Flood Risk Assessment

Prepared by Arup

Submitted on behalf of Lab Selkirk House Ltd

Selkirk House, 166 High Holborn and 1 Museum Street, 10-12 Museum Street, 35-41 New Oxford Street and 16A-18 West Central Street, London, WC1A 1JR

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Executive Summary

Lab Selkirk House Ltd. has commissioned Ove Arup & Partners Limited (Arup) to undertake a Flood Risk Assessment (FRA) for the proposed redevelopment of the land at Selkirk House, 166 High Holborn and 1 Museum Street, 10-12 Museum Street, 35-41 New Oxford Street and 16A-18 West Central Street, London, WC1A 1JR.

The proposals comprise the redevelopment of the site into a mixed-use scheme, comprising office-led buildings with town centre retail units at ground floor level and 44 residential units. The proposed development will deliver significant public realm enhancements, greater pedestrian and cyclist priority, and improved connectivity compared with the existing site.

Table 2 of the technical guidance to the National Policy Planning Framework (NPPF) assesses the flood risk vulnerability of a site based on its site operations. Based on this assessment and the proposed site operations it has been concluded that the proposed development falls within the category of 'more vulnerable'. However, according to the London Borough of Camden (the Council) Strategic Flood Risk Assessment, the proposed development lies within Flood Zone 1 and so it is deemed to be appropriate for development.

Based on EA information on flood risk from rivers and the sea (fluvial and tidal), the area within which the proposed development is located has been assessed to be Low Risk. This risk level is allocated on the basis that there is potential for the site to flood during a 1 in 1000 year event.

The risk of surface water flooding and ground water flooding on the site is low. It is recognised that there are areas of ground water flooding risk within 100m of the site and so should be taken into account in the below ground drainage strategy. The risk from flooding from artificial sources and from groundwater is also considered to be low.

The site has been assessed as being of low risk from flooding occurring from all sources.

1. Introduction

Ove Arup & Partners Limited (Arup) has been commissioned by Lab Selkirk House Ltd. to prepare a Flood Risk Assessment (FRA) in support of the detailed planning application being submitted by Lab Selkirk House Ltd. ('the Applicant') to the London Borough of Camden ('the Council') for the redevelopment of the land at Selkirk House, 166 High Holborn and 1 Museum Street, 10-12 Museum Street, 35-41 New Oxford Street and 16A-18 West Central Street, London, WC1A 1JR ('the site').

This FRA has been requested by London Borough of Camden to be included as part of the planning submission for the proposed scheme. This FRA is intended to summarise flood risks and considerations for the site using readily available sources of information.

The detailed planning application seeks planning permission for the following description of development ('the proposed development'):

"Redevelopment of Selkirk House, 166 High Holborn and 1 Museum Street following the substantial demolition of the existing car park and former Travelodge Hotel to provide a mixed-use scheme, providing office, residential, and town centre uses at ground floor level. Works of part-demolition and refurbishment to 10-12 Museum Street, 35-41 New Oxford Street, and 16A-18 West Central Street to provide further town centre ground floor uses and residential floorspace, including affordable housing provision. Provision of new public realm including a new pedestrian route through the site to link West Central Street with High Holborn. Relocation of cycle hire docking stations on High Holborn (Phased Development)."

This application is submitted alongside a Listed Building Consent for the following:

"Alterations, including part-demolition, to 10-12 Museum Street and 35 and 37 New Oxford Street, to provide flats and townhouses. Demolition of modern rear extension to 11-12 Museum Street from ground to third floors, rebuilding of rear wall. Removal of non-original staircase and internal walls to 11-12 Museum Street along with new layouts and thermal upgrades including internal wall insulation, to facilitate new flats. New bridge links to 12 Museum Street from 16a-18 West Central Street. Removal of non-original partition walls to 35 and 37 New Oxford Street, reinstatement of historic room layouts, thermal upgrades. Across listed buildings: New kitchens, bathrooms and sanitaryware; Introduction of slimline double-glazed retrofit vacuum glazing to existing window joinery, limited replacement frames; New internal and external doors; Façade refurbishment works; Conservation and restoration of historic joinery, plasterwork, fireplaces and other features of heritage importance. Courtyard garden linking buildings at first floor level above ground floor shared services, with new and amended openings to listed buildings to provide access. New and restored retail frontages to all buildings."

This report has been prepared solely for the benefit of the client in connection with this development. The report does not address any other potential impacts that may result from the development.

This FRA is based upon readily available information. Detailed hydrological or hydraulic calculations have not been carried out.

Arup does not accept any liability for the degree of accuracy or correctness of any information derived from secondary sources. However, endeavours have been made to verify the suitability and appropriateness of information where possible.

1.1 Key sources of information

The key documents and sources of information that have been used in the production of the FRA include:

- Borough of Camden Strategic Flood Risk Assessment (SFRA)[1]

[1] Borough of Camden SFRA. Available from: https://www.camden.gov.uk/flooding#wxbh [Accessed:09/05/2023]

- Environment Agency (EA) flood map for planning[2];
- Environment Agency (EA) long term flood mapping[3];
- British Geological Survey[4];
- Defra Data Services Platform[5]
- Defra Magic[6]

1.2 Structure of the report

Following this introductory section, the FRA contains the following chapters:

- Planning context;
- Proposed works description and location;
- Definition of flood hazard;
- Climate change;
- Flood risk management methods; and
- Conclusion.

[2] EA flood mapping for planning. Available from: https://flood-map-for-planning.service.gov.uk/confirm-location?easting=432513&northing=565101 [Accessed: 09/05/2023]

[3] EA long term flood risk information. Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map [Accessed: 09/05/2023]

[4] British Geological Survey, Geology of Britain viewer. Available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html [Accessed: 09/05/2023]

[5] Defra data services platform. Available from: https://environment.data.gov.uk/ [Accessed: 09/05/2023]

[6] DEFRA Magic Mapping. Available from: https://magic.defra.gov.uk/MagicMap.aspx [Accessed: 09/05/2023]

2. Planning context

There are five planning documents that should be considered when assessing flood risk on the site. These are:

- The National Planning Policy Framework (NPPF) (2021)[7];
- Planning Practice Guidance (PPG) (2014)[8];
- London Plan (2021)[9];
- Borough of Camden Local Plan (2017)[10]; and
- Camden Planning Guidance – Water and Flooding (2019)[11].

2.1 National level

Developments in England are required to comply with the following national policies and regulations:

- The National Planning Policy Framework (NPPF) (2021); and
- Planning Practice Guidance (PPG) (2014).

2.1.1 The National Planning Policy Framework

The NPPF sets in place the Government's statutory planning policies for England and how these should be applied. In terms of flooding, the NPPF supports all plans which apply a sequential, risk-based approach to the location of development, with the future impacts of climate change fully incorporated to avoid any future flood risk. Paragraph 149 of the NPPF states that:

"The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."

The NPPF additionally includes a 'presumption in favour of sustainable development' in order to pursue sustainable development throughout planning policies and guidance.

It is also recommended that applications for developments should be supported by a site-specific flood-risk assessment and only allowed in areas at risk of flooding where:

a. "Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b. The development is appropriately flood resistant and resilient;

c. It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

[7] National Planning Policy Framework. Available from: https://www.gov.uk/guidance/national-planning-policy-framework [Accessed: 09/05/2023]

[8] Flood risk and coastal change guidance. Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed: 09/05/2023]

[9] The London Plan (2020). Available from: https://www.london.gov.uk/sites/default/files/the_publication_london_plan_2020_-_clean_version_0.pdf [Accessed 09/05/2023]

[10] Camden Local Plan (2017). Available from: https://www.camden.gov.uk/camden-local-plan1 [Accessed: 09/05/2023]

[11] Camden Planning Guidance – Water and Flooding, Available from: https://www.camden.gov.uk/documents/20142/4823269/Water+and+Flooding+CPG+-+March+2019.pdf/c7633c7d-2b93-cb52-ee01-717fa0416e84 [Accessed: 09/05/2023]

d. Any residual risk can be safely managed; and

e. Safe access and escape routes are included where appropriate, as part of an agreed emergency plan."

2.1.2 Planning Policy Guidance

The PPG provides background information and best practice advice in support of the NPPF. The webpage provides a comprehensive guide to Strategic Flood Risk Assessments.

The PPG sets out Flood Zones referring to the probability of river and sea flooding, ignoring the presence of defences, and the appropriate planning approach for each:

- Zone 1 Low Probability – Land having a less than 1 in 1,000 annual probability of river or sea flooding;
- Zone 2 Medium Probability – Land having between a 1 in 100 and 1 in 1,00 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding;
- 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;
- 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.

The PPG assists in the understanding and the assessment of the relative vulnerability to flooding of different land use types and to assist in the interpretation of the NPPF statutory guidance framework. The land use vulnerability comprises of five categories, with the following examples of uses:

1. Essential Infrastructure: Essential transport infrastructure (including mass evacuation routes) that has to cross the area at risk and essential utility infrastructure that has to be located in a flood risk area for operational reasons;
2. Highly Vulnerable Uses: Police and ambulance stations, fire stations and command centres, telecommunications installations, emergency dispersal points, basement dwelling, caravans, mobile homes and park homes intended for permanent residential use, and sites requiring hazardous substances consent;
3. More Vulnerable: Hospitals, buildings used for dwelling houses, social services homes, hostels and hotels, student halls of residence, non-residential uses for health services, short-term holiday, caravan or camping sites and landfill and sites used for waste management facilities for hazardous waste;
4. Less Vulnerable: Emergency service stations not required to be operational during flooding, units intended for shops, financial, professional, and other services, restaurants and cafés, drinking establishments, offices, leisure, non-residential institutions, waste treatment not included in 'Most Vulnerable' or 'Highly Vulnerable Uses' and land and buildings used for agriculture and forestry;
5. Water Compatible Development: Flood control infrastructure, environmental monitoring stations. water transmission infrastructure and pumping stations, sewage transmission infrastructure and pumping stations, amenity open space and nature conservation and biodiversity.

2.2 Local level

2.2.1 London Plan 2021

The London Plan is a legal part of London's Local Planning Authorities' Development Plan and must be considered when planning decisions are taken in any part of Greater London.

The London Plan sets policies in place to ensure flood risks are effectively managed in a sustainable and cost-effective manner and mitigated or minimised where possible. Policy SI 12 Flood risk management states:

- "Development Plans should use the Mayor's Regional Flood Risk Appraisal and their Strategic Flood Risk Assessment as well as Local Flood Risk Management Strategies, where necessary, to identify areas

here particular and cumulative flood risk issues exist and develop actions and policy approaches aimed at reducing these risks. Boroughs should cooperate and jointly address cross-boundary flood risk issues including with authorities outside London"; and

- "Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat."

The London Plan additionally aims for surface water run-off to be managed as close to its source as possible. Policy SI 13 Sustainable drainage states:

"Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

- Rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
- Rainwater infiltration to ground at or close to source
- Rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
- Rainwater discharge direct to a watercourse (unless not appropriate)
- Controlled rainwater discharge to a surface water sewer or drain
- Control rainwater discharge to a combined sewer"

2.2.2 Camden Local Plan

The Camden Local Plan sets out the Council's planning policies in accordance with The National Planning Policy Framework for the period from 2016-2031. It ensures that Camden:

"Continues to have robust, effective and up-to-date planning policies that respond to changing circumstances and the borough's unique characteristics".

The key source of flooding in Camden is surface flooding, mostly due to impermeable surfaces in highly populated areas. Past significant flooding events in 1975 and 2002 in Camden are highlighted in the Plan. It is also stated that the probability of such events recurring is likely to increase as a result of climate change, which therefore require mitigation and adaption measures.

Policy CC3: Water and Flooding in The Camden Local Plan states that:

"The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible" and should consider surface water flooding (in detail) and groundwater flooding (where applicable).

Additionally, the policy expects all developments to be water efficient and be designed to not require further water infrastructure. This is done through:

- Incorporating water efficiency measures;
- Avoiding harm to the water environment and improving water quality;
- Considering the impact of developments in areas at risk of flooding (including drainage);
- Incorporating flood resilient measures in areas prone to flooding;
- Utilising sustainable drainage systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and
- Not locating vulnerable developments in flood-prone areas.

The Camden Plan additionally requires developments to utilise SuDS and follows the drainage hierarchy stated in the London Plan.

2.3 Guidance

2.3.1 Camden Planning Guidance – Water and Flooding

The Associated Camden Planning Guidance provides supplemental information and guidance to the Camden Local Plan Policy CC3 Water and Flooding. It provides more specific guidance on flood risk assessment methodologies and what is expected from the council for any potential developments. It lays out that the council expects developments to not increase the risk of flooding and where there is potential risk, put mitigation strategies into place.

The guidance additionally states that it is expected for major developments to constrain runoff volumes for a 1 in 100-year, 6-hour rainfall event. Drainage systems should be designed to be accommodate a further 20% climate change allowance on top of the 100-year storms.

The report has been prepared in accordance with Site-Specific Flood Risk Assessment Checklist (Paragraph: 068 Reference ID: 7-068-20140306).

3. Proposed works description and location

The site is located within the Holborn and Covent Garden Ward of the London Borough of Camden ('the Council'). The site comprises a number of individual different buildings within the red line area, which includes Selkirk House, 166 High Holborn and 1 Museum Street, 10-12 Museum Street, 35-41 New Oxford Street and 16A-18 West Central Street, London, WC1A 1JR.

The site is bounded by High Holborn to the south, Museum Street to the east and New Oxford Street to the north, with the rear of the properties fronting Grape Street forming the western boundary. West Central Street dissects the site and separates out Selkirk House from the New Oxford Street and West Central Street block (known as the West Central Street component of the site), **Figure 1**. The site is well served with public transport routes and vehicular routes, as well as maintaining the potential to link into surrounding green and active travel corridors.

Selkirk House comprises a 17-storey building, which includes two basement levels, and a further partial basement level. Selkirk House is occupied by the former Travelodge hotel building and car park. The former Travelodge building provided overspill accommodation from the primary Travelodge hotel building on the opposite side of High Holborn, however, the hotel use at the site ceased all operation in June 2020. At lower levels there is a car park set across basement to second floor level.

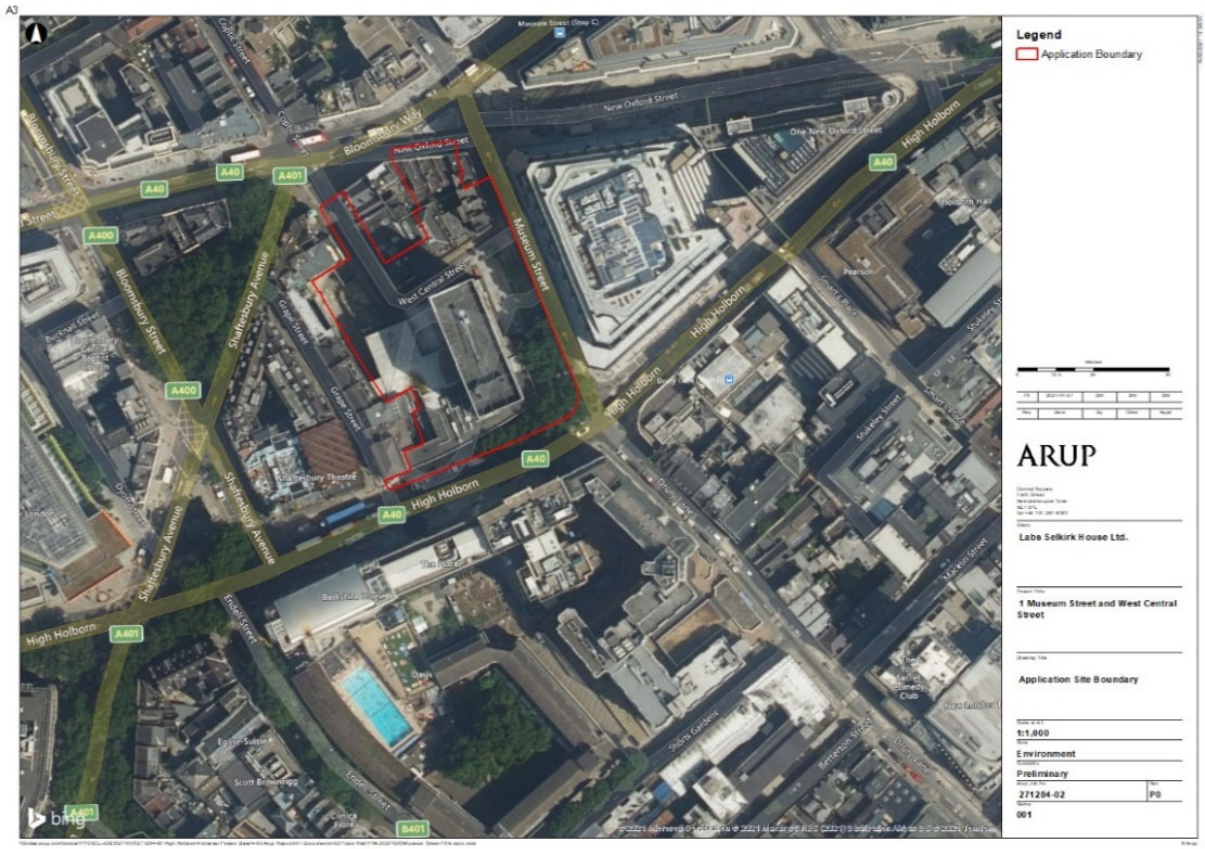

Figure 1: Application site boundary

3.1 Proposed Development

The Proposed Development has been carefully designed with a detailed understanding and analysis of the historic context being fundamental to the architectural response in order to respect and enhance its sensitive setting.

The proposed development falls within a one red line area and comprises of the following components:

Museum Street - a single new building rising to 19 storeys, providing office (Class E(g)(i)) accommodation on upper levels and a range of flexible town centre uses (Class E) at ground level.

High Holborn - a single new building rising to 6 storeys, providing residential (Class C3) accommodation on upper levels and a flexible town centre use (Class E) at ground level.

Vine Lane - a single new building rising to 5 storeys, providing market residential units with a flexible town centre use (Class E) at ground level.

West Central Street - a series of new and refurbished buildings rising to ground plus 5 storeys, providing residential accommodation (market, Low-cost rent and Intermediate rent) on upper levels (Class C3) and flexible town centre uses (Class E) at ground level.

3.2 Planning History

The north-east part of the site adjacent to West Central Street and Museum Street benefits from an existing planning consent for a full planning application submitted in February 2016 (LBC reference: 2016/0477/P). The 2016 application comprised:

"Refurbishment and extension of the site to provide a mixed use scheme which includes 19 self-contained units (6 x 1 bed and 11 x 2 bed and 2 x 3 bed), flexible A1/A2/A3 uses and/or B1 and/or D1 at basement and ground floor levels and associated works"

Planning permission was granted at Committee by the Council in August 2016 but has not been implemented.

A subsequent application (ref. 2021/2954/P) was submitted for the site in 2021, for the comprehensive redevelopment of the Selkirk House tower and the wider site to provide commercial floorspace, housing, enhanced public realm and pedestrian connectivity improvements.

However, following the recent listing of 10-12 Museum Street and 35-37 New Oxford Street, a new planning application has been prepared. Whilst the 2021 application gave significant weight to the heritage interest of the now Grade II listed buildings, the applicant wanted the opportunity to properly consider the implications of the listings on the proposals in order to deliver a revised scheme which maximises the public benefits of the site while also preserving and enhancing these designated heritage assets.

The table below outlines the amendments that have been made to the West Central Street area of the previously submitted scheme:

Previously Submitted Scheme	Amended Scheme
	
Design / Layout • Five storey new-build block to West Central Street. • Roof extension proposed to 10-12 Museum Street & 35-41 New Oxford Street Blocks. • Shared accessible garden amenity at podium level. • Improved access provision to the existing buildings. • Limited internal retention of historic fabric.	Design / Layout • Remove 1990s extension to 11-12 Museum Street. • Omit roof extension to 10-12 MS. • Omit mansard roof extensions to NOS. • Omit central top floor to 16-18 WCS & retain the proposed 5th floor on West Central Street corner.

3.3 Existing topography and landscape

The current site mainly consists of commercial facilities and areas of hardstanding, with West Central Street dividing the site into two sections. There is minimal environmental provision on the site currently, which is limited to some planted trees to the southeast on the Museum Street/High Holborn corner of the site. All four sides of the site are accessible by major roads.

The general topography of the site is flat and at an approximately consistent elevation. The LiDAR (Light Detection and Ranging) data, presented in Figure 2, indicate that the site is elevated to 22m-24m Above Ordnance Datum (AOD).

The site sits on bedrock formed from the London Clay Formation, this bedrock layer consists of clay, silt, and sand. Superficial deposits across the site are categorised as Lynch Hill Gravel Member: sand and gravel. London Clay is impermeable, and due to this it is of little significance as an aquifer[12]. Therefore, it is designated as an Unproductive aquifer. Lynch Hill Gravel is classed as a 'Secondary A' aquifer. A 'Secondary A' aquifer is classified as a bedrock that has permeable layers that are capable of supporting water supplies at a local level and may form important base flow source to local rivers[12]. The volume of superficial deposits across the LBC is low and often does not interact with the hydrology of sites according to the LBC SFRA[1].

[12] British Geological Survey (2000). The physical properties of minor aquifers in England and Wales. Available from: http://nora.nerc.ac.uk/id/eprint/12663/1/WD00004.pdf [Accessed: 09/05/2023]

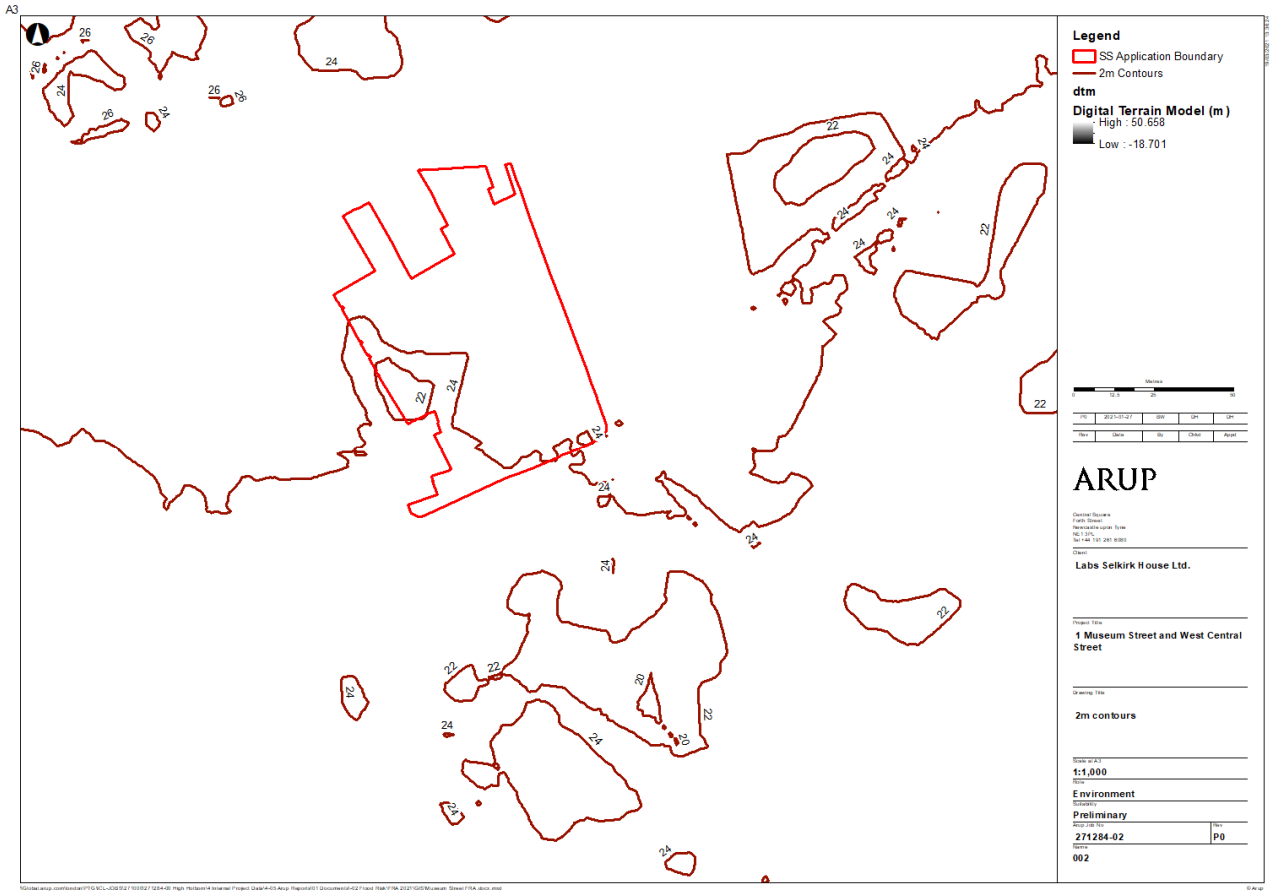

Figure 2: 2m contour lines across the application site and surrounding area

3.4 Existing drainage

Information relating to existing drainage conditions on the site can be found in the Below Ground Drainage Strategy report prepared by Meinhardt[13].

3.5 SuDS feasibility

The developed and constrained surroundings of the site may mean that space is not available for certain types of surface SuDS features. Details of SuDS feasibility for the site are incorporated into the drainage strategy for the site. This document, submitted with the planning application, has also been prepared by Meinhardt[13].

3.6 Development vulnerability

The vulnerability of the proposed development's classification varies depending on the final use of the buildings. Units intended for drinking establishments and residential dwellings are classed as More Vulnerable and the rest of the units that may be used for shops, offices, and cafes are classed as Less Vulnerable according to the Planning Practice Guidance on Flood Risk[14]. The site is assigned according to the highest rating and so it categorised as More Vulnerable in a precautionary approach.

[13] Meinhardt (2021). Below Ground Drainage Strategy.

[14] Flood Vulnerability classifications (Table 2, Paragraph: 066 Reference ID: 7-066-20140306 of Planning Practice Guidance on Flood Risk). Available from https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification [Accessed: 09/05/2023]

4. Consultation

4.1 Environment Agency (EA)

The EA is the main statutory consultee for flood risk matters and has wide-ranging responsibilities including the management of water resources, control of pollution of inland waters, and flood defences including water level management. A principal duty of the EA is to 'contribute towards the achievement of sustainable development'. Therefore, it is usually essential that the EA is consulted when planning for new developments.

The EA was contacted on 27 January 2021 to determine if there are any historical records of flooding, and for an opinion on any other flood risk matters relating to the proposed development. A response was received on the 9 February 2021. Their response highlighted the following:

- The site is outside the combined extents of all of the EA Thames Tidal Upriver Breach Inundation Modelling 2017. Therefore, the EA consider the site to be at extreme low residual risk of tidal flooding.
- The site is within the area benefiting from the Thames flood defences, those defences are designed to defend London up to a 1 in 1000 year tidal flood event.

4.2 London Borough of Camden (LBC)

A consultation response was received from the Council on 2 December 2020. Their response highlighted the following:

- The site is not considered to be a local higher flood risk area;
- There is no increased groundwater susceptibility on site (however there are areas in the vicinity); and
- There are no recorded sewer incidents in the area:
- LBC also provided guidance on key policy documents they would expect to be reviewed and outlined the expectation of the incorporation of highly sustainable SuDS and greenfield rates as feasible.

5. Definition of flood hazard

5.1 Flood sources/mechanisms

5.1.1 Fluvial

Flooding from rivers, streams and other natural inland watercourses is usually caused by prolonged or intense rainfall which then generates high volumes of water.

This can overwhelm the capacity of the system as a flood flow and as a result, spill into available floodplain storage areas.

Flooding from rivers, streams and other natural inland watercourses is usually caused by prolonged or intense rainfall, which generates high volumes of water. This can overwhelm the capacity of the system as a flood flow and, as a result, spills into available floodplain storage areas.

Fluvial flood risk can be classified in terms of probability. The below references to degrees of river and sea flood risk are expressed in terms of Annual Event Recurrence (AER) probability. This reflects the likelihood of an event occurring in any single year, with less frequent and more extreme events having a lower AER probability (and vice versa). This is an alternative means to 'Return Periods' to express flood risk. For comparative purposes, degrees of flood risk can be summarised as:

- (Low Risk): Flood Zone 1 - An AER of 0.1% (equivalent to a 1 in 1000 year return period) or lower chance of occurrence each year from river or sea flooding sources;
- (Medium Risk): Flood Zone 2 - An AER of between 1% and 0.1% (equivalent to between a 1 in 100 and 1 in 1000 year return period) chance of happening each year for river flooding sources. An AER of between 0.5% and 0.1% (equivalent to between a 1 in 200 and 1 in 1000 year return period) chance of occurrence each year for sea flooding sources; and
- (High Risk): Flood Zone 3 - An AER of 1% (equivalent to a 1 in 100 year return period) or greater chance of occurrence each year for river flooding sources. An AER of 0.5% (equivalent to a 1 in 200 year return period) or greater chance of happening each year for sea flooding sources.

5.1.2 Coastal or near coastal flood risk

Coastal and near coastal flooding is caused by extreme sea levels, which can occur due to three main mechanisms and, most commonly, as a combination of two or more of:

1. High astronomical tide level; cyclical variation in tide levels due to the gravitational effects of (mainly) the sun and moon. These effects lead to the twice daily variations between high and low tide, and to the spring-neap tide cycle, which occurs approximately monthly, largely controlled by the phases of the moon;
2. Surge; an increase in water level above the astronomical tide level caused by low barometric pressure exacerbated by the wind acting on the surface of the sea (also known as "set-up");
3. Wave action; dependent on wind speed, wind direction, fetch length, local topography and exposure. Waves can be in the form of sea-scale swell waves, or more local sea surface waves.

5.1.3 Surface water flooding

Overland flow is a description for water flowing over the ground surface, which has yet to enter a natural drainage channel, an artificial drainage system or the natural substrate. It is often a result of very intense and short rainfall events but can also be produced during mild rainfall events when drainage systems are at capacity or blocked, or when the ground is already saturated. Surface water flooding (sometimes referred to as flash flooding) occurs when the rainfall rate is greater than the infiltration rate, causing surface water to be stored above ground. This can result in the inundation of low-lying areas and can also be related to sewer flooding, excessive groundwater and infrastructure failure.

Surface water flood risk can also be classified in terms of probability. For comparative purposes, the following degrees of flooding risk have been classified for surface water:

- Very Low Risk: Each year, this area of land has a less than 1 in 1,000 (0.1%) chance of flooding;
- Low Risk: Each year, this area of land has between 1 in 1,000 (0.1%) and 1 in 100 (1%) chance of flooding;
- Medium Risk: Each year, this area has between a 1 in 100 (1%) and 1 in 30 (3.3%) chance of flooding; and
- High Risk: Each year, this area has greater than 1 in 30 (3.3%) chance of flooding.

5.1.4 Groundwater flooding

Flooding can occur in locations where groundwater naturally occurs at shallow depths under the ground level. Prolonged periods of rainfall can result in increased groundwater levels that can lead to the groundwater level reaching the surface. This can pose a flood risk to developments, particularly basements and cellars, but also the emergence of groundwater will prevent infiltration occurring and so will promote the occurrence of overland flow. In addition, groundwater may leak into existing surface water drainage systems of poor integrity, reducing their ability to accommodate surface water runoff.

5.1.5 Reservoirs, canals, and other artificial sources

Artificial flooding can occur due to infrastructure failure or human intervention. Sources include reservoirs, canals, retention ponds, docks, and other artificial structures. The probability of a structural breach is low; however, the potential extent of damage can be significant.

5.2 Likelihood of flooding

5.2.1 Historical flooding

Environment Agency historic flood maps indicate that no flooding has been recorded on the application site.

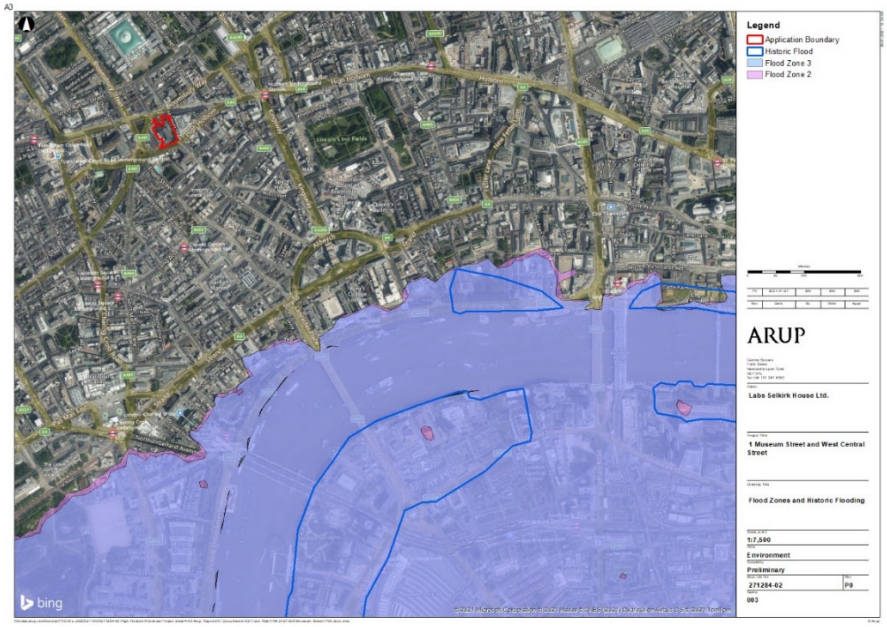

Figure 3: The Council's SFRA mapping showing the application site situated outside of Local Flood Risk Zones[15] and historic flooding areas.

[15] Appendix B Figure 6 in LBC SFRA. Available from: https://www.camden.gov.uk/documents/20142/0/download+%2815%29.pdf/37025249-3da8-4fe1-3075-aa025d3b66de [Accessed: 09/05/2023]

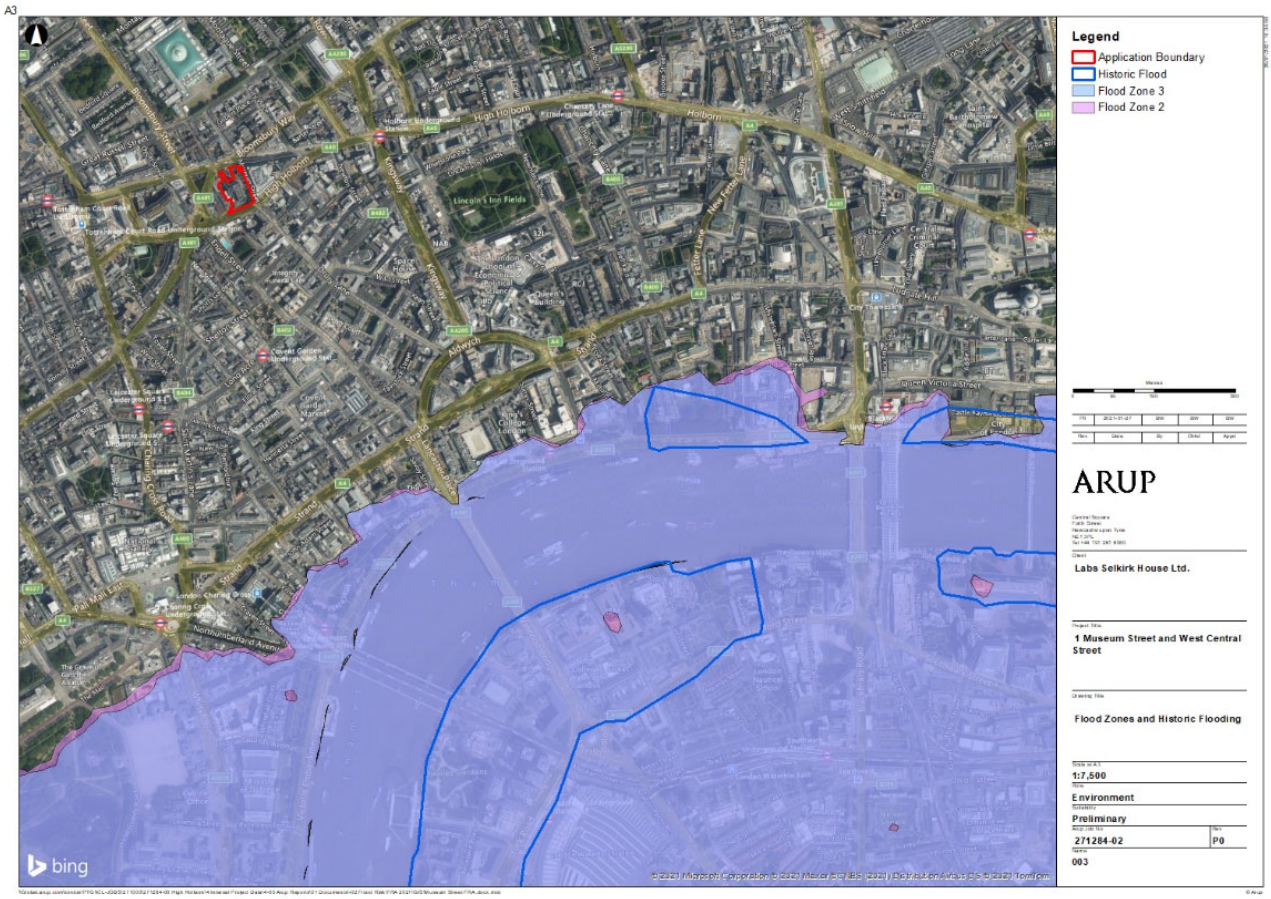

Figure 4: EA Flood Zones and Historic Flooding

5.2.2 Fluvial and tidal flooding

The entire Council area is located within Flood Zone 1 (1 in 1000 year chance of flooding or lower (0.1%)). The application site is 750m from Flood Zone 2 and Flood Zone 3, both of which are associated with the Thames.

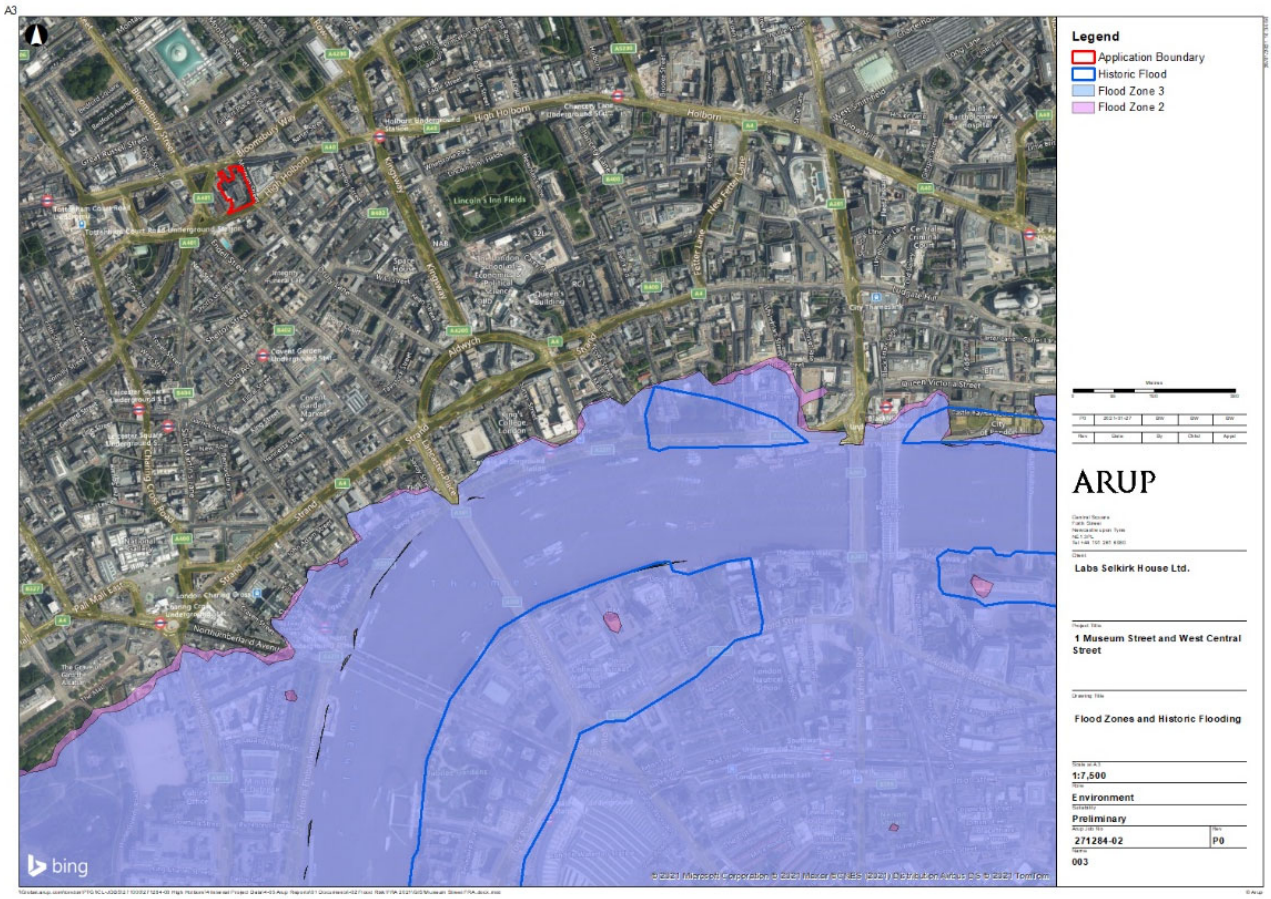

Figure 5: The River Thames has flood defences along its banks, protecting the application site from 1 in 1000 year tidal flood events.

The EA confirmed in their consultation response that the site is considered to be at extreme residual risk of tidal flooding.

The flood risk vulnerability classification, shown in Table 1, indicates that 'more vulnerable' infrastructure constructed in Flood Zone 1 is appropriate for development.

Table 1: Flood risk vulnerability classifications (Paragraph: 067 Reference ID: 7-067-20140306 from the Flood Risk and Coastal Change Guidance)

Flood Zones	Flood Risk Vulnerability				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water-Compliant
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	X	Exception Test required	✓	✓
Zone 3b	Exception Test required	X	X	X	✓

Key:

✓ Development is appropriate

✗ Development should not be permitted

Based on EA information on flood risk from rivers and the sea (fluvial and tidal), the area within which the proposed development is located has been assessed to be **Low Risk.** This risk level is allocated on the basis that the site has no record of historical flooding and has a 1 in 1000-year chance of flooding or lower.

5.2.3 Surface water flooding

The EA flood map for surface water flood risk[16] (Figure 6) indicates that there is minimal areal extent of the application site exposed to a low surface water flood risk (1 in 1000 years) only. This area is situated to the northwest boundary of the application site. To the north, 20m outside of the application site boundary, there are areas of medium risk (1 in 100 years) situated on the New Oxford Street highway.

LBC SFRA maps further indicate that the application site does not intersect any area of local surface water flooding concern[17].

Based on the available information, the risk of surface water flooding within the site is considered to be **Low**. However, it should be noted that there is an ever-present risk of surface water flooding due to unusually high rainfall events and sewer blockages or inundation, which should be managed by appropriate landscaping and surface drainage design.

Figure 6: Risk of flooding from surface waters

5.2.4 Groundwater flooding

The SFRA[1] does not list the application site as being in an area for increased susceptibility to elevated groundwater, nor has it experienced a groundwater incident recorded by the EA[18]. However, the site is located in a Critical Drainage Area (CDA) and within an area with potential for groundwater flooding of property situated below ground level[19]. This will need to be appropriately addressed in the design and associated relevant assessments (e.g., basement impact assessment; drainage strategy). Several areas, greater

[16] EA long term flood risk information. Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map [Accessed: 09/05/2023]

[17] Appendix B Figure 3 in LBC SFRA (2014). Available from: https://www.camden.gov.uk/documents/20142/0/download+%2815%29.pdf/37025249-3da8-4fe1-3075-aa025d3b66de [Accessed: 09/05/2023]

[18] Appendix B Figure 4e in the SFRA (2014). Available from: https://www.camden.gov.uk/documents/20142/0/download+%2815%29.pdf/37025249-3da8-4fe1-3075-aa025d3b66de [Accessed: 09/05/2023]

[19] 1 Museum Street and West Central Street - Geotechnical and Geo-environmental Desk Study Report (doc ref: 1084-A2S-XX-XX-RP-Y-0001-00), A-squared Studio Engineers Ltd (2019)

than 75m from the site, are listed as having the potential for groundwater flooding at the surface. The site is anticipated to be underlain by Made Ground overlying Sand and Gravels of the Lynch Hill Gravel Member which in turn sit on the London Clay. The Lynch Hill Gravel Member is a Secondary A Aquifer; a permeable layer capable of supporting water supplies at a local level. The underlying geology of the site is considered to permit moderate infiltration although permeability is spatially variable.

Historic groundwater monitoring in the area indicates a groundwater level in the Sands and Gravels in the order of 20.5mOD (circa 3.5m bgl), although variability and seasonal changes are anticipated. For the preliminary design, a long-term design level of 23.0mOD (1.0m bgl) has been selected.

Based on the available data, the risk of groundwater flooding at the surface is considered low.

Groundwater monitoring will be required during the GI to confirm the hydrogeology of the site.

Figure 7 shows indicative groundwater levels as recorded from British Geological Survey (BGS) historic borehole records in this location.

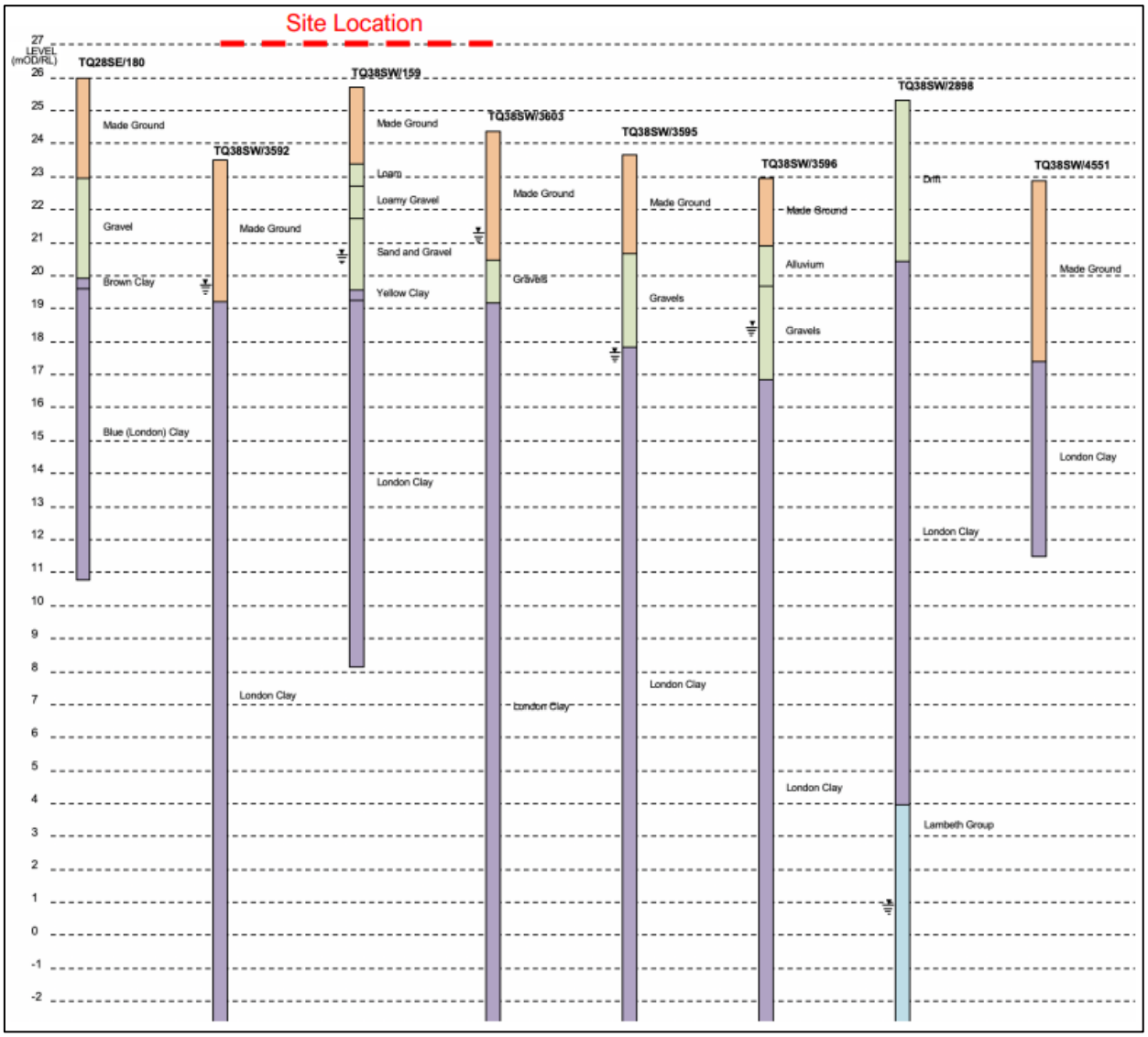

Figure 7: BGS historical borehole data (indicative cross-section, west-east)

5.2.5 Drainage, SuDS and off-site flood risk

The site is developed in a dense urban area with the majority of the application site being hardstanding. The proposed development would not increase the areas of impermeable land from the current situation by a significant degree as similar footprints to the existing buildings will be followed. There is potential to use SuDS within the site drainage plan, also the proposed public realm includes soft landscaping and tree

planting at ground level, with green and blue roofs and terrace planting throughout the design, that will increase environmental amenity and attenuate surface runoff through the site.

Subject to final site levels, SuDS-type surface drainage features should be considered in preference to a traditional piped drainage system where the proposed topography and ground conditions allow. Details can be found in Report Ref: 2413-MHT-CV-RP-0001.

5.2.6 Flooding from reservoirs, canals, and other artificial sources

The Environment Agency reservoirs flooding extent map[20] shows modelled maximum extent of flooding from reservoirs in both 'wet-day' (when there is also flooding from rivers) and 'dry-day' (when river levels are normal) scenarios. In either scenario, the map indicates that the application site is not at risk of flooding from reservoirs. The nearest at risk area is situated on the northern boundary of the Thames River, approximately 750m south-east of the application site.

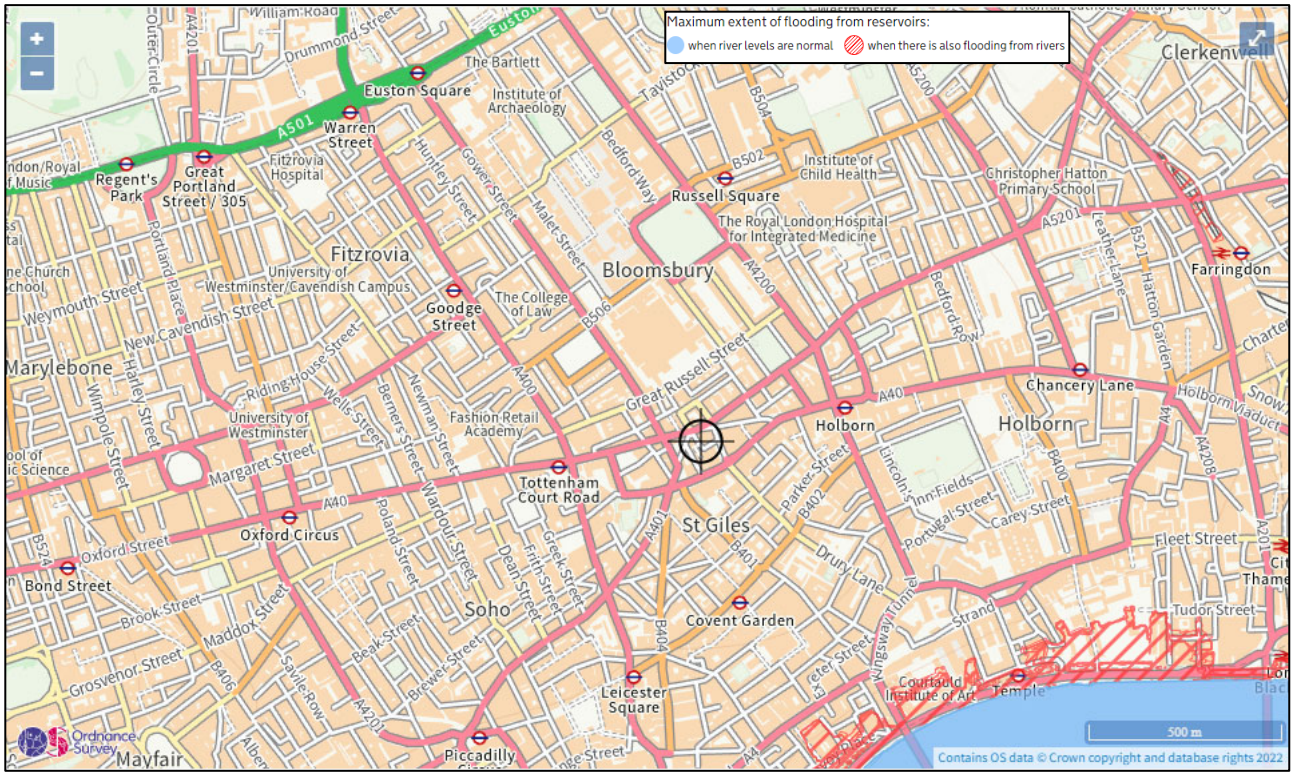

Figure 8: EA extent of flooding from reservoirs map

5.2.7 Residual risks

The residual risks of flooding need to be considered, covering all possible sources of flooding. In the case of this development, the site will discharge into the Thames Water public sewer within West Central Street, at a rate of 5l/s. The proposed development is unlikely to result in increased flood risk elsewhere.

[20] EA Extent of flooding from reservoirs map. Available from: https://check-long-term-flood-risk.service.gov.uk/managing-flood-risk [Accessed: 09/05/2023]

6. Climate change

There are two generic approaches to designing for climate change. The first is the *precautionary approach*, which involves incorporating mitigation measures for potential climate change impacts now. The second is the *managed adaptive approach*, which involves making provisions for mitigation measures to be undertaken at a future date where there will be greater certainty regarding the likely impacts of climate change on parameters such as river flow and rainfall.

The National Planning Policy Framework (NPPF) sets out how the planning system should help to minimise vulnerability and to provide resilience to the impacts of climate change. The UK Government guidance[21] provides climate change allowances that should be considered by designers in assessing the most sustainable means of addressing potential climate change impacts.

The approximate completion year for the construction of the development is estimated to be 2026. The development is estimated to have a design lifetime of 50 years. This estimated figure will be used for the purpose of this climate change assessment. The development will therefore be reaching the end of its design lifetime around the year 2076. The following sections set out the assessment of the site with regards to climate change up to the end of its lifetime.

Note that in the sub-sections that follow, the climate allowances for Peak River Flows and Rainfall Intensity are based on UK Climate Projections 2009 (UKCP09). The EA plan to transition to UKCP18[22] in 2020 but at the time of writing this has not happened. Allowances relating to sea level rise are from UKCP18.

6.1 Peak river flows

Table 2 below shows the peak river flow allowances for the River Thames, which lies in the Thames river basin district. As the proposed development is classified as a 'more vulnerable' development and lies within flood zone 1, the Higher Central or Upper End Allowance should be applied to assess a range of peak river flow allowances. Using Table 2 the total potential anticipated increase in peak river flow is 35% with climate change (covering the lifetime of the development up to 2076).

Table 2. Peak river flow allowances for the Thames river basin district.

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015-2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

6.2 Rainfall intensity

Increased rainfall affects river levels and urban drainage systems. Table 3 shows the anticipated changes in peak rainfall intensity in small or urban catchments. The total potential change anticipated for peak rainfall is between 20% and 40% for the proposed development site (as both allowances are used to understand the range of the impact).

[21] EA (2016). Flood risk assessments: climate change allowances. Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1 [Accessed 09/05/2023]

[22] Met Office (2023). UK Climate Projections. Available from: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index [Accessed 09/05/2023]

Table 3. Peak rainfall intensity allowance in small and urban catchments.

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

6.3 Sea level rise

Table 4 shows the regional sea level allowance for the area classified as Southeast (River Basin District) based on a 1981-2000 baseline. The Thames river basin uses the 'Southeast' sea level allowances. These allowances account for land movement changes that vary from the north to the south of the country due to isostatic rebound. For the proposed development site, the approximate sea level allowance is 474mm above current (2023) water levels. This assumes that the development reaches completion in 2026 and has a 50-year design life (ends in 2076).

As this is a less vulnerable inland development, which is around 22m AOD at its lowest point, it has been deemed not appropriate to consider the H++ scenario of 1.9m total sea level rise to 2100.

Table 4. Sea level allowance for each epoch in millimetres per year, followed by total mm in brackets, using the 1981-2000 baseline).

River Basin District	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
South east	Upper End	6.9 (242)	11.3 (339)	15.8 (474)	18.2 (546)	1.60
South east	Higher Central	4.6 (161)	7.5 (225)	10.1 (303)	11.2 (336)	1.03

6.4 Wind speed and extreme wave heights

Wave heights may change because of increased water depths resulting from climate change. The frequency, duration and severity of storms could also change. Table 5 shows the extreme wave height allowance for the English Coast. For the proposed development site, the approximate wave height allowance, including a sensitivity allowance is 20%.

Table 5. Wind speed and extreme wave heights allowance (using 1990 baseline)

Applies around all of the English coast	1990 to 2050	2051 to 2115
Offshore wind speed allowance	5%	10%
Offshore wind speed sensitivity test	10%	10%
Extreme wave height allowance	5%	10%
Extreme wave height sensitivity test	10%	10%

6.5 Climate summary

To summarise, the suggested allowances recommend under these circumstances for climate change are:

- A potential 10-35% increase in peak river flows (up to 2076);
- A potential 5-20% increase in peak rainfall intensity (up to 2076);
- A potential 474mm increase in sea levels (up to 2076); and
- A potential 20% increase in extreme wave height (up to 2076).

A 10-35% increase in peak river flows could increase the risk of flooding from fluvial sources.

A 5-20% increase in peak rainfall intensities would increase the risk of surface water flooding. It is recommended that this is accounts for in the design of on-site landscaping, drainage systems and any flood resilience measures. The existing areas of surface water flooding may encroach further onto the site due to the effects of climate change. The increased risk due to the potential impacts of climate change can be managed through appropriate design.

A 474mm increase in sea level rise will not affect the development site provided the Thames Barrier is maintained. It is not anticipated that flooding due to sea level rise at the proposed development. Likewise, a 20% increase in extreme wave is unlikely to affect the proposed development.

7. Flood risk management methods

The following section summarises the identified qualitative key Flood Risk Conclusions (FRC) and how they may be removed or reduced to acceptable levels using appropriate Flood Mitigation Measures (FMM), determined from issues previously raised in this FRA.

7.1 Fluvial and tidal flooding

FRC:	The site is located within Flood Zone 1 (less than 1 in 1,000 year return period probability of river or sea flooding (<0.1% chance) in any one year).
FMM:	No mitigation measures required.

7.2 Surface water flooding

FRC:	There is always a risk of surface water flooding. The existing information shows that in general the site is at a low risk of surface water flooding.
FMM:	Surface water flood risk should be minimised by appropriate landscape and drainage design and by positioning and elevating sensitive site elements on relatively high ground at the site and by designing to ensure efficient run-off to the local drainage system and/or SuDS features. Surface water discharge rates for the post-development scheme will not be allowed to exceed, and should ideally improve upon, discharge rates for the existing layout.

7.3 Groundwater

FRC:	The risk of groundwater flooding is assessed for this site as being low although there are areas of groundwater flooding risk located 100m from the site.
FMM:	It is recommended that groundwater depth measurements are taken as part of site investigation process. This information should be used to inform design.

7.4 Drainage management and off site flood risk

FRC:	Site drainage should be designed so that flood risk is managed to acceptable levels on-site, and so that flood risk is not increased elsewhere as a result of the development.
FMM:	Post-development discharge rates will not be allowed to exceed, and ideally should improve upon, the existing drainage regime. A reduction of surface water discharge rates on the existing baseline regime will likely be required to minimise surface water and sewer flood risk in the area. The layout of surface water drainage should be confirmed by subsequent drainage investigations. The provision of surface drainage features, such as filter drains and living roofs will negate the requirement to provide additional capacity during flooding within the subsurface system. Subject to final site levels, surface drainage features should be considered in preference to a traditional piped drainage system where proposed topography allows.

FRC:	Site drainage should be designed so that flood risk is managed to acceptable levels on-site, and so that flood risk is not increased elsewhere as a result of the development.
	In addition, appropriate allowance will be included to address the impact of potential climate change.

7.5 Climate change

FRC:	Climate Change has the potential to increase flood risk at the site and needs to be accounted for in design. It is estimated that the development will have an intended design life of 50 years. This will mean that the development should be reaching the end of its life around 2076. The suggested allowances under these circumstances are: A potential 10-35% increase in peak river flows (up to 2076); A potential 5-20% increase in peak rainfall intensity (up to 2076); A potential 474mm increase in sea levels (up to 2076); and A potential 20% increase in extreme wave height (up to 2076). A 10-35% increase in peak river flows could increase the risk of flooding from fluvial sources. A 5-20% increase in peak rainfall intensities would increase the risk of surface water flooding. It is recommended that this is accounts for in the design of on-site landscaping, drainage systems and any flood resilience measures. The existing areas of surface water flooding may encroach further onto the site due to the effects of climate change. The increased risk due to the potential impacts of climate change can be managed through appropriate design. A 474mm increase in sea level rise will not affect the development site provided the Thames Barrier is maintained. It is not anticipated that flooding due to sea level rise at the proposed development. Likewise, a 20% increase in extreme wave is unlikely to affect the proposed development.
FMM:	Climate change should be accounted for during design in relation to fluvial, tidal, pluvial and drainage aspects of flood risk management. Climate change must be taken into account for the drainage designs to ensure that future drainage scenarios can be accommodated in the area over the lifetime of the development.

8. Conclusion

According to EA flood mapping, the site is located within Flood Zone 1, which has a less than 0.1% Annual Event Recurrence (EAR) probability. Overall, the site is assessed to have a low risk from fluvial flooding, with no historical fluvial flooding events recorded on the site. According to the flood risk vulnerability classification, the proposed development is appropriate for this area of low flood risk.

There is always a risk of surface water flooding that should be managed by appropriate design of surface drainage. The EA flood map for surface water indicates that there are 3 areas of low surface water risk within the site, however LBC SFRA maps do not identify this as an area of concern for surface flooding. Therefore, the overall risk of surface water flooding at the proposed development site is classed as low.

The available information suggests that ground water flooding is not considered to be an issue for this site due to the underlying geology being clay and an unproductive aquifer. There are no historical records of ground water flooding within LBC SFRA and the site is outside any areas of ground water flood risk. However, it is acknowledged that this does not necessarily mean that the site has not flooded in the past and it is highlighted that areas of ground water flood risk exist within 100m of the site.

It has been recommended that appropriate allowances will be included to address the potential impacts of climate change. It is estimated that the approximate construction completion year for the development will be 2026 and that the commercial development will have an intended design life of 50 years. This will mean that the development should be reaching the end of its design life around 2076.

The suggested allowances recommended under these circumstances are:

- A potential 10% increase in storm rainfall intensities and volumes (up to 2076);
- A potential 20% increase in peak river flows (up to 2076).

The redevelopment of the existing site will not increase the area of impermeable hardstanding as the site is already fully developed. The site design has scope to include SuDS and to use green infrastructure such as green roofs and soft landscaping to increase biodiversity and manage surface water on site in a more sustainable manner.

The information presented in this document for the site indicate low flood risk conditions originating from all potential sources.