mason navarro pledge

Bancroft Court
Hitchin
Hertfordshire SG5 1LH

Telephone: 01462 632012
Email: office@mnp.co.uk
www.mnp.co.uk

FLOOD RISK ASSESSMENT AND

SURFACE WATER DRAINAGE STRATEGY

AT

TYBALDS ESTATE

REF: 219218 - June 2021 Rev P03

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APPENDICES

Report prepared by:

Andrew Quinn
BEng (Hons)
Senior Engineer

1. INTRODUCTION

1.1. Mason Navarro Pledge Ltd have been commissioned by Camden Council to produce a Flood Risk Assessment (FRA) and Drainage Strategy report for a proposed development of the Tybalds Estate in the borough of Camden, London.

1.2. The proposed site extends over an area of 15840m^2 (1.584Ha) and is located in the southern portion of the borough of Camden. The site is located off of Orde Hall Street, Holborn, WC1N 3JP, London.

1.3. The proposal involves the redevelopment of the Tybalds Estate across the 1.584Ha site that consists of a mixture of new buildings and redevelopment to existing buildings. The current site proposals have 3No. new blocks known as Blocks B, C and D, some of which are extensions to existing buildings or are standalone new units.

1.4. There is also a proposal for a re development to the external areas, car parking facilities and public open spaces. There is also a proposal for a run of mews properties referred to as the eastern & western mews providing 10no. houses. The proposals also consist of converting the lower ground floor of three existing blocks in to flats, known as the underbuilds.

1.5. Based on the guidance in the National Planning Policy Framework (NPPF, February 2019) and associated Planning Practice Guidance (PPG, amended April 2015), developments should include an appropriate Flood Risk Assessment if any or all of the following criteria are met:

- Site is greater than 1 hectare
- Potentially located in Flood Zone 2 or 3
- Considered a major planning application (as defined by local planning authority)

1.6. In this case, the overall site area extends over 1.584 hectares and is shown to lie within Flood Zone 1 and therefore this assessment has been prepared to accompany the planning application.

1.7. This report has been prepared in accordance with the NPPF and the accompanying Technical Guidance.

1.8. This report has been prepared by Andrew Quinn BEng (Hons).

2. POLICY CONTEXT

NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

2.1 The latest NPPF was adopted in February 2019, one of the overarching objectives of the NPPF is the encouragement of growth and acknowledgement that decision-makers should adopt a presumption in favour of sustainable development. Paragraph 11 of the document states:

> *"For **decision-taking** this means:*
>
> - *approving development proposals that accord with an up-to-date development plan without delay; or*
> - *where there are no relevant development plan policies, or the policies which are most important for determining the application are out of date, granting permission unless:*
>
> - *the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development or*
> - *any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole."*

2.2 Section 14 of the NPPF seeks to address the issues of climate change, flooding and coastal change. In paragraph 155 it states: "Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."

PLANNING PRACTICE GUIDANCE TO THE NATIONAL PLANNING POLICY FRAMEWORK

2.3 The Planning Practice Guidance (PPG) was first published in March 2014 and at the same time the Technical Guidance to the NPPF was withdrawn. The key difference with the new PPG is that it is a web-based resource, and each section is updated as needed.

2.4 Section 7 covers "Flood Risk and Coastal Change" and was last updated in April 2015.

2.5 The assessment of flood risk is based on the definitions in Table 1 of the PPG. This information is replicated below for ease of reference.

TABLE 1: FLOOD ZONE DEFINITIONS

Flood Zone	Annual probability of river or sea flooding
Zone 1 *Low Probability*	■ Land having less than 1 in 1000 annual probability of river or sea flooding (<0.1%)
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.
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.

2.6 The NPPF classifies the Flood Risk Vulnerability of various land uses in Table 2 (reproduced below). The More Vulnerable Classification encompasses usages such as hospitals and buildings used for dwellings. Less Vulnerable applies to buildings used for general industry, storage and distribution.

TABLE 2: LAND USE CLASSIFICATION

Classification	Land Use
Essential Infrastructure	■ Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. ■ Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. ■ Wind turbines.
Highly Vulnerable	■ Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. ■ Emergency dispersal points. ■ Basement dwellings. ■ Caravans, mobile homes and park homes intended for permanent residential use. ■ Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities,

Classification	Land Use
	or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure").
More Vulnerable	■ Hospitals. ■ Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. ■ Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. ■ Non-residential uses for health services, nurseries and educational establishments. ■ Landfill and sites used for waste management facilities for hazardous waste. ■ Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	■ Buildings used for shops; financial, professional and other services, restaurants and cafes, hot ■ food takeaways, offices, general industry, storage and distribution and assembly and leisure. ■ Land and buildings used for agriculture and forestry. ■ Waste treatment (except landfill and hazardous waste facilities). ■ Minerals working and processing (except for sand and gravel working). ■ Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible development	■ Flood control infrastructure. ■ Water transmission infrastructure and pumping stations. ■ Sewage transmission infrastructure and pumping stations. ■ Sand and gravel working. ■ Docks, marinas and wharves.

2.8 The overall aim is to steer new development to Flood Zone 1. Where there are no reasonably available sites within Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. The table below, replicated from Table 3 of the PPG, indicates which

Flood Zones are considered to be appropriate for different land uses based upon the Sequential Test.

TABLE 3: FLOOD RISK VULNERABILITY CLASSIFICATION

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable (Residential)	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	×	Exception Test Required	✓
Zone 3b Functional Floodplain	Exception Test Required	✓	×	×	×

✓ Development is appropriate

× Development should not be permitted

2.9 The sequential approach requires the application of the Sequential Test whereby, in addition to the requirements of Table 3, development should first be directed to Flood Zone 1, then Flood Zone 2 and lastly Flood Zone 3.

2.10 Where the Exception Test is required it is necessary to demonstrate, partly through a site-specific flood risk assessment, that:

- The development will provide extensive sustainability benefits to the community
- And that these benefits outweigh the flood risk
- When considering the vulnerability of its users, the development will be safe for its lifetime
- Flood risk is not increased elsewhere, and reduced overall where possible

2.11 Further detail on the lifetime of development is also given in the PPG, which advises for residential development that a period of 100 years should be considered whilst for non-residential this is dependent upon the development characteristics.

2.12 The use of sustainable drainage systems is considered by the PPG to offer the following benefits:

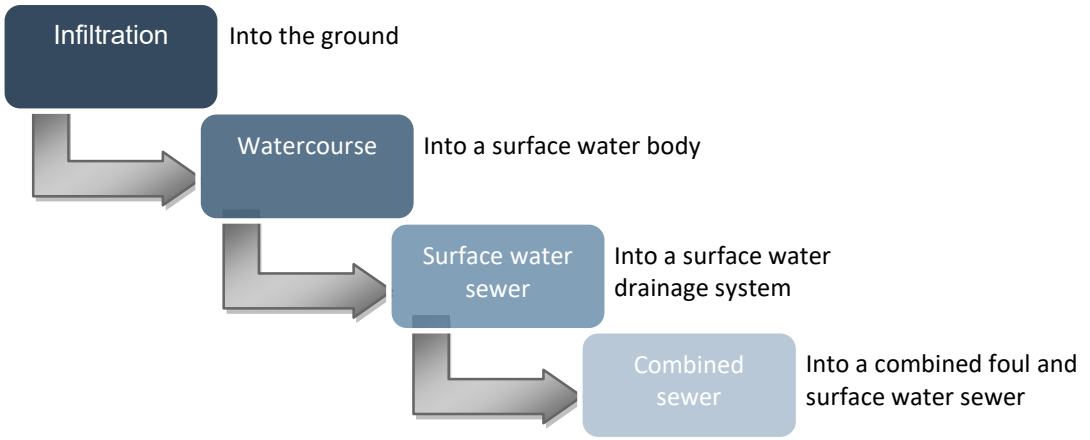
- Reduce the causes and impacts of flooding
- Remove pollutants from urban run-off at source
- Combine water management with green space with benefits for amenity, recreation and wildlife

2.13 In the consideration of major developments, sustainable drainage should be provided unless it can be demonstrated that this would be inappropriate. Major developments are defined in the Town and Country Planning Order 2015; some of these definitions encompass the following:

- Development site area of 1 hectare or more
- Provision of 10 or more residential dwellings
- Development of residential dwellings on a site having an area of 0.5 hectares or more and where the proposed no. of dwellings is not known to fall into the above criterion or not
- Provision of buildings where the floor space to be created by the development is 1,000m^2 or greater

2.14 The aim of sustainable drainage systems is to dispose of surface water using the following hierarchy were reasonably practicable.

FIGURE 1: SURFACE WATER DISPOSAL HIERARCHY



2.15 The assessment of what is considered to be reasonably practicable in terms of sustainable drainage system provision should consider the costs associated with the design, construction, operation and maintenance of the system, and whether these are economically proportionate in relation to the consumer costs for an effective drainage system that instead connects directly to a public sewer.

CAMDEN COUNCIL - STRATEGIC FLOOD RISK ASSESSMENT (SFRA)

2.16 The main purpose of the SFRA is to provide sufficient flood risk information to enable an update of any flooding policies within the area. In achieving this, the SFRA will achieve the objectives of:

- Influencing Council policy regarding decisions that are made
- Aiding the Council's response to proposed developments
- Recognising means of reducing flood risk
- Inform the emergency flood plans

2.17 Camden Council's Strategic Flood Risk Assessment was prepared by URS which was published in July 2014.

ADDITIONAL POLICY / GUIDANCE

2.18 The following documents were consulted to inform the drainage strategy for the site:

- Camden Council Local Plan, *Camden Council 2017*
- Managing flood risk in Camden: The London Borough of Camden flood risk management strategy, *Camden Council 2017*
- Surface Water management Plan, *Halcrow 2011*
- Advice Note on contents of a Surface Water Drainage Statement & Proforma, *Camden Council*
- Camden Planning Guidance Water & Flooding, March 2019
- The London Plan, 2016

2.19 Consideration of the following is also addressed in this report, where applicable:

I. The presence of constraints that must be considered prior to planning infiltration SuDS.

II. The drainage potential of the ground.

III. Potential for ground instability when water is infiltrated.

IV. Potential for deterioration in groundwater quality as a result of infiltration.

2.20 Camden Council Local Plan, **Policy CC2 Adapting to climate change**

The Council will require development to be resilient to climate change. All development should adopt appropriate climate change adaptation measures such as:

A. The protection of existing green spaces and promoting new appropriate green infrastructure;
B. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;
C. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and
D. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

2.21 Camden Council Local Plan, **Policy CC3 Water and flooding**

The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. We will require development to:

A. incorporate water efficiency measures;
B. avoid harm to the water environment and improve water quality;
C. consider the impact of development in areas at risk of flooding (including drainage);
D. incorporate flood resilient measures in areas prone to flooding;
E. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and
F. not locate vulnerable development in flood-prone areas.

Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable.

2.22 The London Plan **Policy SI 13: Sustainable Drainage -** Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation, and 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 drainage hierarchy

2.23 The drainage assessment in this report will ensure that any proposals for additional drainage are assessed and mitigated, against flood risk, and incorporate good SuDS practices where possible.

3. DEVELOPMENT DESCRIPTION

3.1 The Tybalds Estate site is located within the southern portion of the borough of Camden, and is located off Orde Hall Street, Holborn, WC1N 3JP. Please refer to Figure 2 & 3 below for the site location and for an aerial view of the site.

FIGURE 2: SITE LOCATION

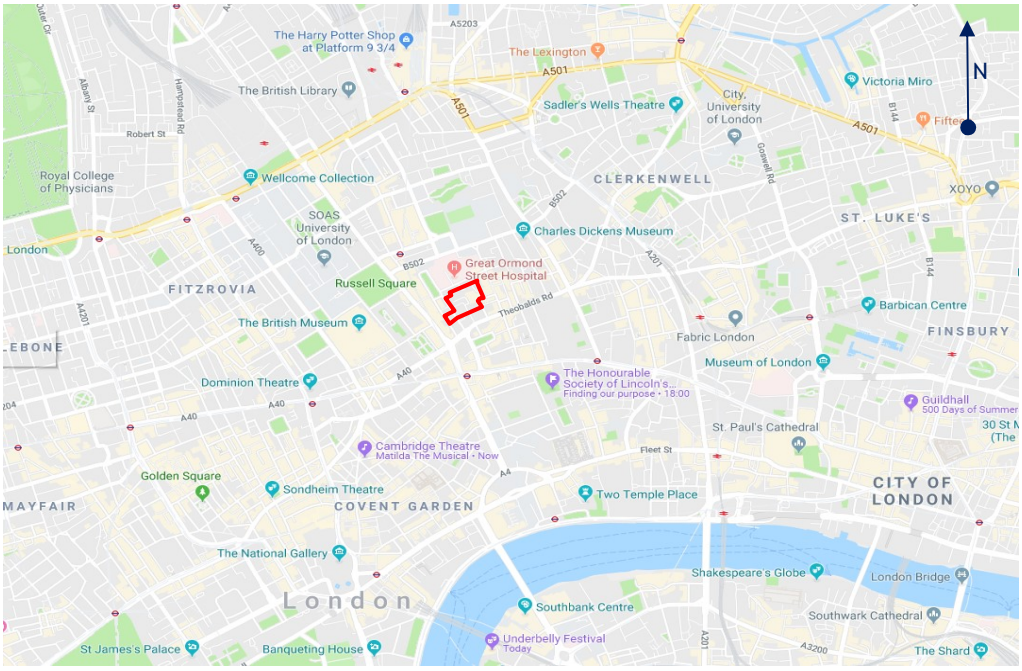
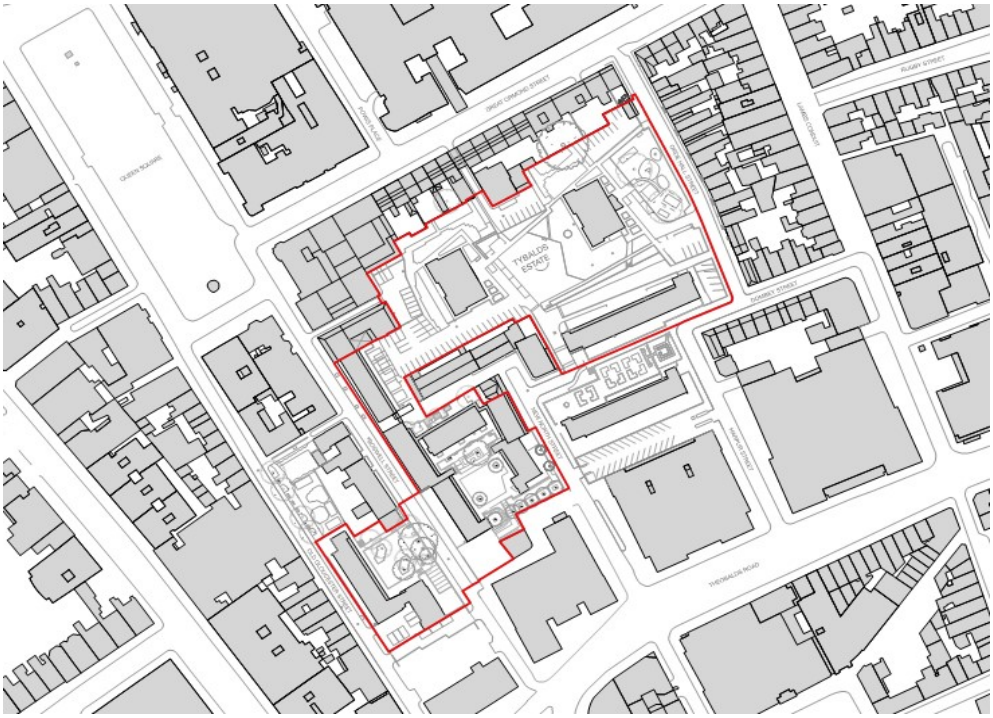


FIGURE 3: SITE ARIEL VIEW (BOUNDARY APPROXIMATED)



3.2 The 1.584Ha site is an irregular shape site and is bound to the north by the rear of the properties that front on to Great Ormond Street, with the Great Ormond Street Hospital on the adjacent site of the road. The eastern side of the site is bounded by the kerb alignment of Orde Hall Street and follows the alignment around Dombey Street and part way down Harpur Street. The boundary then turns southwest, with the southern boundary of the site aligning with the back of commercial properties including Warner Bros & mediaCom, which front on to Theobalds Road. The southern boundary continues southwest and runs across New North Street, where the boundary then turns northwest where it meets Old Gloucester Street, to capture a parcel of land. The site boundary then turns back northeastward up to the back of the properties that front Great Ormond Street.

3.3 The proposed infill development and improvement of Tybalds Estate, which is current housing estate, that has a number of medium to high rise blocks that are made up of a number of apartments. External areas are primarily made up of hard landscaping for car parks and footpaths, with also some soft landscaping areas. The proposals are to provide 3no. new buildings, Blocks B, C, & D. Some of which are extensions on to existing structures and some are standalone new units. In addition, a number of the existing buildings are to have their lower ground floor converted in to habitable spaces providing further residential units. There is also a proposal for a re development to the external areas, providing car parking facilities, sports facilities and public open spaces. There is also a proposal for a run of mews properties referred to as the eastern & western mews providing 10no. houses.

3.4 Refer to Appendix A for a copy of the proposed site layout.

4 GEOLOGY & HYDROLOGY

4.1 Geological conditions at the site are detailed below in Table 4 and are based on on-site intrusive works carried out by GEA as part of a Ground Investigation Report (Ref: J15072 Dated May 2015). These comprised of 4No. Boreholes to a depth of 5.0m. The on-site information has been cross referenced and aligns with the British Geological Survey (BGS) Viewer. The focus of an FRA study on geology is to examine the potential movement of water through the local geology.

TABLE 4: GEOLOGICAL GROUND CONDITIONS

Formation	Depth (bgl)	Description
Artificial Ground (Made Ground)	2.00-4.9m	These soils were variable, and comprised brown, reddish brown and greyish brown very sandy gravelly clay or sandy gravel with brick, concrete, clinker, glass and flint fragments
Superficial Deposits (Drift Deposits)	2.30 - 4.30m	Lynch Hill Gravel Member - Sand and gravel. Sedimentary superficial deposit formed between 362 and 126 thousand years ago during the Quaternary period.
Bedrock	to depth of 5.00m and below	London Clay Formation - Clay, silt and sand. Sedimentary bedrock formed between 56 and 47.8 million years ago during the Palaeogene period.

4.2 With reference to section 4.3.2 of the Camden SFRA '*Flooding From Groundwater' the anticipated groundwater level is as follows* "In the areas with superficial deposits, the expected depths to the water table is either between 3 and 5m for part of year or <3m for part of the year."

4.3 With reference to the GEA Ground Investigation Report a minimum record depth of the groundwater level in a standpipe was 3.42m bgl.

4.4 The GEA ground investigation report notes that results from contamination testing show elevated concentrations of lead and PAH, including benzo(a)pyrene, within the made ground, and minor elevations of hydrocarbons in the groundwater. Asbestos fibres were identified in samples tested from across the site.

4.5 The hydrogeological features of the site are provided in summary in Table 5. Hydrogeological features of the site have been identified from the DEFRA Magic Map application.

TABLE 5: HYDROGEOLOGICAL GROUND CONDITIONS

Map Dataset	Designation	Comment
Groundwater Vulnerability Zone	Minor Aquifer High	This describes the vulnerability of the underlying groundwater body from activities carried out on the surface. High - Areas able to easily transmit pollution to groundwater. They are characterised by high leaching soils and the absence of low permeability superficial deposits.
Aquifer Maps: Bedrock Deposits Designation	Unproductive	These rocks have negligible significance for water supply or baseflow to rivers, lakes and wetlands. They consist of bedrock or superficial deposits with low permeability that naturally offer protection to any aquifers that may be present beneath.
Aquifer Maps: Superficial Deposits Designation	Secondary A	These are Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
Groundwater Source Protection Zone	Zone 0	This zone has no groundwater source protection zone.

5 FLOOD RISK

5.1 The NPPF and the SFRA identifies several potential sources of flooding that must be considered when assessing flood risk, these are considered below in the following order:-

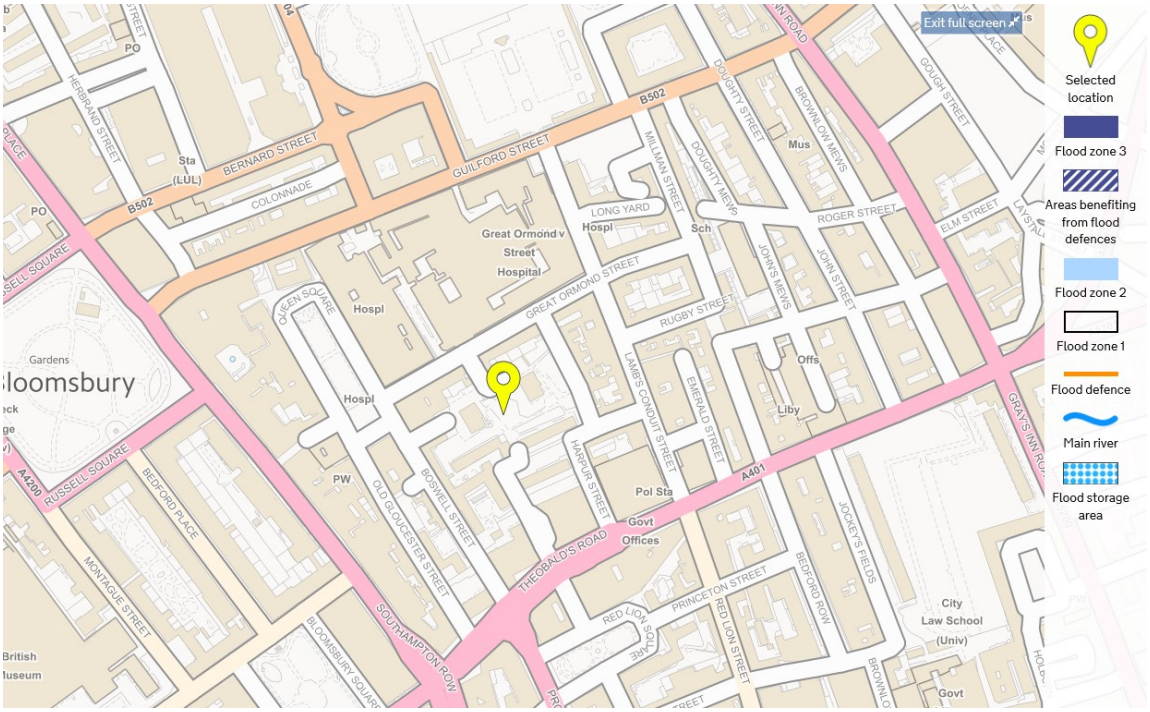
- Flooding from rivers (fluvial flooding)
- Flooding from the sea (tidal flooding)
- Flooding from land
- Flooding from sewers
- Flooding from groundwater
- Flooding from reservoirs, canals, and other artificial sources

5.2 Please refer to Appendix B for a full suite of the flood map data for the site.

FLOODING FROM RIVERS (FLUVIAL FLOODING) & SEA (TIDAL FLOODING)

5.3 The indicative flood maps published by the Environment Agency (EA) identifies that the site is located entirely within Flood Zone 1.

FIGURE 4: EA FLOOD MAP FOR PLANNING



5.4 In summary the site is at less than 1 in 1000 year Annual Exceedance Probability (AEP) of flooding from rivers and seas and is therefore at very low risk.

FLOODING FROM SURFACE WATER

5.5 The EA Risk of Flooding from Surface Water map is published on their website to identify areas potentially at risk of flooding from surface water. This mapping identifies Overland flow and surface water flooding which typically arises following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems, it can run quickly off land and result in localised flooding.

5.6 With reference to the Surface Water flood risk maps, the site is predominantly at very low risk, but within the confines of the site there are some localised areas that are at low risk of surface water flooding.

5.7 With reference to the Camden SFRA Section 4.2, the site is not located within Local Flood Risk Zone (LFRZ) but is located within a Critical Drainage Area (refer to Appendix B: Figure 6 of the SFRA). This is defined as *"A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure."*

5.8 In summary, the site is deemed to be at low risk of flooding from surface water.

FLOODING FROM GROUNDWATER

5.9 Flooding from groundwater can happen when the water table rises. The level of the water table changes with the seasons due to variations in long term rainfall and water abstraction. When the water table rises and reaches ground level, water starts to emerge on the surface and flooding can happen.

5.10 With reference to the Camden SFRA Appendix B Figure 4e, which shows mapping for Increased Potential for Elevated Groundwater. The development site is shown to lie outside an area that has elevated susceptibility to groundwater flooding. There is also no recorded groundwater flooding incidents record within the site.

5.11 In summary, the site is deemed to be at low risk of flooding from groundwater.

FLOODING FROM SEWERS

5.12 During heavy rainfall, flooding from the sewer system may occur where the rainfall event exceeds the capacity of the drainage system. The system becomes blocked by debris or sediment. The system surcharges due to high water levels in receiving watercourses.

5.13 With reference to Section 4.4 of the Camden SFRA *'Flooding from Sewers'* it denotes that the majority of borough is served by a combined sewer system. The North London SFRA identifies the sewer network within Camden is particularly old,

with some sections of sewer potentially designed to only convey storms up to the 10% AEP event.

5.14 The combined sewer network currently outfalls into the River Thames during intense rainfall events when the sewer network reaches capacity. However, there is evidence that during the 1975 and 2002 extreme rainfall events surcharging of the local sewer network occurred as its capacity was exceeded. This is potentially due to the inability of the combined sewer network to discharge to the River Thames at a high enough rate to convey surface water during extreme rainfall events.

5.15 With reference to Appendix B Figure 5a & 5b of the Camden SFRA, which maps out recorded internal sewer flooding & external sewer flooding records respectively which were provided by Thames Water. Neither maps show recorded events in and around the site, where most events are recorded in the northern portion of the borough of Camden.

5.16 In summary, the site is deemed to be at low risk of flooding from sewers.

HISTORICAL FLOODING

5.17 Section 4.2 of the Camden Council SFRA notes two significant flood events that happened within the borough. One in August of 1975 and one in August 2002. It is of note that both events took place within the northern portion of the borough and not within proximity of the site. The SFRA documents that both events were due to large intense rainfall events causing surcharging of the sewers.

FLOODING FROM RESERVOIRS, CANALS & OTHER ARTIFICIAL SOURCES

5.18 Environment Agency Reservoir Flood Mapping shows that flooding from reservoir failure in this area would not extend into the development site.

5.19 With reference to the ordnance survey map and mapping provided by the River & Canal Trust there is no other water sources within reasonable proximity of the site. The nearest watercourse in the Regents Canal which is approximately 1.5km directly north of the site.

5.20 In summary the site is deemed to be at very low risk of flooding from reservoirs and other sources.

6 SURFACE AND FOUL WATER DRAINAGE DESIGN

EXISTING

6.1 A utilities survey of the site has been carried out. The survey picks up a number of utilities, including drainage infrastructure. Refer to Appendix C.

6.2 From the survey there is no apparent separate foul and surface water network serving the site. Given the information provided by Camden Council and the information provided in the utility survey, it is therefore assumed that the network serving the site is a combined sewer network. It is important to note that the site is served by a live and fully operational sewer network.

6.3 The surface water run-off from the site is primarily collected either through a series of rainwater pipes from the existing buildings or a number gullies at ground level that serve the hardstanding areas around the site. All of these drain in to one of the combined sewer networks that are located within the site bounds.

6.4 The utility survey identifies a number of combined sewer discharge locations around the site, all of which are assumed to outfall in to the public combined sewers under ownership of the local water authority – Thames Water.

6.5 A combined sewer network to the north of the site conveys both foul and surface water from Babington Court and Chancellors Court and the surrounding hardstanding areas through a series of 150mm pipes and discharges from the site to the north through a vehicular passage (Barbon Street) on to Great Ormond Street. It is assumed there is an outfall in to a public sewer under Great Ormond Street.

6.6 To the east and the portion of the site fronting on to Orde Hall Street, another combined network conveys surface water flows from the hardstanding areas and foul flows from Chancellors Court. Flows are carried through 100 & 150mm pipes and outfall in to what is assumed a 1067x610 public combined sewer under Orde Hall Street. As the site boundary turns around Dombey Street, there is another combined sewer discharge location, which takes foul and surface flows from Blemundsbury and discharges this through a 225mm pipe in to a 1118x787 combined sewer under Dombey Street.

6.7 To the south of the site there are 3no. identifiable discharge locations one to the east of Windmill block and two to the west all of which discharge flows from the Windmill block to the public combined sewer under Harpur Street (1143x762) and New North Street (1143x762) respectively.

6.8 Richbell House and Springwater is also served by a combined sewer network that conveys foul and surface water flows through a series of 150mm pipes and heads eastward towards New North Street. Although the final outfall location has not been traced by the survey, it is assumed that it discharges in to the public combined sewer under New North Street.

6.9 In the south west corner of the site sits Falcon House. Foul and surface water from this area is conveyed in a 150mm diameter combined sewer that discharges to a 1093x635 public trunk sewer under Old Gloucester Street.

6.10 The utility survey provides no evidence of any on site SuDS features or flow control devices, and therefore it is assumed that the site discharges surface water at an unrestricted rate.

6.11 In Table 6 below, is a summary of the greenfield run off rates for the entire developable site (1.584Ha). Refer to Appendix D for a Micro Drainage calculations.

TABLE 6: GREENFIELD RUN OFF RATES

Event	Greenfield Run Off Rate
QBar	2.46 l/s
1 in 1 year	2.09 l/s
1 in 30 year	5.66 l/s
1 in 100 year	7.85 l/s

6.12 As the site is already developed (brownfield) the greenfield runoff rates above do not give a true representation of the current surface water discharge rates from the site. An assessment of the existing impermeable areas within the site has been conducted and shows that within the redline boundary, a total area of 14,032m^2 of hardstanding discharges surface water to the sewer network. Please refer to Appendix E.

6.13 On the basis that the site freely discharges, the modified rational method can be adopted in line with Section 24.6.2 of the CIRIA "The SuDS Manual", in order to determine an estimate for the existing surface water runoff rate from the site. Table 7 below outlines the existing run off rates for a number of events. The average intensities are based on FSR rainfall data and a winter rainfall profile for a duration of 15 minutes, please refer to Appendix F for Micro Drainage results.

TABLE 7: EXISTING BROWNFIELD RUN OFF RATES

Event	Average intensity (i) 15min Winter Event	Calculation	Brownfield Discharge Rate
1 in 1 year	33.1mm/hr	Q= 3.61 x 1.00 x 33.1 x 1.403	**167.65l/s**
1 in 30 year	81.3mm/hr	Q= 3.61 x 1.00 x 81.3 x 1.403	**411.80l/s**
1 in 100 year	105.8mm/hr	Q= 3.61 x 1.00 x 105.8 x 1.403	**535.90l/s**

6.14 Below in Table 8 is a calculation providing discharge volumes from the existing site based on an average intensity for varying events for a 6 hour winter storm for the 14,032m^2 of impermeable hardstanding. Please refer to Appendix G for Micro Drainage results for determining the average intensity values.

TABLE 8: EXISTING BROWNFIELD DISCHARGE VOLUMES

Event	Average intensity (i) 6hr Winter Event	Calculation	Brownfield Discharge Volume
1 in 1 year	3.62mm/hr	V = (3.62/1000) x 6 x 14032	**304.80m^3**
1 in 30 year	7.98mm/hr	V = (7.98/1000) x 6 x 14032	**671.90m^3**
1 in 100 year	10.36mm/hr	V = (10.36/1000) x 6 x 14032	**872.25m^3**

PROPOSED

6.15 Of the 1.584Ha site at the post development stage the site is proposed to consist 1.37Ha (13,743m^2) of hard landscaping the remainder of the site will consist of soft landscaped areas. The development results in a decrease of 289m^2 of hard landscaping which is a decrease of 2.00% in hard paved areas. Refer to Appendix H.

6.16 There are a number of guidance documents provided by Camden Council relating to the design and implementation of SuDS within the borough of Camden. They set out the following guidance on sustainable drainage system:

- *Major developments (including refurbishments) should submit a drainage report and meet London Plan run-off reduction targets. The drainage system needs to be able to cope with the heaviest of rainfall expected over the building's lifetime, water infrastructure should be designed to cope with all storms up to and including the 1 in 100 year 6 hour storm.*

- *The Council also expects the drainage system to be designed to accommodate a 20% climate change allowance on top of the 1 in 100 year storms. Applicants should apply a sensitivity test against the 40% climate change allowance to ensure that the additional runoff is wholly contained within the site and that there is no increase in the rate of runoff discharged from the site.*

- *Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.*

- *Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded.*

- *Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required.*

CLIMATE CHANGE ALLOWANCES

6.17 In accordance with the Camden Planning Guidance Water & Flooding, The Council expects the drainage system to be designed to accommodate a 20% climate change allowance on top of the 1 in 100 year storms. Applicants should apply a sensitivity test against the 40% climate change allowance to ensure that the additional runoff is wholly contained within the site and that there is no increase in the rate of runoff discharged from the site. This aligns with the guidance provided by the EA replicated in Table 9 below.

TABLE 9: PEAK RAINFALL INTENSITY CLIMATE CHANGE ALLOWANCE

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

6.18 In accordance with the hierarchy for discharge of surface water. It is considered that infiltration is unlikely to be a suitable method of surface water disposal, primarily due to underlying geology, hydrogeology and existing ground contamination as per section 4.4.

6.19 Following the surface water disposal hierarchy downwards, the next suitable method of discharge is to a watercourse. Given that the existing site is not within close proximity of a water course, this is not a viable option for the site. The nearest water course is the River Thames which is 1.3km due south from the site.

6.20 The site is not served by a separate surface and foul water network system. As detailed through points 6.1 – 6.10 there is an extensive existing combined sewer system serving the site that discharges at a number of locations around the site. As per the surface water hierarchy the next viable option is to discharge to a combined public sewer.

6.21 Given that the proposed re-development of the 1.584Ha Tybalds Estate, primarily consists of a number of new buildings spread across the site that amount to a small land area in comparison to the whole site, It would be impractical for the project to restrict the surface water discharge from the entire 1.584Ha site. This would result in a huge amount of works to the existing drainage infrastructure, that is already serving the site.

6.22 It is proposed to provide betterment on the surface water run off where possible across the site. As part of the re-development, it is proposed to incorporate green/blue roofs to all new buildings which will discharge at a restricted rate in to the nearest existing combined sewer. The green roof will not only provide attenuation but will also enhance the water quality of the discharge and limit the discharge rate off the roof.

6.23 The approximate available roof space is made up of proposed Blocks B (220m^2), C (137m^2), D (125m^2), Western Mews (195m^2) and the Eastern Mews (112m^2). The total roof area amounts to 790m^2. Based on a typical 80mm storage layer within the green/blue roof construction, this will provide 60.00m^3 of surface water attenuation.

6.24 Also, where possible permeable paving will be proposed to new parking areas within the site. This will again provide a controlled discharge to the surface water as the run off routes through the permeable sub-base, it is not anticipated that a designated flow control device is required as the permeable pavement will itself provide a slower discharge rate which will provide a form of betterment to the existing rate.

6.25 There are a number of proposed external areas that are to be occupied with permeable pavement amounting to approximately 510m^2 (inclusive of pitch area). Based on the assumption of a 150mm depth permeable sub-base with a typical 30% void ratio, this has the potential to provide 23.00m^3 of surface water storage.

6.26 The combination of the proposed green/blue roofs and the lined permeable pavement amounts to 83.00m^3 of on-site surface water attenuation.

6.27 The proposed multi-use sports pitch located in the centre of the site covers an area of 295m^2. This sports pitch is subject to specialist design but also has the potential to be a SuDS feature by being underlain with a lined permeable sub-base. The pitch is currently assumed as an impermeable area as it will contribute to the developments runoff.

6.28 All proposed surface water networks mentioned above will be connected to the nearest existing combined sewer location, to minimise unnecessary below ground drainage runs. It is not proposed to do any major alterations to the existing drainage infrastructure which will stay primarily the same.

6.29 As in accordance with the SuDS requirements of Camden Council, the proposed new drainage infrastructure will be designed to accommodate all storm events up to and including the 1 in 100 year storm event plus the allowance for climate change in accordance with Camden Council guidance.

6.30 For the existing buildings, it is anticipated that the foul network serving these buildings along with SVP and foul pop-up locations will stay the same as existing and no alterations will be required. Where an under build is taking place to introduce flats in the converted lower ground floor space, foul water infrastructure will be required to serve the habitable spaces. It is anticipated that these will drain in to the nearby combined sewer network that are already serving the buildings.

6.31 The new proposed buildings within the development will have a proposed foul water network that will convey all generated foul flows through a gravity system and connect in to the nearest viable point in to the existing on site combined sewer.

6.32 A Thames Water pre-development enquiry has been submitted with a response expected shortly. The response is expected to confirm that there is capacity within the public sewer network to accommodate the post development flows from the site.

6.33 Refer to Appendix I for a proposed Drainage General Arrangement drawing.

7 SUDS MAINTENANCE AND MANAGEMENT

7.1 The responsibility for the enacting of this SuDS Maintenance and Management Plan will be the responsibility of the property owner.

CATCHPITS

7.2 Catchpit chambers and manholes provide a degree of pollution control in preventing silt and debris passing forwards into the drainage network.

7.3 The operation and maintenance requirements are given in the table below:

Maintenance Schedule	Required Action	Recommended Frequency
Regular maintenance	Clean and empty catchpits.	Quarterly.

PERMEABLE PAVING

7.4 Permeable block paving allows water to infiltrate through gaps between the blocks into a layer of gravel / granular material.

7.5 The operation and maintenance requirements are given in the table below:

Maintenance Schedule	Required Action	Recommended Frequency
Regular maintenance	Sweeping. **Note:** Any jointing material between the blocks that is lost or displaced as a result of sweeping must be replaced. New jointing material must be the same type as that removed or a suitable replacement.	Three times a year at the end of winter, mid-summer and after autumn lead fall. Also as required based on site-specific observations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas to prevent excess sediment being washing into the paving.	As required.
	Removal of weed.	As required.
Remedial actions	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users.	As required.
	Rehabilitation of surface and underlying sand and geotextile.	As required (if performance is significantly reduced as a result of significant clogging).

Monitoring	Inspect for evidence of poor operation and/or weed growth. If required take remedial action.	Monthly for three months after installation, then during regular maintenance visits.

7.6 Refer to the design drawing in Appendix I for the location of the areas of permeable paving.

7.7 Over time the ability of the permeable paving to infiltrate and convey surface water run-off may degrade due to clogging of the joints by silt and other sediments.

7.8 All areas of permeable pavement should be regularly inspected by those responsible, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

GREEN ROOF

7.9 Intensive green roofs are likely to require regular inspection and maintenance.

7.10 Grassed areas may require mowing weekly or fortnightly, plant beds may require weeding on a weekly or fortnightly basis during the growing season, and wildflower meadows may require annual mowing with the cuttings removed. Extensive green roofs should normally only require biannual or annual visits to remove litter, check for breaks and drains and, in some cases, remove unwanted invasive plants. The most maintenance is generally required during the establishment stage (12 to 15 months).

Maintenance Schedule	Required Action	Recommended Frequency
Regular maintenance	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability.	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Occasional maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant	Six monthly and annually or as required

	growth	
	During establishment (i.e. year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Action	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

8 RECOMMENDATIONS AND CONCLUSIONS

8.1 The proposal consists of the redevelopment of the Tybalds Estate across the 1.584Ha site that consists of a mixture of new buildings and redevelopment to existing buildings. The current site proposals have 3No. new buildings (Blocks B, C, D), some of which are extensions to existing buildings or are standalone new units. There is also a proposal for a run of mews properties to the north referred to as the eastern & western mews, providing 10no. houses. The lower ground floors of existing blocks are to be converted in to residential units and improvement works to the existing site parking and communal spaces.

8.2 Geological conditions at the site are based on the Ground Investigation Report by GEA (Ref: J15072 Dated May 2015). According to the investigation, superficial deposits consist of Lynch Hill Gravel Member - Sand and gravel and bedrock deposits of London Clay Formation.

8.3 The proposed site is not located in a groundwater source protection zone. Bedrock deposits are an 'Unproductive' aquifer and superficial deposits are a 'Secondary A' designation. The site is also located over a 'Minor Aquifer High' groundwater vulnerability zone.

8.4 The proposed development site is located within Flood Zone 1. From Table 2 the site is classified as 'More Vulnerable' (Flood Risk Vulnerability Classification) and therefore, from Table 3 the development is classified as 'appropriate'.

8.5 The EA published flood risk from surface water map shows that there is a predominately very low flood risk from surface water across the site. The reservoir flood risk map shows the site is not thought to be at flood risk from reservoirs and any other artificial sources. The Camden Council SFRA indicates that the site is shown to lie outside an area that has elevated susceptibility to groundwater flooding.

8.6 Due to the nature of the underlaying geology and presents of contaminates in the ground it is considered unlikely that infiltration will be a suitable means of surface water disposal. Given this, surface water discharge will be to the onsite combined sewer network.

8.7 In accordance with the Camden Planning Guidance Water & Flooding, The Council expects the drainage system to be designed to accommodate a 20% climate change allowance on top of the 1 in 100 year storms. Applicants should apply a sensitivity test against the 40% climate change

8.8 Given that the proposed re-development primarily consists of a number of new buildings. It would be impractical for the project to restrict the surface water discharge from the entire 1.584Ha site. This would result in a huge amount of works to the existing drainage infrastructure, that is already serving the site.

8.9 Of the 1.584Ha site at the post development stage the site is proposed to consist 1.37Ha (13,743m^2) of hard landscaping the remainder of the site will consist of soft landscaped areas. The development results in a decrease of 289m^2 of hard landscaping which is a decrease of 2.00% in hard paved areas.

8.10 It is proposed to provide betterment on the surface water run off where possible across the site. As part of the re-development, it is proposed to incorporate green/blue roofs to all new buildings which will discharge at a restricted rate. Also, where possible permeable paving will be proposed to new parking areas within the site. This will again provide a controlled discharge to the surface water as the run off routes through the permeable sub-base.

8.11 The combination of the proposed green/blue roofs and the lined permeable pavement amounts to 83.00m^3 of on-site surface water attenuation.

8.12 The nature of the proposed scheme comprises 3no. new block, 10no. town houses, new under build properties and the retention of the existing buildings. Given the uniqueness of the scheme, the amount of feasible SuDS features has been maximised in the development where possible to adhere to local policy, and minimise runoff rates as much as possible.

8.13 As in accordance with the SuDS requirements of Camden Council, the proposed new drainage infrastructure will be designed to accommodate all storm events up to and including the 1 in 100 year storm event plus the allowance for climate change.

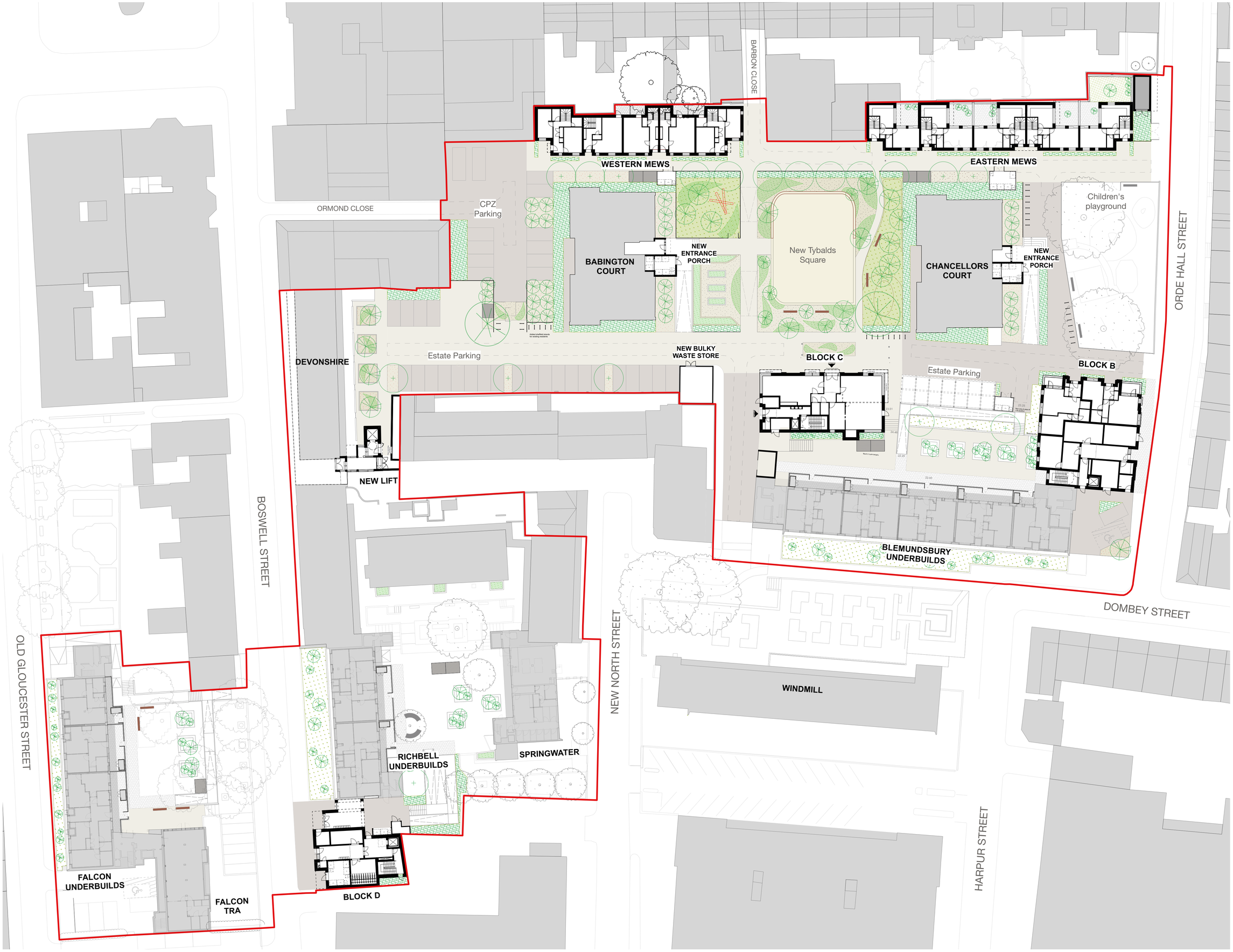
8.14 The new proposed buildings within the development will have a proposed foul water network that will convey all generated foul flows through a gravity system and connect in to the nearest viable point in to the existing on site combined sewer.

8.15 The responsibility for the enacting of this SuDS Maintenance and Management Plan will be the responsibility of the property/land owner.

APPENDICES

APPENDIX A

Proposed Site Layout



Notes:

1. Do not scale from this drawing.
2. All dimensions to be verified prior to the commencement of any work or the production of any shop drawings.
3. Matthew Lloyd Architects (MLA) shall be notified in writing of any discrepancies.
4. Survey and boundaries indicative only.
5. Proposals are subject to utilities surveys and specialist consultants' input & coordination.
6. Any areas indicated are approximate and indicative only.
7. Where an item is covered by drawings in different scales the larger scale drawing is to be worked to.
8. Drawing to be read in conjunction with relevant consultant's drawings and specifications.
9. Where MLA services on a project do not include for site inspections and work surveys, MLA do not warrant that 'as built' issue drawings are a complete and accurate record of what has been built.
10. MLA shall not be liable for the consequences of any use, misuse or variation of this drawing for any purpose other than that for which it was originally prepared.
11. This title block is copyright of MLA and should not be used, removed, or altered without permission and clear identification.

PROPOSED MASTERPLAN:

BLOCK B: 18 Private Tenure units

BLOCK C: TRA Hall and 6 Social Tenure units

BLOCK D: 12 Mixed Tenure units

EASTERN MEWS: 5 Private Tenure units

WESTERN MEWS: 5 Private Tenure units

UNDERBUILDS BLEMUNDSBURY: 5 Social Tenure units

UNDERBUILDS FALCON: TRA Hall and 3 Social Tenure units

UNDERBUILDS RICHBELL: 2 Social Tenure units

UNDERBUILDS SPRINGWATER: New caretaker's office

DEVONSHIRE COURT: New Lift

NEW BULKY WASTE STORE

BABINGTON COURT: New entrance porch

CHANCELLORS COURT: New entrance porch

BLEMUNDSBURY, RICHBELL, FALCON: New PVs on roofs

PUBLIC REALM UPDATES

Revisions:

PLANNING

Camden

MatthewLloydArchitectsLLP
1b The Hangar
Perseverance Works
38 Kingsland Road
London E2 8DD
T 020 7613 1934
email: mail@matthewlloyd.co.uk
www.matthewlloyd.co.uk

Original Sheet Size A1

0 5m 10m 15m

Date:	Scale:	Checked by:	Drawn by:
Jun-21	1:300 @ A1	ASp	GP

Project:
TYBALDS ESTATE
CAMDEN

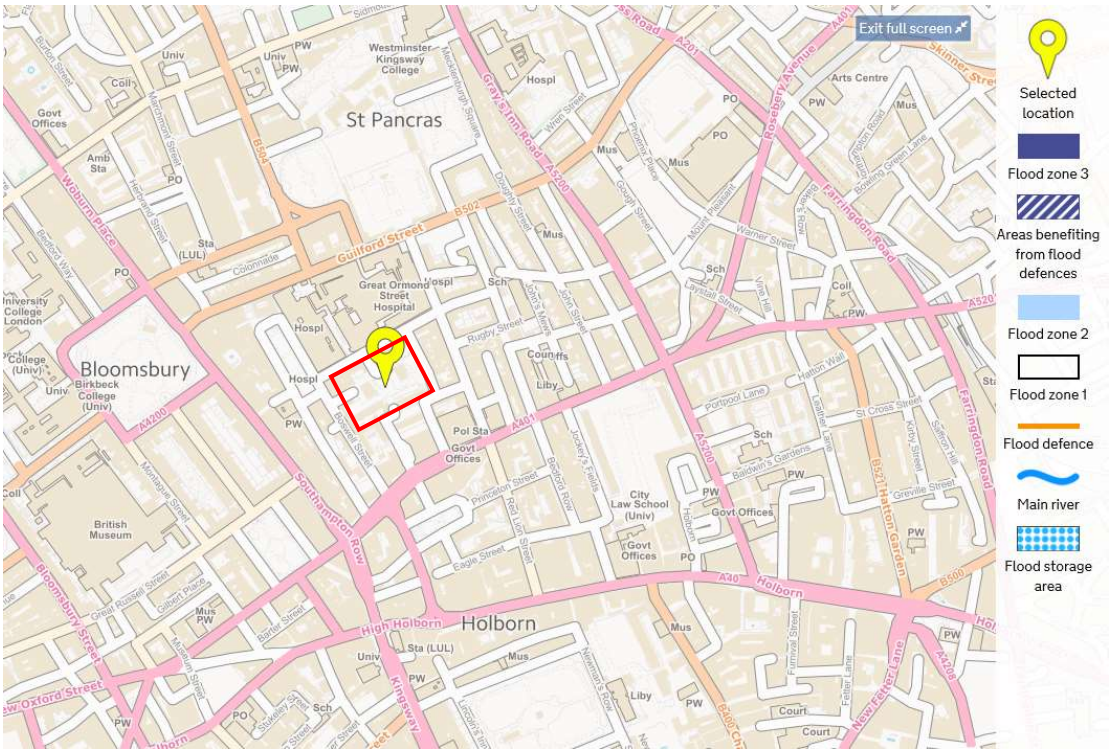
Drawing title:
PROPOSED MASTERPLAN-colour

Reference:	Dwg. No:	Rev.
TE	X-116	-

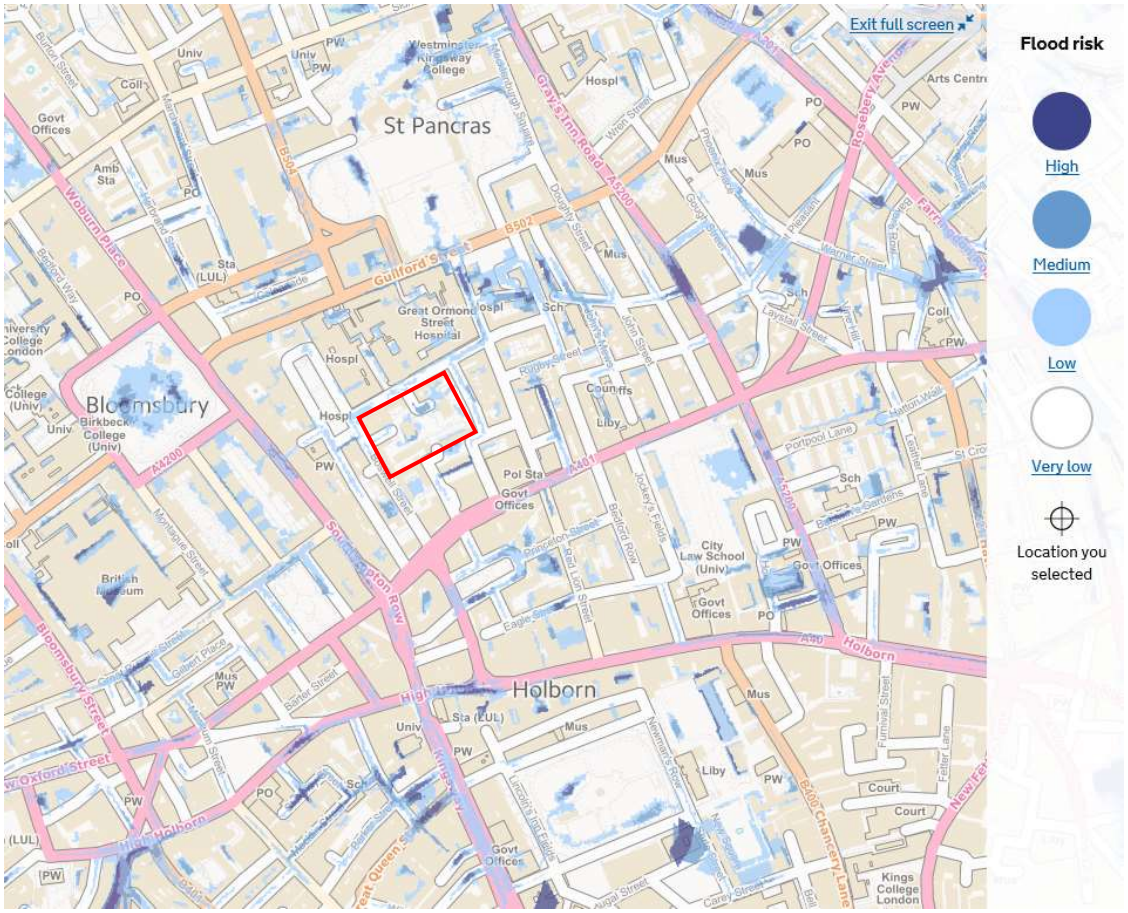
APPENDIX B

Flood Map Data

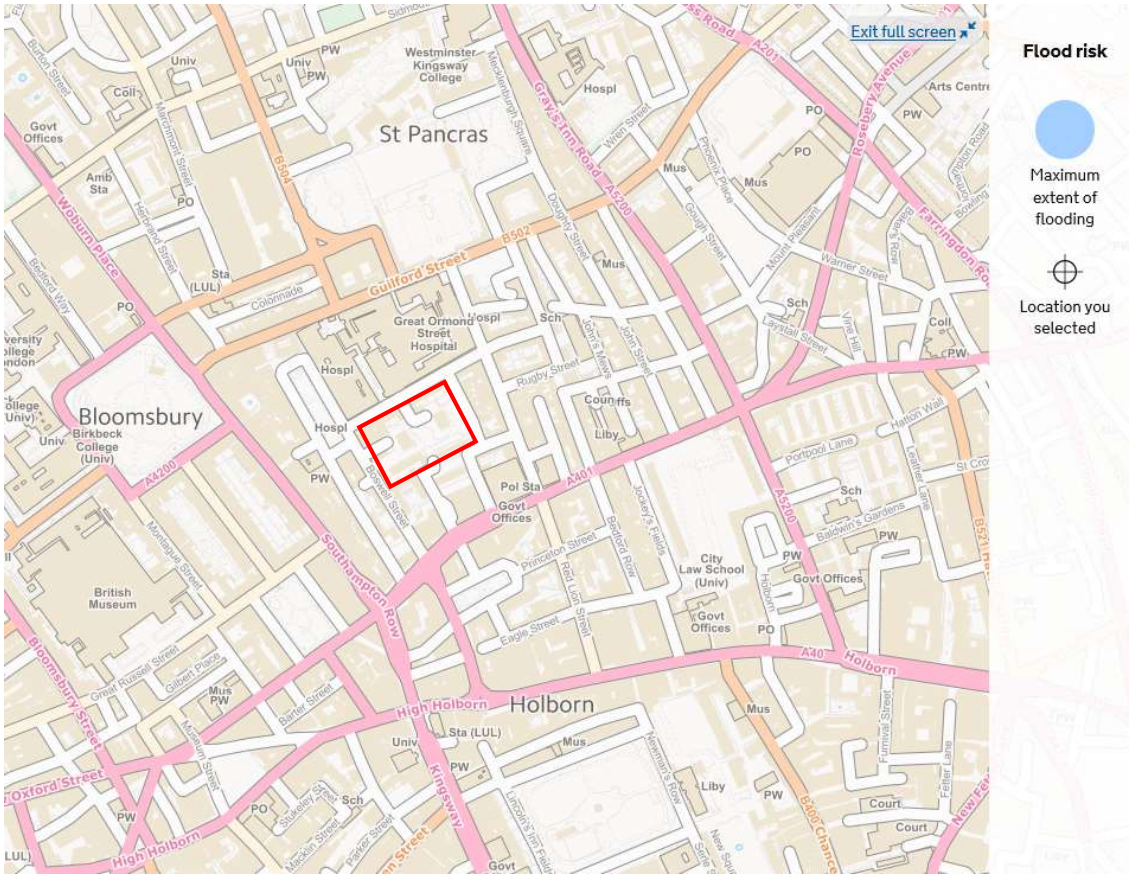
Flood Risk Map from Rivers & Seas



Flood Risk map from Surface Water



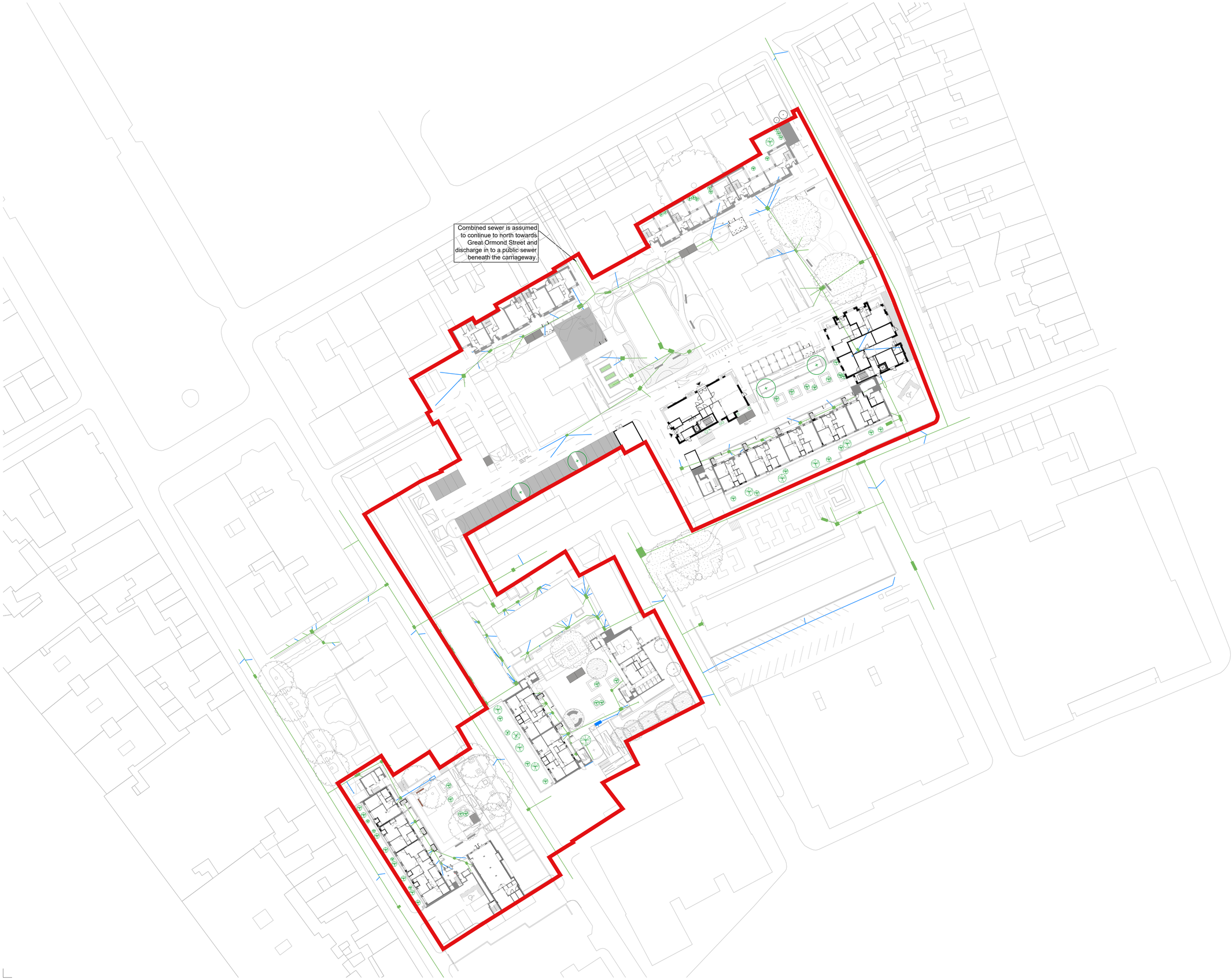
Flood Risk Map from Reservoirs



APPENDIX C

Existing Drainage Plan

General
1.1 This drawing is to be read in conjunction with all Architect's, Engineer's and Services Engineer's drawings and specifications.
1.2 Do not scale from any of the structural drawings. All dimensions to be verified on site and any discrepancies should be highlighted.
1.3 The contractor is responsible for the stability of the building and adjoining structures during construction and shall design, install, adapt and maintain all necessary propping and temporary works. A method statement for the temporary works must be submitted to the contractor
administrator for comment before work begins.
1.4 All materials to comply with the relevant British Standard.



REV	COMMENTS	DATE	CHK
P2	Revised for Site Layout	14.06.21	RJ
P1	For Information	26.09.19	RJ

STATUS
PRELIMINARY

mnp
mason navarro pledge
Consulting Civil and Structural Engineers
Bancroft Court
Hitchin
Hertfordshire, SG5 1LH
Telephone: 01462 632012
Email: office@mnp.co.uk
www.mnp.co.uk

CLIENT
Camden

PROJECT
Tybalds Estate
Camden

DRAWING TITLE
Drainage Survey Plan

SCALE	DRAWN BY	DATE
1:500 @ A1	AQ	Sept 2019

DRAWING No. **219218-C-901**
REV **P2**

APPENDIX D

Greenfield Runoff Rate

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Andrew Quinn
Site name:	Tybalds Estate
Site location:	London

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.52129° N
Longitude:	0.12008° W
Reference:	650627083
Date:	Jun 08 2021 13:50

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 1.584

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	611	611
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	2.46	2.46
1 in 1 year (l/s):	2.09	2.09
1 in 30 years (l/s):	5.66	5.66
1 in 100 year (l/s):	7.85	7.85
1 in 200 years (l/s):	9.21	9.21

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.500
Ratio R	0.437
Areal Reduction Factor	1.00
Area (ha)	1.584
SAAR (mm)	613
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	27.00
Greenfield Runoff Volume (m^3)	91.971

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.500
Ratio R	0.437
Areal Reduction Factor	1.00
Area (ha)	1.584
SAAR (mm)	613
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	28.85
Greenfield Runoff Volume (m^3)	217.137

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.500
Ratio R	0.437
Areal Reduction Factor	1.00
Area (ha)	1.584
SAAR (mm)	613
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	30.88
Greenfield Runoff Volume (m^3)	301.600

APPENDIX E

Existing Impermeable Area Plan

General

1.1 This drawing is to be read in conjunction with all Architect's, Engineer's and Services Engineer's drawings and specifications.
1.2 Do not scale from any of the structural drawings. All dimensions to be verified on site and any discrepancies should be highlighted.
1.3 The contractor is responsible for the stability of the building and adjoining structures during construction and shall design, install, adapt and maintain all necessary propping and temporary works. A method statement for the temporary works must be submitted to the contractor
administrator for comment before work begins.
1.4 All materials to comply with the relevant British Standard.

Legend

Key	Description
	Impermeable Area = 14,031,942m^2
	Permeable Area = 1,804,370m^2

REV	COMMENTS	DATE	CHK
P3	Revised for Site Layout	14.06.21	RJ
P2	Minor update	05.05.21	RJ
P1	Preliminary Issue	25.09.19	RJ

STATUS

PRELIMINARY

mnp
mason navarro pledge
Consulting Civil and Structural Engineers
Bancroft Court
Hitchin
Hertfordshire, SG5 1LH
Telephone: 01462 632012
Email: office@mnp.co.uk
www.mnp.co.uk

CLIENT

Camden

PROJECT

Tybald Estate
Orde Hall Street
Camden

DRAWING TITLE

Existing Impermeable Area Plan

SCALE	DRAWN BY	DATE
1:500 @ A1	AQ	Sept 2019

DRAWING No. **219218-C-SK001** REV **P3**

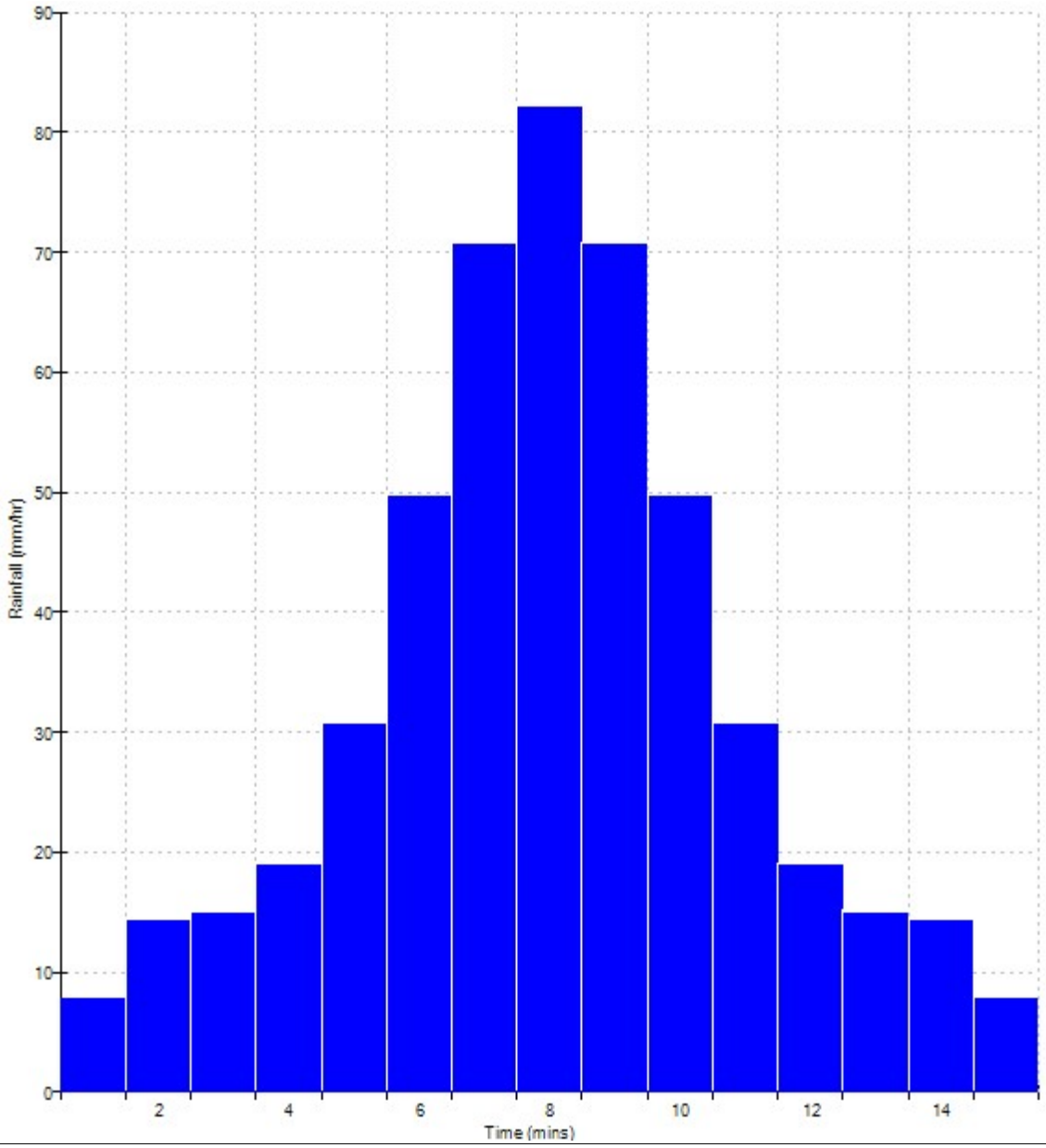
APPENDIX F

Existing Brownfield Intensity Values

Rainfall profile

Storm duration (mins) 15

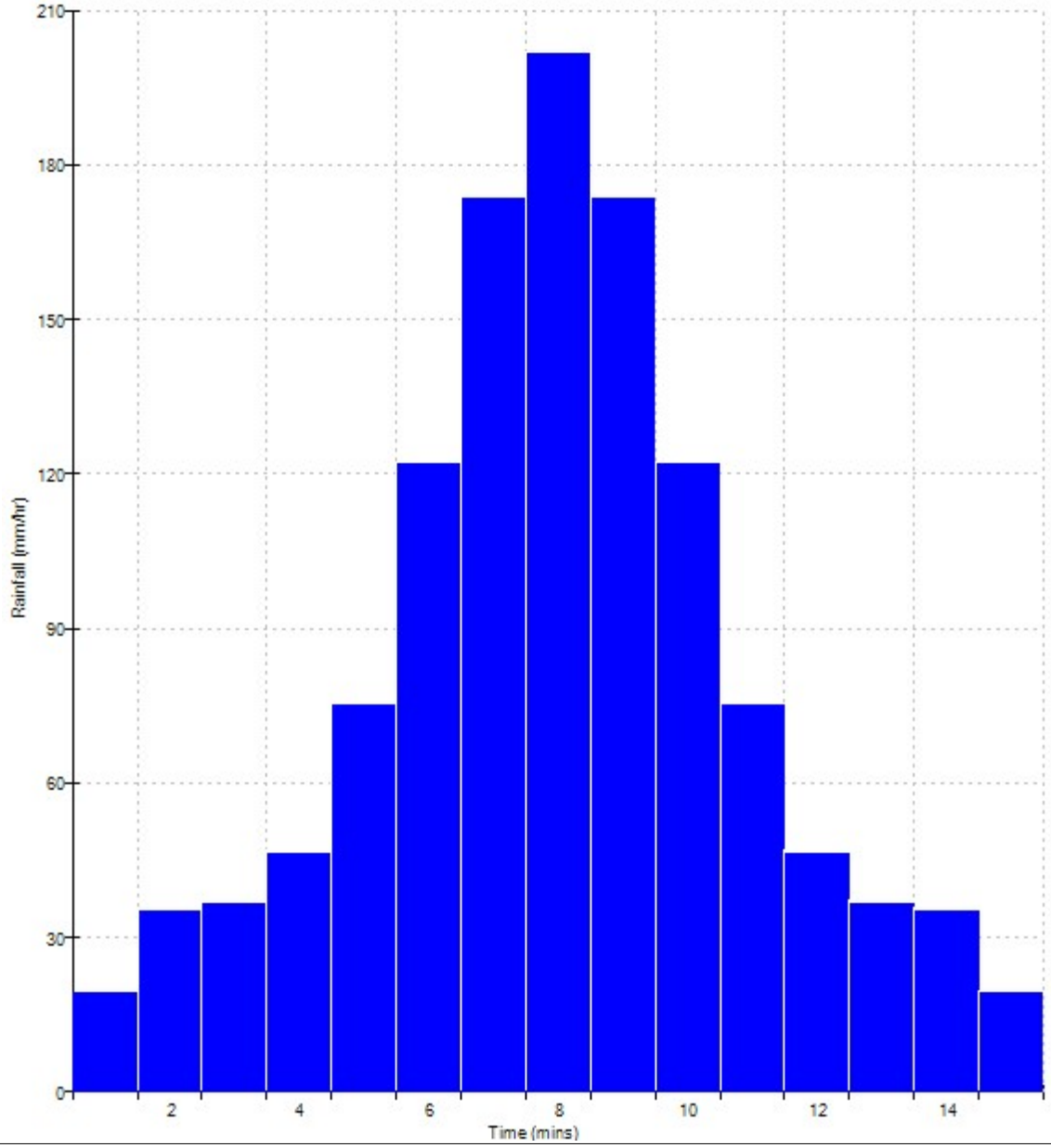
FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	82.101
Ave. Intensity (mm/hr)	33.106
Return Period (years)	1.0



Rainfall profile

Storm duration (mins) 15

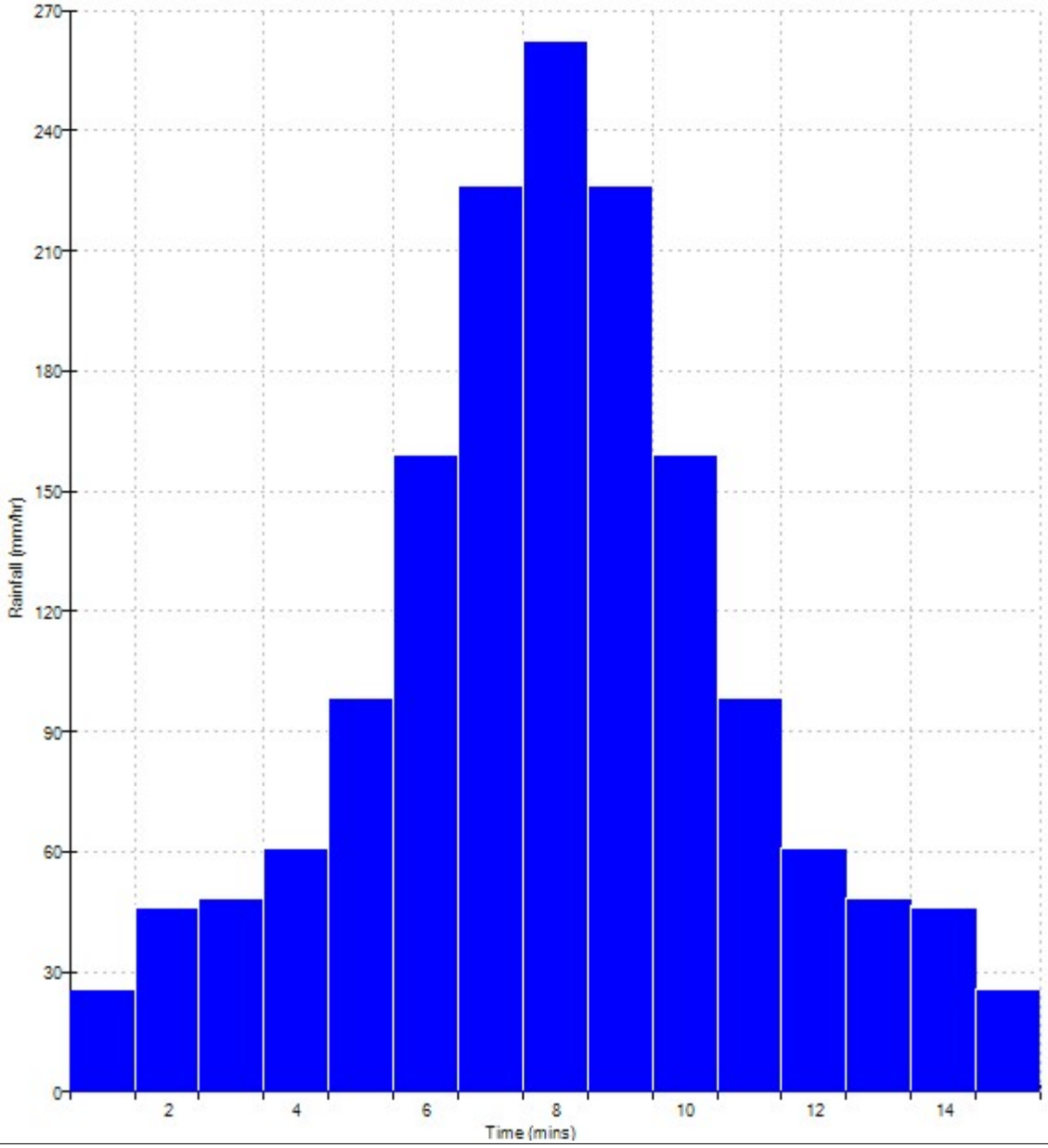
FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	201.632
Ave. Intensity (mm/hr)	81.304
Return Period (years)	30.0



Rainfall profile

Storm duration (mins) 15

FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	262.293
Ave. Intensity (mm/hr)	105.764
Return Period (years)	100.0



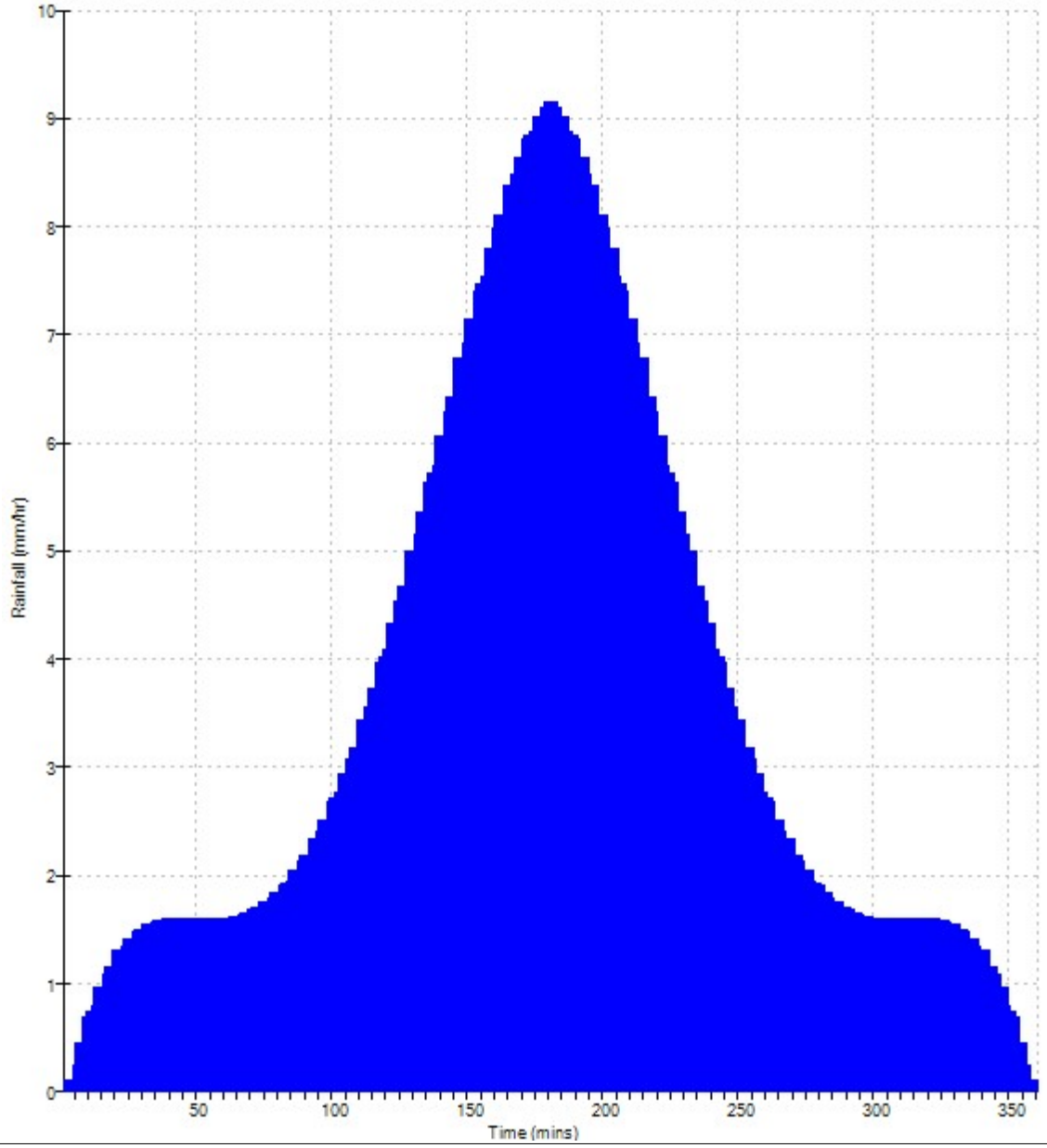
APPENDIX G

Existing Brownfield Volume Run Off

Rainfall profile

Storm duration (mins) 360

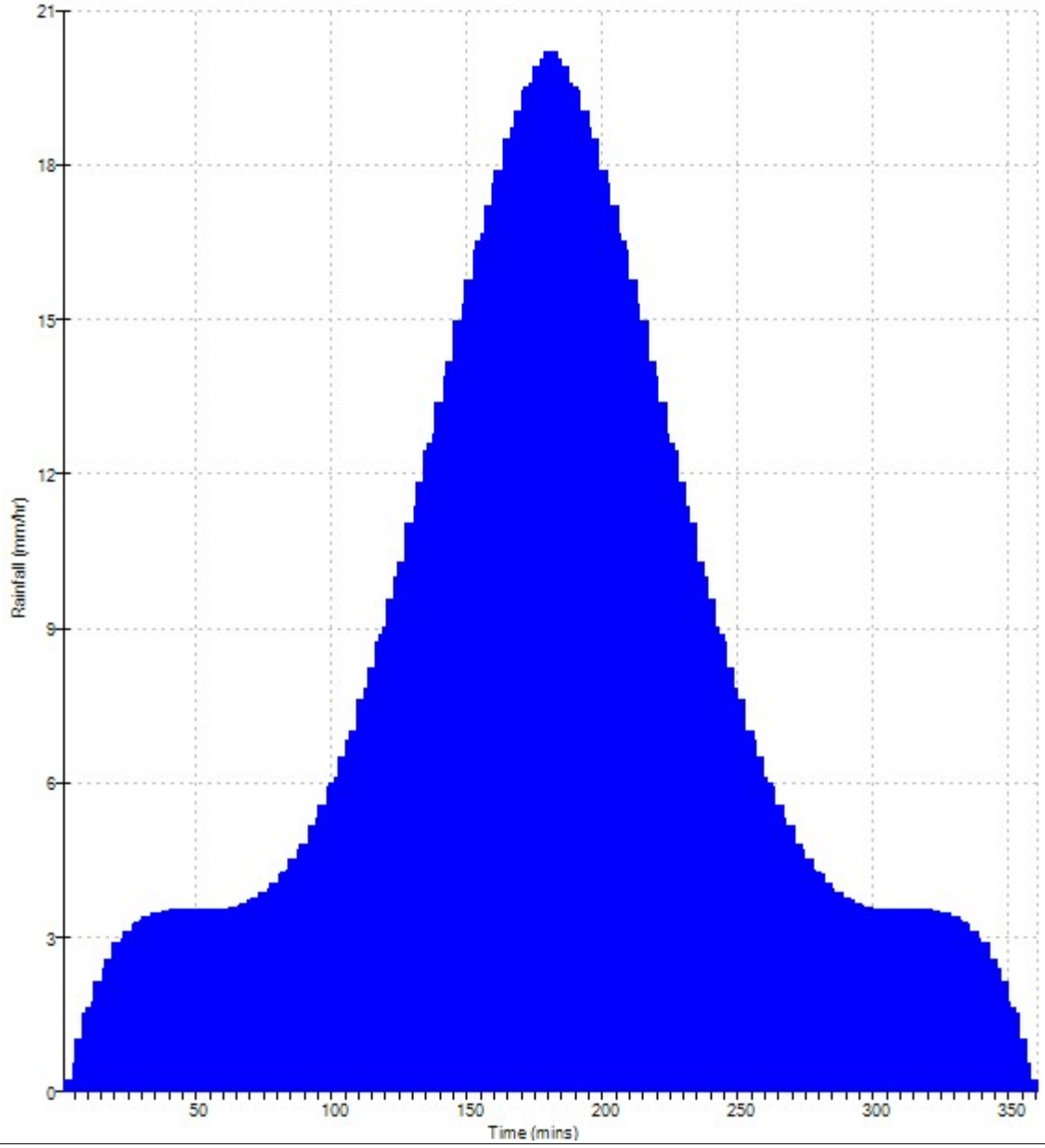
FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	9.151
Ave. Intensity (mm/hr)	3.618
Return Period (years)	1.0



Rainfall profile

Storm duration (mins) 360

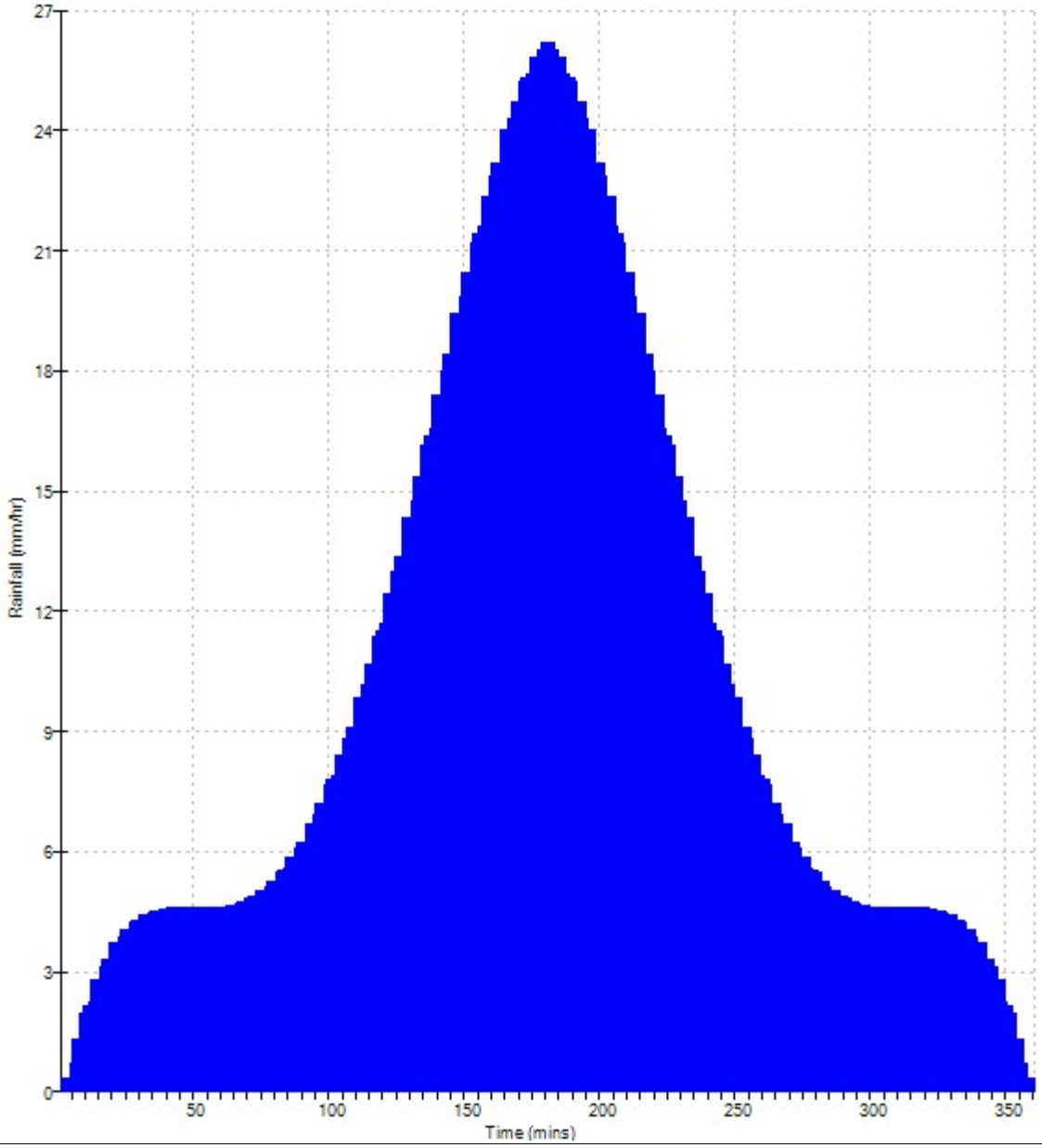
FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	20.190
Ave. Intensity (mm/hr)	7.983
Return Period (years)	30.0



Rainfall profile

Storm duration (mins) 360

FSR Data	
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.438
Peak Intensity (mm/hr)	26.189
Ave. Intensity (mm/hr)	10.355
Return Period (years)	100.0



APPENDIX H

Proposed Impermeable Area Plan