### *Basement Dwellings*

6.4.3 LBC guidance CPG4[49] covers basements and lightwells and supports the policies in the Local Development Framework (LDF). There are two aspects relating to basement dwellings covered by the guidance;

1. *basement impact assessments, principal impacts of basements, planning and design considerations; and*

2. *how basement dwellings may be affected in streets at risk from flooding.*

6.4.4 The issue of basements built within the borough has received a lot of recent press coverage. The issue which a groundwater specialist needs to consider is how the basements will affect groundwater flow in the local area. Factors which will influence this are the geological setting, thickness of the strata, the depths to the water table and permeability/confining nature of the layers. The creation of a barrier in the sub-surface may cause an obstruction to groundwater flow, with can lead to a rise in the water table on the upstream side and a fall in the water table on the downstream side. An example of what may happen to groundwater flows when a single basement is constructed is shown in the diagrams below.

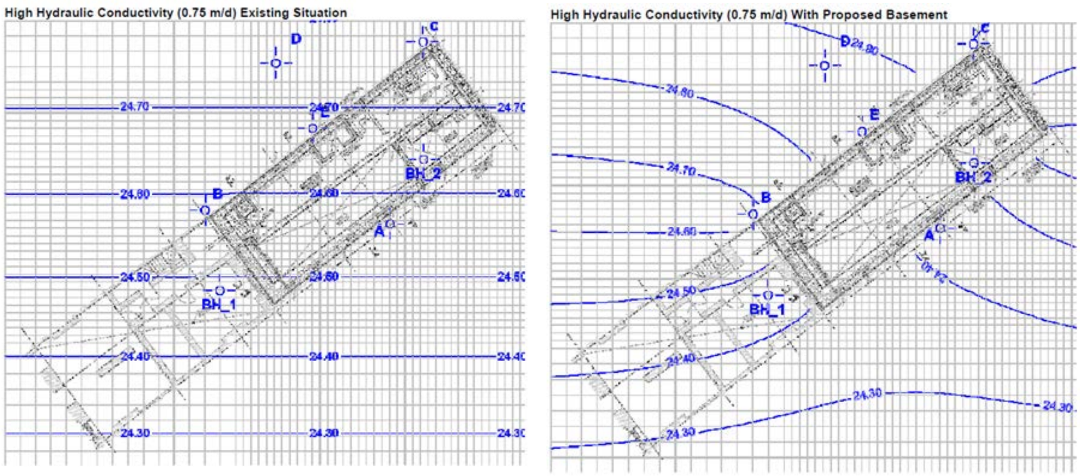



**Figure 6.1: Groundwater flows around basements – pre and post-development**

6.4.5 Moreover, if a basement development is close to a well or a spring feeding a surface water feature, the effect of groundwater taking a new flow pathway may result in reduced flow to the well or spring. Alternatively, a dormant spring may be reactivated or new spring activated, causing groundwater to take a different flow path. A larger basement will have a larger impact on the groundwater flow regime. A Basement Impact Assessment should assess the likely damming effect of the development and assess the likely rise in groundwater levels. The impact should not be considered in isolation. An example of predicted groundwater rise is provided below.

6.4.6 The pre-development conditions (Figure 6.1, left hand drawing) show groundwater movement in a southerly direction (at right angles to the blue groundwater contours). With the basement constructed (Figure 6.1, right hand drawing) – it is predicted that groundwater levels would rise by 0.2m on the north west side of the structure, and correspondingly lower to the south east. As part of the assessment carried out for basement development it will be important to identify any potential receptors which may be affected by the change in water level. Locally within the LBC area, the main receptors are likely to be existing basements, various abstraction sources from the River Terrace Deposits and groundwater-fed water features. A basement search radius of 500m around a development is advisable to inform a basement impact assessment.

6.4.7 In terms of groundwater flooding basement impact assessments should consider the following:

- Quantitative assessment of groundwater level rise; and
- Design the basement and selecting construction method to minimise the impact on groundwater flow.

6.4.8 This is relevant to both groundwater within River Terrace Deposits, and within perched water within sand pockets within London Clay and Bagshot Beds.

6.4.9 The other issue which may affect basement dwellings is in streets which are affected by surface water flooding. Basement dwellings are classified in the NPPF as Highly Vulnerable development and therefore should be discouraged within areas at risk of surface water or groundwater flooding. LBC Core Strategy Camden Development Policy 27 – Basements and lightwells (see Section 2.4.6) outlines requirements for basement development when it is proposed. Adverse impacts on drainage and runoff must be avoided.

6.4.10 Where basement dwellings are constructed, access must be situated 300mm above the design flood level, and waterproof construction techniques should be employed to avoid seepage during flood events. Similar problems can also occur where excessive surface water ponding occurs close to the sides of buildings, leading to significant infiltration. Surface water flow paths should be assessed to ensure that this does not occur, and to inform the strategic location of SuDS and techniques to route flows around the edge of buildings.

6.4.11 LBC should consider restricting the placement of sleeping accommodation below the external street level in areas of 'High' surface water flood risk in order to reduce the risk of water ingress into bedrooms during extreme rainfall events. For dwelling and non-dwelling basements, single storey accommodation and multi-storey buildings with ground floor sleeping accommodation in areas of flood risk from sources other than fluvial external, access should be located above the predicted flood level. For example, should the uFMfSW indicate that a proposed development is in an area of medium or high flood risk, the level of external access should be of primary consideration. It should be noted that the uFMfSW should not be used on a site-specific basis due to the limitations of the modelling, but instead should be used as a guide for potential risk.

### *Flood Resistant and Resilient Design*

6.4.12 In order to mitigate any potential flood damage, there are a range of flood resilient construction techniques that can be implemented in new developments. The Department for Communities and Local Government (CLG) has published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[50], the aim of which is to provide guidance to developers and designers on how to improve the resilience of new properties in low or residual flood risk areas, through the use of suitable materials and construction details. Figure 6.2 provides a summary of different design strategies depending on the depth of floodwater that could be experienced.

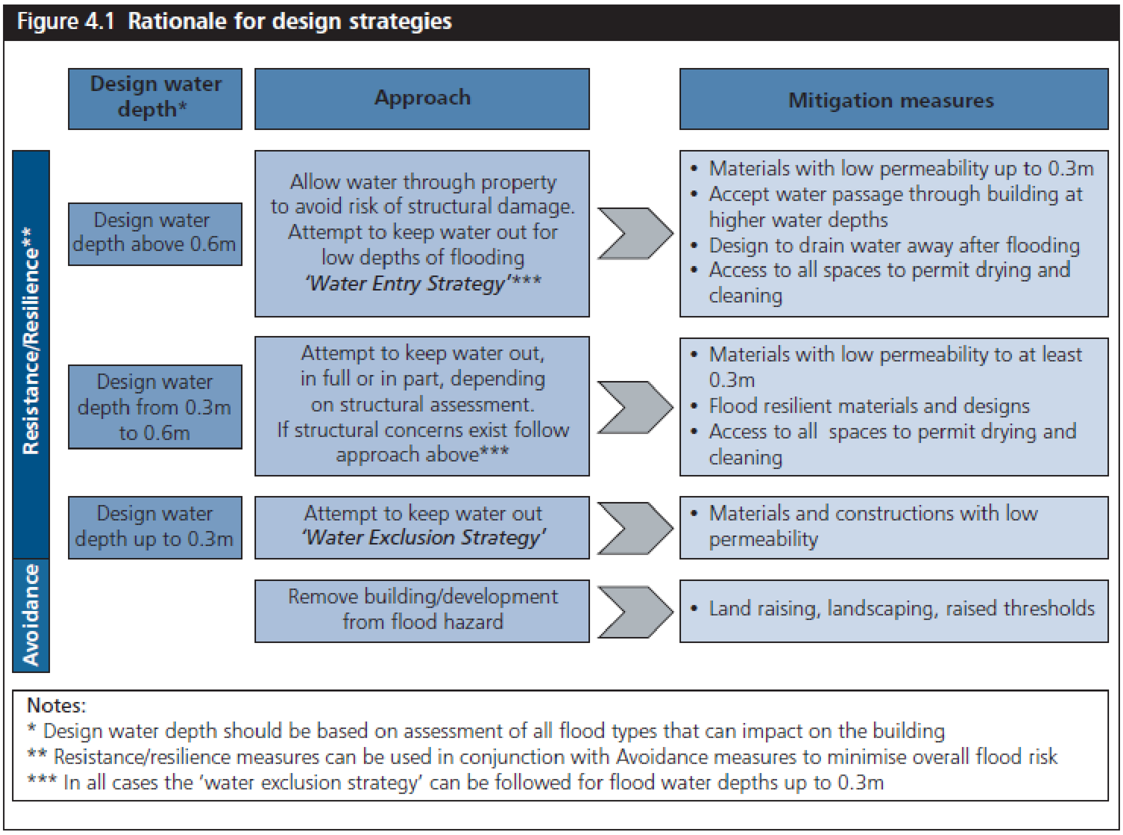



**Figure 6.2: Flood Resilient Design Strategies, Improving Flood Performance, CLG 2007**

6.4.13 A number of design strategies are detailed including the Water Exclusion Strategy and Water Entry Strategy. Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m.

6.4.14 For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, i.e. the Water Entry Strategy.

6.4.15 Due to the absence of fluvial flood risk, and the nature of surface water flood risk and the likely flood depths, the Water Exclusion Strategy is most appropriate within LBC for the majority of cases. In areas within the flood extent in the event of a reservoir breach, flood depths may potentially exceed 0.6m and therefore the Water Entry Strategy may be most appropriate. It is recommended that Environment Agency Risk of Flooding from Reservoirs Mapping be consulted for detailed information on potential flood water depths in the event of such a breach.

6.4.16 The principle behind the Water Entry Strategy is not only to allow water through the property to avoid the risk of structural damage, but also to implement careful design in order to minimise damage and allow rapid re-occupancy of the building. The NPPF considers these measures to be appropriate for both changes of use and for Less Vulnerable uses where temporary disruption is acceptable and suitable flood warning is received.

6.4.17 Materials will be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

6.4.18 Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction' (CLG, 2007).

## 6.5 Property Level Resilience Measures

6.5.1 Following the intense rainfall events of 1975 and 2002, parts of LBC suffered notable flooding associated with surface water and the local drainage network. Current climate change predictions suggest that intense rainfall events are likely to become more frequent, thereby putting a greater strain on the local drainage network and increasing the potential for surface water flooding. It is not possible for the drainage network to be upgraded to accommodate extreme rainfall events and consequently there remains a risk that sewer and surface water flooding can occur. To mitigate the effects of flooding from these extreme events the homeowner or developer can install permanent or temporary flood proofing measures.


**Figure 6.3: Examples of property level flood barriers, air bricks, non-return valves (Floodguards)**

6.5.2 Temporary flood barriers (Figure 6.3) are moveable flood defences that can be fitted to doorways or windows. On a smaller scale, temporary clip-on covers for airbricks and air vents can also be fitted to prevent water entry.

6.5.3 Permanent flood barriers can also be created, which may comprise built up doorsteps, rendered brick walls and toughened glass barriers. There are methods for ensuring that such measures are sympathetic to the surroundings.

6.5.4 In order to provide protection from the risk of sewer flooding, non-return valves can be installed to prevent water entering the property from drains and sewers. Further information can be found in the CIRIA publication 'Low cost options for preventing flooding from sewers'[51].

## 6.6 Car Parks

6.6.1 Where car parks are specified as areas for the temporary storage of floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

## 6.7 Structures

6.7.1 Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

## 6.8 Safe Access and Egress

6.8.1 Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

6.8.2 A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances.

6.8.3 For developments located in areas at flood risk the Environment Agency consider 'safe' access/egress to be in accordance with 'FRA Guidance for new Developments FD 2320' (Defra and EA 2005). The requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles;
- Safe, dry route for people;
- If a dry route for people is not possible, a route for people where the flood hazard, in terms of depth and velocity of flooding, is low and should not cause risk to people;
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

## 6.9 Flood Warning and Evacuation Plans

6.9.1 Flood warning and emergency procedures tend to form part of higher level emergency management plans for the wider area including information such as repair procedures, evacuation routes, refuge areas, flood warning dissemination and responsibilities.

6.9.2 No Environment Agency Flood Alerts or Warnings would be issued in LBC due to the absence of watercourses within the borough. Met Office Severe Weather Warnings provide warning to communities of extreme weather events, including rainfall events, and can be viewed at http://www.metoffice.gov.uk/public/weather/warnings/?regionName=uk.

## 6.10 Emergency Plan

6.10.1 LBC has developed a Multi-Agency Flood Plan (MAFP) to allow all responding parties to work together on an agreed coordinated response to severe flooding within the borough. Where necessary the LBC Multi Agency Flood Plan should be reviewed in the light of information generated by this SFRA and updated where appropriate. This will ensure that emergency plans are appropriate to the conditions expected during a flood event and that the local authority and emergency services are fully aware of the likely conditions and how this may affect their ability to safeguard the local population.

6.10.2 When submitting FRAs for developments within flood risk areas, developers should make reference to local flood warning and emergency procedures to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population. The flood hazard in a particular area must be viewed in the context of the potential evacuation and rescue routes to and from that area and discussed as part of a site-specific FRA.

## 6.11 Flood Routing

6.11.1 Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

6.11.2 Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

# 7 SUSTAINABLE DRAINAGE SYSTEMS

7.1.1 When designing buildings, flood risk management policies require that the developments are 'safe', do not increase flood risk elsewhere and where possible reduce flood risk overall.

7.1.2 It is strongly recommended that suitable surface water mitigation measures are incorporated into any development plans in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should ideally be achieved by incorporating SuDS.

7.1.3 SuDS are typically softer engineering solutions inspired by natural drainage processes such as ponds and swales which manage water as close to its source as possible. Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the preferred system contributing significantly to each objective. Where possible SuDS solutions for a site should seek to:

1. *Reduce flood risk (to the site and neighbouring areas);*
2. *Reduce pollution; and,*
3. *Provide landscape and wildlife benefits.*

7.1.4 These goals can be achieved by utilising a management plan incorporating a chain of techniques, as outlined in the Interim Code of Practice for Sustainable Drainage Systems[52], where each component adds to the performance of the whole system:

| | |
|---|---|
| Prevention | Good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping). |
| Source Control | Runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements). |
| Site Control | Water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site). |
| Regional Control | Integrate runoff management systems from a number of sites (e.g. into a detention pond). |

7.1.5 The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

7.1.6 SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc.), which is of particular importance for mineral sites. Various SuDS techniques are available and operate on two main principles:

- Infiltration
- Attenuation

7.1.7 All systems generally fall into one of these two categories, or a combination of the two.

7.1.8 SuDS designs should aim to reduce runoff by integrating storm water controls throughout the site in small, discrete units. Through effective control of runoff at source, the need for large flow attenuation and flow control structures should be minimised.

7.1.9 As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development.

7.1.10 Table 7.1 has been reproduced from the SuDS Manual, CIRIA C679[53] and outlines typical SuDS options and details their typical components.

**Table 7.1: Typical SuDS Components**

| Component Description | Example |
|---|---|
| Filter Strips | Wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas. |
| Swales | Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow). |
| Infiltration Basins | Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value. |
| Wetland Ponds | Wetland ponds are basins that can remove pollutants present within surface water. They provide runoff attenuation and wildlife benefits. |
| Extended Detention Basins | Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment. |
| Constructed Wetlands | Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat. |
| Filter Drains and Perforated Pipes | Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect |

| Component Description | Example |
|---|---|
| | and convey the water. |
| Infiltration Devices | Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground. |
| Pervious Surfaces | Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water. |
| Green Roofs | Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697). |
| Rainwater Harvesting | Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event. |

### *SuDS Approval Body (SAB)*

7.1.11 Under the FWMA, LBC is designated as the SuDS Approval Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new SuDS within the area.

7.1.12 The SAB will have responsibility for the approval of proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds, and approval must be granted before the developer can commence construction.

7.1.13 In order to be approved, proposed drainage systems will have to meet new national standards for sustainable drainage. Where planning permission is required, applications for drainage approval and planning permission may need to be lodged jointly with the planning authority but LBC, as the SAB, will determine the drainage application. Regulations will set a timeframe for the decision so as not to hold up the planning process.

7.1.14 The SAB will also be responsible for adopting and maintaining SuDS which serve more than one property, where they have been approved. Highways authorities will be responsible for maintaining SuDS in public roads, to National Standards.

7.1.15 The SAB must arrange for SuDS on private property, whether they are adopted or not, to be designated under Schedule 1 to the FWMA as features that affect flood risk. The SAB will also be required to arrange for all approved SuDS to be included on the register of structures and features (as a separate category).

7.1.16 The National Standards will set out the criteria by which the form of drainage appropriate to any particular site or development can be determined, as well as requirements for the design, construction, operation and maintenance of SuDS. Local authorities are represented on the Project Advisory Board for the development of these National Standards.

7.1.17 The FWMA, in response to Sir Michael Pitt's Review, also makes the right to connect surface water drainage from new development to the public sewerage system conditional on the surface water drainage system being approved by the SAB.

7.1.18 Defra has worked closely with key stakeholders and technical experts including the Environment Agency, Local Authorities, developers and water companies to develop National Standards. The National Standards will apply to construction work (domestic and commercial new developments and redevelopments) and will allow flexibility for local conditions.

7.1.19 The requirements for SuDS in England is yet to be implemented and in the interim period, the ongoing requirement is to continue to seek advice from the Environment Agency regarding the design of SuDS and the management of surface water runoff from development sites.

## 7.2 The SuDS hierarchy

7.2.1 The National Standards for sustainable drainage systems[54] states that *"the following destinations must be considered for surface runoff in order of preference":*

1. *Discharge into the ground*
2. *Discharge to a surface water body*
3. *Discharge to a surface water sewer*
4. *Discharge to a combined sewer*

7.2.2 In addition to these standards, as outlined in Section 2.3, The London Plan Policy 5.13 provides further detail for Sustainable Drainage, following the principles of the National Standards:

7.2.3 *"Development 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:*

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

## 7.3 Feasibility of the SUDs Hierarchy in Camden

### *Discharge into the ground*

7.3.1 SuDS suitability – In Source 8 (see Table 3.2), the southern part of borough is likely to suffer very significant constraints associated with infiltration SuDS, in particular in the area along the northern edge of the River Terrace Deposits. The area with the least constraints i.e. suitable for free-draining infiltration SuDS, is the area in the north of borough underlain by the Bagshot Formation. In between these two areas, there lies an area which is classed as either probably suitable for infiltration SuDS (where depth to water table is >5m through the year) or potentially suitable for infiltration SuDS (where depth to water table is <3m for part of year). In this central part of the borough, local confirmation would be required of depth to the water table before design of SuDS is considered.

7.3.2 Overall, it is areas in the southern part of borough which are likely to have the biggest constraints on the use of infiltration SuDS, and in particular in those areas where the depth to the water table <3m below the ground surface occur. In the northern part of the borough, the use of infiltration SuDS will generally be suitable on the free-draining Bagshot Formation. In the central parts of borough, some areas may have potential for infiltration SuDS, although the design will be influenced by local ground conditions.

### *Discharge to a surface water body*

7.3.3 Section 3.2 provides details of surface water bodies located within LBC over 1500m$^2$ in surface area. OS MasterMap was utilised in order to identify all inland water bodies

7.3.4 All surface water bodies above 1500m$^2$ in surface area are located within Hampstead Heath and Waterlow Park, with the exception of the Regent's Canal. Therefore there is limited potential for new development within LBC to discharge to a surface water body. No watercourses, except for those located within Hampstead Heath, exist within the borough. The surface water bodies above 1500m$^2$ in area are located close to the Allocated Sites included in this SFRA.

### *Discharge to a surface water sewer*

7.3.5 A desktop study was carried out to identify the location of LBC Highways drains and TWUL surface water assets in order to ascertain the potential for new development to discharge surface water runoff to a surface water sewer. Although a limited number of surface water sewers are located with LBC, all subsequently connect to a combined sewer and therefore any connection to a surface water sewer will still add flow to the combined sewer network. The NPPF states that new development must not increase surface water runoff rates post-development, and the London Plan states that all new development should aim to achieve greenfield runoff rates where practicable. Opportunities for surface water attenuation and water re-use, such as through use of water butts, should be considered as part of any new development.

# 8 POLICY OPTIONS

## 8.1 Overview

8.1.1 This section provides options for LBC to consider as part of the development of the LBC Local Plan.

## 8.2 Policy Aims within Flood Zone 1

8.2.1 The entirety of LBC is located within Flood Zone 1, which comprises land outside the extent of fluvial flooding in a 0.1% AEP event. As set out in the NPPF all types of development are considered appropriate within Flood Zone 1. Proposals for new development greater than 1 hectare in Flood Zone 1 will require a site specific FRA to ensure that surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Due to the majority of the borough being located within a Critical Drainage Area as defined by the LBC SWMP, all opportunities should be taken during development to reduce existing runoff rates post-development. Policy 5.13 of the London Plan[55] states that all development should aim to achieve greenfield runoff rates, and where this is not possible, runoff rates post-development should not exceed those pre-development, as per the NPPF. The SWMP Critical Drainage Areas and Local Flood Risk Zones, and the Environment Agency's uFMfSW dataset should be used as a starting point to indicate broad areas with a potential for surface water flood risk in the borough. In the absence of fluvial flood risk within the borough, a clear focus for new development should be a reduction in surface water runoff rates post-development, wherever practicable.

## 8.3 Policy Options

### *Spatial Planning*

1. *Sites should be allocated in accordance with the Sequential Test to reduce the flood risk and ensure that the vulnerability classification of the proposed development is appropriate to the flood risk. In the absence of fluvial flood risk within the borough, available information, such as the Environment Agency's uFMfSW and Flood Risk from Reservoirs should be utilised to direct development towards areas of lowest flood risk.*

2. *Basement dwellings and other 'Highly Vulnerable' development should be discouraged in areas where a high surface water flood risk has been identified.*

3. *LBC should consider requiring a FRA to accompany any planning application for 'Highly Vulnerable' development in an area of Medium surface water flood risk, and for 'More Vulnerable' development in an area of High surface water flood risk as defined by the uFMfSW.*

4. *LBC should consider the cumulative impact of new development on flood risk.*

### *Flood Risk Management*

1. *FRAs are required for proposals of 1 hectare or greater in Flood Zone 1 and for new development (including minor development and change of use) in an area of Flood Zone 1 which has critical drainage problems. The majority of the borough is located within a CDA as defined by the LB Camden SWMP and therefore LB Camden should consider requiring FRAs for all development located within Local Flood Risk Zones as defined by the SWMP, which show discrete areas of flooding.*
2. *For proposed developments located within a CDA, as indicated by Appendix B, Figure 6, LBC should consider setting as a requirement a minimum reduction in surface water runoff rates post-development of 50%. The intention of such a requirement would be to reduce surface water runoff and also reduce the strain on the combined sewer network.*
3. *Where changes of use result in an increase in the vulnerability classification of a development, applicants should be required to provide an assessment of flood risk to accompany their planning application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress.*
4. *Flood Risk to development should be assessed for all sources of flooding.*
5. *Surface water flooding should be investigated in detail as part of site specific FRAs for future developments and early liaison with LBC is recommended for appropriate management techniques.*
6. *Groundwater flooding should be investigated in more detail as part of site specific FRAs for developments located in areas of the borough where a potential for groundwater flooding exists.*
7. *When re-developing existing buildings in areas at risk from flooding, the use of flood resilient measures should be promoted at the individual property level.*
8. *The screening stage of a Basement Impact Assessment should be applied to all basement developments to identify any potential risks in relation to the water environment or local properties. Should any risks be identified, appropriate assessment of these risks should be carried out.*
9. *A Basement Impact Assessment should demonstrate that the impacts of the proposed development are acceptable, or that appropriate mitigation measures will be adopted.*

### *Sustainable Drainage Systems & Surface Water Management*

1. *Sustainable Drainage Systems (SuDS) should be included in new developments unless it is demonstrably not possible to manage surface water using these techniques. Section 7.3 should be consulted in the first instance for guidance on the potential for SuDS techniques.*
2. *NPPF requires the use of SuDS as an opportunity for managing flood risk, improving water quality and increasing amenity and biodiversity.*
3. *FRAs are required for proposals of 1 hectare or greater in Flood Zone 1 and for new development (including minor development and change of use) in an area of Flood Zone 1 which has critical drainage problems.*
4. *Policy 5.13 of the London Plan states that development should aim to achieve greenfield runoff rates, and where this is not possible, runoff rates post-development should not exceed those pre-development, as per the NPPF. In addition, an allowance should be made for climate change.*
5. *For proposed developments located within a CDA, as indicated by Appendix B, Figure 6, LBC should consider setting as a requirement a minimum reduction in surface water runoff rates post-development of 50%. The intention of such a requirement would be to reduce surface water runoff and also reduce the strain on the combined sewer network.*
6. *Potential overland flow paths should be considered to ensure that buildings do not obstruct flows.*
7. *Where basements are proposed the risk of surface water flooding should be considered, with possible mitigation options including raised thresholds and inclusion of storage for surface water in such developments.*
8. *Opportunities should be sought to reduce the risk of flooding from the sewer network through consultation with TWUL to determine key areas for maintenance and flood alleviation schemes.*
9. *At the site specific FRA level, the suitability of SuDS should be investigated for each development. Section 7.3 indicates that the southern section of the borough is likely to suffer significant constraints associated with infiltration SuDS, with such techniques likely to be least constrained in the north of the borough where it is underlain by the Bagshot Formation (Appendix B: Figure 4b).*
10. *The vulnerability and importance of local ecological resources, such as water quality and biodiversity, should be considered when determining the suitability of SuDS.*

***Residual Risk & Emergency Planning***

1. *Where development within flood risk areas is absolutely necessary, flood proof construction methods should be employed to reduce the impact of flooding.*
2. *Where development is within flood risk areas, emergency planning strategies should be put in place in order to direct people to safety during times of flooding.*

## APPENDIX A: DATA SOURCES

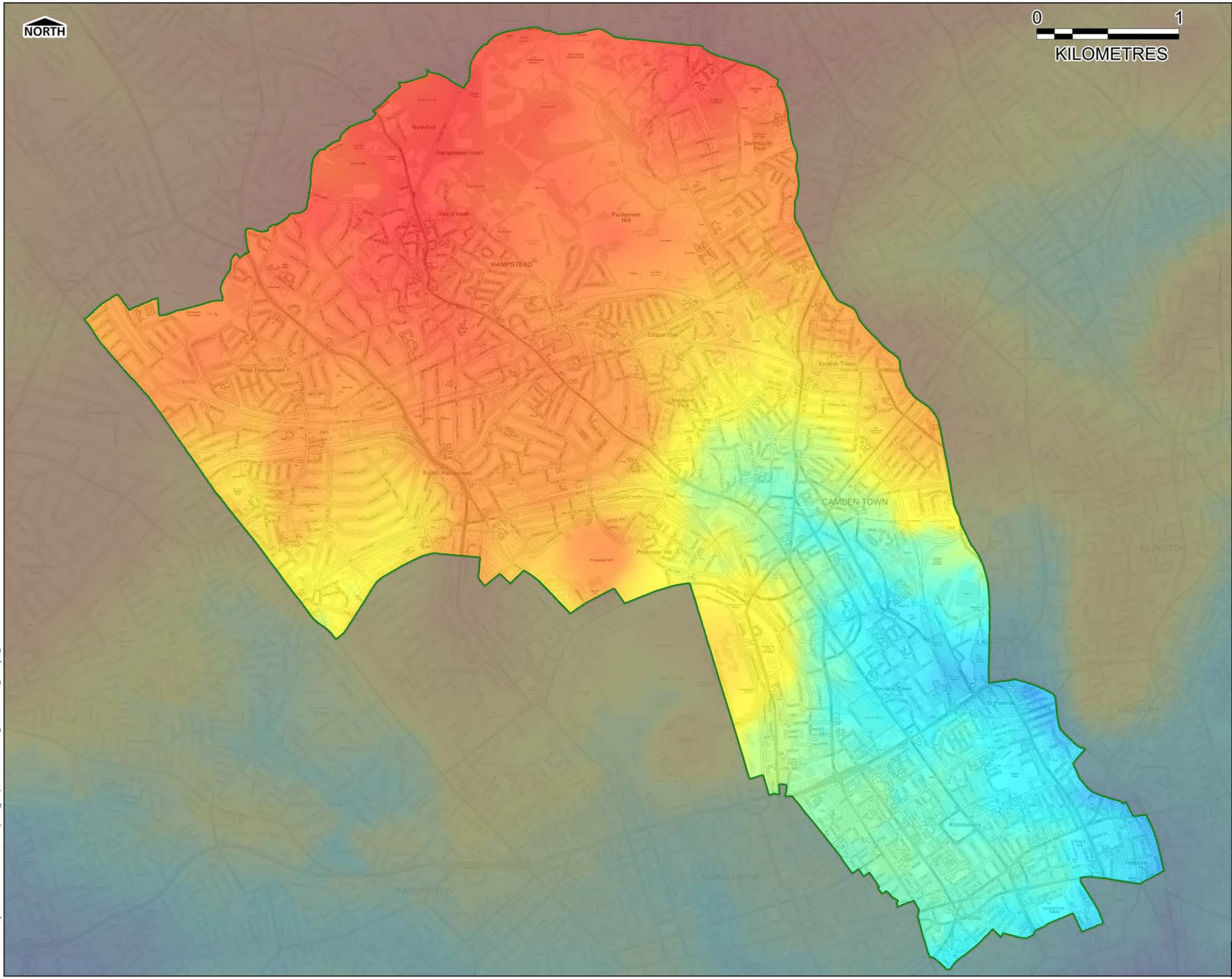
| Dataset Description | Source | Format | Benefits / Limitations |
|---|---|---|---|
| **Fluvial** | | | |
| Environment Agency Flood Zones | Environment Agency Geostore | GIS Layer | Confirmation that LBC is located entirely within Flood Zone 1. |
| Detailed River Network (DRN) | Environment Agency Geostore | GIS Layer | Identification of the river network including Ordinary Watercourses and Regent's Canal. |
| Historic Flood Map | Environment Agency Geostore | GIS Layer | Confirmation that no fluvial historic events have been recorded in LBC. |
| **Surface water** | | | |
| 'Updated Flood Map for Surface Water' dataset | LBC (Camden LLFA) | GIS Layer | Provides an indication of the broad areas likely to be at risk of surface water flooding, i.e. areas where surface water would be expected to flow or pond. This dataset does not show the susceptibility of individual properties to surface water flooding. |
| Surface Water management Plan and associated GIS deliverable | LBC | GIS Layer | GIS layer identifying Critical Drainage Areas: A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.<br>CDAs indicate areas where surface water management should be a key focus of any future development. |
| Local surface water modelling outputs for Highgate and West Hampstead | WSP | GIS Layer | GIS outputs from detailed local pluvial modelling within Highgate and West Hampstead areas within LBC. |
| Records of flooding from all sources | LBC | GIS Layer | Identifies locations within the borough which are vulnerable to flooding. |
| **Groundwater** | | | |
| Underlying Geology | LBC | GIS Layer | Illustrates bedrock and superficial geology across the Borough. |

| Dataset Description | Source | Format | Benefits / Limitations |
|---|---|---|---|
| 'Areas Susceptible to Groundwater Flooding' dataset | Environment Agency Geostore | GIS Layer | A strategic scale map showing groundwater flood areas on a 1km square grid. It was developed specifically by the Environment Agency for use by Lead Local Flood Authorities (LLFAs) for use in Preliminary Flood Risk Assessment (PFRA) as required under the Flood Risk Regulations. The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding, but may be of use to LLFAs in identifying where, for example, further studies may be useful. |
| Groundwater vulnerability zone | Environment Agency Geostore | GIS Layer | Broadly shows extents of aquifers in the Borough. Where aquifers are highly vulnerable, they often have a more permeable covering and, together with dry valley and watercourse networks, potential groundwater flooding areas can be identified. |
| Aquifer Designation Map for bedrock and superficial deposits | Environment Agency Geostore | GIS Layer | A polygon shapefile that shows aquifer designations for bedrock aquifers. The designations identify the potential of the geological strata to provide water that can be abstracted and have been defined through the assessment of the underlying geology. |
| Increased Potential for Elevated Groundwater dataset | LBC | GIS Layer | This dataset was derived from four individual data sources (BGS Groundwater Flood Susceptibility maps; Environment Agency Thames Estuary 2100 groundwater hazard maps; DEFRA Groundwater emergence maps; and JBA. Groundwater flood maps) and identifies areas where there is increased potential for groundwater levels to rise within 2 m of ground surface following periods of higher than average recharge. |
| Infiltration for SuDS | British Geological Survey | GIS Layer | Dataset produced by the BGS of relevance to professionals who make decisions on SuDS design, construction and approval. The maps will help: (1) make preliminary decisions on the suitability of the subsurface for infiltration SuDS; (2) make preliminary decisions on the type of infiltration SuDS that will likely be appropriate; (3) assess SuDS planning applications to determine whether the necessary factors have been considered; and (4) determine whether infiltration SuDS could be appropriate where a non-infiltrating SuDS technique has been proposed. |
| EA Groundwater Flood Calls | Environment Agency | MS Excel Spreadsheet | Records of calls to the Environment Agency regarding suspected groundwater flooding. |
| **Sewer** | | | |

| Dataset Description | Source | Format | Benefits / Limitations |
|---|---|---|---|
| Sewer flooding records | Thames Water | MS Word Doc | Indicates post code areas that may be prone to flooding as have experienced flooding in the last 10 years due to hydraulic incapacity. However, given that TWUL target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding. |
| TWUL asset information | Thames Water | GIS Layer | GIS layer of all TWUL assets including surface and foul water and combined sewers. Layer provides confirmation of the route of the sewers which have incorporated the 'lost rivers' of Camden. |
| Flow rates from Hampstead Heath Ponds to local sewer network | City of London Corporation | MS Word Doc | Confirmation of the sizes of the outlet pipes from the Hampstead and Highgate Pond Chains within Hampstead Heath, and the flow rates from the ponds into the local sewer network. |
| **Planning** | | | |
| OS Mapping of LBC administrative area (1:10K Streetview, 1:50K, OS MasterMap) | LBC | GIS Layer | Provides background mapping to other GIS layers. Designed for use at 1:50K and 1:10K scales. |
| GIS layer of administrative boundary | LBC | GIS Layer | Defines the administrative area of the Borough for mapping purposes. |
| GIS layer of post code boundaries | LBC | GIS Layer | Delineates post code boundaries for the Borough. Enables mapping of TWUL datasets which are provided by post code sector. |
| GIS layer of development sites. | LBC | GIS Layer | Layer of LBC Allocated Sites. |
| LBC highways assets | LBC | GIS Layer | Identifies highways gullies maintained by LBC |
| Emergency Planning | | | |
| Borough-wide Emergency Flood Plan | LBC | PDF document | Details LBC's co-ordinated response to a flood event. |
| National Receptor Database (NRD) | Environment Agency Geostore | GIS Layer | Spatial dataset which contains a number of layers categorised into the themes of Buildings, Transport, Utilities, Land Use, Agriculture, Heritage, Environment and Miscellaneous. Each information theme contains a number of relevant data layers. |
| **Canal** | | | |

| Dataset Description | Source | Format | Benefits / Limitations |
|---|---|---|---|
| Asset Inspection Procedures Manual | Canal and River Trust | PDF document | Detailed information on the inspection and management of Canal and River Trust assets to ensure their continued safety. |
| Canal and River Trust asset information | Canal and River Trust | GIS layer | Detailed information in GIS format of all Canal and River Trust asset data within LBC. |
| **Reservoirs** | | | |
| Management of the Hampstead Heath Ponds | City of London Corporation | PDF document | Details of current management of the Hampstead Heath Ponds by CoLC which may have an impact on flood risk. |
| Hampstead Heath Ponds Project information | City of London Corporation | PDF document | A number of documents have been published by City of London Corporation detailing the existing flood risk at the Hampstead Heath Ponds and the proposed works to ensure the safety of the ponds in the future. |

## APPENDIX B: BOROUGH MAPPING






**LEGEND**

London Borough Camden Boundary

**Topography (mAOD)**

- -2 to 12
- 12 to 25
- 25 to 39
- 39 to 53
- 53 to 80
- 80 to 121
- 121 to 135

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|---|---|---|---|

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: LB Camden Topography

| Drawn | Checked | Approved | Date |
|---|---|---|---|
| CB | JS | MT | 03/07/2014 |

URS Internal Project No. 47070547

Scale at A3 1:40,000



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Drawing Number: FIGURE 1

Rev: Rev 1

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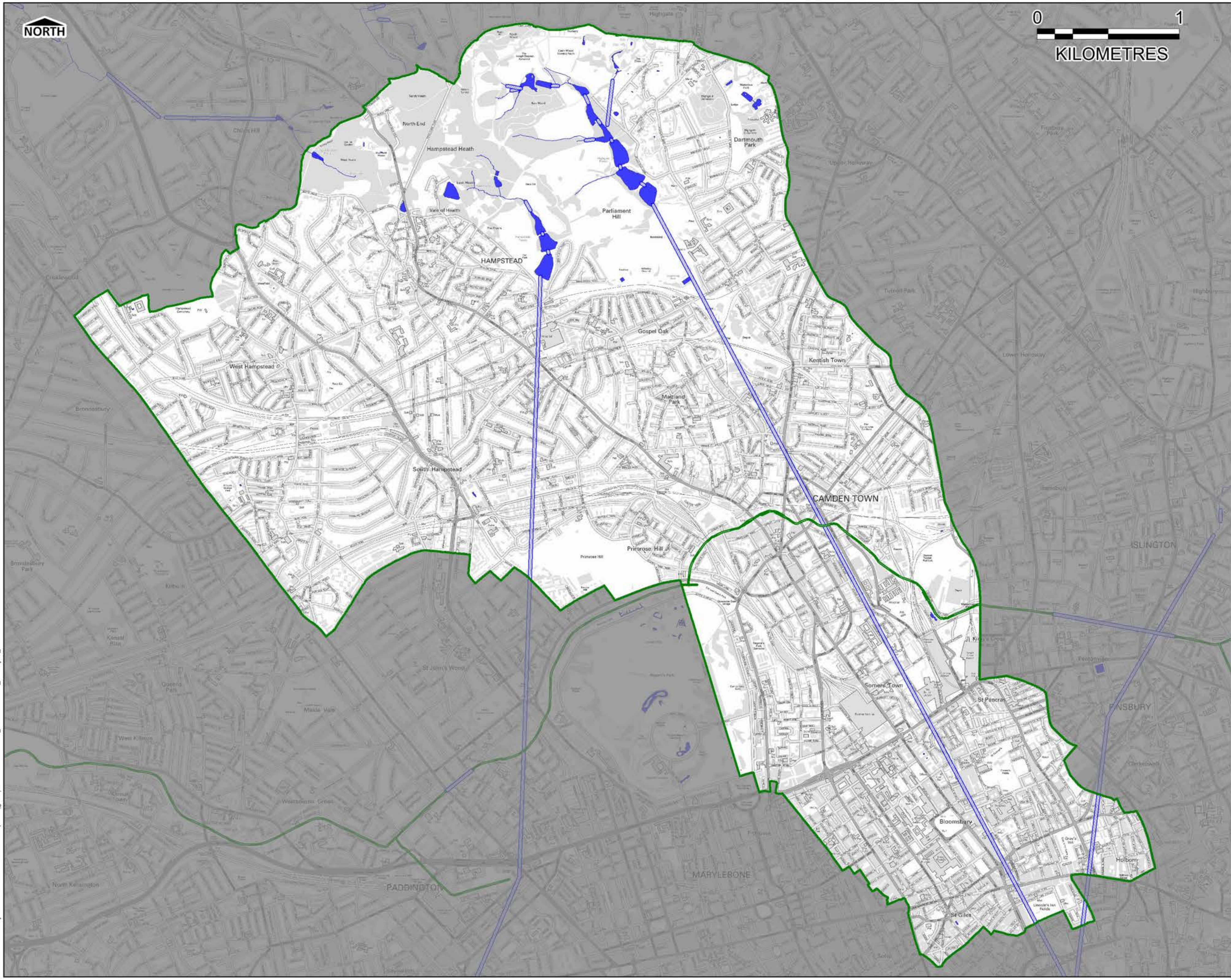


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**LEGEND**

- London Borough Camden Boundary
- Inland Waters
- Open Watercourse
- Culverted Watercourse
- Canal



| Revision Details | By / Check | Check Date | Suffix |
|---|---|---|---|

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: LB Camden Surface Waterbodies

| Drawn | Checked | Approved | Date |
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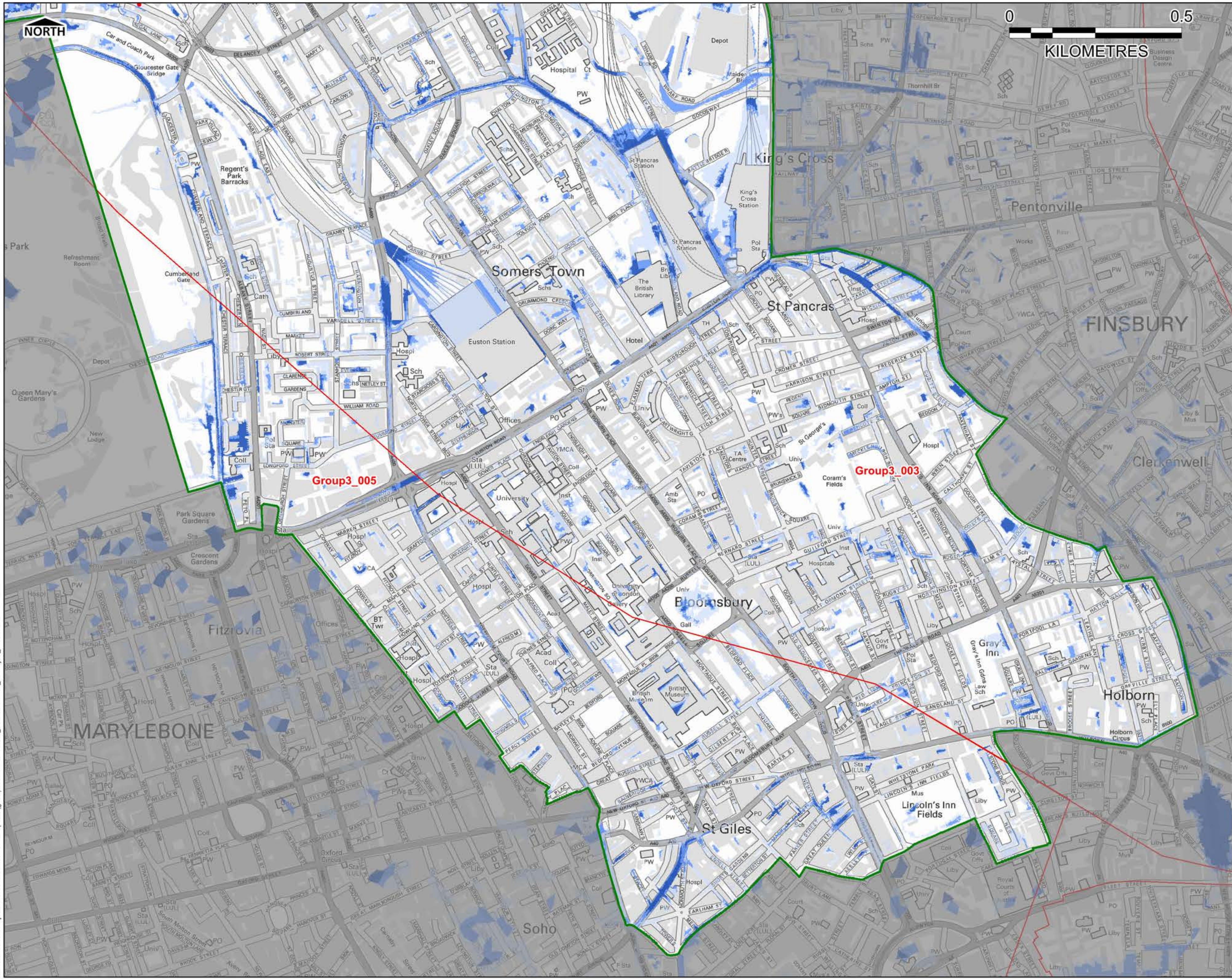


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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area

**Risk of Flooding from Surface Water**

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)



| Revision Details | By / Check | Check Date | Suffix |
| --- | --- | --- | --- |

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

| Drawn | Checked | Approved | Date |
| --- | --- | --- | --- |
| CB | JS | MT | 03/07/2014 |

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Rev: Rev 1

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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Records
No. Properties affected
- 1
- 2

**Risk of Flooding from Surface Water**
- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

| Revision Details | By | Check | Check Date | Suffix |
|---|---|---|---|---|

Purpose of Issue
FINAL

Client
Camden

Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
Updated Flood Maps for Surface Water Flooding (uFMfSW)

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|---|---|---|---|
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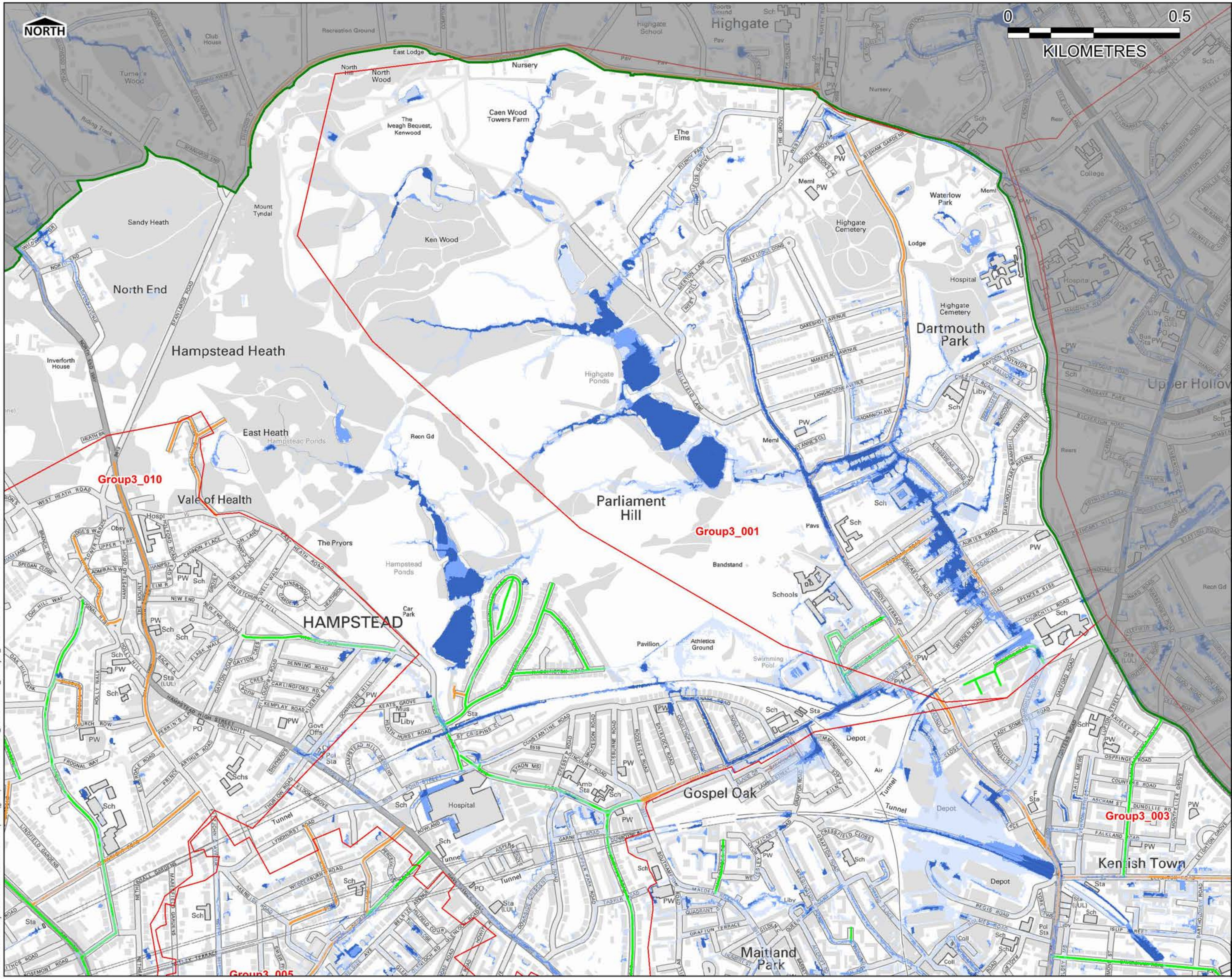


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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

**Risk of Flooding from Surface Water**

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)



| Revision Details | By | Check | Date | Suffix |
|---|---|---|---|---|

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

| Drawn | Checked | Approved | Date |
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| FIGURE 3 iii | Rev 1 |

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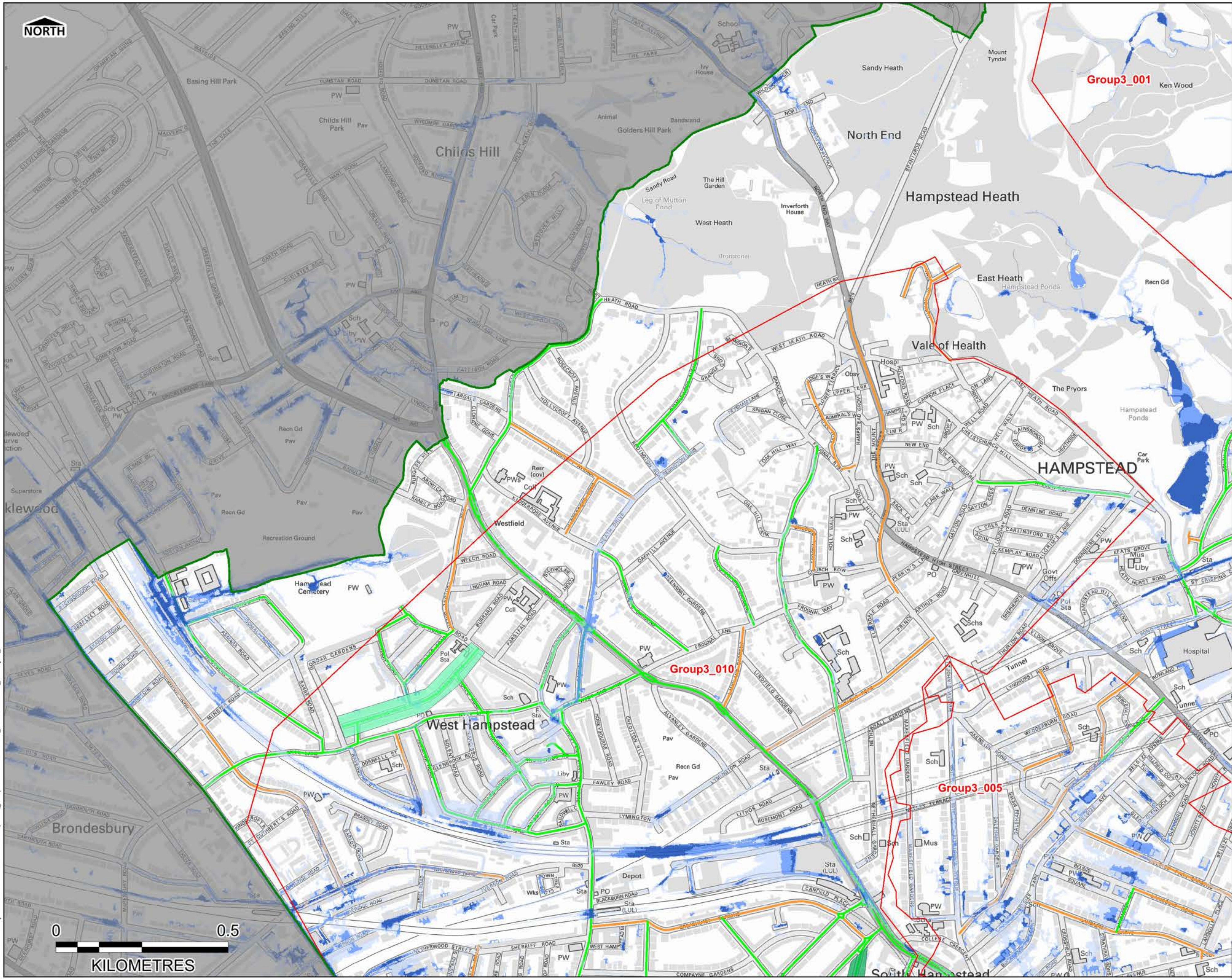


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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Record
No. Properties affected
- 1
- 2

**Risk of Flooding from Surface Water**
- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)



| Revision Details | By / Check | Check Date | Suffix |
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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

| Drawn | Checked | Approved | Date |
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| FIGURE 3 iv | Rev 1 |

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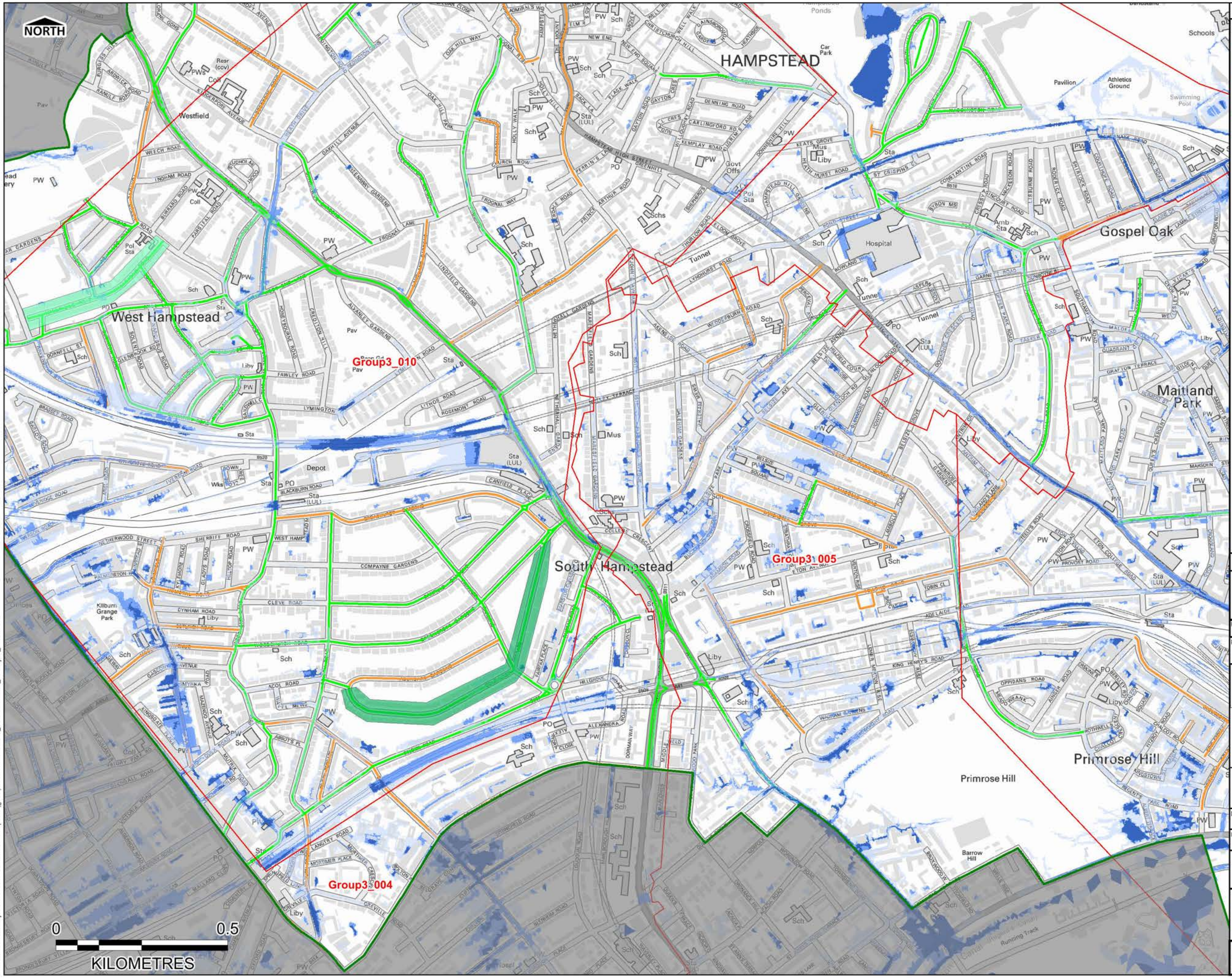


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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Record
No. Properties affected

- 1
- 2

**Risk of Flooding from Surface Water**

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)



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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

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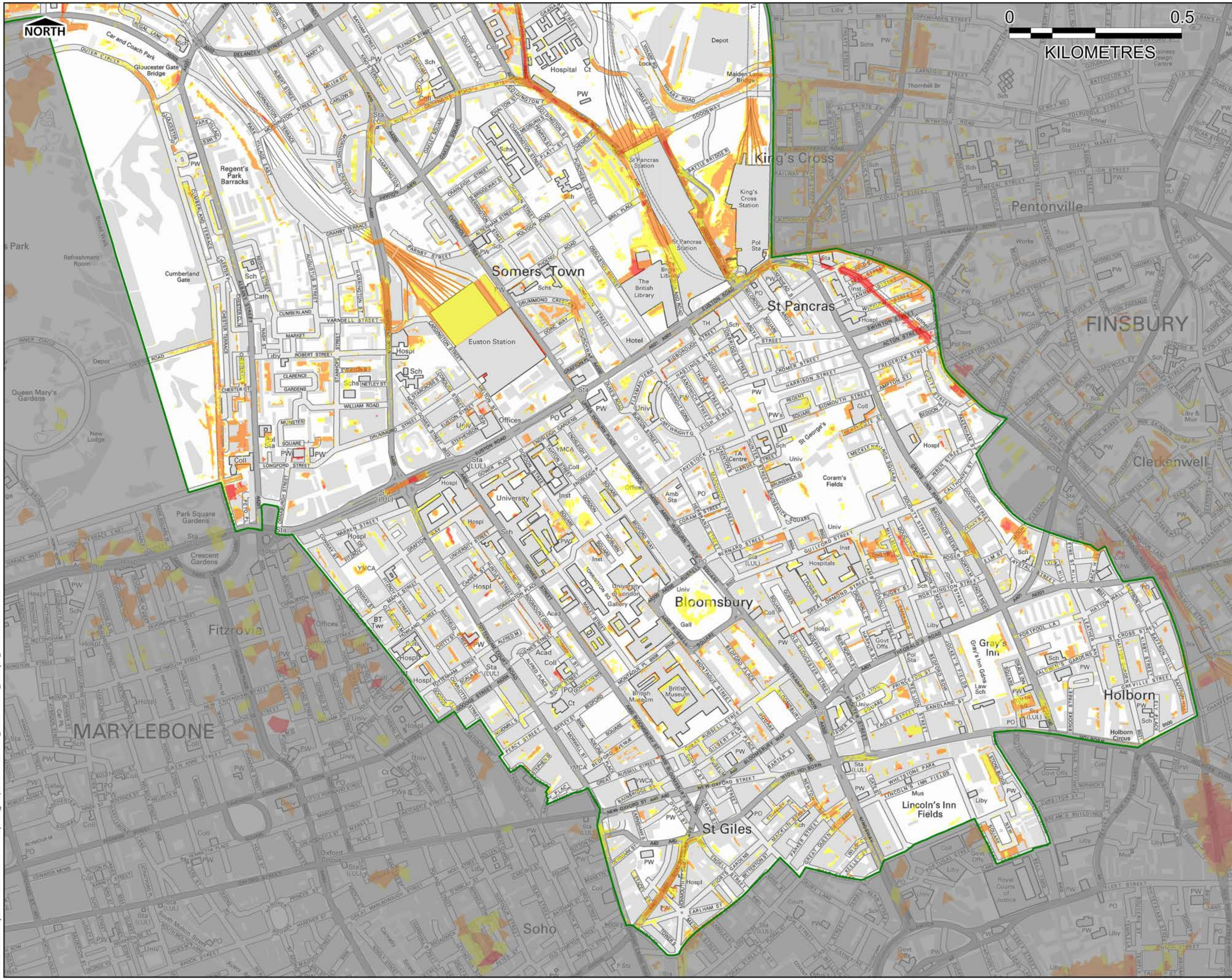


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**LEGEND**

London Borough Camden Boundary

**Flood Hazard (m)**

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)



| Revision Details | By | Check | Date | Suffix |
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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

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**LEGEND**

London Borough Camden Boundary

**Flood Hazard (m)**

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

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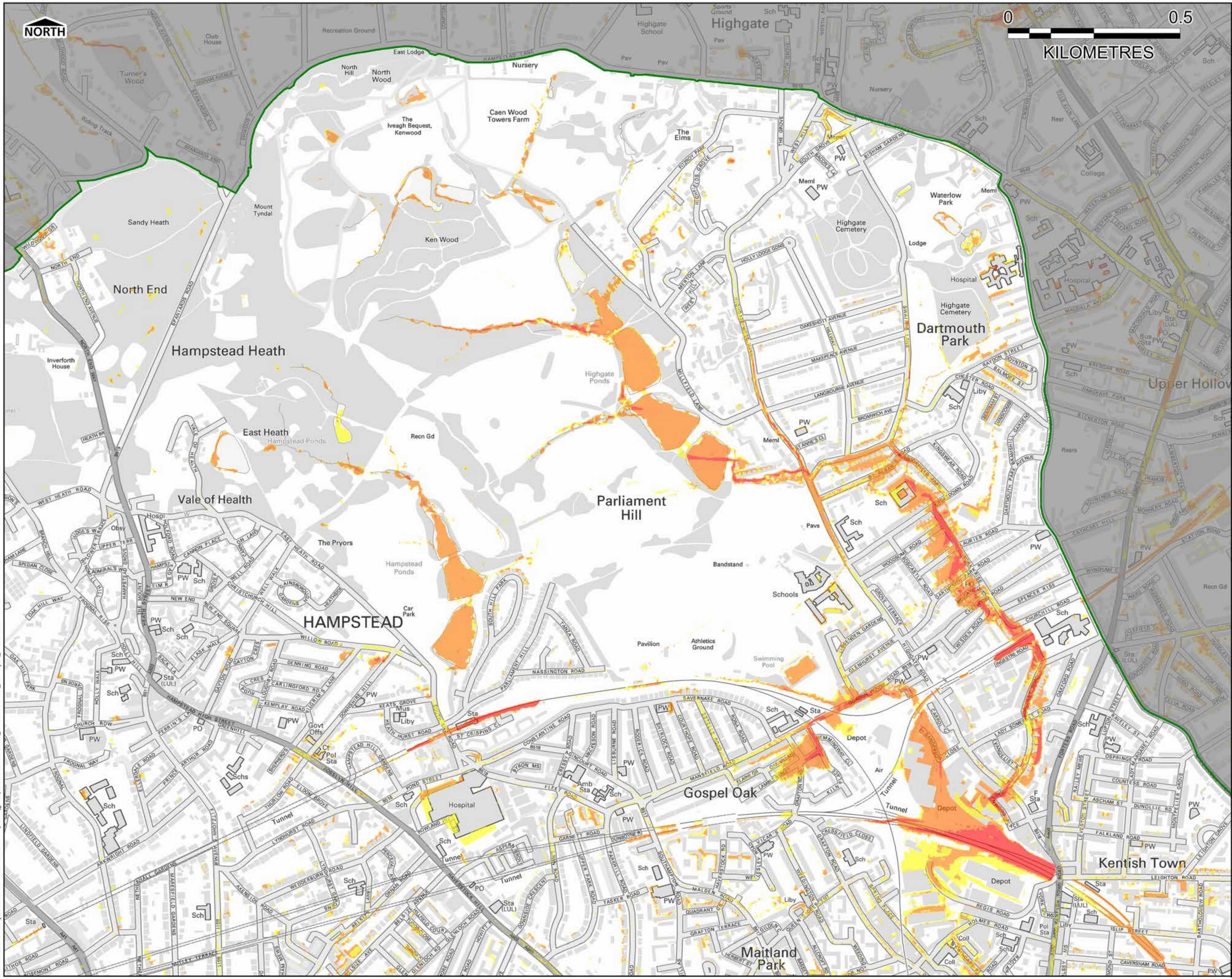


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**LEGEND**

London Borough Camden Boundary

**Flood Hazard (m)**

- >2.5 Extreme (Danger for all)
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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

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| FIGURE 3 viii | Rev 1 |

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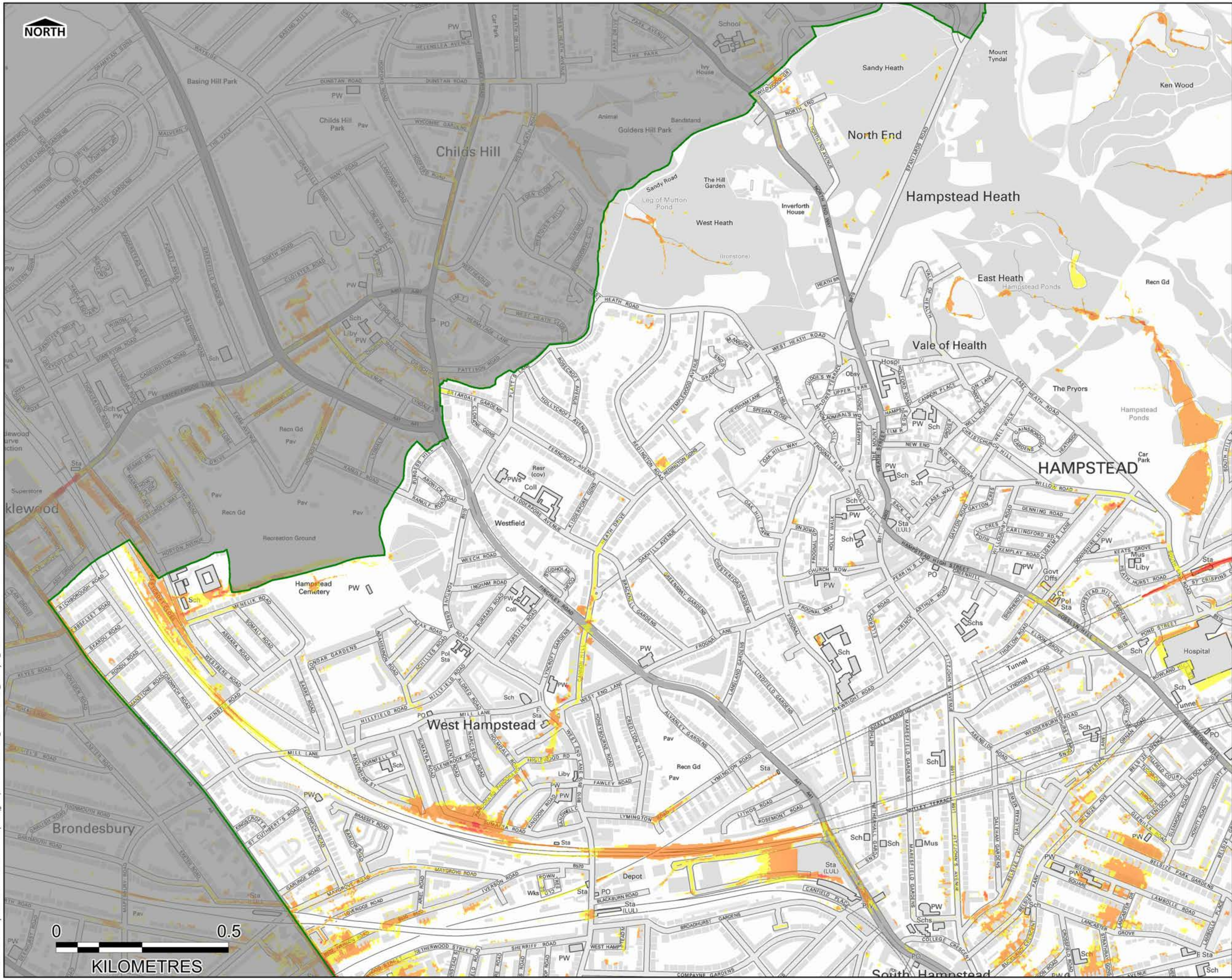


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London Borough Camden Boundary

**Flood Hazard (m)**

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- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)



| Revision Details | By Check | Check Date | Suffix |
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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

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**LEGEND**

London Borough Camden Boundary

**Flood Hazard (m)**

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

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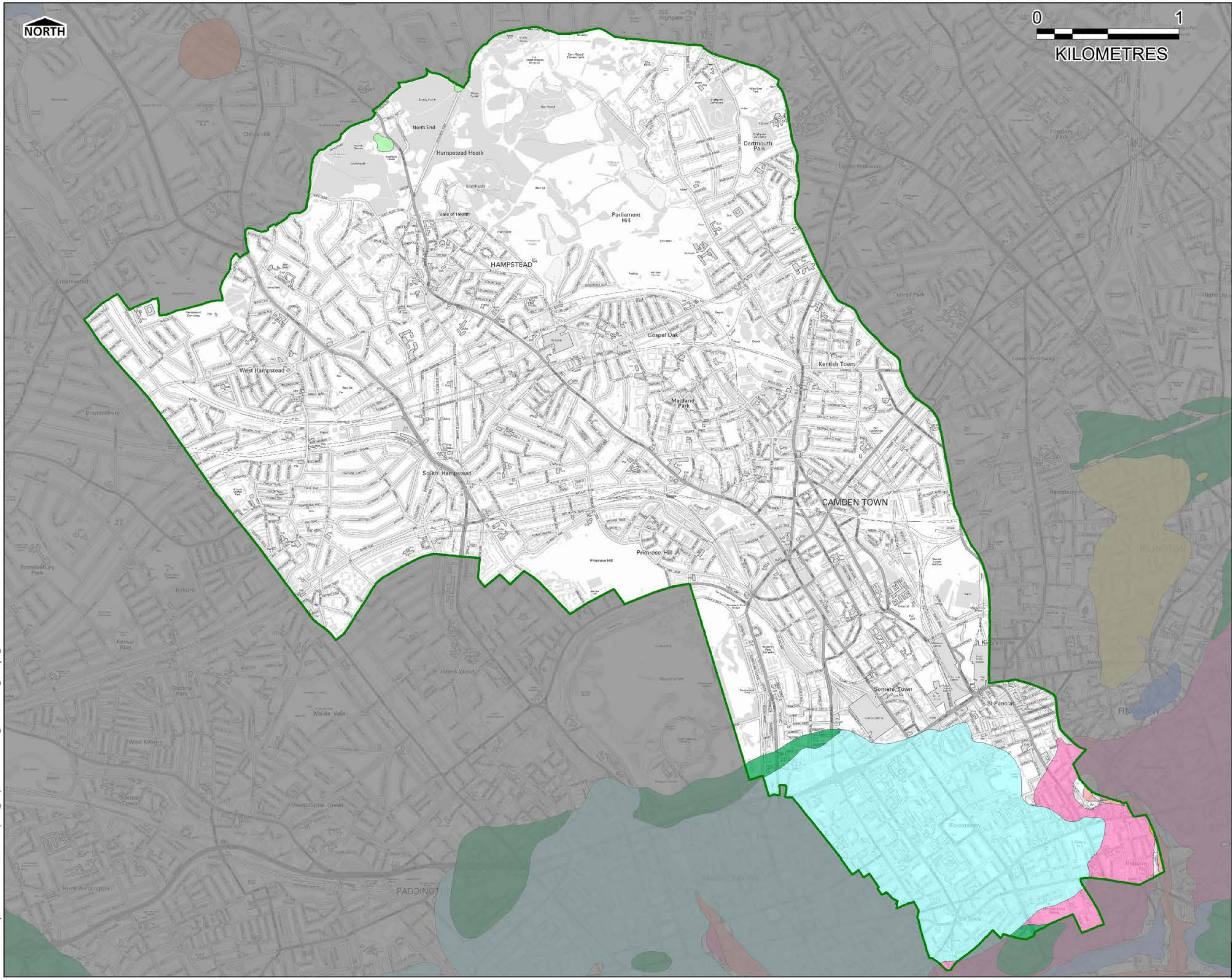


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**LEGEND**

- London Borough Camden Boundary
- HACKNEY GRAVEL
- LANGLEY SILT
- LYNCH HILL GRAVEL
- STANMORE GRAVEL

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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society Superficial Deposits Geology

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| FIGURE 4a | Rev 1 |

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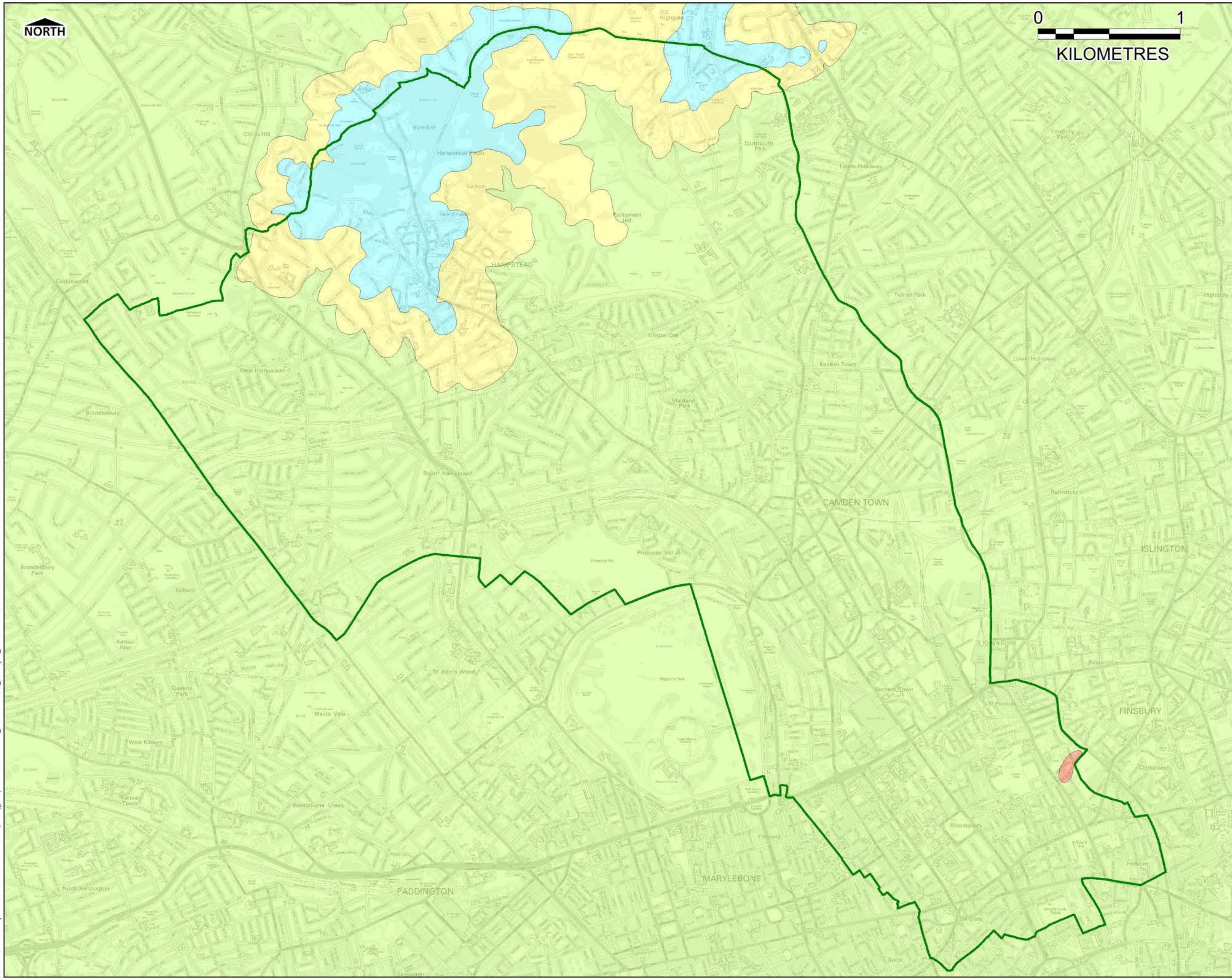


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**LEGEND**

- London Borough Camden Boundary
- Bagshot Formation
- Claygate Member
- Lambeth Group
- London Clay Formation



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Purpose of Issue
FINAL

Client
Camden

Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
British Geological Society Bedrock Geology

| Drawn | Checked | Approved | Date |
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| FIGURE4b | Rev 1 |

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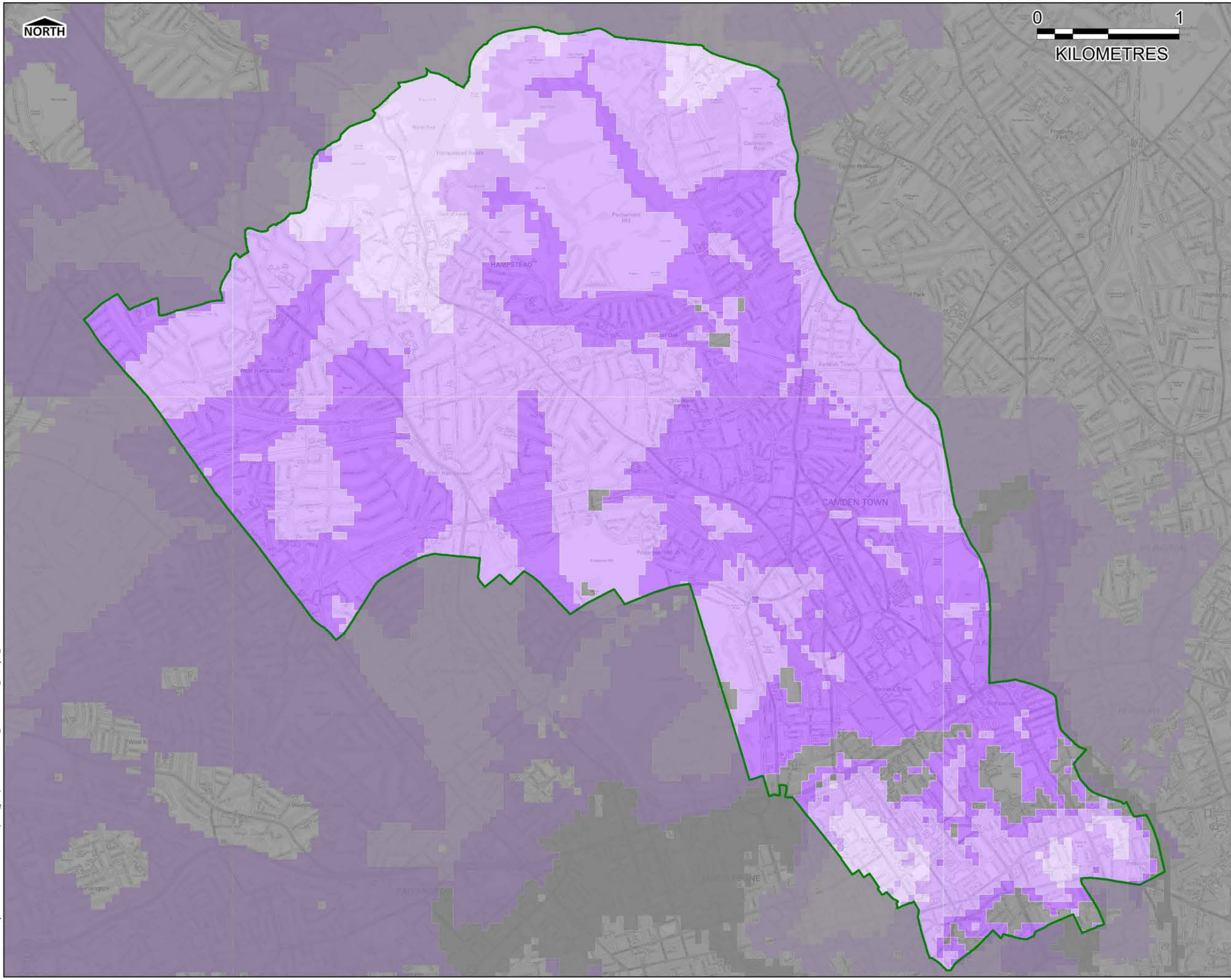




**LEGEND**

- London Borough Camden Boundary

BGS Infiltration SuDS Map

- Highly compatible for infiltration SuDS
- Probably compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Very significant constraints are indicated



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Purpose of Issue
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Client
Camden

Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
British Geological Society SuDS Drainage Potential

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FIGURE 4c

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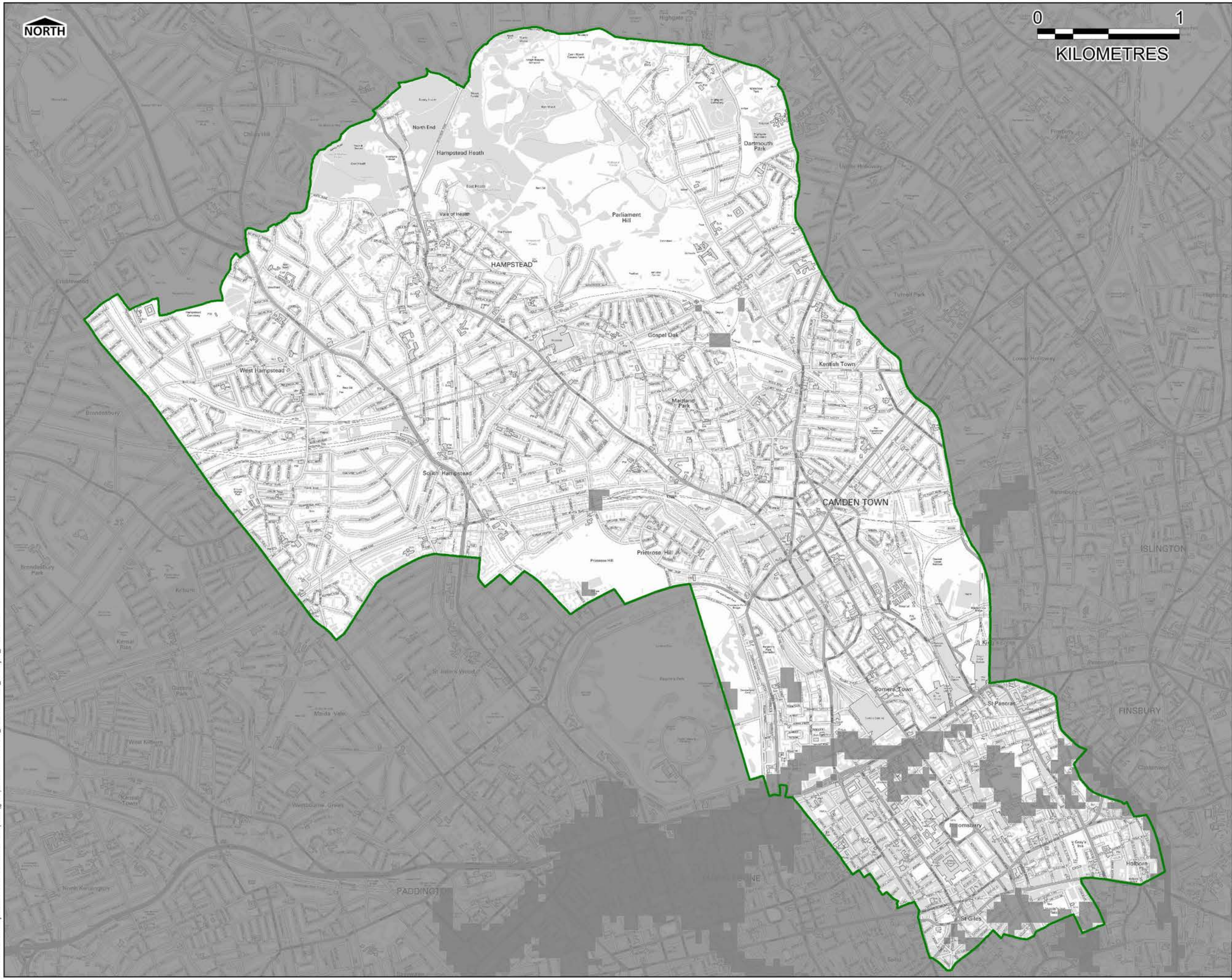


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**LEGEND**

London Borough Camden Boundary

Infiltration Constraints

Very significant constraints are indicated

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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society SuDS Infiltration Constraints

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| FIGURE 4d | Rev 1 |

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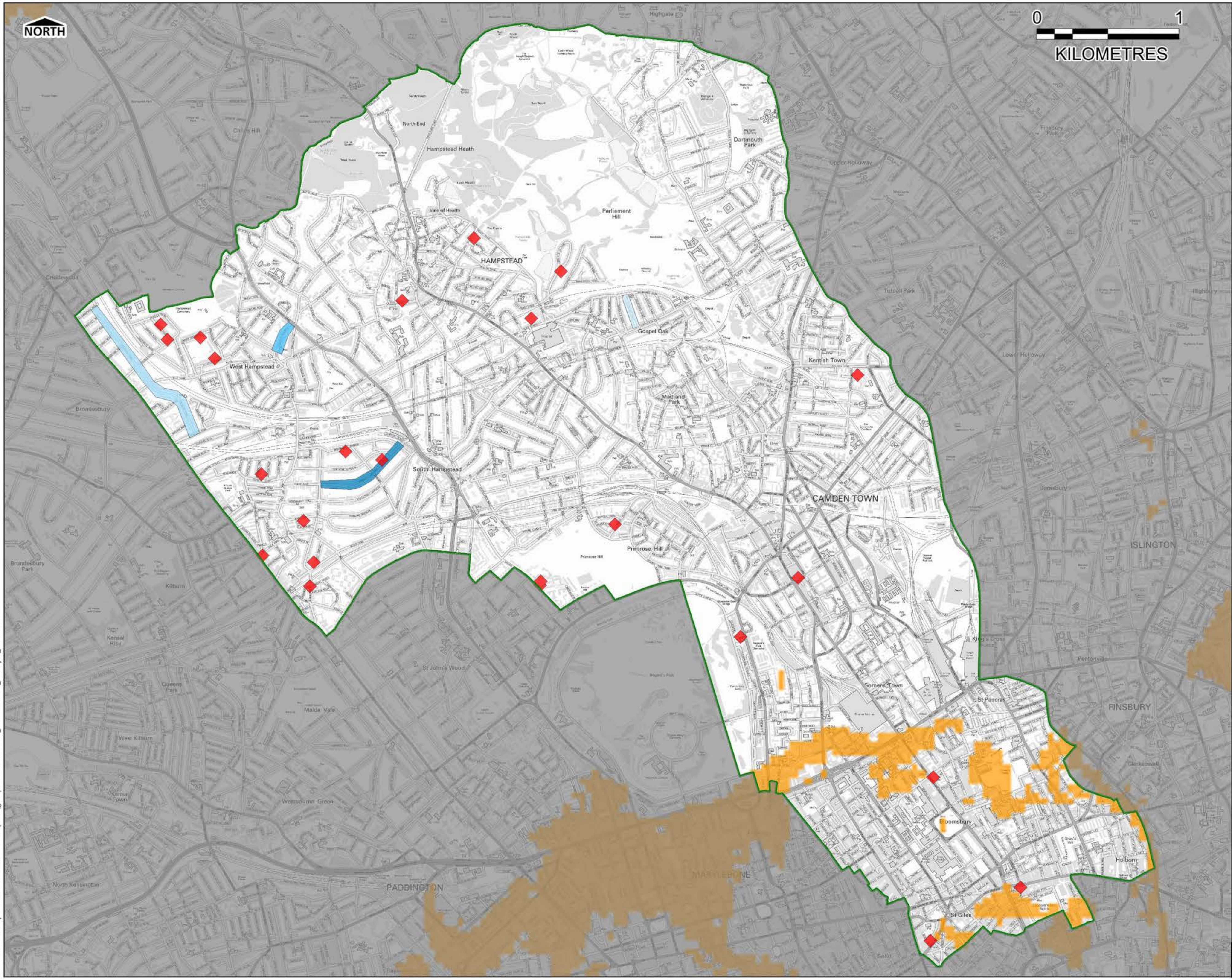




**LEGEND**

- London Borough Camden Boundary

LBC Historic GW Flooding Record
No. Properties affected

- 1
- 6
- 7
- 8

- Increased Susceptibility to Elevated Groundwater

- Environment Agency groundwater flood incidents



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Purpose of Issue
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Client
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Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
Increased Susceptibility to Elevated Groundwater

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| FIGURE 4e | Rev 1 |

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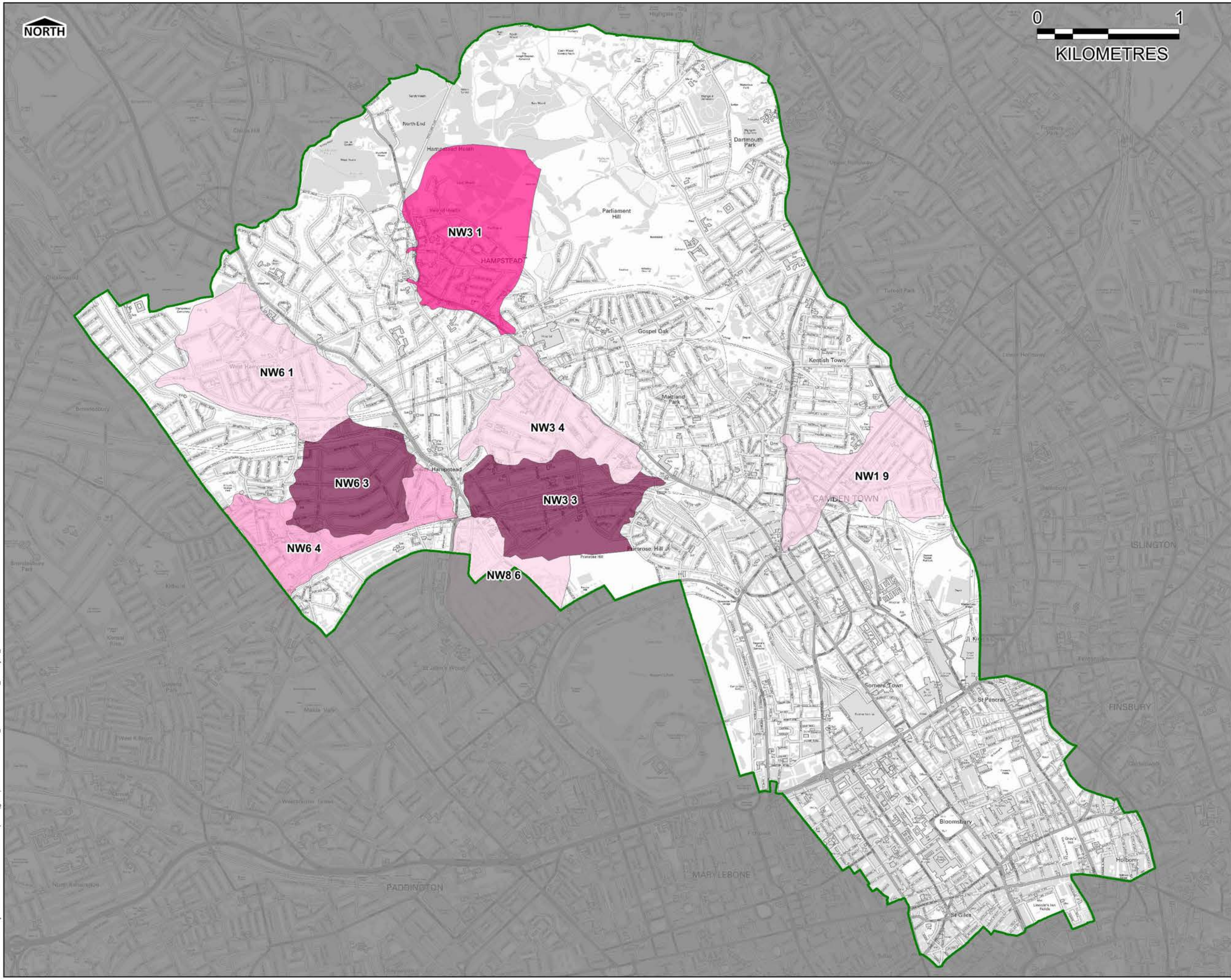


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**LEGEND**

London Borough Camden Boundary

Internal Sewer Flooding
No. of Properties affected

- 1
- 2
- 4
- 8



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Purpose of Issue
FINAL

Client
Camden

Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
DG5 Internal Sewer Flooding

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| FIGURE 5a | Rev 1 |

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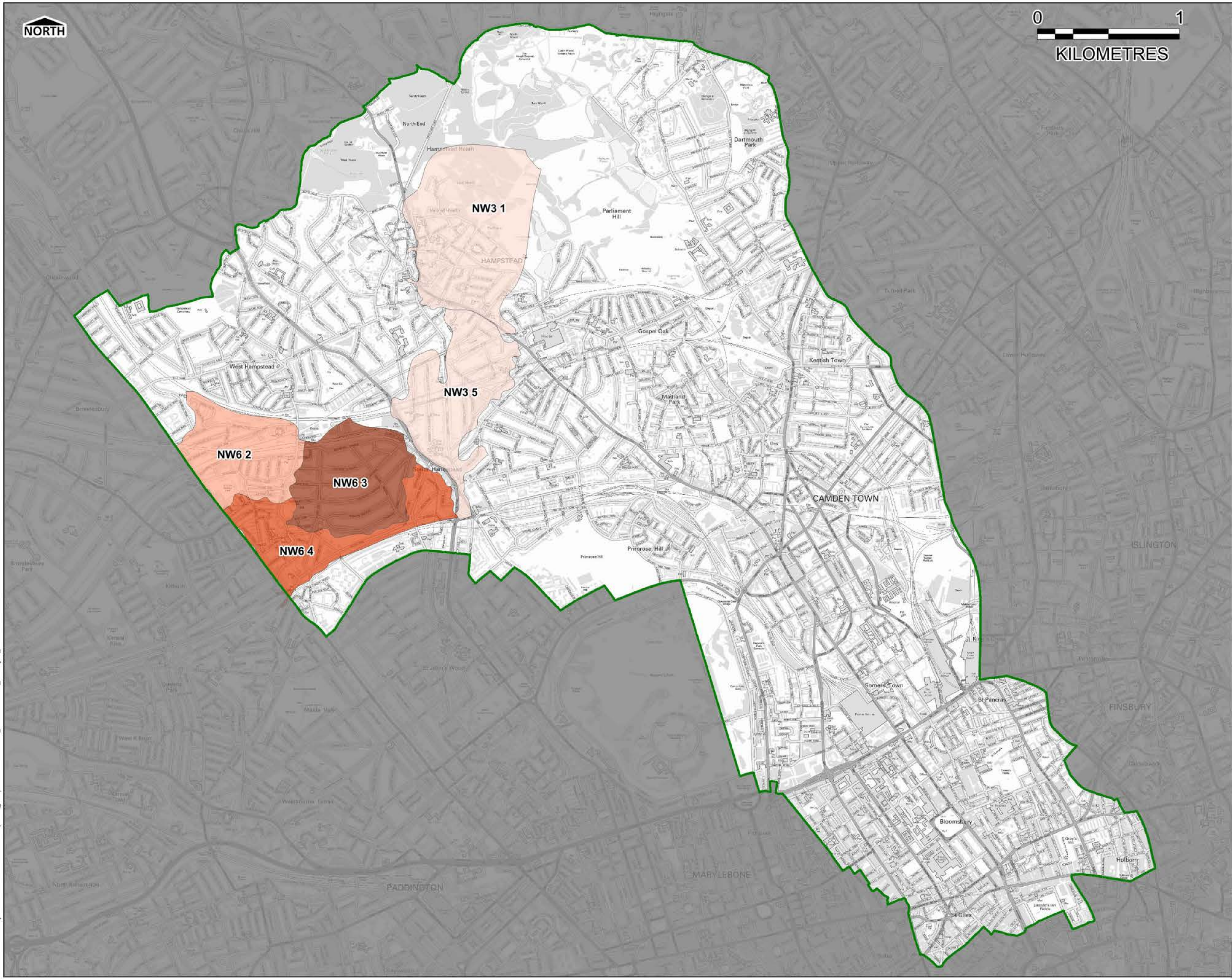


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**LEGEND**

London Borough Camden Boundary

Exterior Sewer Flooding
No. of Properties affected

1
2
4
18

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Purpose of Issue
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Client
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Project Title
LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
DG5 External Sewer Flooding

| Drawn | Checked | Approved | Date |
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| Drawing Number | Rev |
|---|---|
| FIGURE 5b | Rev 1 |

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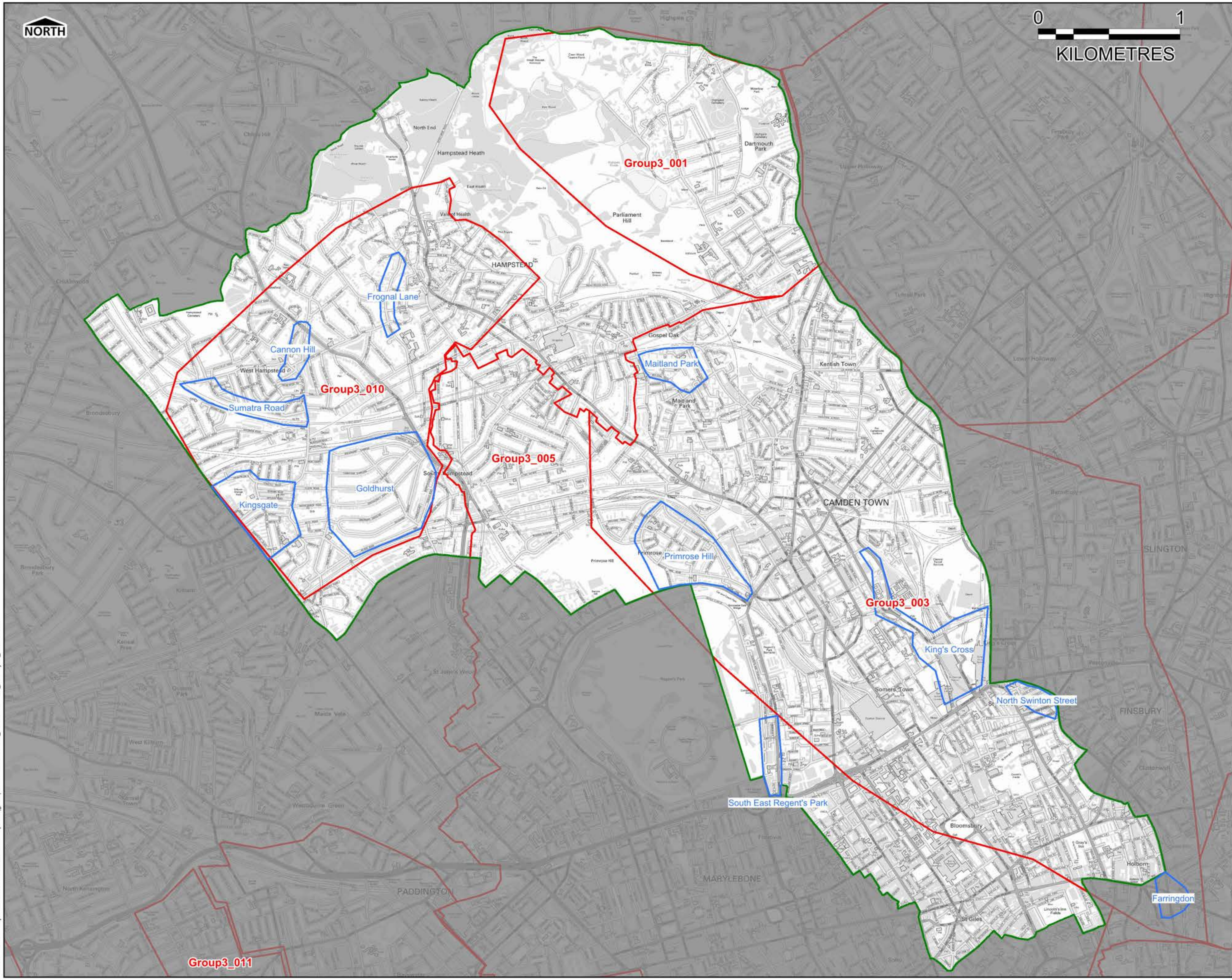


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**LEGEND**

- London Borough Camden Boundary
- Critical Drainage Area
- Local Flood Risk Zone

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Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Critical Drainage Areas / Local Flood Risk Zones

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| FIGURE 6 | Rev 2 |

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