Flood Risk Assessment and Surface Water Drainage Strategy for Planning

Prepared for:
Christopher Stuart Taylor

Location:
23 Ravenshaw Street
London
NW6 1NP

December 2020

Our reference:
89947-Taylor-RavenshawSt

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Document Issue Record

Location:	23 Ravenshaw Street, London, NW6 1NP				
Application:	Erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house at 23 Ravenshaw Street, London, NW6 1NP				
Prepared for:	Christopher Stuart Taylor				
Title:	Flood Risk Assessment and Surface Water Drainage Strategy for Planning				
Project No.:	89947	**Date:**	9th December 2020	**Issue No.:**	1
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1. Introduction

1.1. This Flood Risk Assessment and Surface Water Drainage Strategy has been prepared by Unda Consulting Limited on behalf of Christopher Stuart Taylor, in support of a planning application for erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house at the site of 23 Ravenshaw Street, London, NW6 1NP. This report assesses the flood risk assessment and surface water drainage strategy for the proposed development.

1.2. The proposed planning application is for erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house at 23 Ravenshaw Street, London, NW6 1NP. Overall, post development, the newly introduced built footprint will cover approximately 380m².

1.3. In order to mitigate flood risk posed by post development runoff, adequate control measures will be required within the site. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.

Figure 1: Site location (Source: Google Earth)

2. Existing Site:

2.1. The proposed development site is currently an existing two storey Victorian end of terrace house with accompanying hard standing car park. The overall plot is approximately 484m². The existing site comprises:

The site comprises:

23A: 2 Bed Ground 69.7 m²
23B: 3 Bed Maisonette 94.7 m²
86.3 m² House Footprint
98.3 m² Permeable Garden Area
34.4 m² Semi Permeable Garden Paving
265.1 m² Concrete Hard Standing and Steps to 23B.

Total Site Area: 484.1 m²

The existing site is predominantly brownfield.

2.2. A topographical site survey has been undertaken by Icelabz in October 2020.

2.3. The topographical survey indicates that levels on site range between 57.91mAOD at the front of the property and 58.70mAOD at the south of the site.

Existing Ground Conditions:

2.4. No site investigation has been undertaken at this stage.

2.5. The bedrock geology taken from BGS records is London Clay Formation – Clay, Silt and Sand. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Ypresian Age.

2.6. No superficial geological deposits are recorded.

2.7. The soil type taken from the UK soils website shows relatively deep prequaternary marine/estuarine sand and silt, with a clayey loam to silty loam soil texture.

2.8. The published Environment Agency Groundwater Vulnerability map shows the site to be located outside of an area classified as a Groundwater Source Protection Zone.

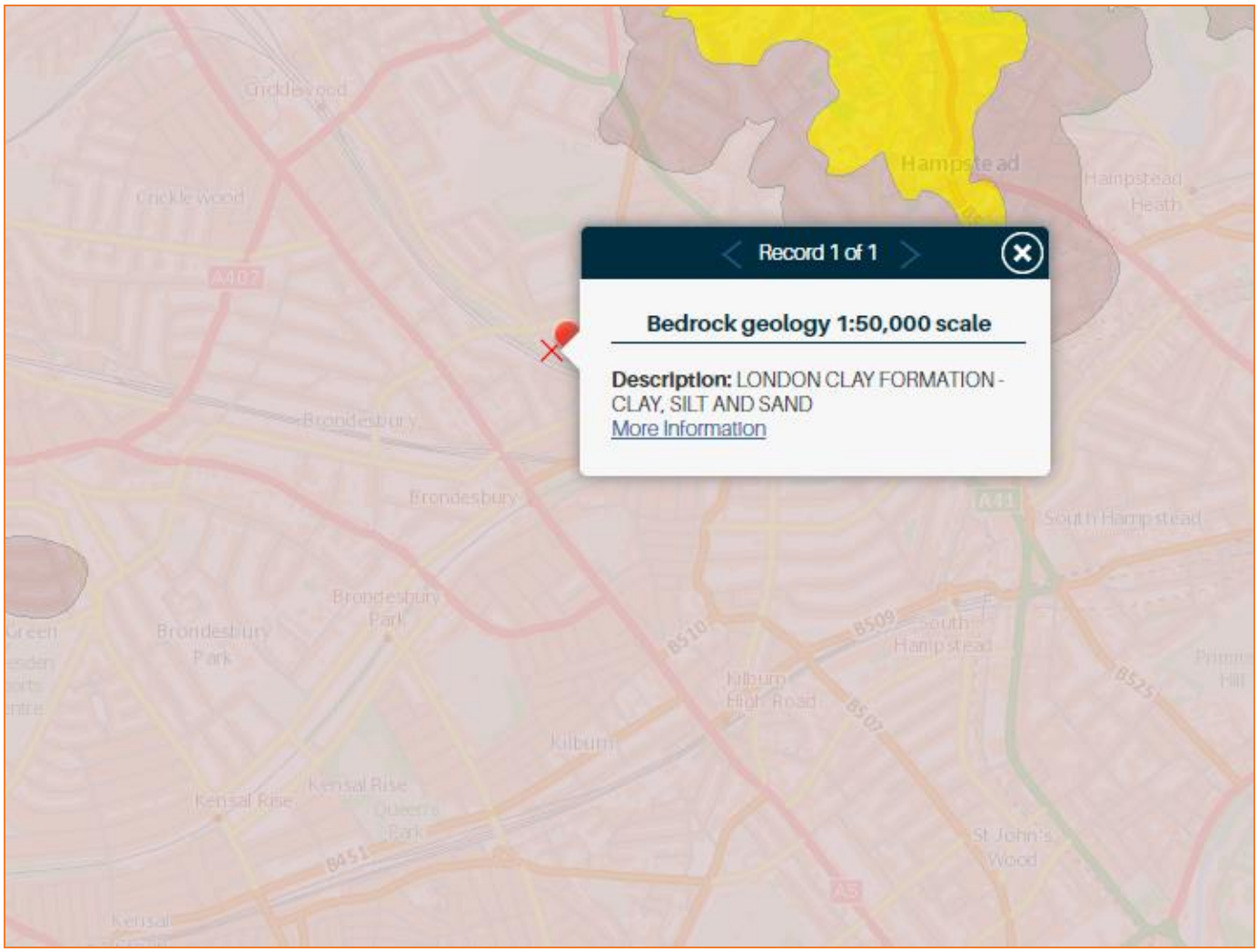

Figure 2: BGS Bedrock Geology (Source: BGS)

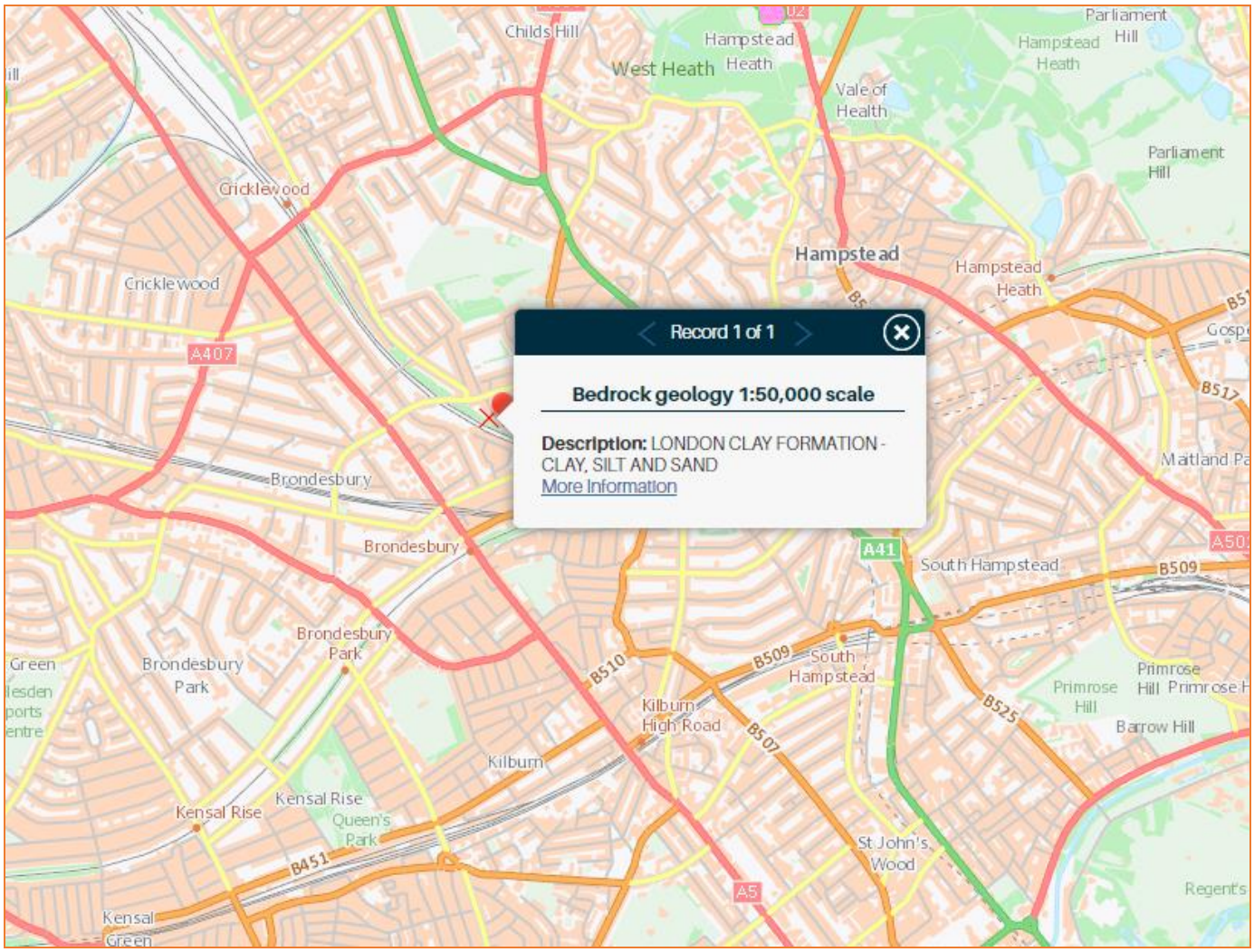

Figure 3: BGS Superficial Deposits (Source: BGS)

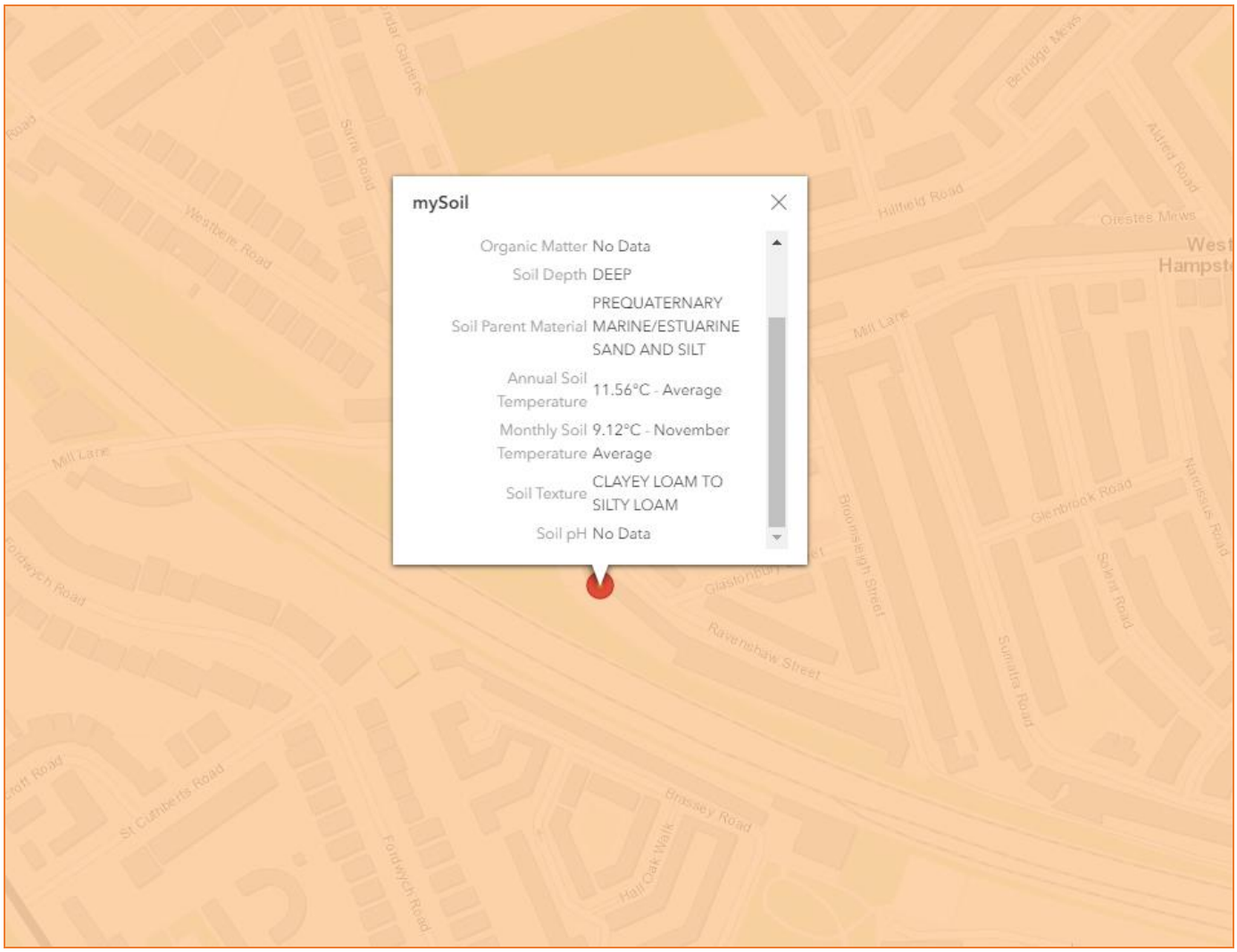

Figure 4: Soil Map (Source: UK Soils, BGS)

Nearby Watercourses / Drainage Features:

2.9. The closest Environment Agency 'Main River' to the site is the River Brent, which is approximately 3km to the north west of the site. There are no drains / ditches located on site.

Existing Drainage:

2.10. Asset records obtained from Thames Water Utilities Ltd (TWU) indicate the presence of a 305mm combined water sewer flowing from north to south beneath Ravenshaw Street.

2.11. A site drain survey shows the existing manholes and inspection chambers on site, and shows that surface water generated within the existing site currently discharges to the existing public combined sewer beneath Ravenshaw Street.

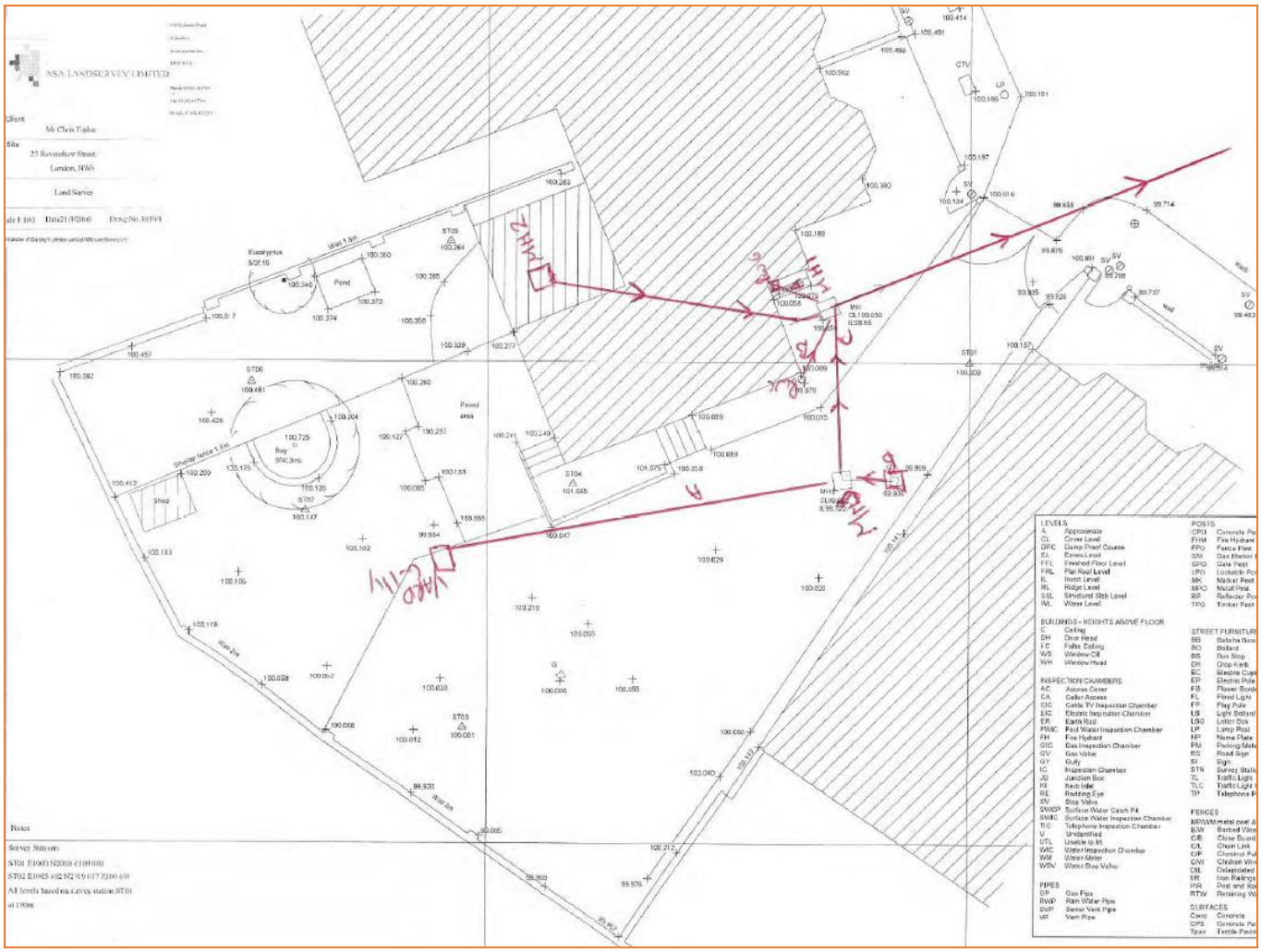

Figure 5: Existing Site Drain Survey (Source: Surveyed by Ricky Smith)

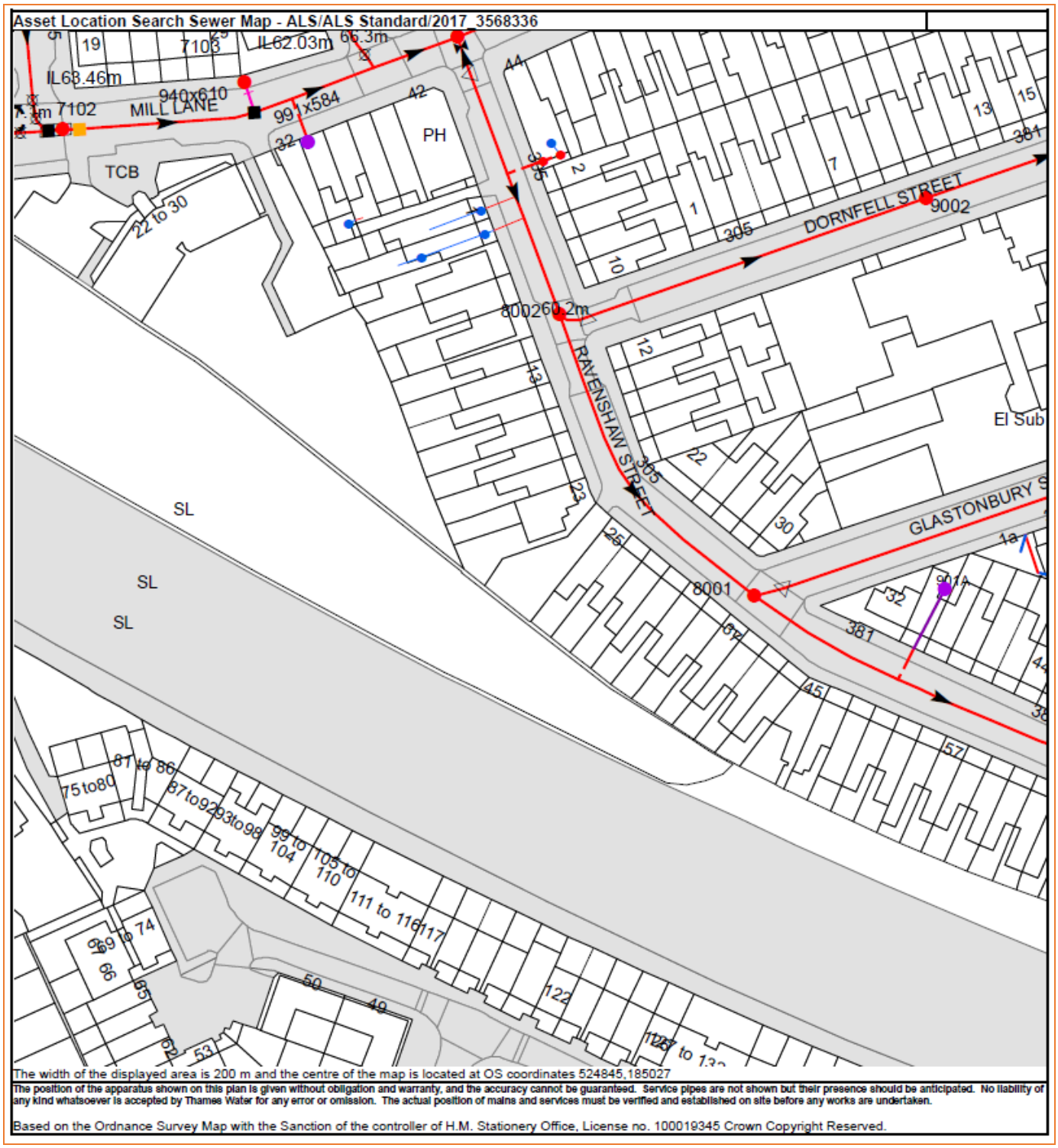

Figure 6: Existing Public Sewers (Source: Thames Water Asset Records)

3. Development Proposals:

Proposed Development:

3.1. The proposed planning application is for erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house at the site of 23 Ravenshaw Street, London, NW6 1NP.

3.2. Overall, post development, the built footprint will cover approximately 380m^2.

3.3. Attenuation sizing within the strategy has been based upon Policy CPG3 and will reduce runoff rates from the entire site to greenfield runoff rates.

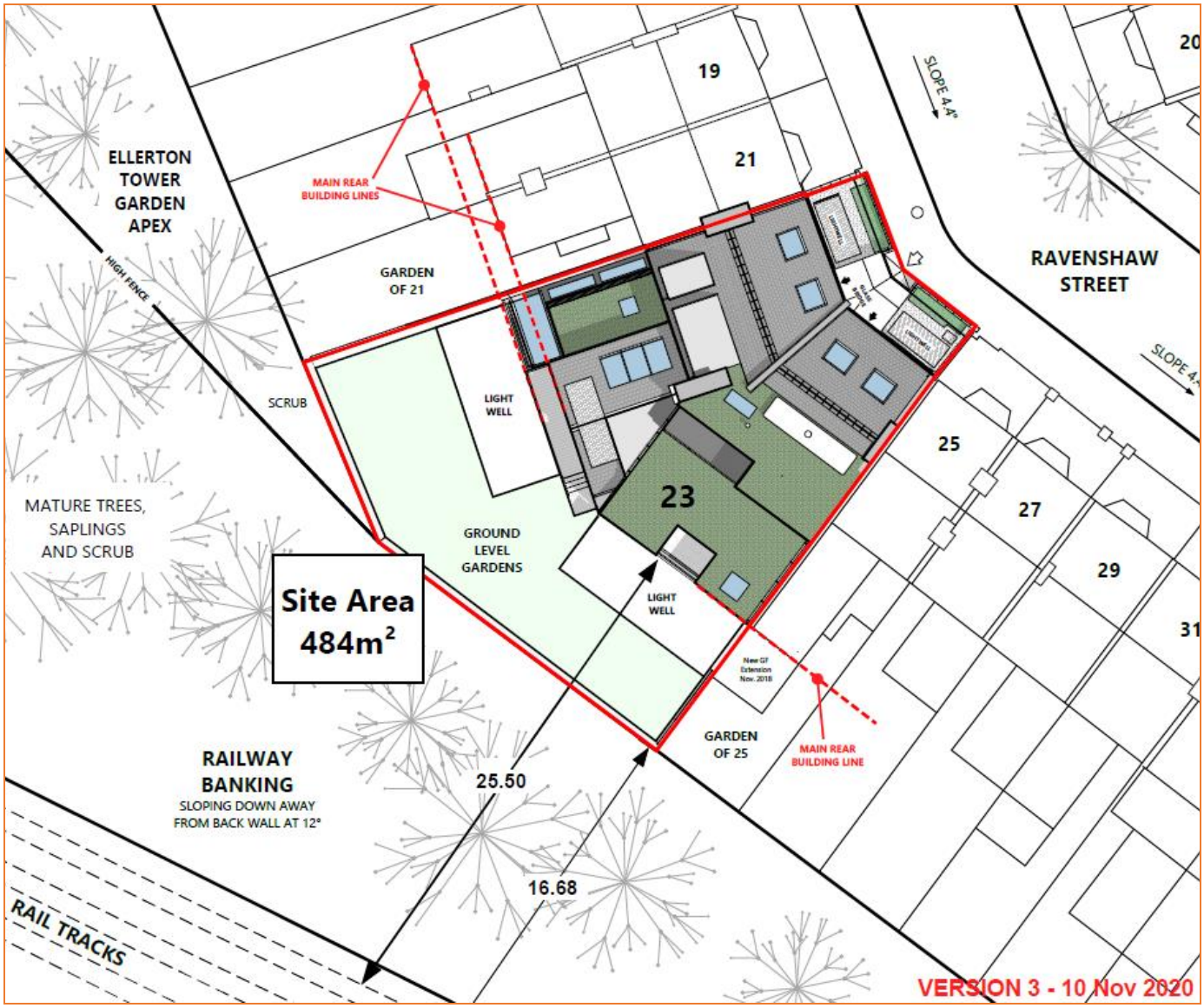

Figure 7: Proposed Site Plan (Source: Chris Taylor)

Vulnerability to flooding:

3.4. The NPPF classifies property usage by vulnerability to flooding. The existing site is currently classified as "more vulnerable" under the NPPF and will remain "more vulnerable" post development, but will introduce additional residential dwellings. Based on the plans provided, two new self-contained basement flats will be provided post development, which will be classified as "highly vulnerable".

3.5. Accordingly, it is considered that the vulnerability of the site as a whole will increase post development.

4. Flood Risk Assessment:

Flood Zones:

4.1. Within planning, Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's Flood Map for Planning (Rivers and Sea), available on the Environment Agency's website.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 1: Environment Agency Flood Map for Planning (Rivers and Sea) (Source: EA)

4.2. The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Further investigation is therefore not required.

4.3. The entire site, and therefore the existing and proposed dwelling footprints are located within Flood Zone 1 (Low Probability) which means it is defined as land having a less than 1:1000 annual probability of fluvial flooding.

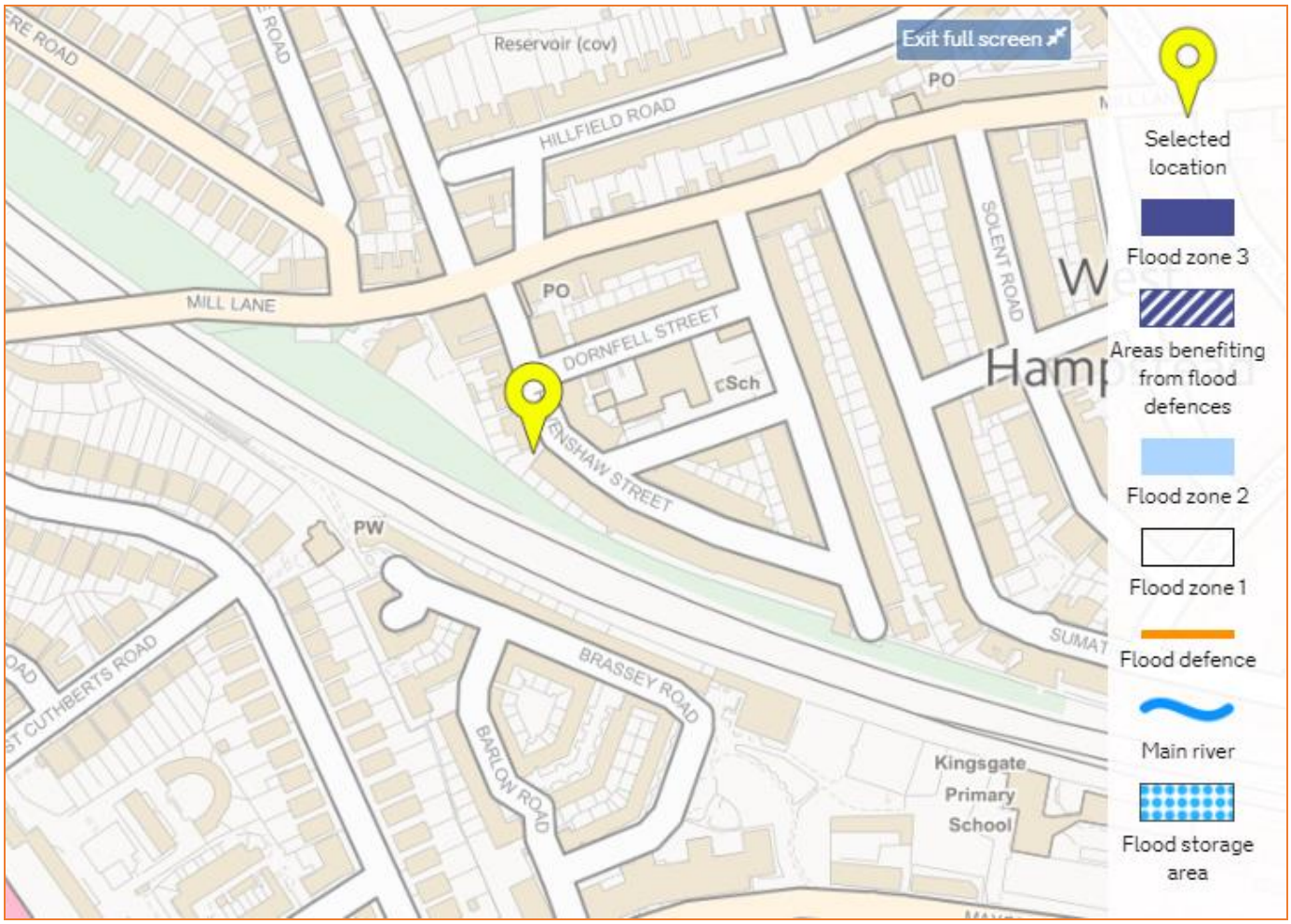

Figure 8: Environment Agency Flood Map for Planning (Rivers and Sea) (Source: EA)

Historical flood events:

4.4. The site is not located in an area that that has previously flooded according to the EA.

4.5. The Camden SFRA states that Historic flood records indicate that Camden, particularly to the north of Euston Road, is prone to surface water flooding. Two large surface water flooding events have occurred in LBC in 1975 and 2002 causing widespread damage, as described below:

- A large storm event occurred in north London on 14th August 1975, and has been identified as the most extreme rainfall event ever recorded in London, with approximately 170.8mm of precipitation recorded by the Hampstead Scientific Society in a 2 to 3 hour period.

- Numerous roads and houses in the area were severely flooded, with the local sewer network overloaded leading to surcharging. One member of the public lost their life as a result of flood waters and over 250 people were re-housed either temporarily or permanently. The following areas were identified as being affected by flooding during the August 1975 rainfall event:

  - Gospel Oak
  - West Hampstead
  - Kilburn
  - Primrose Hill

- Oak Village
- Hampstead Garden Suburb
- Hornsey
- Golders Green
- Willesden
- Cricklewood
- Kentish Town.

- In 1994 a Flood Relief Sewer was constructed by Thames Water; the North West Storm Relief Sewer. The sewer runs from the western end of Fawley Road in West Hampstead south-eastward roughly parallel to Fairhazel Road, before turning approximately south-west along Belsize Road and Oxford Road. The Storm Relief Sewer was designed to accommodate a 1 in 10 year storm event (10% AEP).

- Severe surface water flooding was also experienced in Camden on 7th August 2002. Figure 3 of the SFRA shows the location of roads affected by surface water flooding during this event. As with the 1975 flooding records, this mapping is relatively course and should be used to indicate roads where flooding was experienced and not to identify the exact extent of flood waters during the rainfall event. The Report of the Floods Scrutiny Panel for the 2002 floods found that Hampstead Heath experienced 60mm of rain in under an hour resulting in flooding primarily in West and South Hampstead and Kentish Town, with flooding on a number of other roads.

- As with the 1975 rainfall event, the sewer system capacity was exceeded resulting in surcharging of the sewer system in a number of locations. The flooding caused damage to housing, public services and private businesses. Following the flood event, Thames Water provided evidence confirming that the sewer system had reached maximum capacity reducing the ability of the sewer network to drain surface water. Evidence suggests that during extreme rainfall events, the Thames Water sewer network reaches capacity very quickly resulting in surcharging of sewers. Due to the magnitude of the rainfall event, the North West Storm Relief Sewer also reached capacity and therefore flooding was experienced along roads in proximity to the sewer.

- Thames Water, upon consultation, provided details of a flood alleviation scheme at Sumatra Road, West Hampstead, delivered after the 2002 flood event. A sewer was constructed at Sumatra Road, designed to intercept and divert flow towards a storage tank which provides approximately 1700m3 of storage during extreme rainfall events. Whilst the scheme will help to reduce the local flood risk, there is still potentially still a flood risk during an extreme rainfall event.

- An extract from the Camden SFRA Figure 3 shows that Ravenshaw Street was not recorded as being flooded during either the 1975 or 2002 flood events. No properties along Ravenshaw Street were reported as having been affected by historic surface water flooding records.

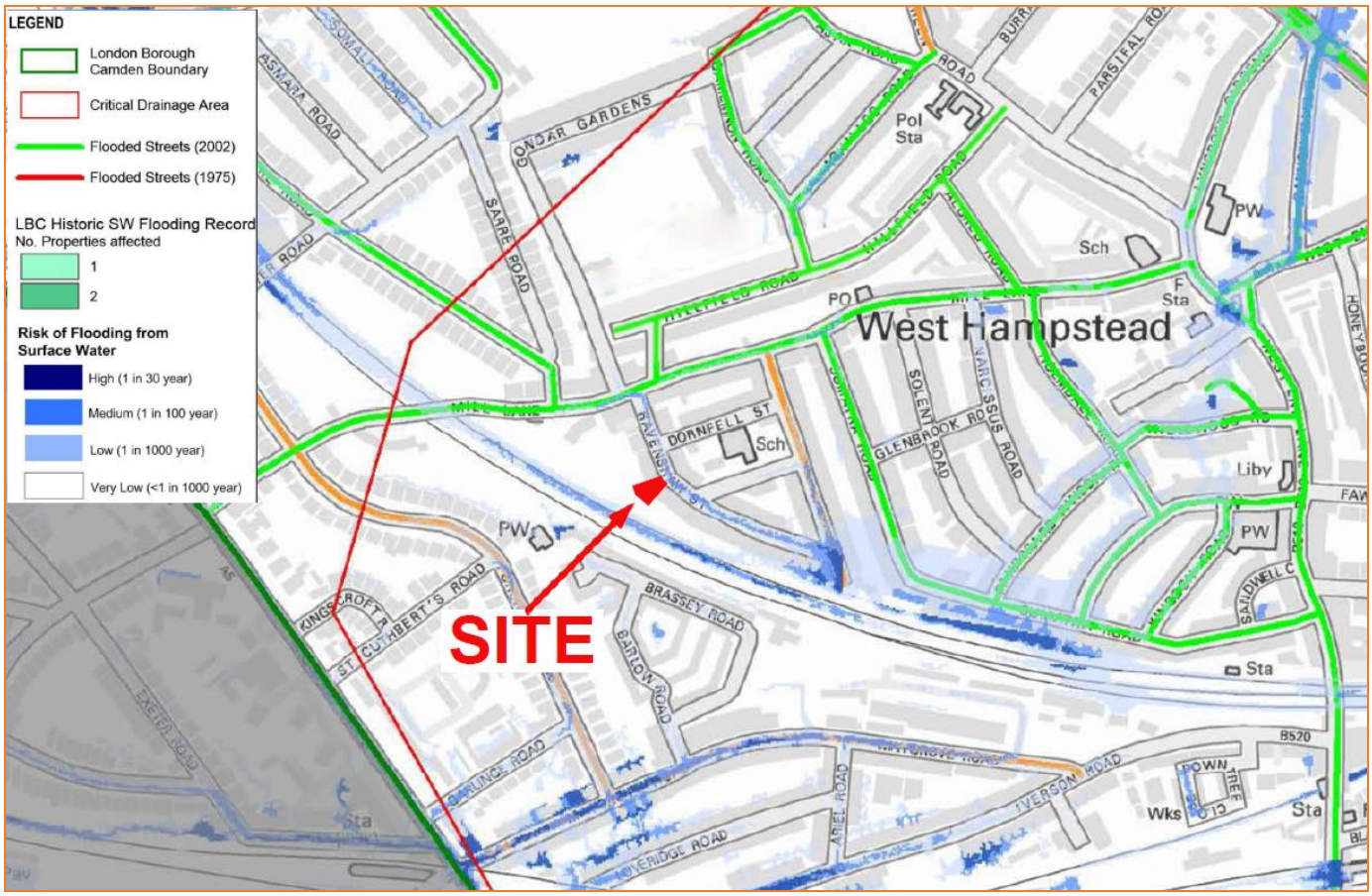

Figure 9: Extract from Camden SFRA Figure 3 (Source: Camden SFRA)

Pluvial:

4.6. Pluvial (surface water) flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but instead it lies on or flows over the ground instead.

4.7. In 2013 the EA, working with Lead Local Flood Authorities (LLFAs), produced an updated Flood Map for Surface Water. It is considered to represent a significant improvement on the previous surface water flood maps available, both in terms of method and representation of the risk of flooding. The modelling techniques and data used are considerably improved, and also incorporated locally produced mapping where this is available to represent features best modelled at a local scale.

4.8. The Flood Map for Surface Water assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year (annual probability of flooding is shown in brackets):

- 1 in 30 (3.3%)
- 1 in 100 (1%)
- 1 in 1000 (0.1%)

4.9. The mapping below shows the Risk of Flooding from Surface Water centred on the site. Please note that the EA to not consider this information suitable to be used to identify the risk to individual properties or sites. It is useful to raise awareness in areas which may be at risk and may require additional investigation.

4.10. The EA Risk of Flooding from Surface Water Map suggests that the site itself is shown to be at "Very low" risk of flooding from surface water, while Ravenshaw Street adjacent to the site is shown to be at "Low" and "Medium" risk of flooding from surface water.

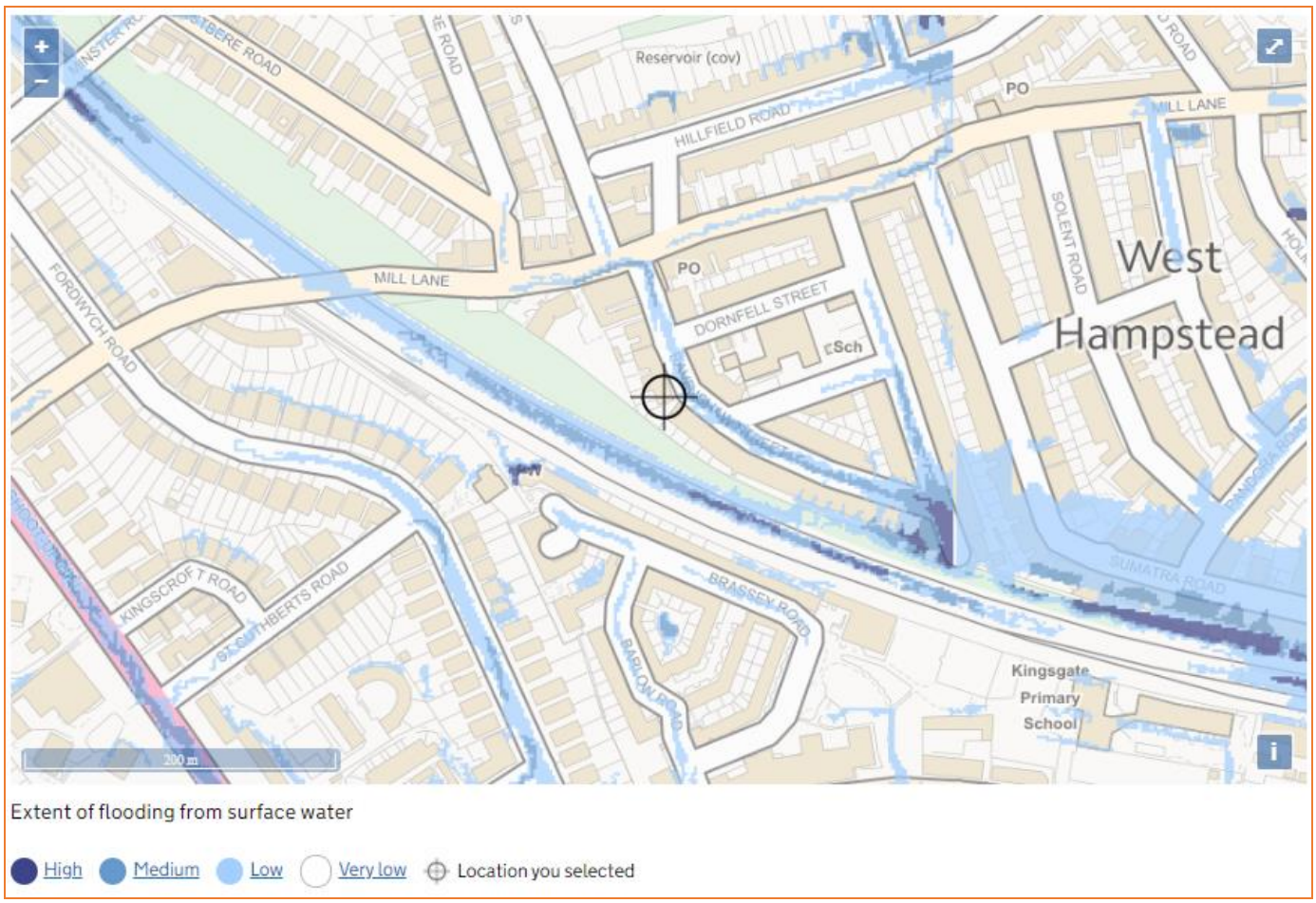

Figure 10: Extract from Environment Agency RoFSW map (Source: EA)

4.11. The EA Risk of Flooding from Surface Water modelled data also provides surface water depths for the High (1:30yr), Medium (1:100yr) and Low (1:1000yr) events.

4.12. The flood depth data shows the site to be entirely outside of the 'High', 'Medium' and 'Low' maximum flood extents. For the 'High' 1:30yr event, no flooding is shown along Ravenshaw Street. For the 'Medium' 1:100yr event, a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site, and for the 'High' 1:1000yr event a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site.

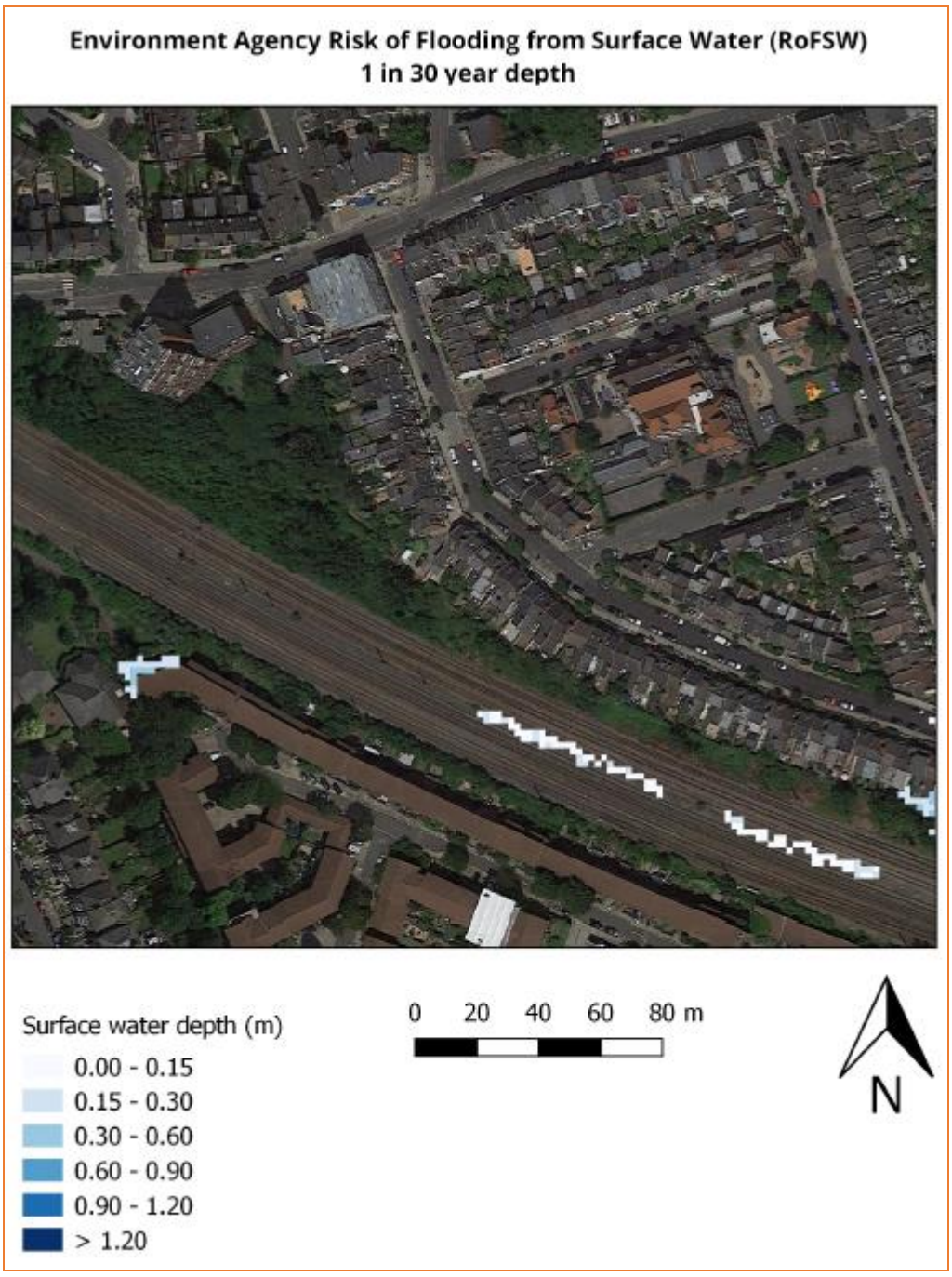

Figure 11: Extract from Environment Agency RoFSW High Risk (1:30yr) depth map (Source: EA)

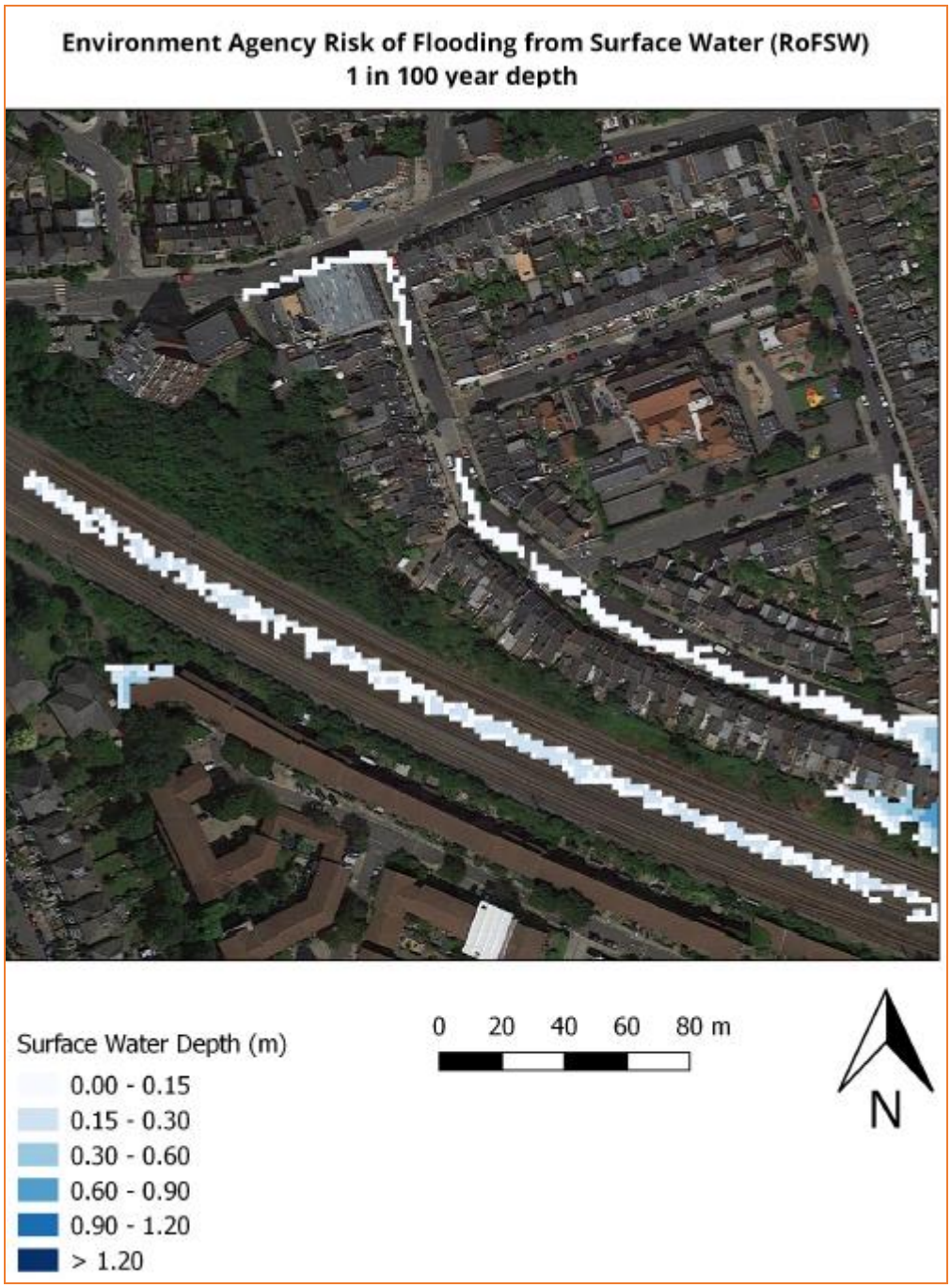

Figure 12: Extract from Environment Agency RoFSW Medium Risk (1:100yr) depth map (Source: EA)

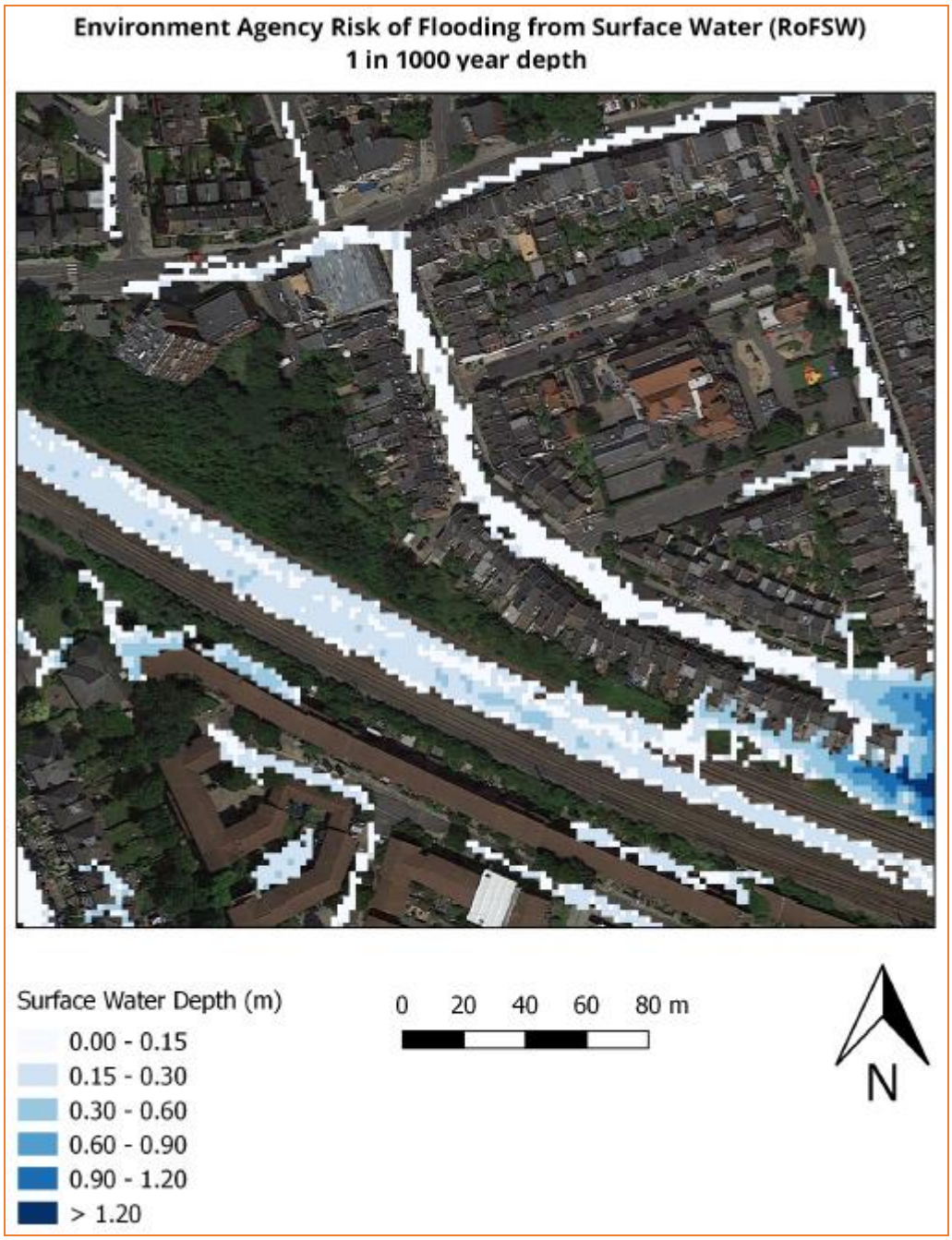

Figure 13: Extract from Environment Agency RoFSW Low Risk (1:1000yr) depth map (Source: EA)

4.13. The EA Risk of Flooding from Surface Water modelled data also provides flow direction data, which shows surface water runoff to flow down Ravenshaw Street from Mill Lane, and pond at the bottom of Black Path, near the junction of Ravenshaw Street and Broomsleigh Street. No surface water is shown to flow from Ravenshaw Street onto the site.

Figure 14: Extract from Environment Agency RoFSW Low Risk (1:1000yr) depth map, showing flow directions in red arrows (Source: EA)

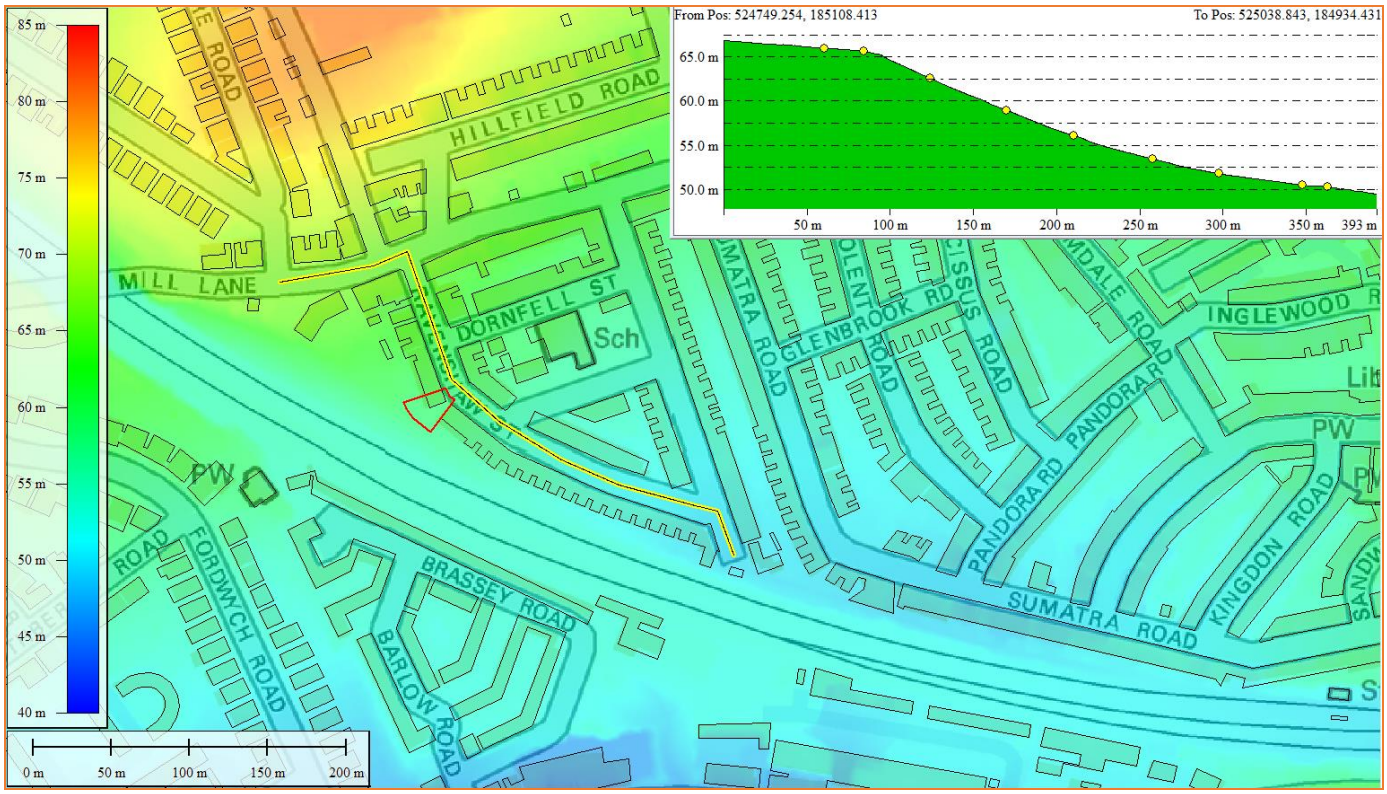

Figure 15: Extract from Environment Agency 1m LiDAR DTM, showing topographic levels along the surface water flowroute identified in the RoFSW (transect inset runs east along Mill Lane and then southeast along Ravenshaw Street). Site outlined in red (Source: EA LiDAR, OS Mapping)

4.14. It is understood that the existing site has an extant cross-over and lack of raised kerb – which creates a low point and allows surface waters to flow onto the pavement of Ravenshaw Street.

4.15. The Environment Agency Risk of Flooding from Surface Water data represents the road network by lowering road surfaces selected from OS MasterMap data by 0.125m (the height of a British Standard kerb) (Source: EA). As such with a maximum potential depth of flooding of 0.15m for the 1:100 year surface water flood event – this equates to 0.025m (0.25cm) flooding above the actual topographic road level.

4.16. A new (reinstated) 100mm kerb will be installed to replace the extant crossover as part of the development.

4.17. The Camden SFRA states that the Camden Surface Water Management Plan has identified a number of Critical Drainage Areas (CDA), defined as:

- "A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure."

4.18. The site is shown to be located within a CDA (Group3-010), which the Camden SFRA states indicates that it is within a catchment area which contributes to a flooding hotspot. Within CDAs, surface water management should be a particular focus of new developments.

4.19. The SWMP also identifies a number of Local Flood Risk Zones (LFRZ), which are defined in the SWMP as:

- "discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location."

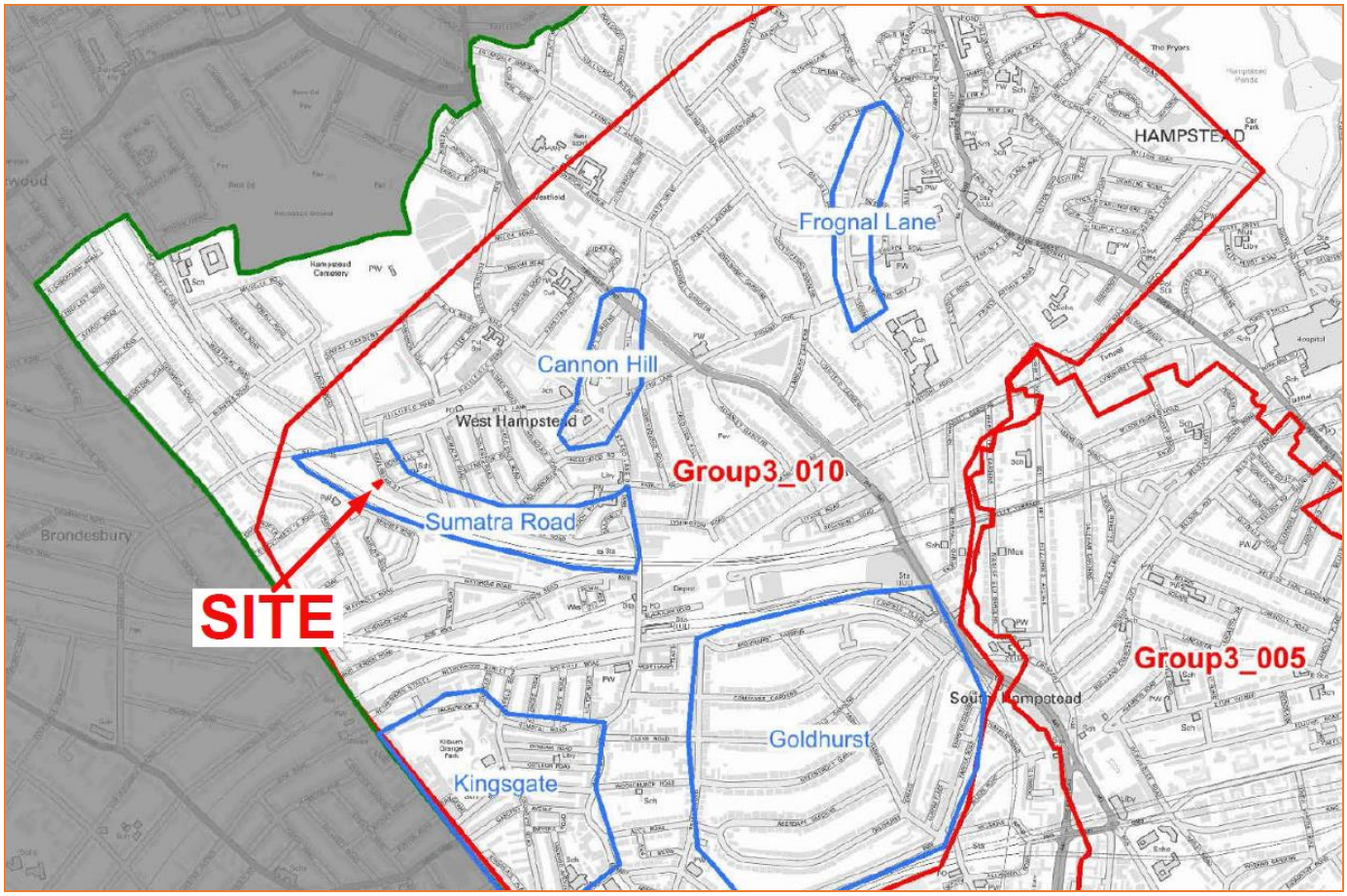

Figure 16: Extract from Camden SFRA Figure 6 (Source: Camden SFRA)

4.20. The site is shown to be within the Sumatra Road Local Flood Risk Zone.

Groundwater:

4.21. Groundwater flooding occurs as a result of water rising up from the underlying rocks or from water flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas, the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise to the surface causing groundwater flooding

4.22. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding takes longer to dissipate because groundwater moves much more slowly than surface water and will take time to flow away underground.

4.23. The London Borough of Camden SFRA indicates that no records have been provided to suggest that the site has flooded from groundwater previously. The site is not located within an area of increased susceptibility to elevated groundwater.

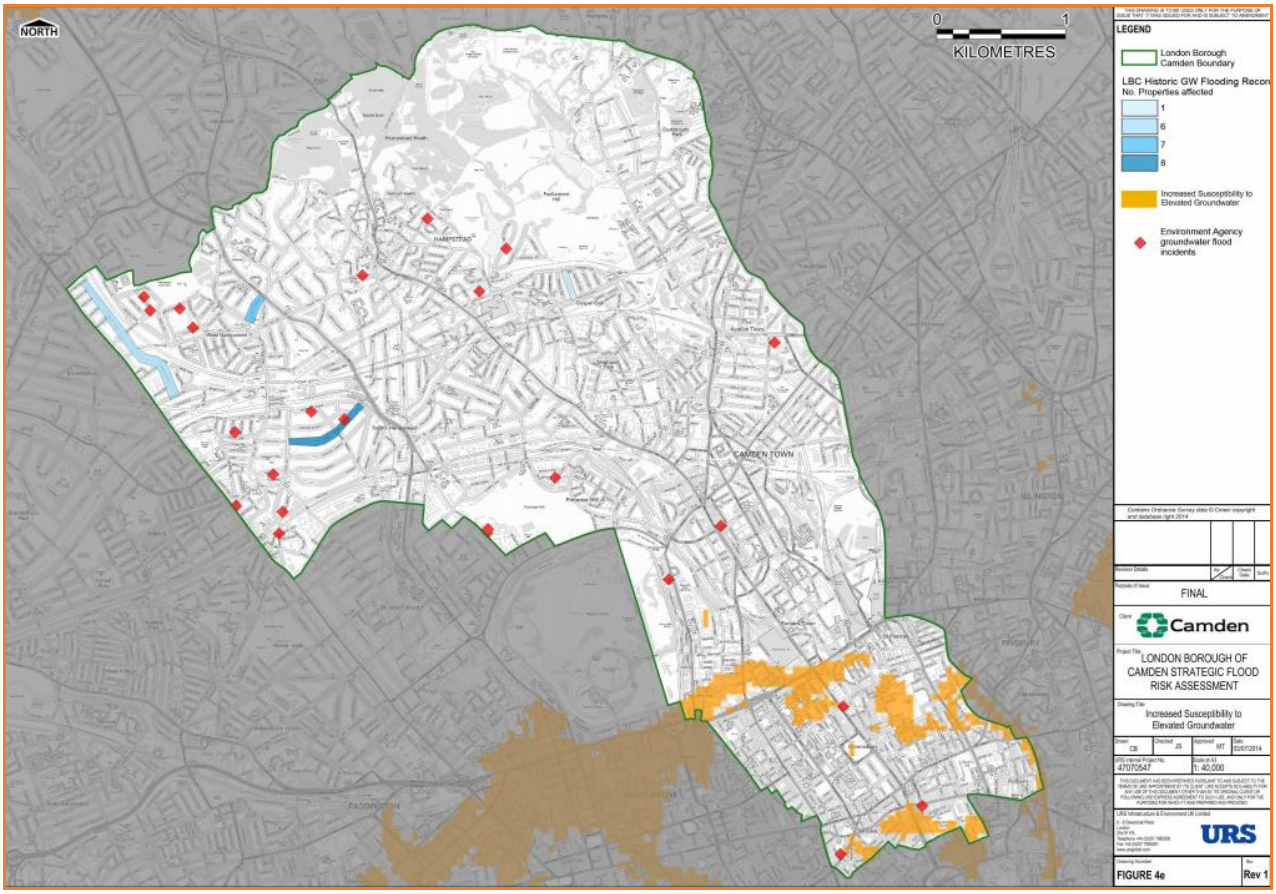

Figure 17: Increased Susceptibility to Elevated Groundwater (Source: Camden SFRA)

4.24. No further information has been provided to suggest that the site has flooded from groundwater flooding previously.

4.25. It is understood that a Basement Impact Assessment (Hydrogeology, Hydrology and Land Stability) has been undertaken by Maund Geo-Consulting.

Sewer:

4.26. Sewer flooding occurs when the sewer network cannot cope with the volume of water that is entering it. It is often experienced during times of heavy rainfall when large amounts of surface water overwhelm the sewer network causing flooding. Temporary problems such as blockages, siltation, collapses and equipment or operational failures can also result in sewer flooding.

4.27. All Water Companies have a statutory obligation to maintain a register of properties/areas which have reported records of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by the Water Company. The DG5 register records of flood incidents resulting in both internal property flooding and external flooding incidents. Once a property is identified on the DG5 register, water companies can typically put funding in place to address the issues and hence enable the property to be removed from the register. It should be noted that flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register.

4.28. The London Borough of Camden SFRA indicates that the sites postcode of NW6 1 lies within an area where no properties have been affected by exterior sewer flooding and 1 property has been affected by internal sewer flooding.

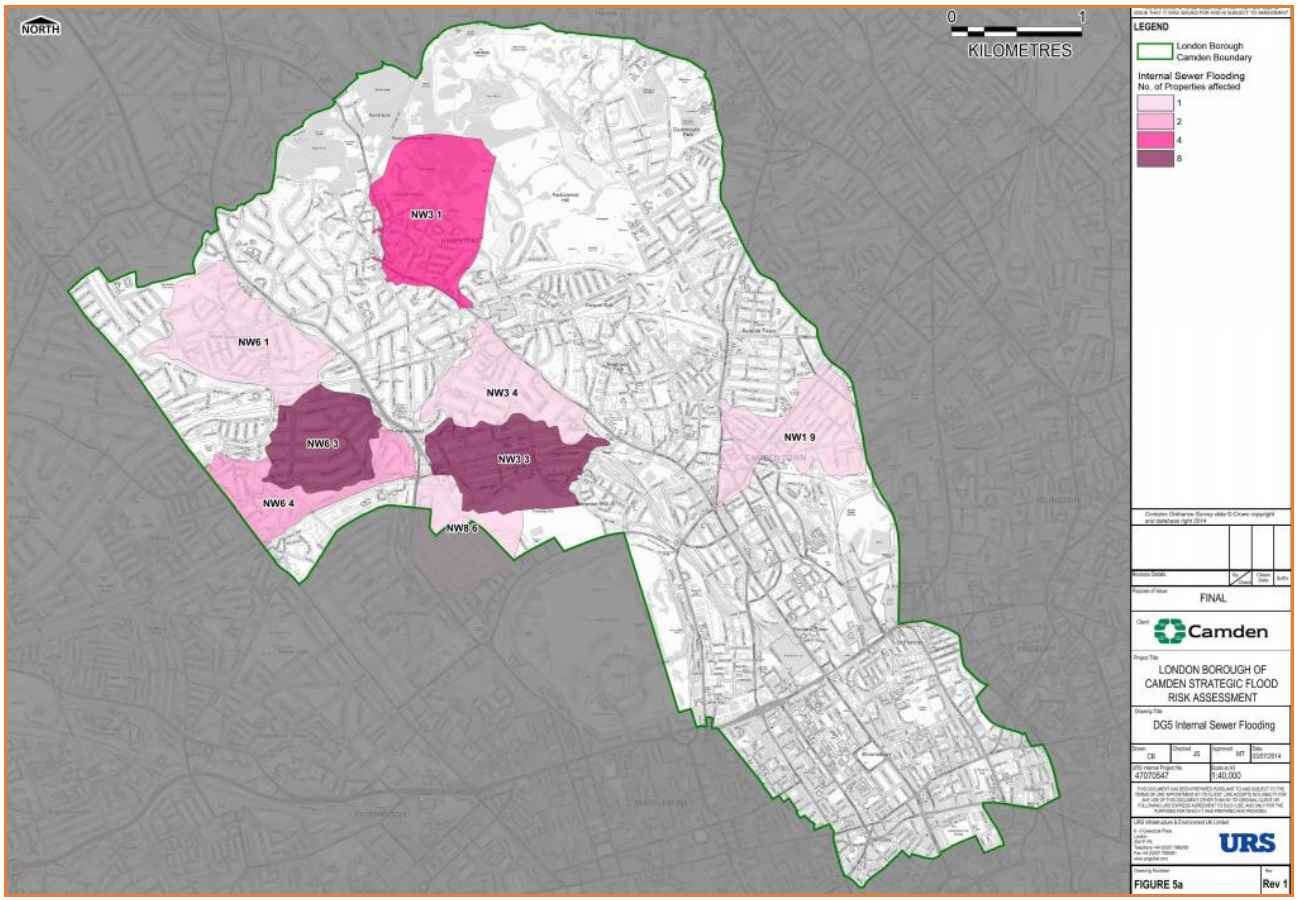

Figure 18: BG5 Internal Sewer Flooding (Source: London Borough of Camden SFRA)

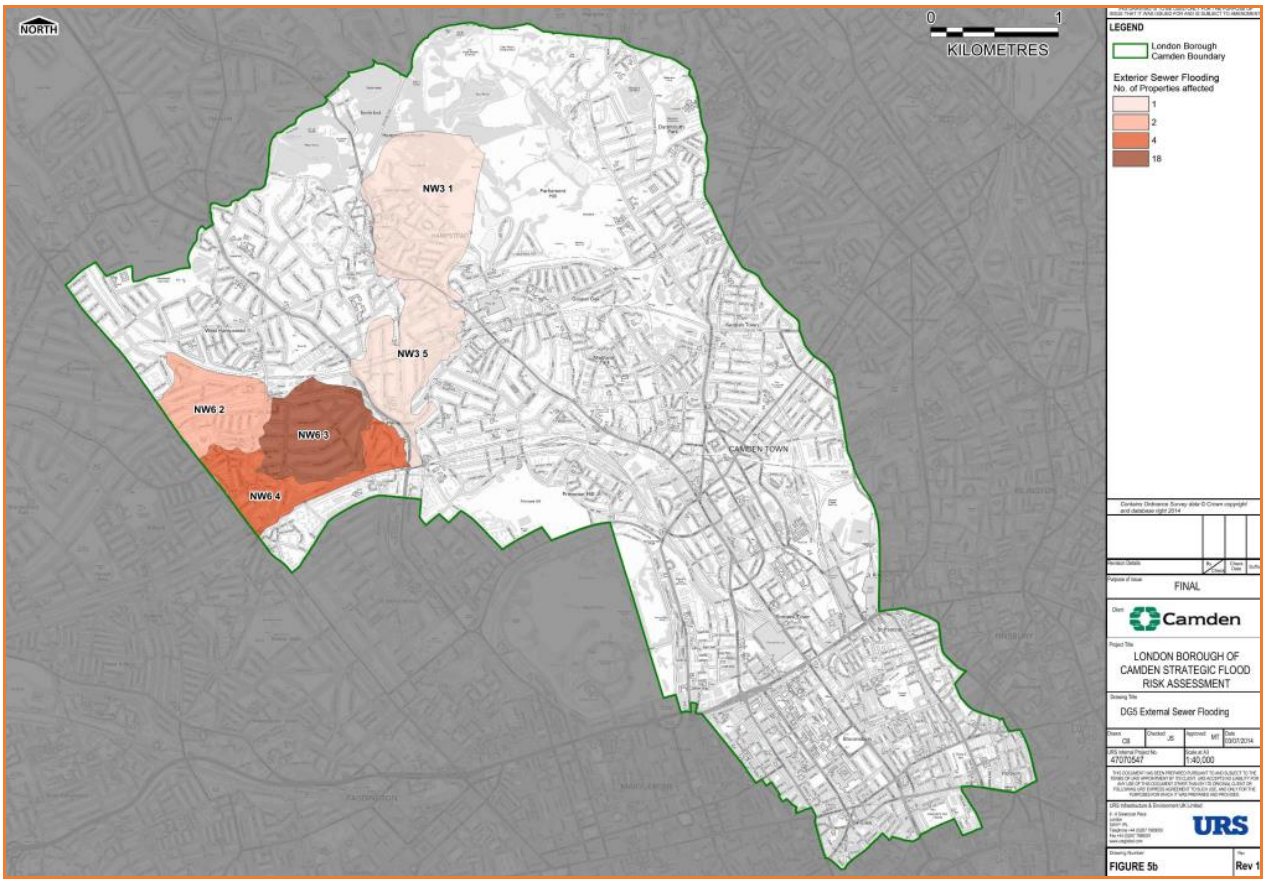

Figure 19: BG5 External Sewer Flooding (Source: London Borough of Camden SFRA)

4.29. Thames Water has confirmed that the flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

4.30. No information has been provided to suggest that the site has flooded from sewer surcharge flooding previously.

Other Sources:

4.31. The EA Risk of Flooding from Reservoirs Map suggests that the site lies outside of the "Maximum extent of flooding" from reservoir failure, therefore, the EA advise on their website that reservoir flooding is extremely unlikely. The risk to the site from reservoir flooding is therefore minimal and is far lower than that relating to the potential for fluvial flooding to occur.

4.32. No further information has been provided to suggest the site is susceptible to from the failure of reservoirs, canals or other artificial infrastructure from the risk of flooding.

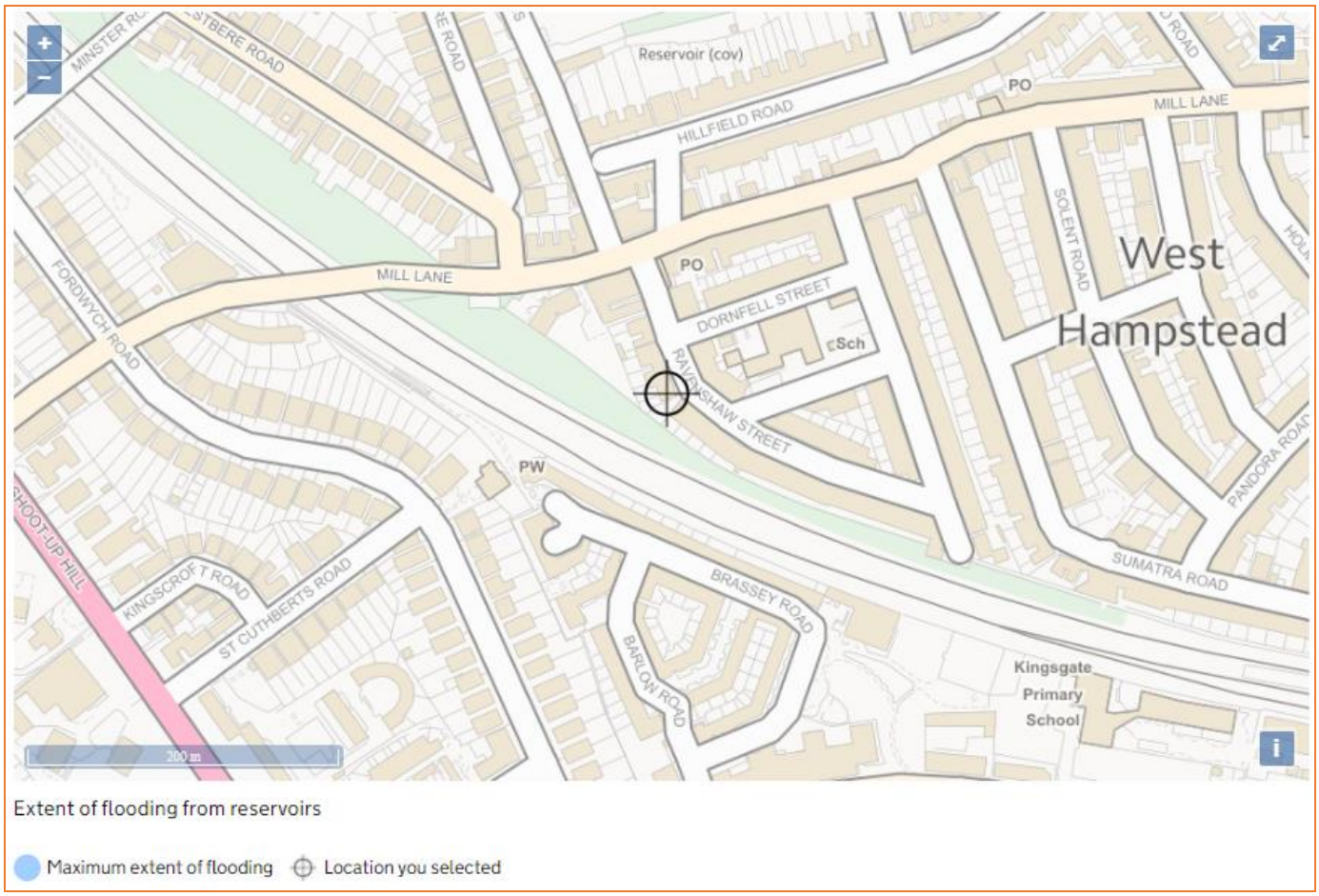

Figure 20: Extract from Environment Agency Reservoir Flooding map (Source: EA)

5. Surface Water Drainage Strategy:

5.1. In order to mitigate flood risk posed by post development runoff, adequate control measures will need to be considered within the site. This will ensure that surface water runoff is dealt with at source and flood risk is not increased elsewhere.

Drainage Hierarchy:

5.2. The drainage strategy for the site has been prepared according to the drainage discharge hierarchy from CIRIA C753 The Suds Manual, as follows:

- Infiltration to the maximum extent that is practical;
- Discharge to surface waters;
- Discharge to surface water sewer.

Infiltration Potential:

5.3. The bedrock geology taken from BGS records is London Clay Formation – Clay, Silt and Sand. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Ypresian Age. No superficial geological deposits are recorded. In addition, the soil type taken from the UK soils website shows relatively deep prequaternary marine/estuarine sand and silt, with a clayey loam to silty loam soil texture.

5.4. Due to the likely low infiltration rate, infiltration is considered inappropriate and an attenuation based drainage strategy has been proposed for the site, connecting to the existing drainage discharge arrangement. In addition, soakaways and other infiltration devices wouldn't be suitable at the site as a means of storm/surface water disposal) as they must not be constructed near/within 20 metres of Network Rail's boundary or at any point which could adversely affect the stability of Network Rail's property.

Existing Discharge rates

5.5. The total area of the site is some 480m². Existing greenfield runoff rates for the site have been calculated as 0.2l/s for the 1:1 annual runoff event, 0.4l/s for the 1:30 year event and 0.6l/s for the 1:100 year event.

Attenuation SuDS – Tank:

5.6. Roof runoff from the front roof, yard and entrance will flow to a tank at the rear of the house (~74m^2). The remaining roof areas (~132m^2 of rear pitched flat and dormer roofs and ~80m^2 of green roofs) will also flow into the tank in the rear garden. The runoff from the front grilles, basement patios and steps to the rear of the house

(~85m^2) will be pumped to the tank at the rear of the house. This produces an approximate total of 371m^2 runoff area to flow into the tank.

5.7. In Order to comply with CIRIA C753 The SuDS Manual, a 10% allowance will be added to the impermeable areas to take into account future urban creep. Applying a 10% allowance to the new front impermeable surfaces (371m^2) gives a value of 408m^2. Therefore, all drainage calculations within this assessment have been made based on a total impermeable area of 408m^2.

5.8. MicroDrainage software has been used to estimate the tank size requirement to provide adequate surface water run-off management (see Appendix).

5.9. Preliminary calculations indicate that sufficient storage required to attenuate runoff from the proposed impermeable areas (408m^2) arising from the critical 1:100 year + 40% climate change event can be provided within an attenuation storage tank of dimensions 12.6m^2 x 1.8m deep.

5.10. Preliminary calculations indicate that approximately 22.68m^3 of storage is required to attenuate the runoff for all storms up to and including the 1:100 year + 40% climate change event. A Hydro-Brake would be proposed as the outlet control, restricting the maximum flow rate to 0.6l/s. This system will be connected into the Combined sewer within Ravenshaw street utilising the existing connection that the current site uses.

5.11. All preliminary surface water drainage calculations have been undertaken using MicroDrainage software. Refer to the appendix.

5.12. This system will manage the entire proposed additional roof area, providing significant betterment over the existing run off situation.

Water Re-Use (Optional Addition):

5.13. Based on the plans provided runoff from the new residential dwellings will be collected, filtered and stored in the attenuation storage tank buried under a soft landscaped area in the garden. From the tank, water will be pumped to a header tank, and piped to toilets (and optionally to an outlet where it can be drawn off for irrigation use). The toilets and outlet would have a back-up connection to a mains water supply, to provide water when the attenuation tank (and therefore header tanks) are empty.

5.14. If the tank contains more water than required for toilet and garden usage, the additional water will be discharged from the attenuation storage tank, at a controlled rate, detailed within strategy.

Water Quality:

5.15. Water quality has been assessed in line with the Simple Index approach from Chapter 26 of CIRIA C753 The SuDS Manual:

Step 1 – Allocate suitable pollution hazard indices for the proposed land use.

Step 2 – Select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index.

5.16. The highest pollution hazard level for the proposed land use is Very Low (residential roofs). The pollution hazard indices for this land use are shown in Table 2 below.

Total suspended solids (TSS)	Metals	Hydrocarbons
0.2	0.2	0.05

Table 2: Pollution Hazard Indices for the proposed site (from Table 26.2 of CIRIA C753 The SuDS Manual)

5.17. Runoff from roof areas is considered to be uncontaminated and does not warrant any form of treatment process to improve water quality prior to discharge to the public sewer.

Design Exceedance:

5.18. Should the onsite drainage system fail under extreme rainfall events or blockage, flooding may occur within the site. In the event of the drainage system failure, the runoff flow can be managed through detailing the new external levels to direct water away from structures.

Adoption and Maintenance:

5.19. It is proposed that all SuDS facilities will be maintained privately by the end user.

5.20. A draft Maintenance Schedule is outlined in the Table below.

Tank:

5.21. It is not envisaged that silt build up within the attenuation tank systems will require a rigorous maintenance regime so long as silt is removed from upstream catch pits and inspection chambers on a regular basis. Notwithstanding this, a suitable maintenance regime for the systems will comprise of routine inspection and silt removal (as necessary). Inspection should be undertaken using CCTV equipment. Camera access can be gained via inspection chambers.

5.22. Silt removal can be achieved by jetting. Jetting should be undertaken in accordance with current jetting guidelines, in particular the Code of Practice for Sewer Jetting published by The Water Research Centre. Jetting at 150bar at 300l/min should be more than adequate in removing any build-up of material within the tank.

5.23. A standard jet head with rear facing nozzles should be used. The head should be fed to the far end of the inspection chamber, activated and retracted. As the nozzle is removed, debris will be swept back into the inspection chamber where it can then be removed with the use of a standard gully sucker. This method will ensure the effective removal of gross solids (carrier bags, cans, leaf litter etc.) from the system. Whilst 100%

removal cannot be guaranteed, it has been shown that this jetting method will also remove an element of finer material which would otherwise be 'lost' within the system.

Pipework and Catchpits:

5.24. It is not envisaged that silt build up within the pipework systems will require a rigorous maintenance regime so long as silt is removed from upstream catch pits on a regular basis. Notwithstanding this, a suitable maintenance regime for the systems will comprise of routine inspection (every three months) and silt removal (as necessary).

Pumps and Hydro-Brake:

5.25. The proposed pumps and Hydro-Brake should be maintained in strict accordance with the manufacturer's instructions.

Drainage Element	Maintenance Requirement	Frequency
Gutters & Downpipes	Inspect and remove silt/ debris	To be inspected every three months and silt/ debris removed as necessary.
Catchpits and Inspection Chambers	Inspect and remove silt	To be inspected every three months and silt/ debris removed as necessary. Flow control to be checked for blockages.
Tank	Inspect and remove debris	CCTCV inspection following first storm event. Monthly CCTV inspections for first 3 months. 6 monthly CCTV inspections thereafter. Jetting to remove silt as necessary.
Flow Controls	Inspected for blockage and blockage / debris build up removed	Every six months

Table 3: Suggested Maintenance Regime for Elements of the Drainage Infrastructure

Note: In addition to the above maintenance requirements, it is recommended that all drainage elements are inspected:

- Following the first storm event
- Monthly for the first 3 months following commissioning

6. Flood Risk Mitigation:

Physical Design Measures:

5.26. The NPPF requires residential finished floor levels to be 300mm above the modelled 1:100 year fluvial / 1:200 year tidal flood level with allowance for Climate Change.

5.27. However, the proposed development area lies within Flood Zone 1 according to the EA Flood Map for planning (Rivers and the Sea).

5.28. The Camden SFRA states that where 'More Vulnerable' development is proposed within an area at potential flood risk, suitable mitigation measures should be utilised in order to mitigate risks to property and people. The development is classified as both 'Highly Vulnerable' – self-contained basement dwellings, and 'More Vulnerable' – residential dwellings.

5.29. Ravenshaw Street is shown to be partially at 'Medium' risk of flooding from surface water.

5.30. It should be noted that Ravenshaw Street is shown to be entirely outside of a 'High' surface water risk area.

5.31. Ravenshaw Street was not shown to be affected by surface water flooding in the 1975 or 2002 surface water flood events in Camden.

5.32. The Camden SFRA states that sleeping accommodation should not be located below external street level in areas of 'High' surface water flood risk. It should be noted that the site and Ravenshaw Street is entirely outside of areas of 'High' risk of surface water flooding.

5.33. The Environment Agency Risk of Flooding from surface water modelling data shows a maximum depth of surface water flooding of 0.15m (for both the 1:100 – Medium, and 1:1000 – High scenarios).

5.34. Based on the plans provided, the existing extant crossover will be replaced with a new (reinstated) 100mm kerb. The Entrance floor level (and therefore all entrance points to the basement flats) will be raised to 58.655mAOD – which is 0.245m above road level. Given that the road crest level is lowered by 0.125mm as part of the EA Risk of Flooding from surface water modelling (Source: EA), with a maximum potential depth of flooding of 0.15m for the 1:100 year surface water flood event – this equates to 0.025m (0.25cm) flooding above the actual topographic road level. The Entrance floor level is therefore 0.22m above the maximum predicted depth of surface water flooding for both the 1:100 year and 1:1000 year events.

5.35. In addition, to mitigate the effects of potential surface water flooding the applicant will install permanent and temporary flood proofing measures.

5.36. Toughened glass barriers (watertight balustrade) around the front lightwells and front doors and basement flat doors specified as PAS 1188:2014 Rated Flood Protection Doors. Sealed to 600mmand use water pressure to seal the door so it tightens the seal as the water rises.

5.37. The ground floor is split level: only the entrance hall and Bin/Bike room are actually at street level. The GF flats themselves are 770mm above the level of the pavement anyway.

5.38. The above measures therefore ensure that there are no active flowpaths to the basement or ground floor for the potential surface water flooding from Ravenshaw Street.

5.39. To help protect against flooding during extreme events, the applicant has agreed to implement flood resistant design measures into the new properties, in consultation with the Local Authority building control department. These measures can include the following:

- Solid concrete basement and ground floor slab, with waterproof membrane;
- Waterproof screed used on basement and ground floors;
- Closed-cell foam used in wall cavities;
- Waterproof basement and ground floor internal render;
- External walls rendered resistant to flooding to at least 300mm above ground floor level;
- Exterior ventilation outlets, utility points and air bricks fitted with removable waterproof covers;
- Basement floor electrical main ring run from ground floor level; and on separately switched circuit from ground floor;
- Electrical incomer and meter situated at least 300mm above ground floor level;
- Boilers, control and water storage / immersion installed at least 300mm above ground floor level;
- Gas meter installed at least 300mm above ground floor level;
- Plumbing insulation of closed-cell design;
- Non-return valves fitted to all drain and sewer outlets;
- Manhole covers secured;
- Anti-syphon fitted to all toilets;
- Kitchen units of solid, water resistant material at basement and ground floor level;
- Use of MDF carpentry (i.e. skirting, architrave, built-in storage) avoided at basement ground floor level;
- Stairs of solid hardwood construction with wood faces treated to resist water penetration at basement and ground floor level.

5.40. The applicant should also consider the use of demountable flood defence barriers to defend ground level doorways and low windows.

Safe Escape:

5.41. The NPPF requires a route of safe escape for all residents and uses to be provided from residential properties in Flood Zone 3. Safe escape is usually defined as being though slow-moving flood water no deeper than 25cm.

5.42. Safe escape can be provided to an area entirely within Flood Zone 1.

5.43. The site is shown to be entirely outside of areas of 'High', 'Medium' and 'Low' risk of flooding from surface water. For the 'High' 1:30yr event, no flooding is shown along Ravenshaw Street. For the 'Medium' 1:100yr event, a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site, and for the 'High' 1:1000yr event a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site.

5.44. The Environment Agency risk of flooding from surface water data also includes Flood Hazard. The degree of flood hazard is shown to be Low or Very Low along the entirety of Ravenshaw Street and Mill Lane. As such, safe escape from the site can be provided.

5.45. It should be noted that the degree of flood hazard along Ravenshaw Street (and Mill Lane) is also shown to be Low or Very Low for the 'High' 1:1000yr event.

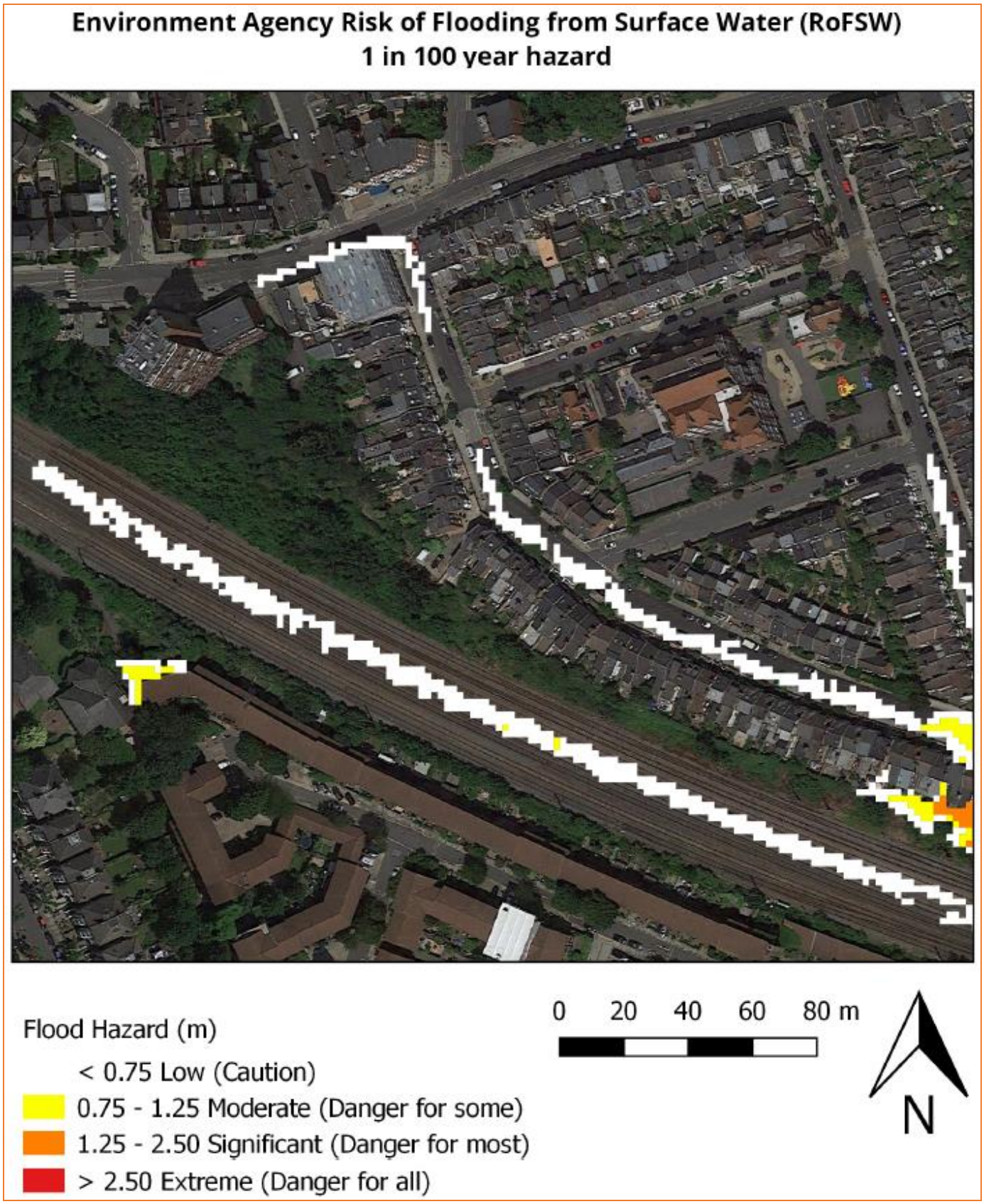

Figure 21: Extract from Environment Agency RoFSW Medium Risk (1:100yr) flood hazard map (Source: EA)

Flood Warning:

5.46. As the UK's official weather service, the Met Office is responsible for issuing weather warnings, which warn of impacts caused by severe weather. The Met Office provide warnings up to seven days ahead for rain, thunderstorms, wind, snow, lightning, ice and fog.

5.47. Met Office weather warnings are available in a number of ways, which make it easy to get the very latest information wherever you are. These include the Met Office app and website, social media, email alerts, TV, radio and RSS.

5.48. It is recommended that the site owner sign up to the National Severe Weather Warning Service. More information can be found here: https://www.metoffice.gov.uk/weather/guides/warnings.

5.49. The Met Office issues weather warnings, through the National Severe Weather Warning Service, when severe weather has the potential to bring impacts to the UK. These warnings are given a colour (yellow, amber or red) depending on a combination of both the impact the weather may have and the likelihood of those impacts occurring.

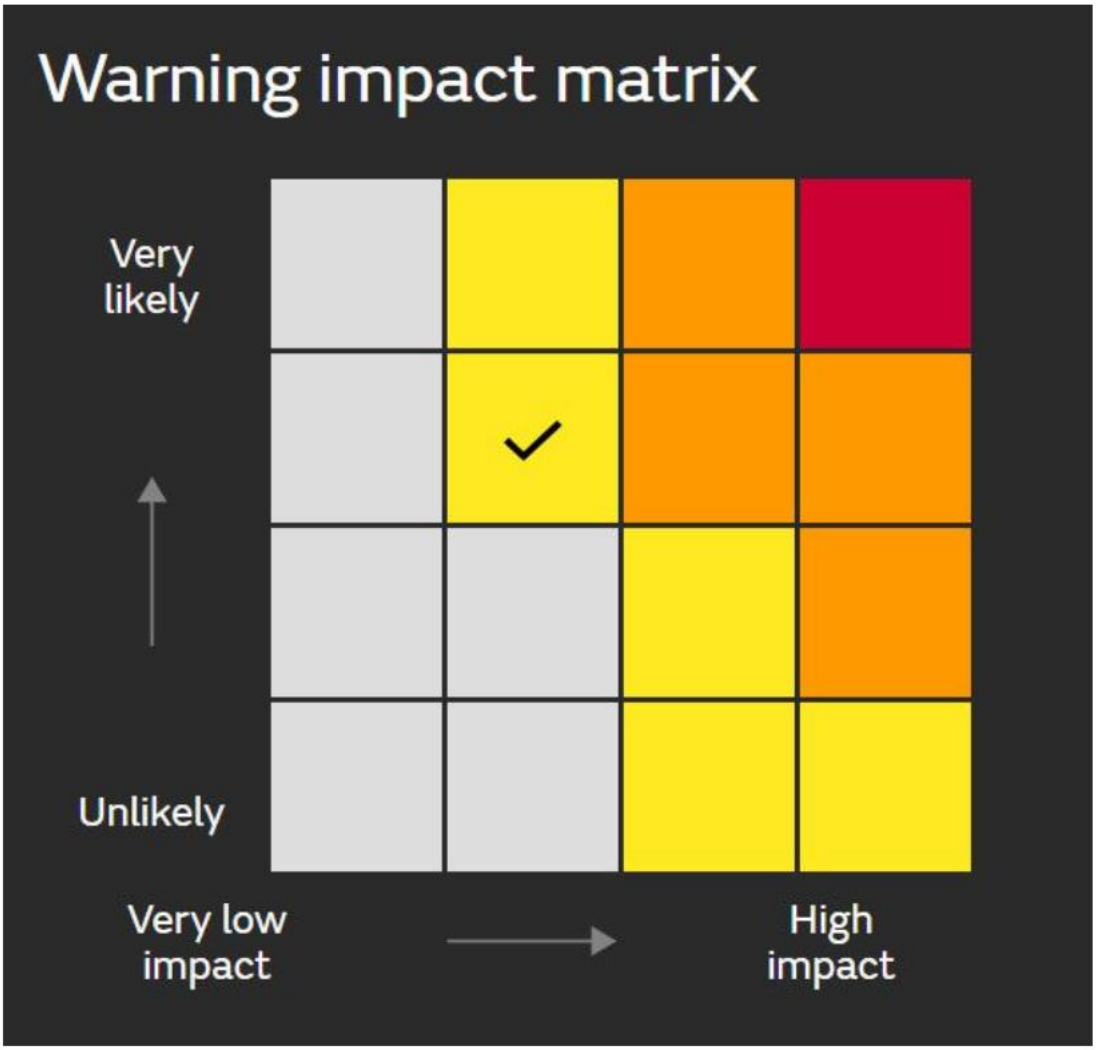

Figure 22: Met Office Weather Warning Impact Matrix (Source: Met Office)

5.50. **Yellow Warning:** Yellow warnings can be issued for a range of weather situations. Many are issued when it is likely that the weather will cause some low level impacts, including some disruption to travel in a few places. Many people may be able to continue with their daily routine, but there will be some that will be directly impacted and so it is important to assess if you could be affected. Other yellow warnings are issued when the weather could bring much more severe impacts to the majority of people but the certainty of those impacts occurring is much lower. It is important to read the content of yellow warnings to determine which weather situation is being covered by the yellow warning.

5.51. **Amber Warning:** There is an increased likelihood of impacts from severe weather, which could potentially disrupt your plans. This means there is the possibility of travel delays, road and rail closures, power cuts and the potential risk to life and property. You should think about changing your plans and taking action to protect yourself and your property. You may want to consider the impact of the weather on your family and your community and whether there is anything you need to do ahead of the severe weather to minimise the impact.

5.52. **Red Warning:** Dangerous weather is expected and, if you haven't already done so, you should take action now to keep yourself and others safe from the impact of the severe weather. It is very likely that there will be a risk to life, with substantial disruption to travel, energy supplies and possibly widespread damage to property and infrastructure. You should avoid travelling, where possible, and follow the advice of the emergency services and local authorities.

Flood Plan:

5.53. It is recommended that the applicant and future owners, occupiers and Landlords of the properties prepare a flood plan to protect life and property during a flood event:

Before a flood:

- Find out if you are at risk of flooding.
- Find out if you can receive flood warnings.
- Prepare and keep a list of all your important contacts to hand or save them on your mobile phone.
- Think about what items you can move now and what you would want to move to safety during a flood such as pets, cars, furniture, and electrical equipment.
- Know how to turn off gas, electricity and water supplies.
- Prepare a flood kit of essential items and keep it handy. It can include copies of important documents, a torch, a battery-powered or wind-up radio, blankets and warm clothing, waterproofs, rubber gloves and a first aid kit including all essential medication.
- Consider buying flood protection products such as flood boards and airbrick covers to help reduce flood water getting into your property.

During a flood:

- Tune into your local radio station on a battery or wind-up radio.
- Fill jugs and saucepans with water.
- Grab your flood kit - if you have prepared one.
- Collect blankets, torch, first aid kit, medication and food.
- Move important documents, personal items, valuables, and lightweight belongings upstairs or to high shelves.
- Raise large items of furniture or put them in large bags if you have them.
- Move people, outdoor belongings, cars and pets to higher ground.
- Switch off water, gas and electricity at mains when water is about to enter your home. Do not touch sources of electricity when standing in water.
- Fit flood protection products, if you have them, for example flood boards, airbrick covers, sandbags.
- Put plugs in sinks and baths. Weigh them down with a pillowcase or plastic bag filled with soil.
- If you do not have non-return valves fitted, plug water inlet pipes with towels or cloths.
- Move your family and pets upstairs or to a high place with a means of escape.
- Listen to the advice of the emergency service and evacuate if told to do so.
- Avoid walking or driving through flood water. Six inches of fast-flowing water can knock over an adult and two feet of water can move a car.

After a flood:

- If you have flooded, contact your insurance company as soon as possible.
- Take photographs and videos of your damaged property as a record for your insurance company.

- If you do not have insurance, contact your local authority for information on grants and charities that may help you.
- Flood water can contain sewage, chemicals and animal waste. Always wear waterproof outerwear, including gloves, wellington boots and a face mask.
- Have your electrics, central heating and water checked by qualified engineers before switching them back on.

7. Discussion and Conclusions:

7.1. This Flood Risk Assessment and Surface Water Drainage Strategy has been prepared by Unda Consulting Limited on behalf of Christopher Stuart Taylor, in support of a planning application for erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house at the site of 23 Ravenshaw Street, London, NW6 1NP. This report assesses the flood risk assessment and surface water drainage strategy for the proposed development.

7.2. The proposed planning application is for erection of a three storey plus basement building comprising 7x flats (4 x 3-bed units and 3 x 2-bed units) with balconies at rear following the demolition of the existing house to 23 Ravenshaw Street, London, NW6 1NP.

7.3. The proposed development site is currently an existing two storey Victorian end of terrace house with accompanying hard standing car park. The overall plot is approximately 484m^2. The existing site is predominantly brownfield.

7.4. Asset records obtained from Thames Water Utilities Ltd (TWU) indicate the presence of a 305mm combined water sewer flowing from north to south beneath Ravenshaw Street.

7.5. A site drain survey shows the existing manholes and inspection chambers on site, and shows that surface water generated within the existing site currently discharges to the existing public combined sewer beneath Ravenshaw Street.

7.6. The topographical survey indicates that levels on site range between 57.91mAOD at the front of the property and 58.70mAOD at the south of the site.

7.7. Overall, post development, the built footprint will cover approximately 380m^2.

7.8. The bedrock geology taken from BGS records is London Clay Formation – Clay, Silt and Sand. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Ypresian Age.

7.9. No superficial geological deposits are recorded.

7.10. The soil type taken from the UK soils website shows relatively deep prequaternary marine/estuarine sand and silt, with a clayey loam to silty loam soil texture.

7.11. The published Environment Agency Groundwater Vulnerability map shows the site to be located outside of an area classified as a Groundwater Source Protection Zone.

7.12. There are no watercourses within the immediate vicinity of the property.

Flood Risk Discussion

7.13. The entire site, and therefore the existing and proposed dwelling footprints are located within Flood Zone 1 (Low Probability) which means it is defined as land having a less than 1:1000 annual probability of fluvial flooding.

7.14. The site is not located in an area that that has previously flooded according to the EA.

7.15. No properties along Ravenshaw Street were reported as having been affected by historic surface water flooding records from 1975 or 2002.

7.16. Ravenshaw Street is not reported as being a flooded street during the 1975 or 2002 historic surface water flood events.

7.17. The EA Risk of Flooding from Surface Water Map suggests that the site itself is shown to be at "Very low" risk of flooding from surface water, while Ravenshaw Street adjacent to the site is shown to be at "Low" and "Medium" risk of flooding from surface water.

7.18. The flood depth data shows the site to be entirely outside of the 'High', 'Medium' and 'Low' maximum flood extents. For the 'High' 1:30yr event, no flooding is shown along Ravenshaw Street. For the 'Medium' 1:100yr event, a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site, and for the 'High' 1:1000yr event a maximum flood depth of 0.15m is shown on Ravenshaw Street in the vicinity of the site.

7.19. The EA Risk of Flooding from Surface Water modelled data also provides flow direction data, which shows surface water runoff to flow down Ravenshaw Street from Mill Lane, and pond at the bottom of Black Path, near the junction of Ravenshaw Street and Broomsleigh Street. No surface water is shown to flow from Ravenshaw Street onto the site.

7.20. The site is shown to be within the Sumatra Road Local Flood Risk Zone.

7.21. No further information has been provided to suggest that the site has flooded from groundwater flooding previously.

7.22. It is understood that a Basement Impact Assessment (Hydrogeology, Hydrology and Land Stability) has been undertaken by Maund Geo-Consulting.

7.23. No further information has been provided to suggest that the site has flooded from groundwater flooding previously.

7.24. It is understood that a Basement Impact Assessment (Hydrogeology, Hydrology and Land Stability) has been undertaken by Maund Geo-Consulting.

7.25. The London Borough of Camden SFRA indicates that the sites postcode of NW6 1 lies within an area where no properties have been affected by exterior sewer flooding and 1 property has been affected by internal sewer flooding.

7.26. No information has been provided to suggest that the site has flooded from sewer surcharge flooding previously.

7.27. The EA Risk of Flooding from Reservoirs Map suggests that the site lies outside of the "Maximum extent of flooding" from reservoir failure.

7.28. The Camden SFRA states that where 'More Vulnerable' development is proposed within an area at potential flood risk, suitable mitigation measures should be utilised in order to mitigate risks to property and people. The development is classified as both 'Highly Vulnerable' – self-contained basement dwellings, and 'More Vulnerable' – residential dwellings.

7.29. Ravenshaw Street is shown to be partially at 'Medium' risk of flooding from surface water.

7.30. It should be noted that Ravenshaw Street is shown to be entirely outside of a 'High' surface water risk area.

7.31. The Camden SFRA states that sleeping accommodation should not be located below external street level in areas of 'High' surface water flood risk. It should be noted that the site and Ravenshaw Street is entirely outside of areas of 'High' risk of surface water flooding.

5.54. Based on the plans provided, the existing extant crossover will be replaced with a new (reinstated) 100mm kerb. The Entrance floor level (and therefore all entrance points to the basement flats) will be raised to 58.655mAOD – which is 0.245m above road level. Given that the road crest level is lowered by 0.125mm as part of the EA Risk of Flooding from surface water modelling (Source: EA), with a maximum potential depth of flooding of 0.15m for the 1:100 year surface water flood event – this equates to 0.025m (0.25cm) flooding above the actual topographic road level. The Entrance floor level is therefore 0.22m above the maximum predicted depth of surface water flooding for both the 1:100 year and 1:1000 year events.

5.55. In addition, to mitigate the effects of potential surface water flooding the applicant will install permanent and temporary flood proofing measures.

5.56. Toughened glass barriers (watertight balustrade) around the front lightwells and front doors and basement flat doors specified as PAS 1188:2014 Rated Flood Protection Doors. Sealed to 600mmand use water pressure to seal the door so it tightens the seal as the water rises.

5.57. The ground floor is split level: only the entrance hall and Bin/Bike room are actually at street level. The GF flats themselves are 770mm above the level of the pavement anyway.

5.58. The above measures therefore ensure that there are no active flowpaths to the basement or ground floor for the surface water flooding from Ravenshaw Street.

Surface Water Drainage Strategy Discussion

7.32. The bedrock geology taken from BGS records is London Clay Formation – Clay, Silt and Sand. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Ypresian Age. No superficial geological deposits are recorded. In addition, the soil type taken from the UK soils website shows relatively deep prequaternary marine/estuarine sand and silt, with a clayey loam to silty loam soil texture.

7.33. Due to the likely low infiltration rate, infiltration is considered inappropriate and an attenuation based drainage strategy has been proposed for the site, connecting to the existing drainage discharge arrangement. In addition, soakaways and other infiltration devices wouldn't be suitable at the site as a means of storm/surface water disposal) as they must not be constructed near/within 20 metres of Network Rail's boundary or at any point which could adversely affect the stability of Network Rail's property.

7.34. The total area of the site is some 480m². Existing greenfield runoff rates for the site have been calculated as 0.2l/s for the 1:1 annual runoff event, 0.4l/s for the 1:30 year event and 0.6l/s for the 1:100 year event.

7.35. Roof runoff from the front roof and yard will flow to a tank at the rear of the house (~74m^2). The remaining roof areas (~132m^2 of rear pitched flat and dormer roofs and ~80m^2 of green roofs) will also flow into the tank in the rear garden. The runoff from the front grilles, basement patios and steps to the rear of the house (~85m^2) will be pumped to the tank at the rear of the house. This produces an approximate total of 371m^2 runoff area to flow into the tank.

7.36. In Order to comply with CIRIA C753 The SuDS Maunual, a 10% allowance will be added to the impermeable areas to take into account future urban creep. Applying a 10% allowance to the new front impermeable surfaces (371m^2)

gives a value of 408m^2. Therefore, all drainage calculations within this assessment have been made based on a total impermeable area of 408m^2.

7.37. MicroDrainage software has been used to estimate the tank size requirement to provide adequate surface water run-off management (see Appendix).

7.38. Preliminary calculations indicate that sufficient storage required to attenuate runoff from the proposed impermeable areas (408m^2) arising from the critical 1:100 year + 40% climate change event can be provided within an attenuation storage tank of dimensions 12.6m^2 x 1.8m deep.

7.39. Preliminary calculations indicate that approximately 22.68m^3 of storage is required to attenuate the runoff for all storms up to and including the 1:100 year + 40% climate change event. A Hydro-Brake would be proposed as the outlet control, restricting the maximum flow rate to 0.6l/s.

7.40. All preliminary surface water drainage calculations have been undertaken using MicroDrainage software. Refer to the appendix.

7.41. This system will manage the entire proposed additional roof area, proving significant betterment over the existing run off situation.

7.42. Runoff from roof areas is considered to be uncontaminated and does not warrant any form of treatment process to improve water quality. Nevertheless, it is suggested to include debris / sediment traps on any new drainage.

7.43. Should the onsite drainage system fail under extreme rainfall events or blockage, flooding may occur within the site. In the event of the drainage system failure, the runoff flow can be managed through detailing the new external levels to direct water away from structures.

7.44. This drainage strategy has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised above, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government and the EA.

Unda Consulting Limited

December 2020

8. Appendix

A. Topographical Site Survey;
B. Proposed Plans
C. Proposed Drainage Plan;
D. Crossover and Pavement Detail with EA RoFSW Data;
E. Greenfield Runoff Calculations;
F. Attenuation Tank Calculations;
G. Thames Water Sewer Records.