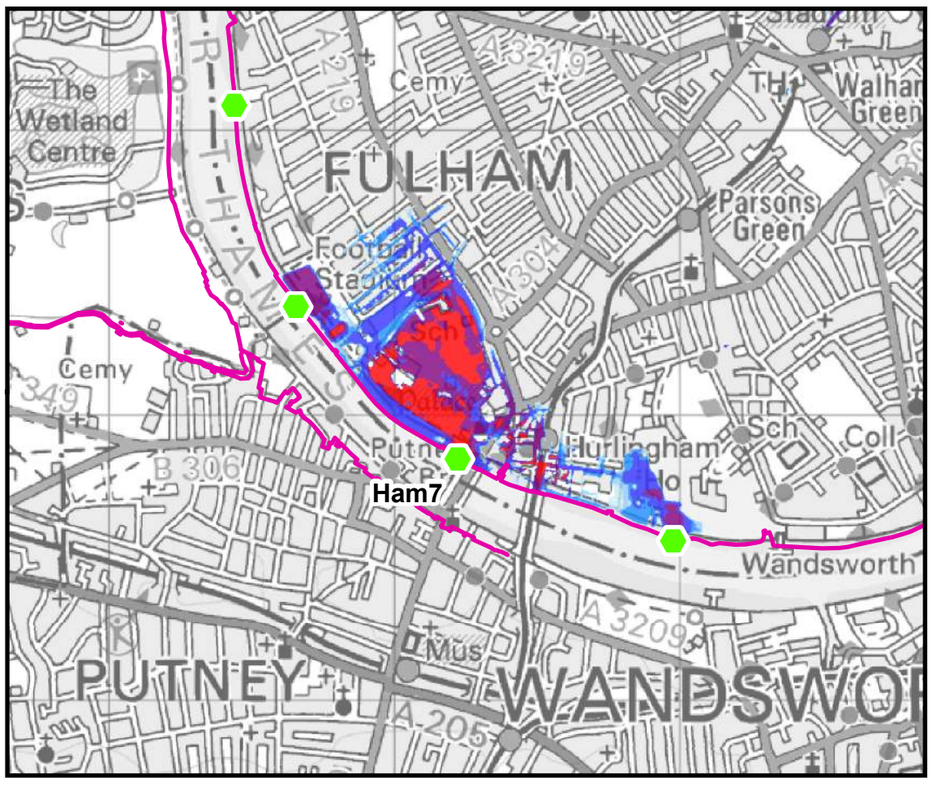

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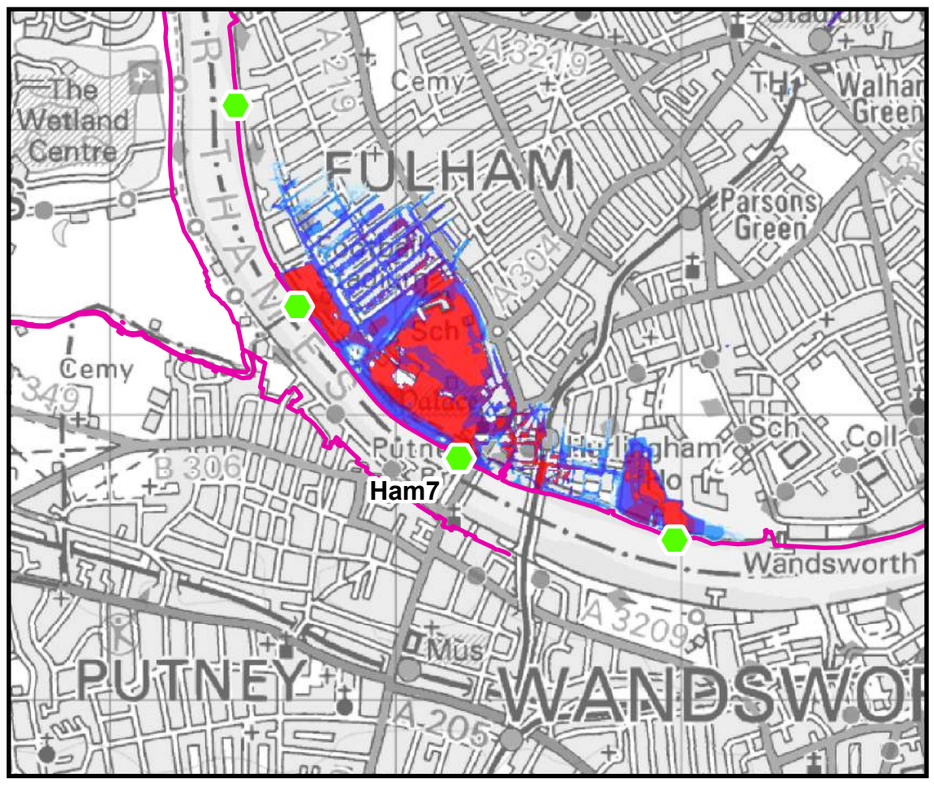

Time After Breach = 2.0hrs

0 0.1 0.2 0.3 0.4 0.5
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:21,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham7
1 in 200yr Event
Commercial in Confidence

Consultant

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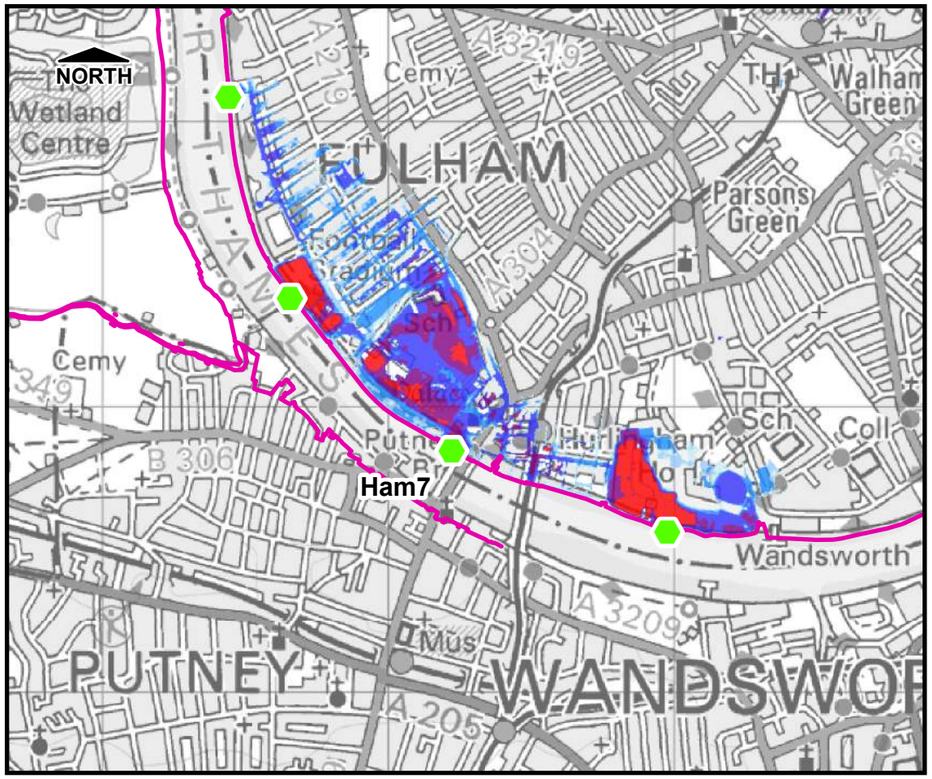
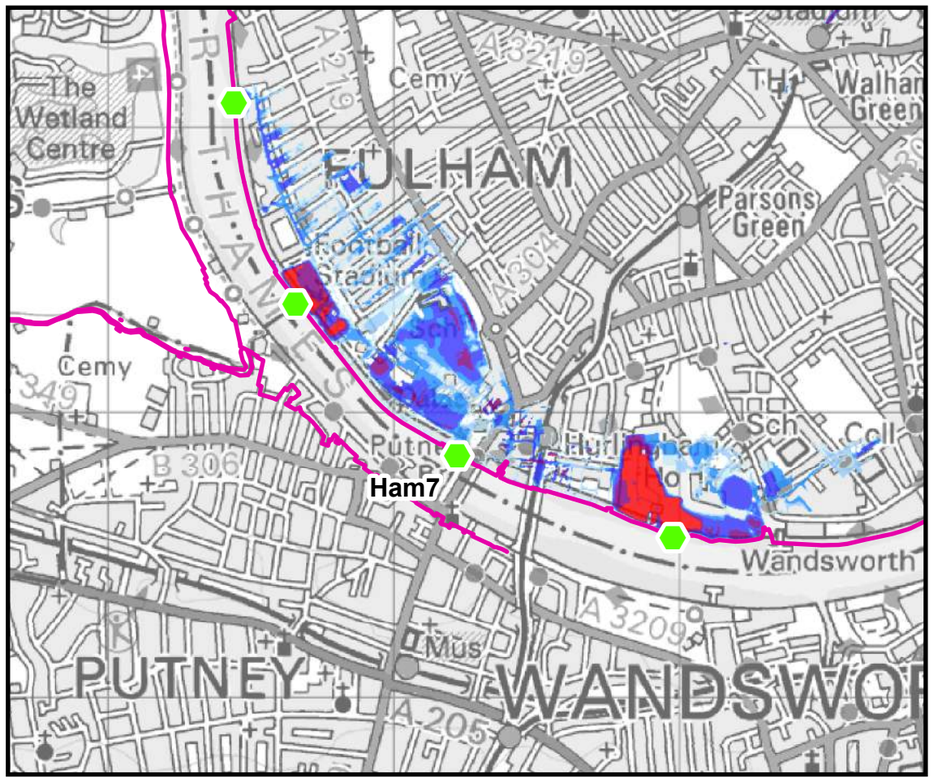
London
EC2V 7NQ

FIGURE 8.7.1

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&F\Fig8_7_1_Ham7_Depth_200_001.mxd



Time After Breach = 3.0hrs



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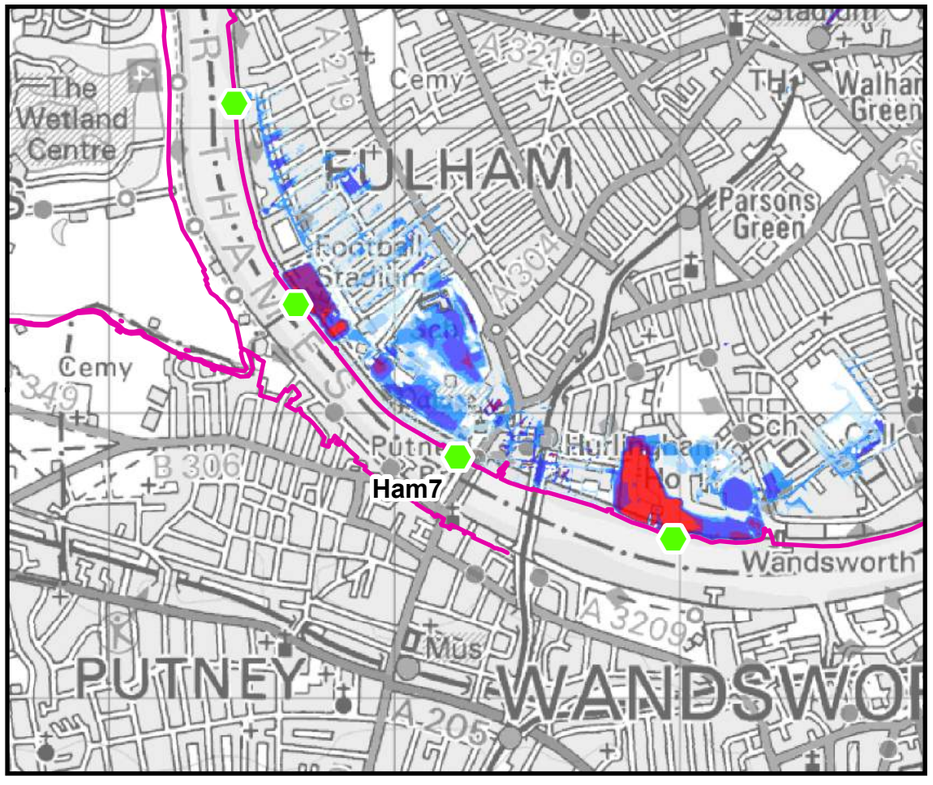

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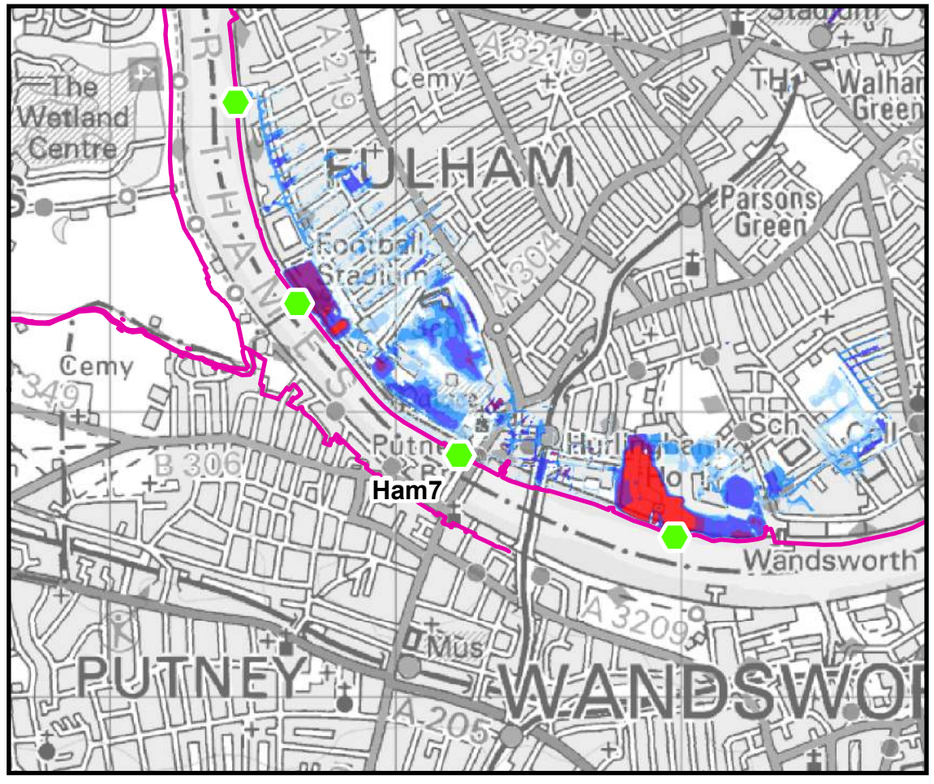

Time After Breach = 6.0hrs

0 0.1 0.2 0.3 0.4 0.5
Kilometres

L:\Environment\ZWETCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&FFig8_7_2_Ham7_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:21,500	FEB. 2015	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham7
1 in 200yr Event
Commercial in Confidence

Consultant

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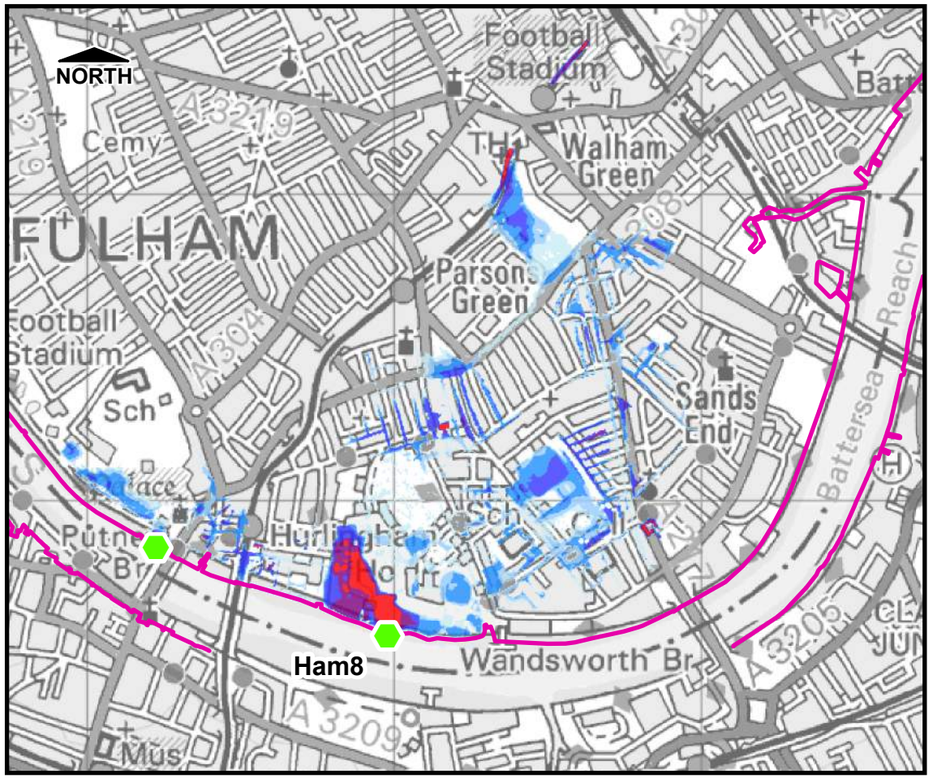
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.7.2



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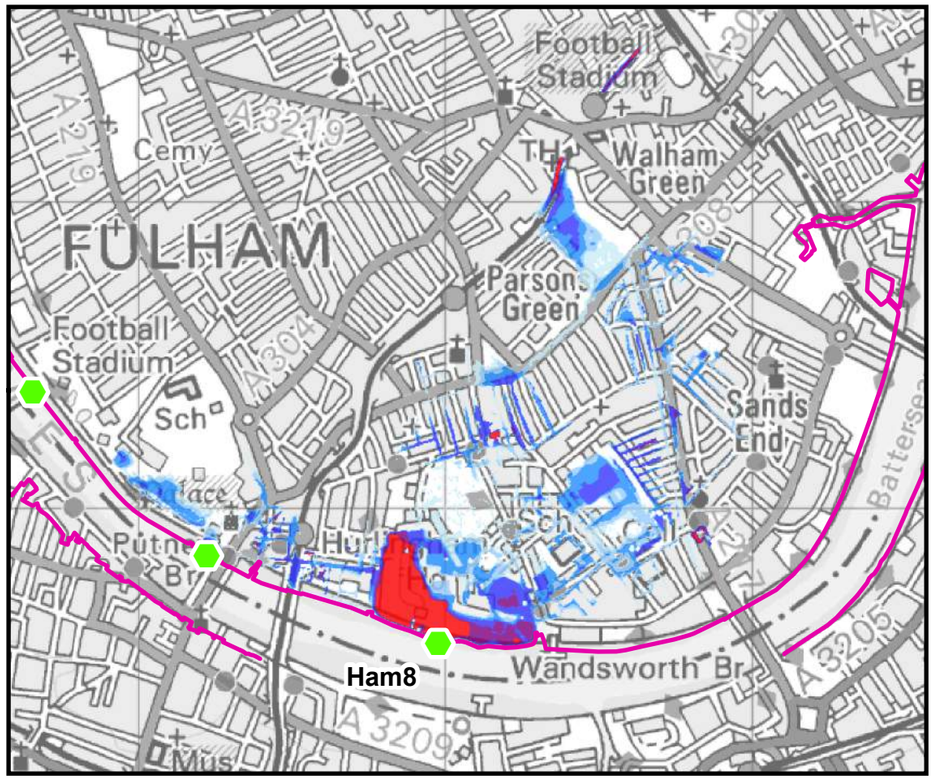

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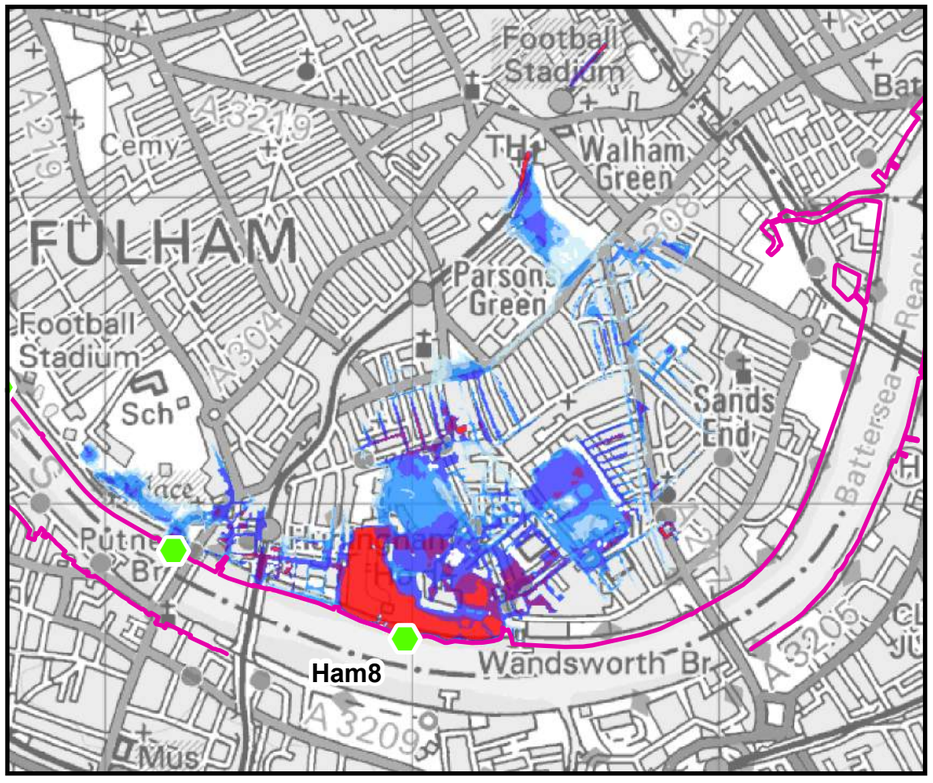

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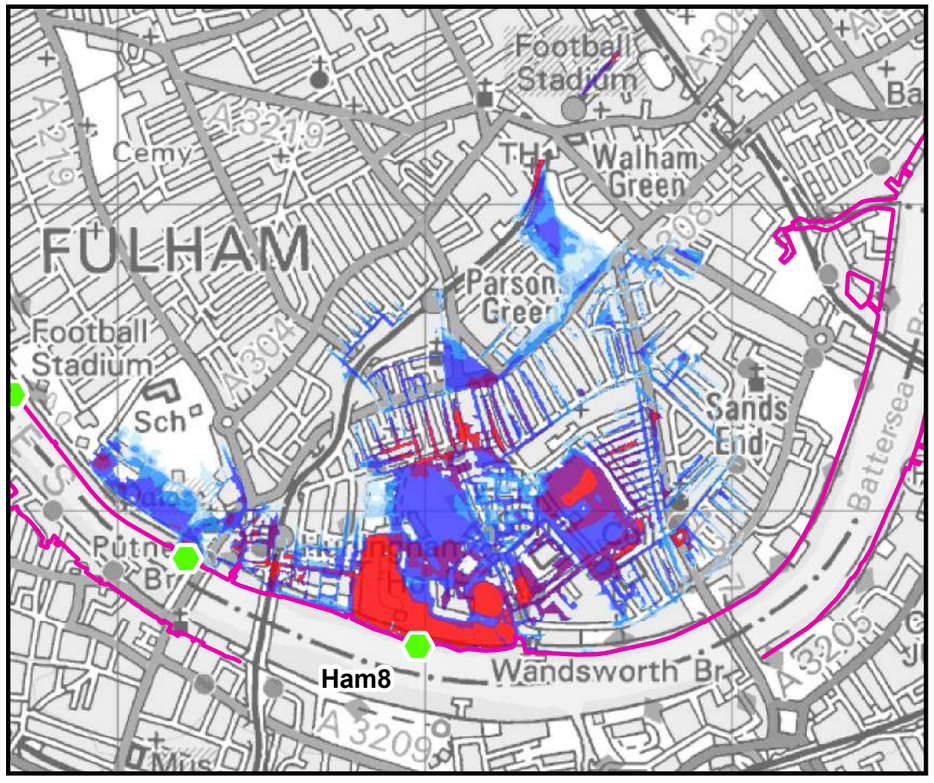

Time After Breach = 2.0hrs

0 0.1 0.2 0.3 0.4 0.5
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Tidal Breach Depth
Breach Location Ham8
1 in 200yr Event
Commercial in Confidence

Consultant

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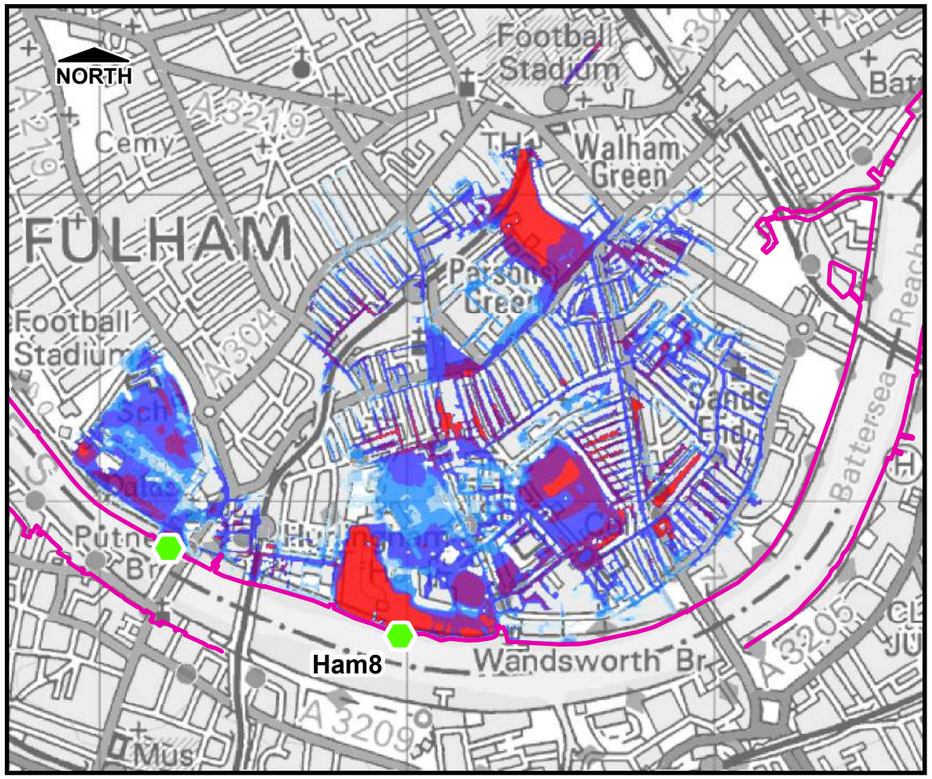
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.8.1

L:\Environment\ZWETCS\065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&FFig8_8_1_Ham8_Depth_200_001.mxd



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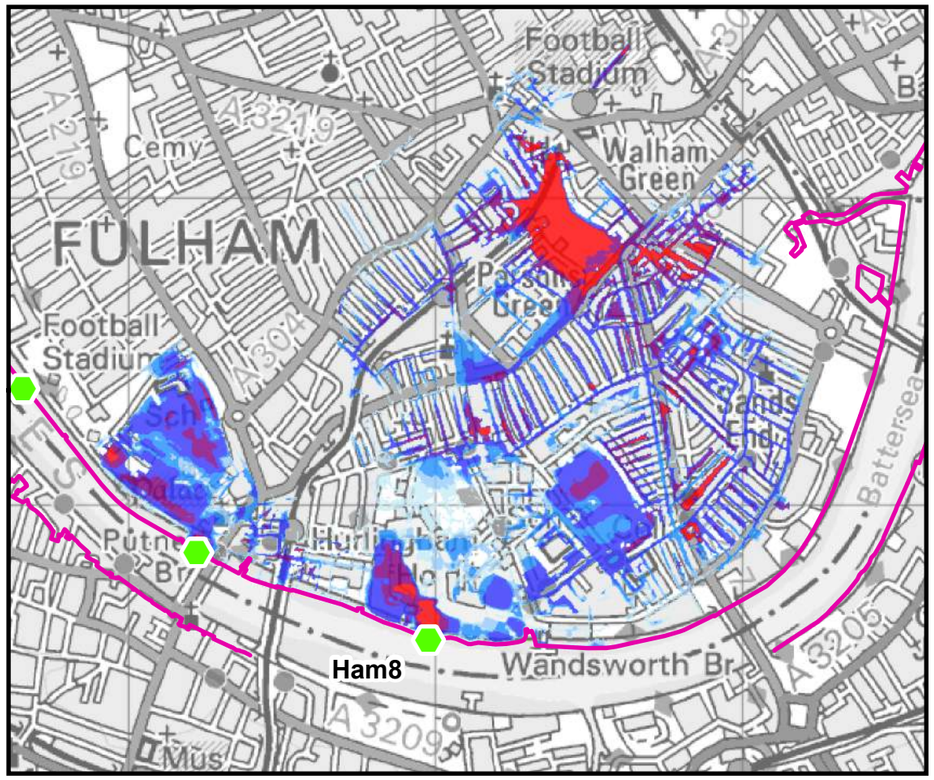

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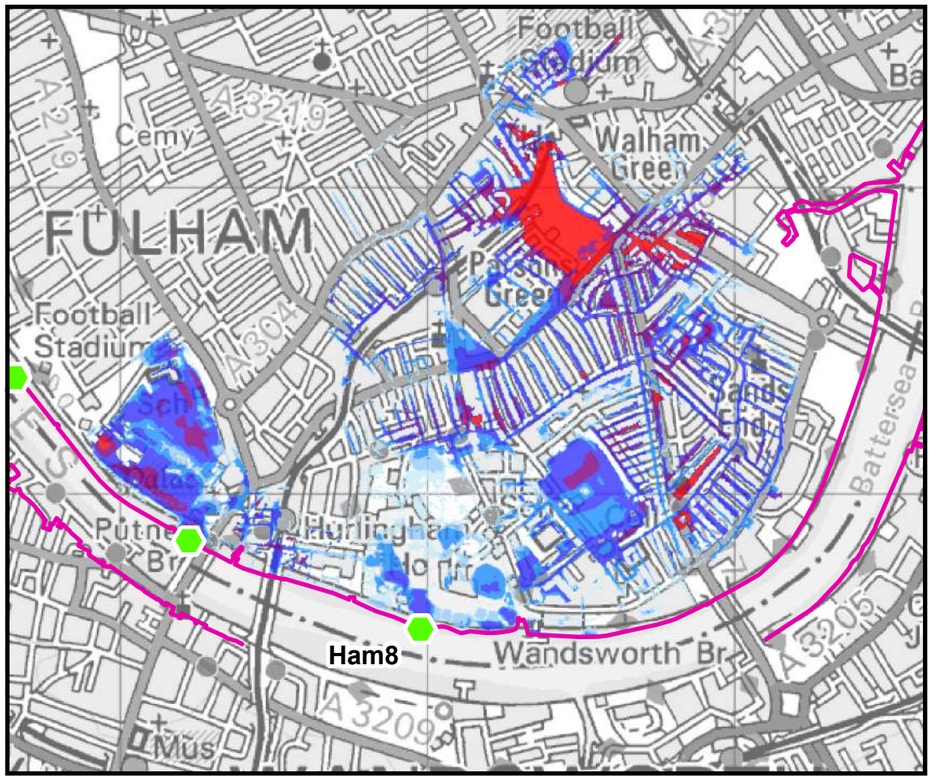

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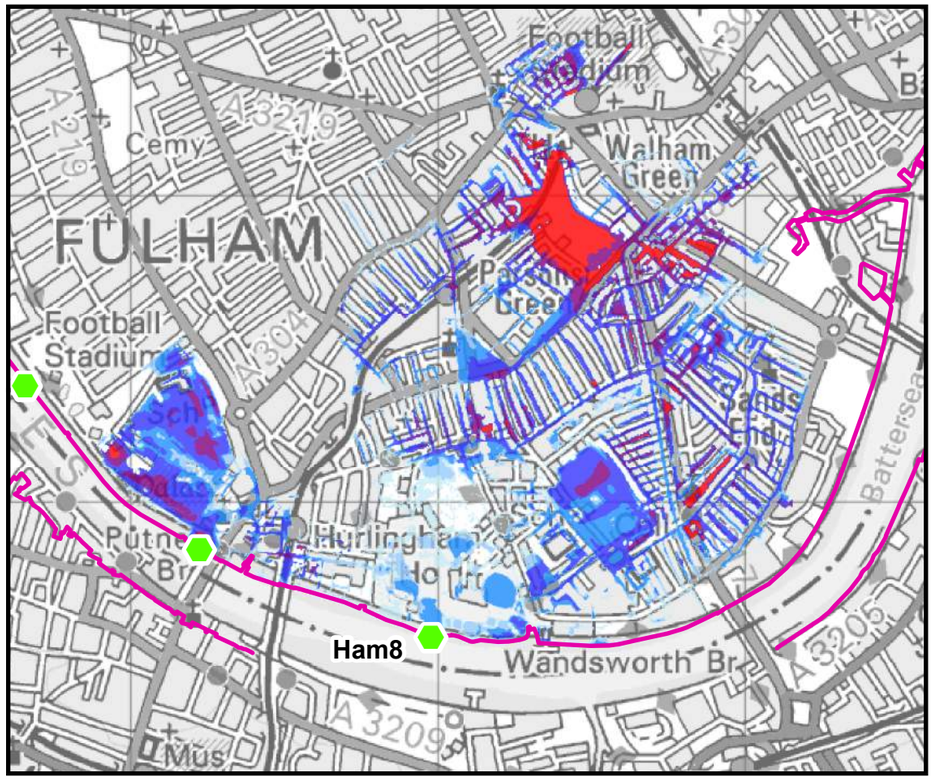

Time After Breach = 6.0hrs

0 0.1 0.2 0.3 0.4 0.5
Kilometres

L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcIMxds\SFRA_Maps\H&F\Fig8_8_2_Ham8_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:20,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

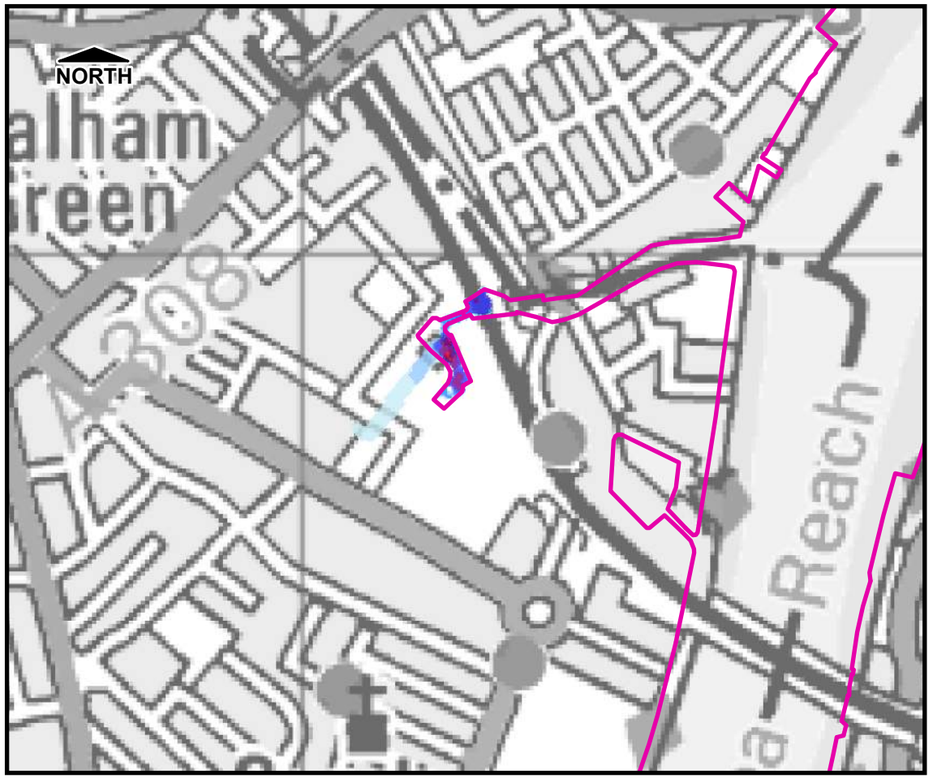
Tidal Breach Depth
Breach Location Ham8
1 in 200yr Event
Commercial in Confidence

Consultant

CAPITA | AECOM

Capita
Level Four,
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.8.2



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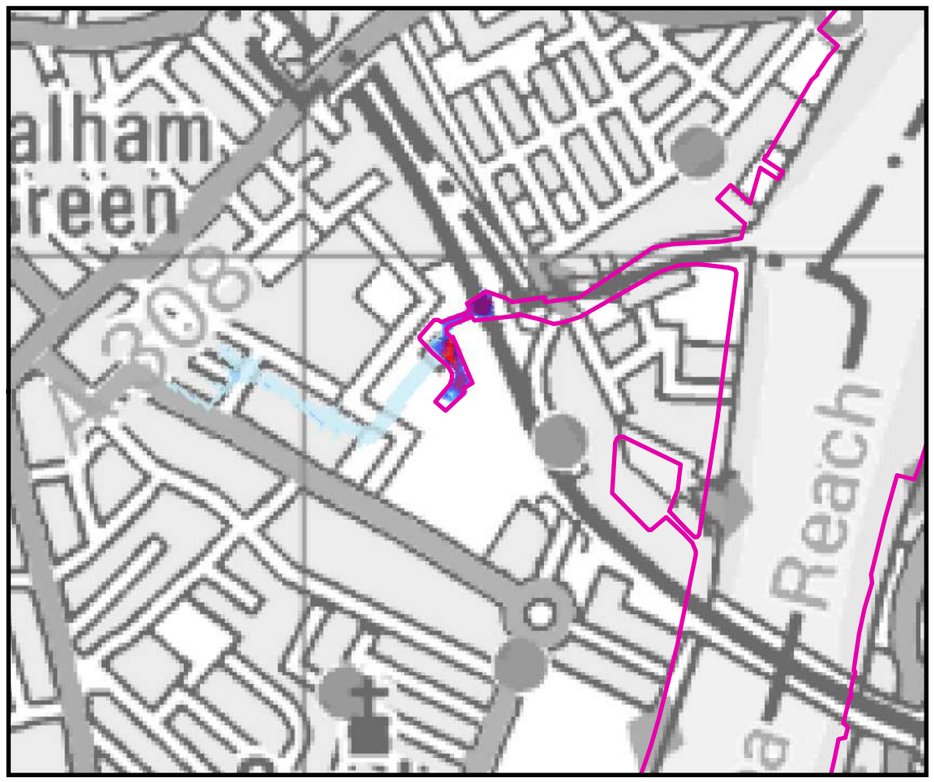
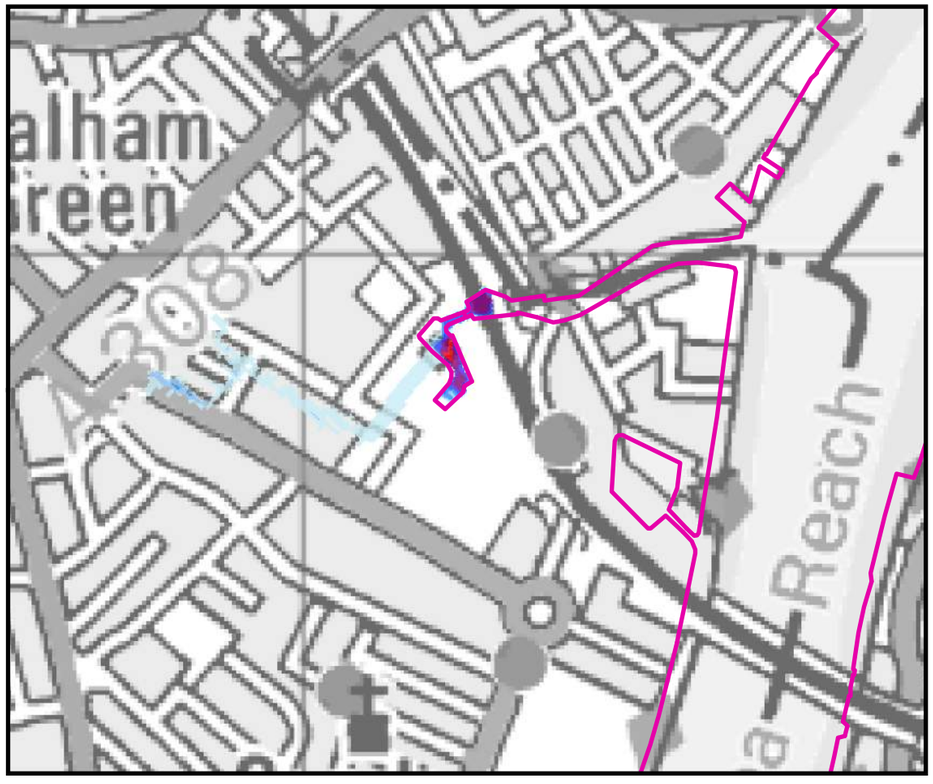


Time After Breach = 1.0hrs



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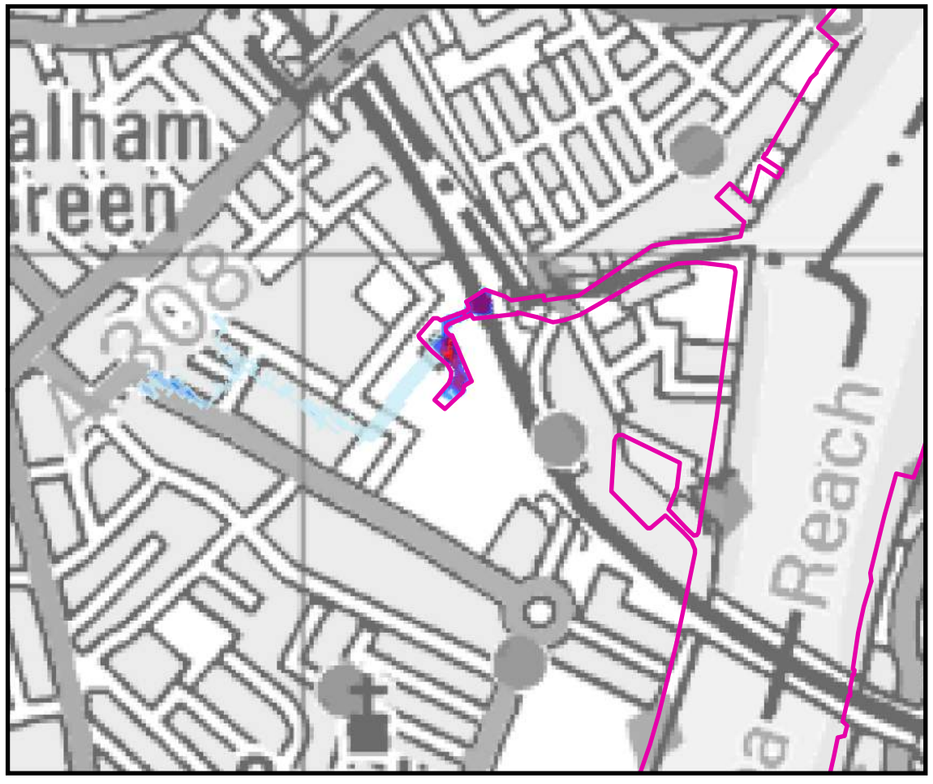

Time After Breach = 2.0hrs

0 0.06 0.12 0.18 0.24 0.3
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Tidal Breach Depth
Breach Location Ham9
1 in 200yr Event
TE2100 Tidal Data

Commercial in Confidence

Consultant

CAPITA | AECOM

Capita
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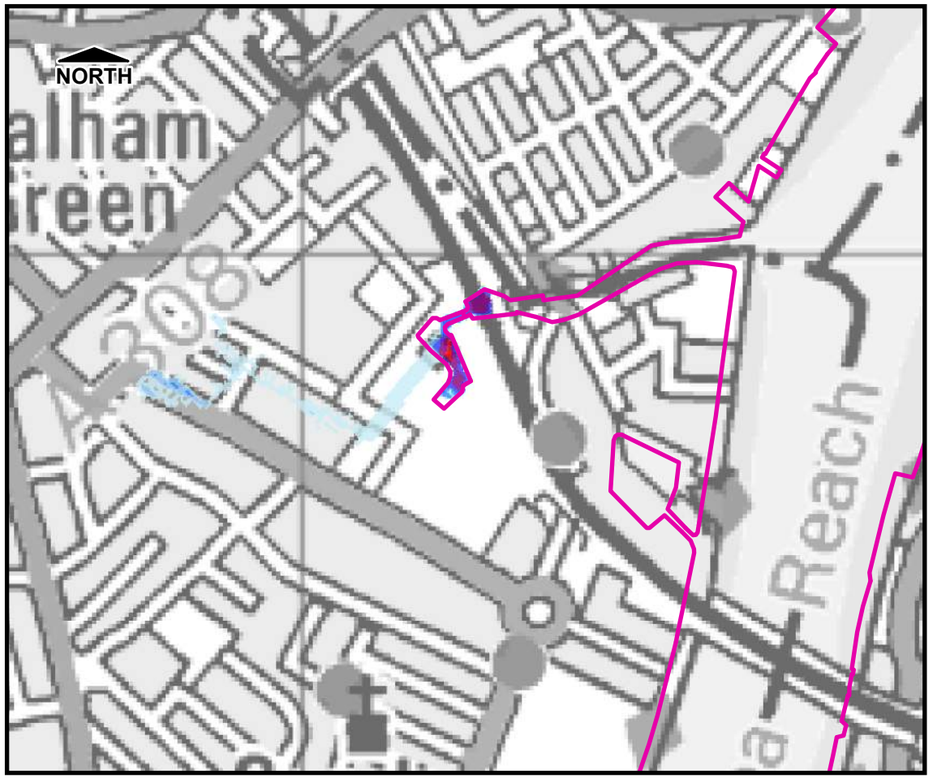
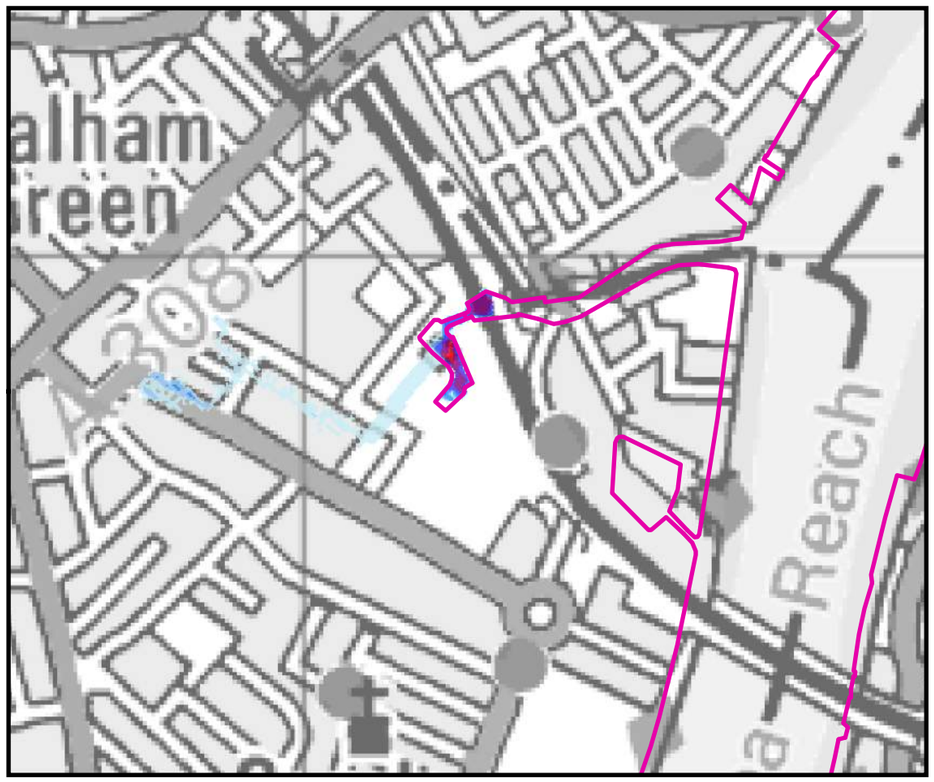
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.9.1

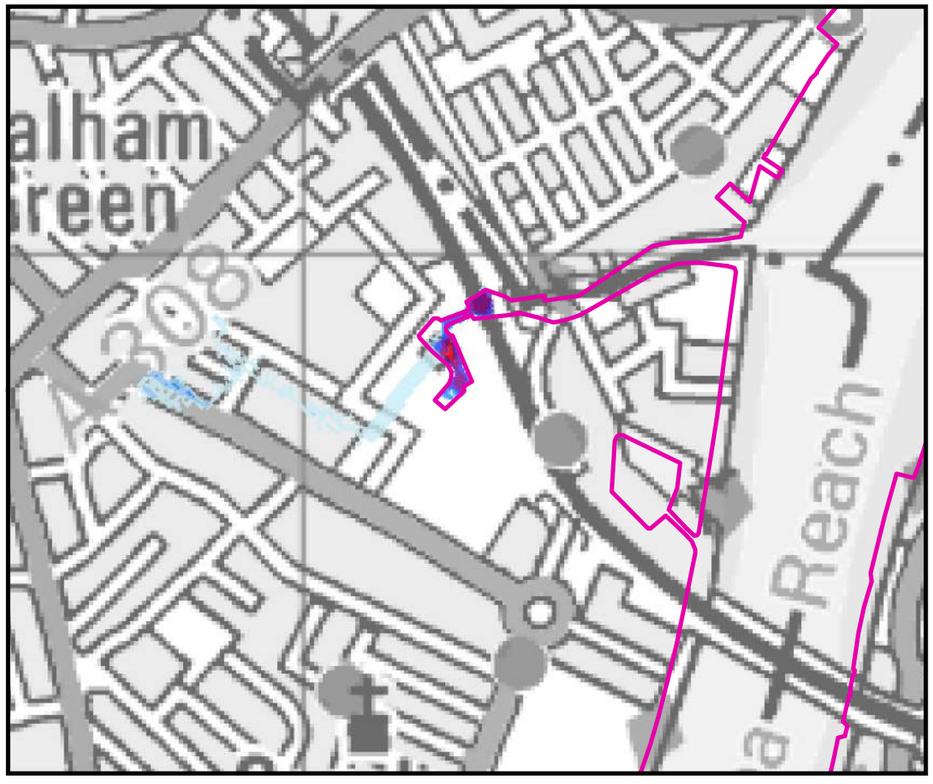
L:\Environment\ZWETVCS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_9_1_Ham9_Depth_200_001.mxd



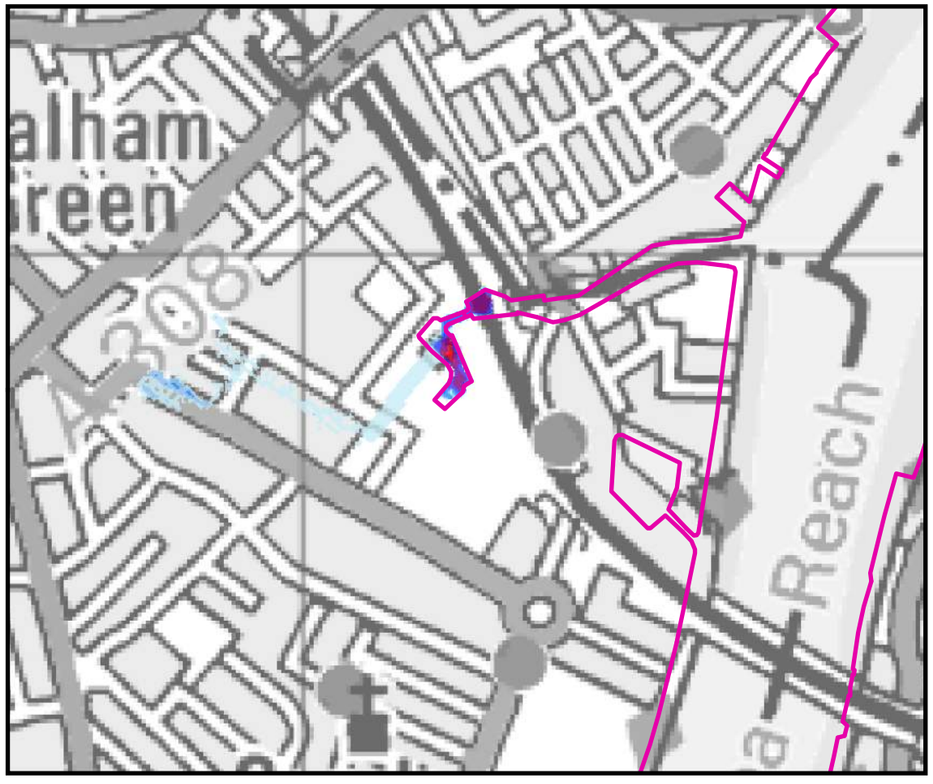
Time After Breach = 3.0hrs



Time After Breach = 4.0hrs



Time After Breach = 5.0hrs



Time After Breach = 6.0hrs

0 0.06 0.12 0.18 0.24 0.3
Kilometres

L:\Environment\ZWETVCS0065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig8_9_2_Ham9_Depth_200_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:7,500	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Depth
Breach Location Ham9
1 in 200yr Event
TE2100 Tidal Data
Commercial in Confidence

Consultant

CAPITA | AECOM
Capita
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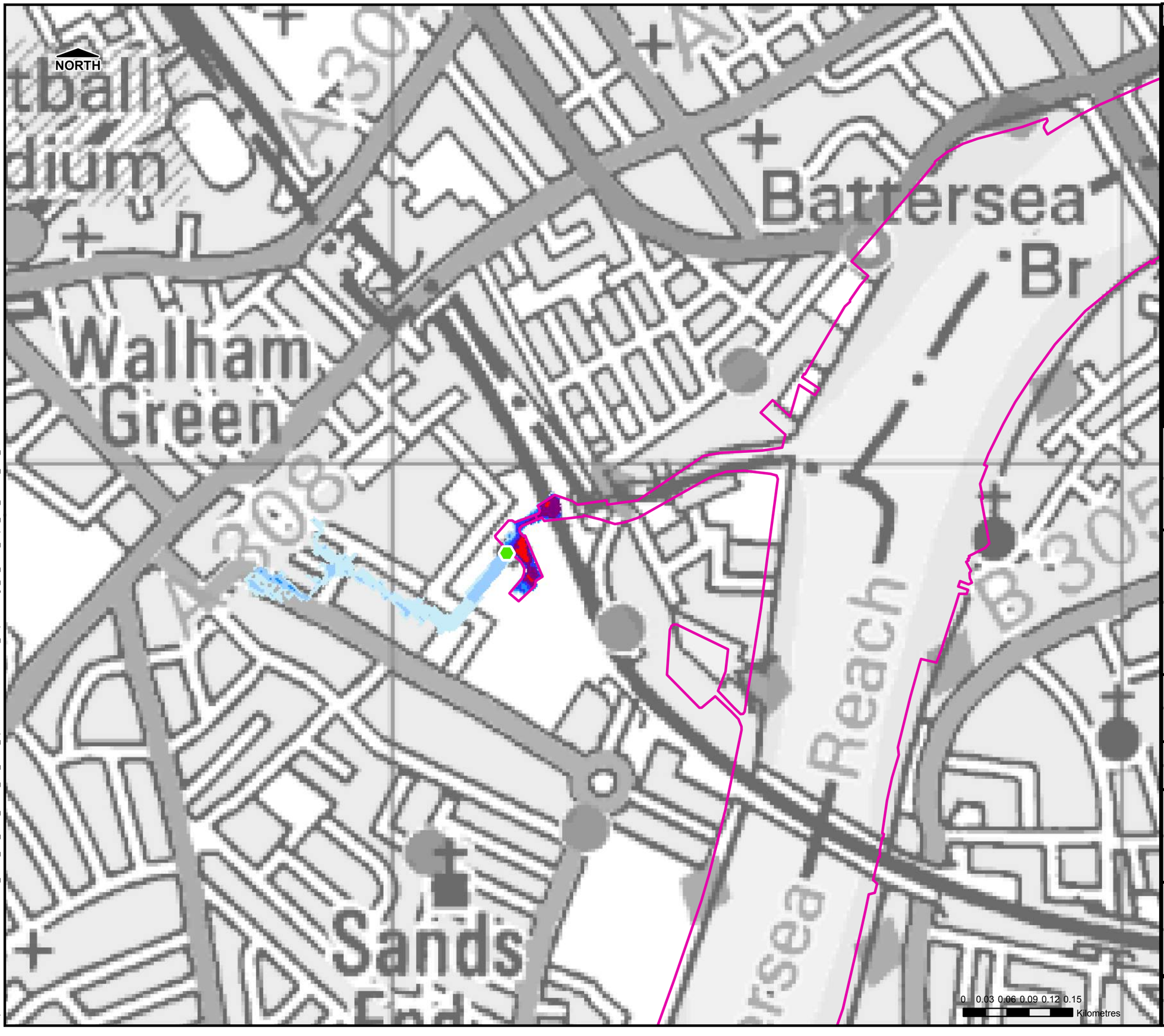
65 Gresham Street,
London
EC2V 7NQ

FIGURE 8.9.2



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Flood Depth (m)

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

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:5,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Breach Ham9
Tidal Breach Depth (Maximum)
1 in 200yr event
TE2100 Tidal Data
Commercial in Confidence

Consultant

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London
EC2V 7NQ

FIGURE 8.10

Filepath: L:\Environment\ZWET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_MapsH&F\Fig8_10_Ham9_Depth_200_TE2100_Max_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Hazard

- Caution (Very Low Hazard)
- Moderate (Danger for Some)
- Significant (Danger for Most)
- Extreme (Danger for All)

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:18,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Tidal Breach Hazard (Maximum)
1 in 200yr event

Commercial in Confidence

Consultant

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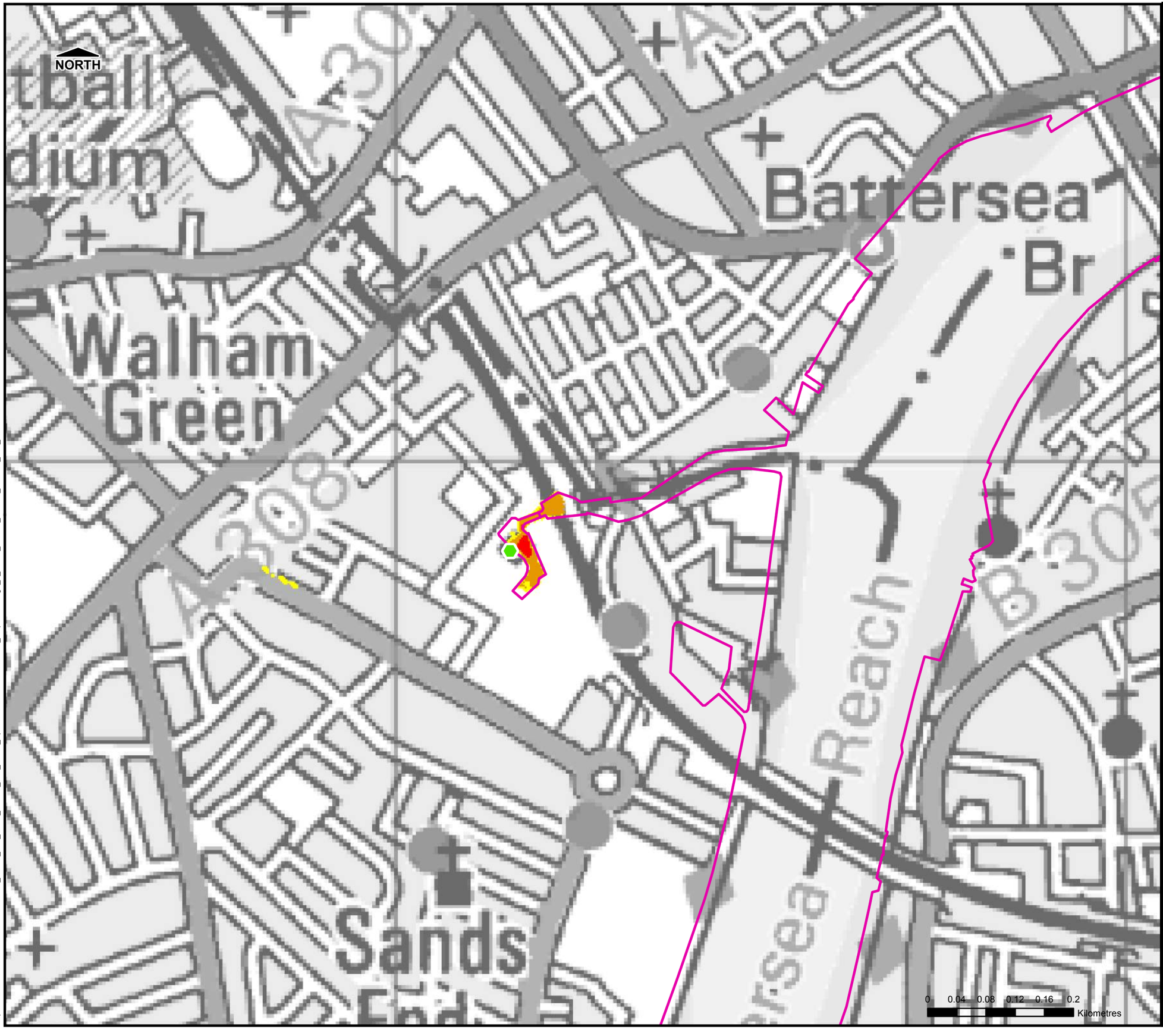
65 Gresham Street,
London
EC2V 7NQ

FIGURE 9

0 0.1 0.2 0.3 0.4 0.5 Kilometres

Filepath: N:\Environment\2WET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\K&C\Fig9_Breach_Hazard_200_Max.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Defences

Tidal Breach Hazard

- Caution (Very Low Hazard)
- Moderate (Danger for Some)
- Significant (Danger for Most)
- Extreme (Danger for All)

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:5,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Breach Ham9
Tidal Breach Hazard (Maximum)
1 in 200yr event
TE2100 Tidal Data
Commercial in Confidence

Consultant

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Capita
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65 Gresham Street,
London
EC2V 7NQ

FIGURE 9.1

Filepath: L:\Environment\ZWET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig9_1_Ham9_Breach_H

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Strategic Sites
- Environment Agency Flood Zone 2
- Environment Agency Flood Zone 3

Note:
Refer to chapter 6 of the SFRA report for site specific flood risk information

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:30,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Strategic Sites

Commercial in Confidence

Consultant

Capita
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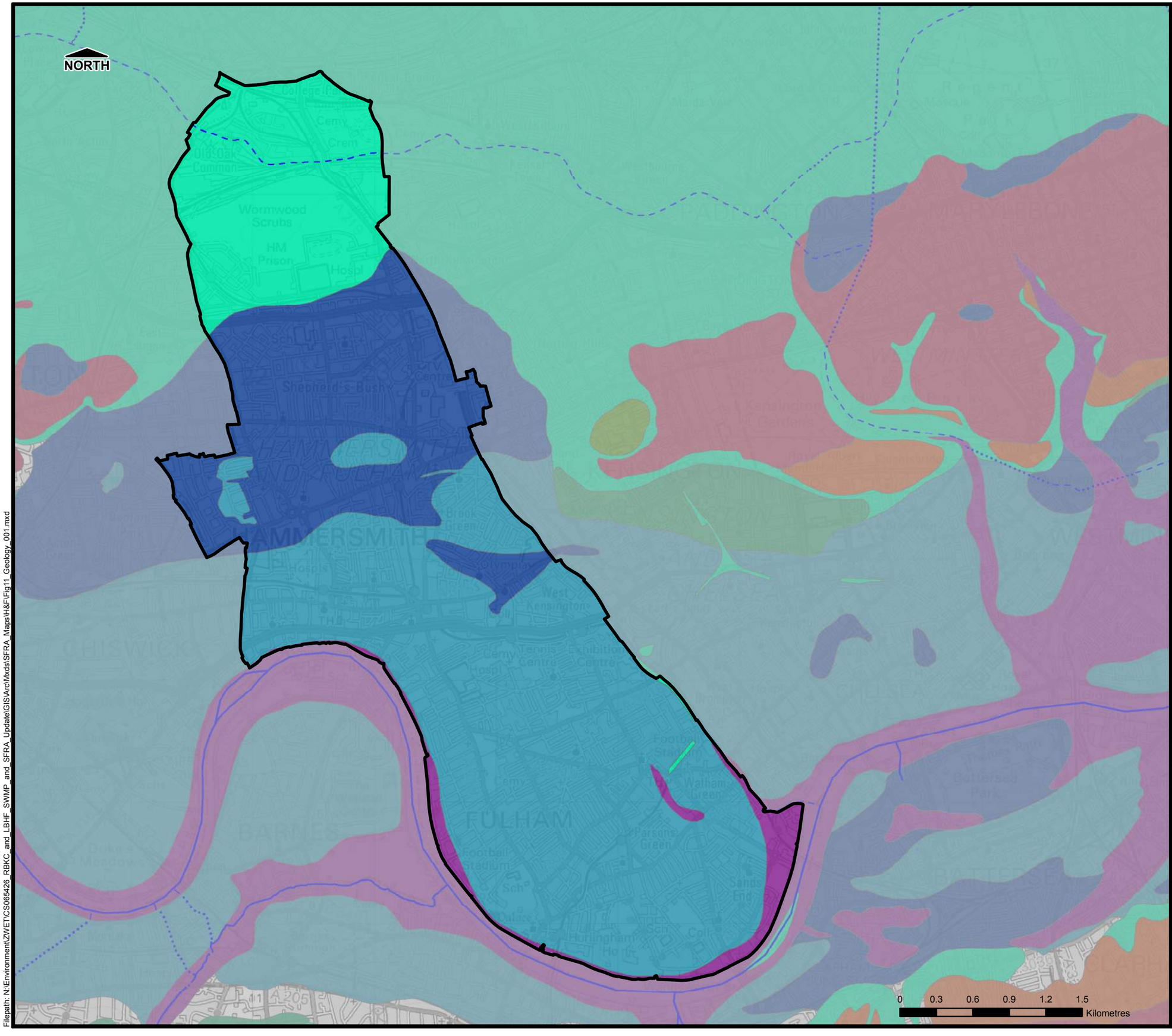
65 Gresham Street,
London
EC2V 7NQ

FIGURE 10

Filepath: L:\Environment\ZWET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&FFig10_Strategic_Sites_004.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Main River
- Ordinary Watercourse
- Culverted Watercourse

Bedrock

- London Clay Formation (LC-CLSS)

Superficial Deposits

- Alluvium (ALV-CZPS)
- Boyn Hill Gravel Member (BHT-XSV)
- Hackney Gravel Member (HAGR-XSV)
- Kempton Park Gravel Formation (KPGR-XSV)
- Langley Silt Member (LASI-XCZ)
- Lynch Hill Gravel Member (LHGR-XSV)
- Taplow Gravel Formation (TPGR-XSV)

Notes

London Borough of Hammersmith and Fulham

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Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:30,000	FEB. 2016	G.ATHANASIA	L.MARKOSE

Geological Map Overview

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FIGURE 11

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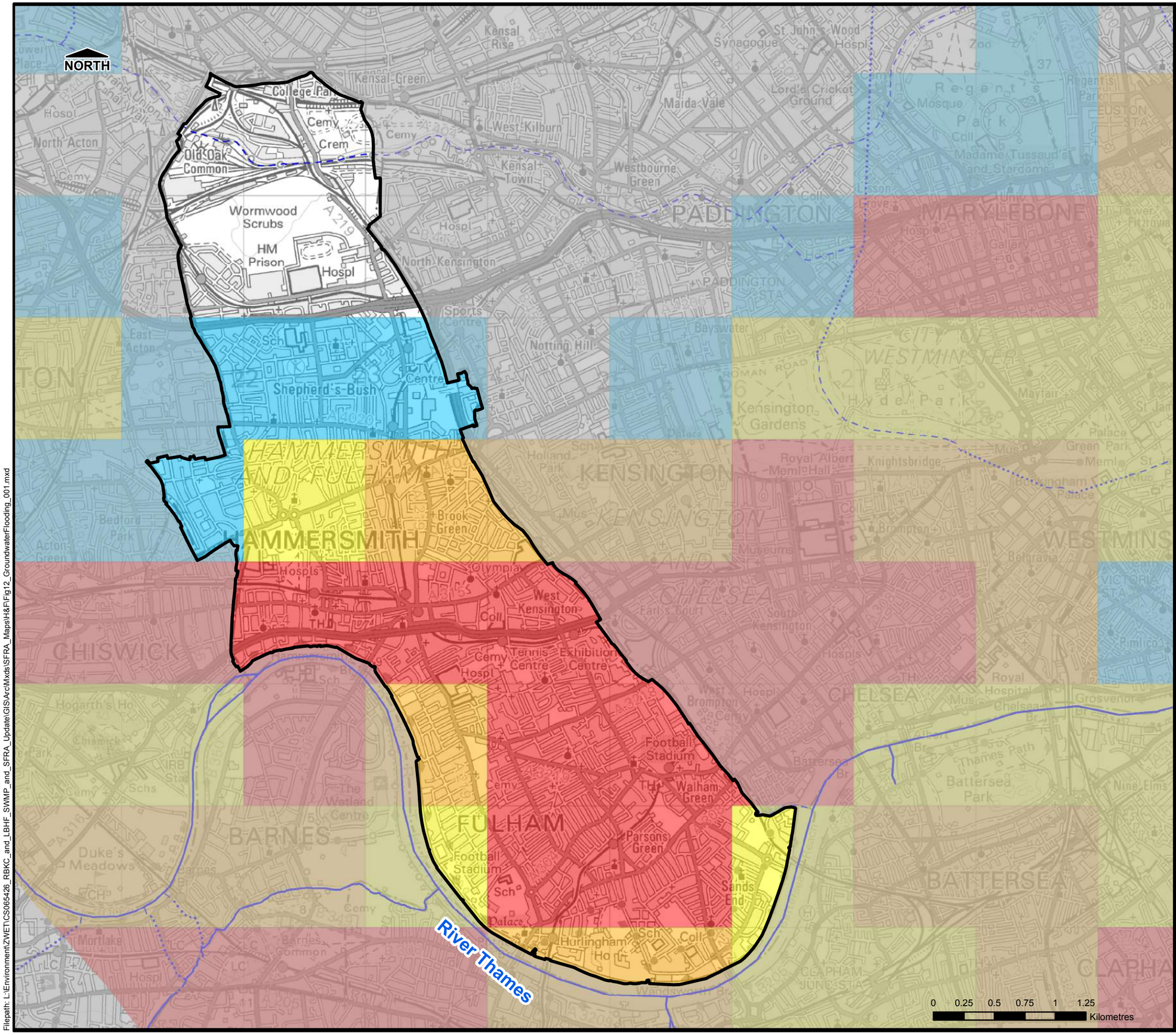

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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Main River
- Ordinary Watercourse
- Culverted Watercourse

Susceptibility to Groundwater Flooding

- Very High >=75%
- High; >=50% <75%
- Moderate; >=25% <50%
- Low; <25%

Notes

This susceptibility data is suitable for use for regional or national planning purposes where the groundwater flooding information will be used along with a range of other relevant information to inform land-use planning decisions. The susceptibility data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding.

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Susceptibility to Groundwater Flooding Map

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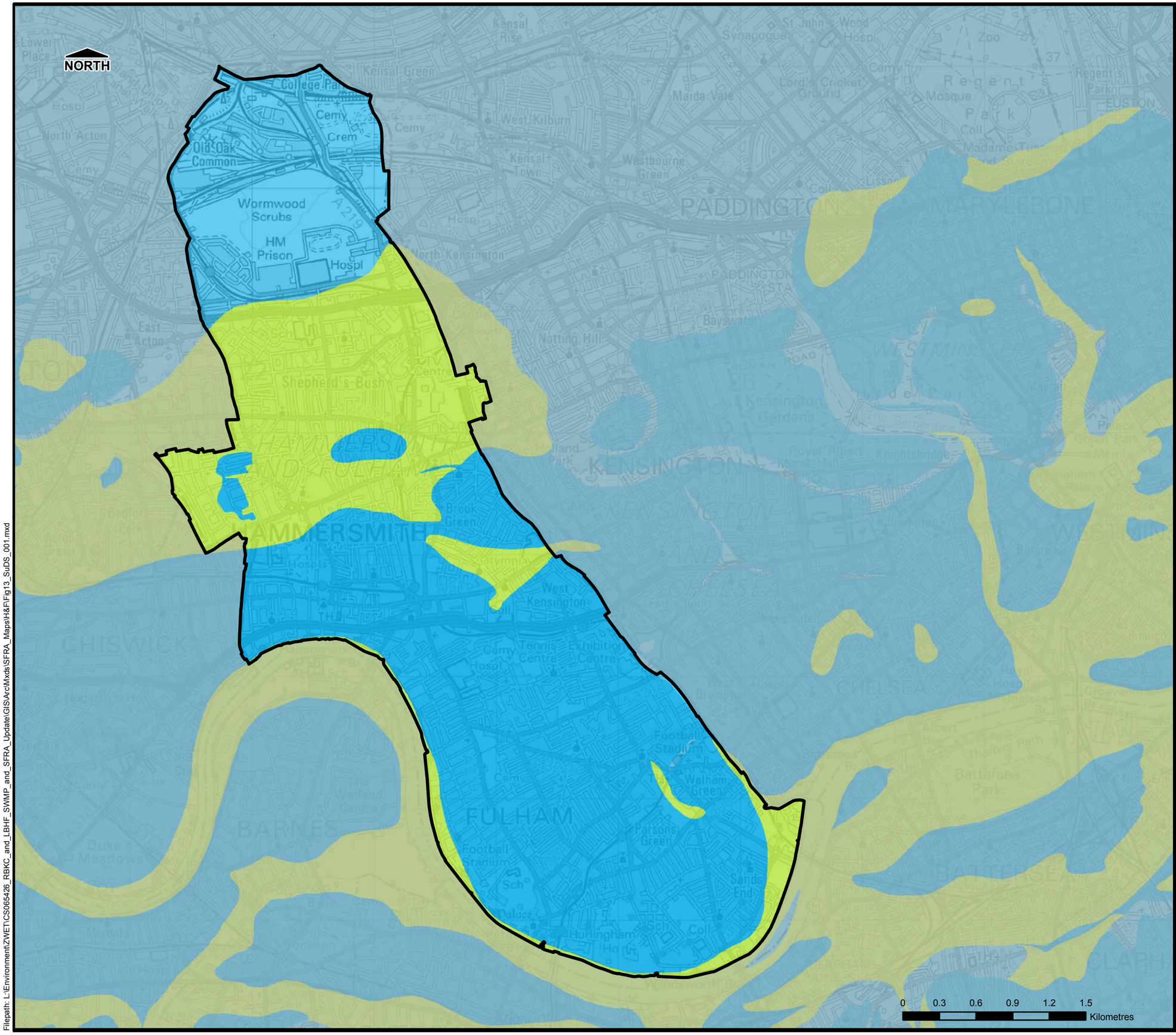
FIGURE 12



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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Administrative Boundary
- Infiltration SuDS Potentially Suitable
- Infiltration SuDS Unsuitable or Suitability Uncertain

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
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Infiltration SuDS Suitability Map

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FIGURE 13

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

Administrative Boundary

Potential for Elevated Groundwater

Permeable Superficial Deposits

Notes

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

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Increased Potential for Elevated Groundwater

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FIGURE 14

0 0.25 0.5 0.75 1 1.25 Kilometres

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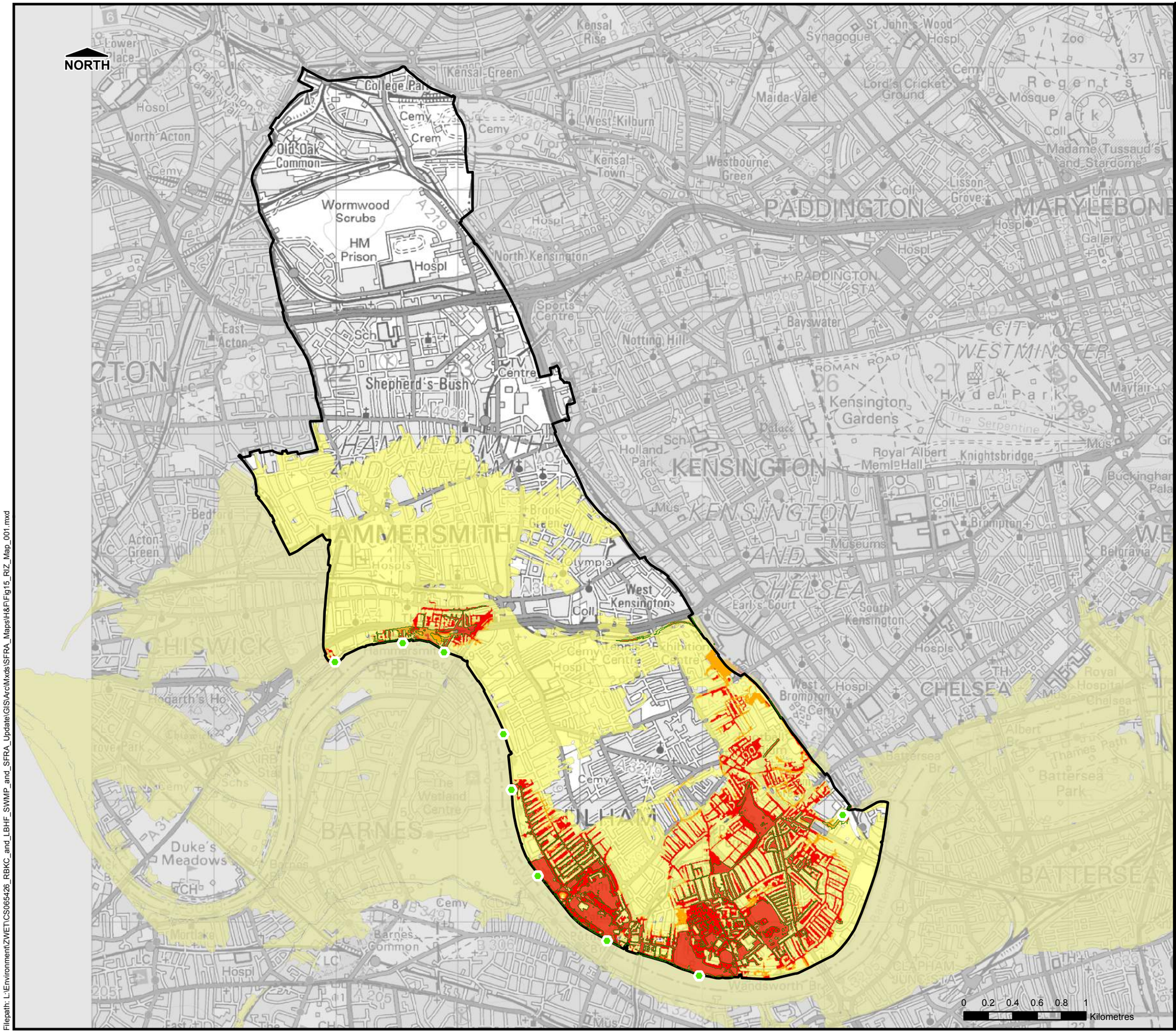

Filepath: L:\Environment\ZWET\CS065426_RBKC_and_LBHF_SWMP_and_SFRA_Update\GIS\ArcMxds\SFRA_Maps\H&F\Fig15_RIZ_Map_001.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Breach Location
- Rapid Inundation Zone
- LBHF Borough Boundary
- MH: Medium Residual Risk
- HH: High Residual Risk

Residual Risk Classification

- LH: Low Residual Risk

Notes

The Rapid Inundation Zone (RIZ) can be defined as the area that a flood will cover within half an hour of a breach occurring. The RIZ is often the area which suffers the highest flood depths and velocities.

The residual risk classifications are as follows:

LH: Low Residual Risk: Areas which have not been defined as medium of high risk but are still within the Environment Agency Flood Zone 3.

MH: Medium Residual Risk: Areas within the RIZ with flood depth of less than 0.25m; areas outside of the RIZ with flood depth less than0.6m.

HH: High Residual Risk: Areas within the RIZ with flood depth greater than 0.25m; areas outside of the RIZ with flood depth of greater than 0.6m.

London Borough of Hammersmith and Fulham

Strategic Flood Risk Assessment

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Residual Risk within Flood Zone 3
1 in 200 Year Event

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FIGURE 15

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