ROYAL ARSENAL RIVERSIDE
THE ROPEYARDS
PLOTS D & K

FLOOD RISK ASSESSMENT

To Support a Reserved Matters Application

MARCH 2024

Berkeley
Designed for life

Client: Berkeley Homes (East Thames) Ltd

Flood Risk Assessment and Drainage Strategy for the Proposed Development at Royal Arsenal Riverside, The Ropeyards, Plots D & K

March 2024

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Flood Risk Assessment and Drainage Strategy for the Proposed Development at Royal Arsenal Riverside, The Ropeyards, Plots D & K

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1 Background and Scope of Appraisal

1.1.1 Flooding is a major issue in the United Kingdom. The impacts can be devastating in terms of the cost of repairs, replacement of damaged property and loss of business. The objectives of the Flood Risk Assessment (FRA) are therefore to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source.
- whether the development will increase flood risk elsewhere within the floodplain.
- whether the measures proposed to address these effects and risks are appropriate.
- whether the site will pass Part B of the Exception Test (where applicable).

1.1.2 Herrington Consulting has been commissioned by Berkeley Homes (East Thames) Ltd to prepare a Flood Risk Assessment (FRA) and Drainage Strategy for the proposed development at **Royal Arsenal Riverside, The Ropeyards, Plots D & K** located at **Land between Duke of Wellington Avenue and Beresford Street, London, SE18 6NP.**

1.1.3 This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (2023) and the National Planning Practice Guidance Suite (August 2022) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs. In addition, reference has also been made to Local Planning Policy.

1.1.4 To ensure that due account is taken of industry best practice, this FRA has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

1.1.5 New development has the potential to increase the risk of flooding to neighbouring sites and properties through increased surface water runoff and as such, an assessment of the proposed site drainage can help to accurately quantify the runoff rates, flow pathways and the potential for infiltration at the site. This assessment considers the practicality of incorporating Sustainable Drainage Systems (SuDS) into the scheme design, with the aim of reducing the risk of flooding by actively managing surface water runoff.

1.1.6 New developments are also required to undertake an assessment to identify how the foul water from the site will be managed. This assessment considers how foul water is expected to be discharged from the proposed development and whether there are any appropriate connection points, such as nearby sewers or treatment plants.

1.1.7 This report has been prepared to accompany a reserved matters application and has been prepared in accordance with the requirements of both national and local planning policy. To ensure that due account is taken of industry best practice, reference has also been made to, CIRIA Report C753 'The SuDS Manual' and any relevant local planning policy guidance. The surface water management strategy included within this report is not intended to constitute a detailed drainage design.

2 Development Description and Planning Context

2.1 Site Location and Existing Use

2.1.1 The site is located at OS coordinates 543619, 179194, on the western edge of the wider Royal Arsenal Riverside masterplan. The site covers an area of approximately 2.3 hectares and currently sits on a temporary park, bound by the A206, the Royal Arsenal Riverside A & B Plots to the north (and north east) and Royal Arsenal Riverside Phase 3, the Brass Foundry and The Guard House to the west. The location of the site in relation to the surrounding area and the River Thames is shown in Figure 2.1.

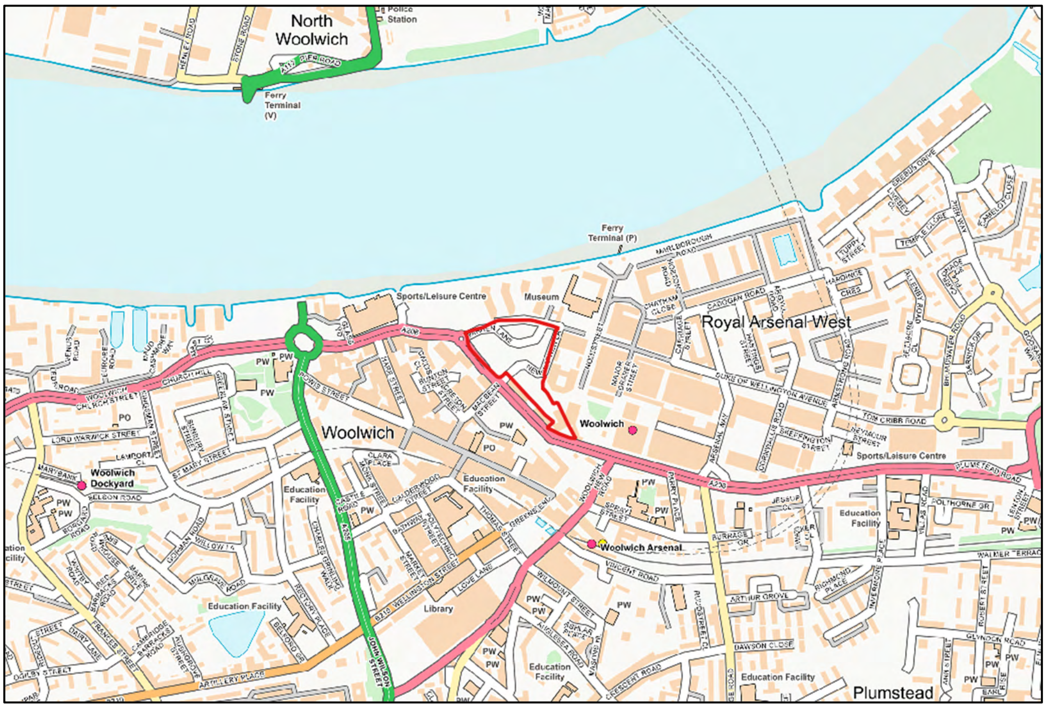

Figure 2.1 – Location map (contains Ordnance Survey data © Crown copyright and database right 2024).

2.1.2 The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

2.2 Relevant Planning History

2.2.1 The Warren Masterplan at Land Adjacent to Beresford Street/Woolwich High Street, Woolwich, SE18, was consented in 2013 for the western area of the wider Royal Arsenal Riverside masterplan, including Plots D & K (Planning Reference 13/0117/0). The application comprised:

"Outline planning permission for a mixed-use development comprising 2,032 residential units and 2,442 (GEA) sqm of non-residential floor space (A1 / A2 / A3 / A4 / B1 / D1 uses), access, landscaping, publicly accessible open space, car and cycle parking provision and refuse and recycling storage areas."

2.2.2 In 2017, a Section 73 application (Planning References 16/3025/MA) was granted approval to vary the outline planning permission consented in 2013. Application 16/3025/MA comprised:

"S73 Variation application in respect of planning permission reference 13/0117/O being an Outline Planning Permission for mixed use development comprising 2,032 units and 2,442 (GEA) sqm of non-residential floor space (A1/A2/A3/A4/B1/D1 Use), access, landscaping, public accessible open space, car and cycle parking provision and refuse and recycling storage areas…"

2.3 Proposed Development

2.3.1 This document has been prepared to accompany the submission of Reserved Matters application (Appearance, Landscaping, Layout and Scale) pursuant to Condition 2 of planning permission reference 16/3025/MA, dated 17.03.2017, for residential units and non-residential floorspace within Plots D and K, along with public / private landscaping details, car / cycle parking, refuse / recycling facilities and play provision (Figure 2.2). The development will provide 663no. residential units onsite, as well as 959.1m^2 of non-residential use space.

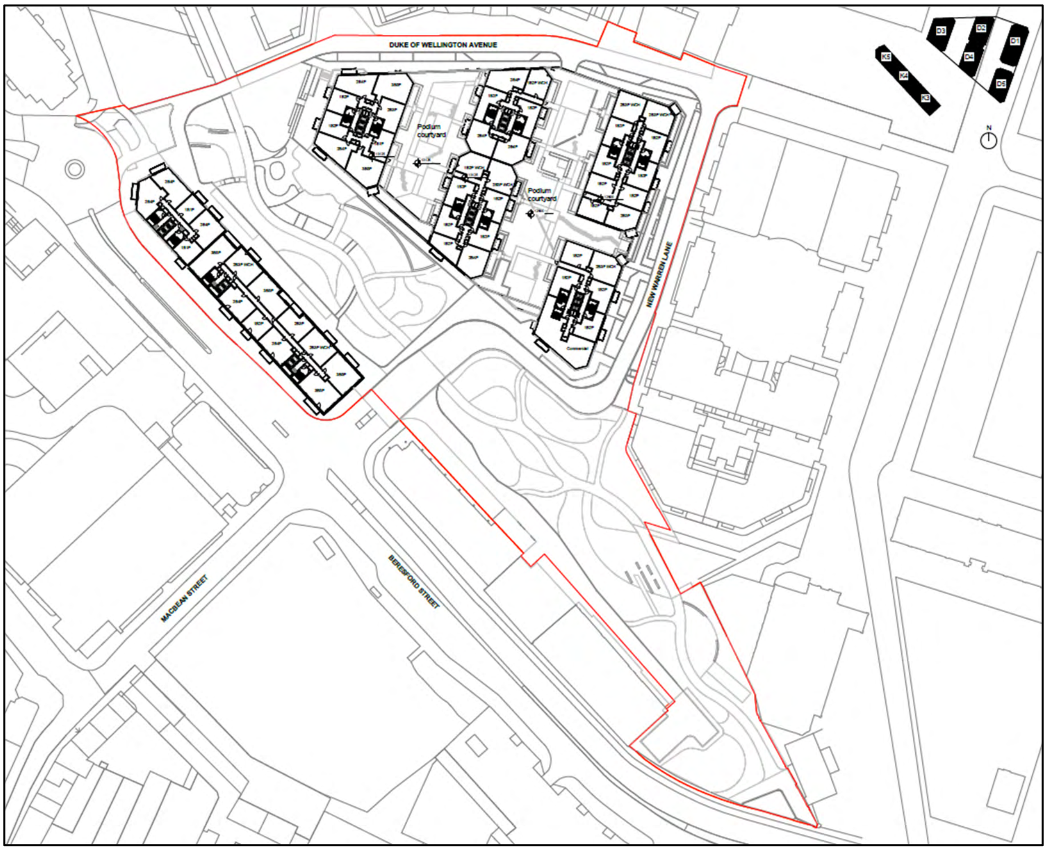

Figure 2.2 – Proposed site layout.

2.3.2 Drawings of the proposed scheme are included in Appendix A.1 of this report.

2.4 Flood Zone Classification

2.4.1 When appraising the risk of flooding to a site, generally the starting point is the Environment Agency's (EA) 'Flood Map for Planning' (Figure 2.3). These maps and the associated information are intended for guidance and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site-based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The Flood Zones are classified as follows:

Zone 1 – *Low probability of flooding* – This zone is assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any one year.

Zone 2 – *Medium probability of flooding* – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – *High probability of flooding* - This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

Zone 3b – *The Functional Floodplain* – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 30 or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

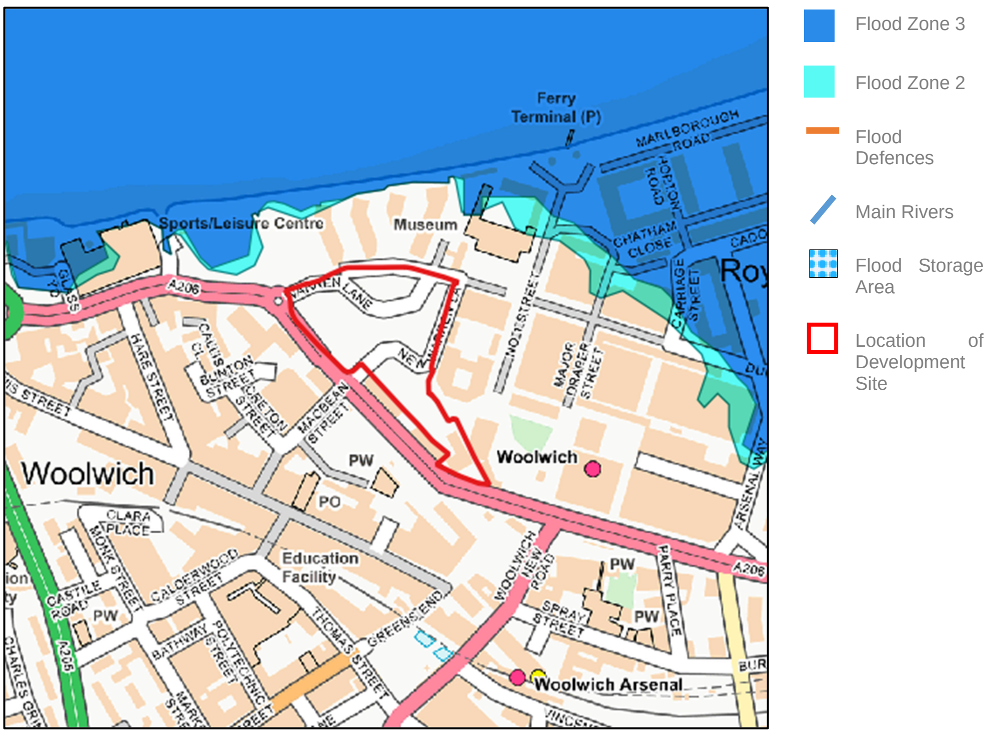

Figure 2.3 – EA's 'Flood Map for Planning' (© Environment Agency).

2.4.2 From Figure 2.3, it can be seen that the development is located within Flood Zone 1. However, given the scale of the development, it is required by the NPPF that a site-specific flood risk assessment is undertaken to appraise the risk of flooding from all sources. Therefore, this is the purpose of this document.

2.5 Existing Flood Risk Management Measures

2.5.1 The flood defences in this area of the River Thames provide a 1 in 1000 year standard of protection and are all raised, man-made and privately owned. The EA inspects them twice a year to ensure that they remain fit for purpose, although they must be maintained by their owners to a crest level of 7.2m AODN (the Statutory Flood Defence Level in this reach of the Thames). The current condition grade for defences in this area is 2 (good), on a scale of 1 (very good) to 5 (very poor).

2.5.2 The Thames Barrier is a significant feature of the Thames Tidal Defences and is located between Newham and Greenwich. It became operational in October 1982 and was closed for the first time in February 1983. The Barrier is part of a system of tidal defences that currently protect London to extremely high standards. However, this level of protection is expected to decline in the future.

2.5.3 The Thames Estuary 2100 (TE2100) project sets out the strategic direction for managing flood risk in the Thames Estuary up to the year 2100. The TE2100 plan is now live and forms the overarching flood management strategy for the Thames Estuary. The TE2100 takes into account operation of the Thames Barrier when considering future levels. The Thames Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels for which the barrier would normally be shut, will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upstream of the barrier will increase and the tidal walls will need to be heightened to match (Table 2.1).

	Present Day	**2065 to 2100**	**2100**
Defence Level (m AODN)	7.2	8.3	8.8

Table 2.1 – Future defence levels for the River Thames tidal defences.

2.5.4 The 'Thames Estuary 2100' document can be found on the EA's website for the short, medium and long term Flood Risk Management strategy for London:

http://www.environment-agency.gov.uk/homeandleisure/floods/125045.aspx

3 Climate Change

3.1.1 The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present, and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

3.1.2 The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall could be expected.

3.1.3 These effects will tend to increase the size of Flood Zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

3.2 Planning Horizon

3.2.1 To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years. The development that is the subject of this FRA is classified as residential, therefore a design life of 100 years is assumed.

3.3 Potential Changes in Climate

Peak Rainfall Intensity

3.3.1 Recognising that the impact of climate change will vary across the UK, the allowances were updated in May 2022 to show the anticipated changes to peak rainfall across a series of management catchments. The proposed development site is located in the **London Management Catchment**, as defined by the 'Peak Rainfall Allowance' maps, hosted by the Department for Environment, Food and Rural Affairs. Guidance provided by the EA states that this mapping should be used for site-scale applications (e.g. drainage design), in small catchments (less than $5km^2$), or urbanised drainage catchments. For large rural catchments, the peak river flow allowances should be used.

3.3.2 The proposed development will include a Drainage Strategy and the Peak Rainfall Allowances for the London Management Catchment should be applied to the hydraulic calculations undertaken as part of this.

3.3.3 For each Management Catchment, a range of climate change allowances are provided for two time epochs and for each epoch, there are two climate change allowances defined. These represent different levels of statistical confidence in the possible scenarios on which they are calculated. The two levels are as follows:

- Central: based on the 50th percentile
- Upper End: based on the 90th percentile

3.3.4 The EA has provided guidance regarding the application of the climate change allowances and how they should be applied in the planning process. The range of allowances for the Management Catchment in which the development site is located are shown in Table 3.1 below.

Management Catchment Name	Annual exceedance probability	Allowance Category	2050s	2070s
London	3.3 %	Central	20%	20%
		Upper End	35%	35%
	1 %	Central	20%	25%
		Upper End	40%	40%

Table 3.1 – Recommended peak rainfall intensity allowances for each epoch for the London Management Catchment.

3.3.5 For a development with a design life of 100 years the Upper End climate change allowance is recommended to assess whether:

- there is no increase in flood risk elsewhere, and;
- the development will be safe from surface water flooding.

3.3.6 From Table 3.1 above, it can be seen that the recommended climate change allowance for this site is a 40% increase in peak rainfall. Therefore, this increase has been applied to the hydraulic drainage model constructed to inform the Drainage Strategy. Where this allowance has been applied the abbreviation "+40%cc" has been used.

4 Definition of Flood Hazard

4.1 Site Specific Information

4.1.1 Information from a wide range of sources has been referenced to appraise the true risk of flooding at this location. This section summarises the additional information collected as part of this FRA.

4.1.2 ***Site specific flood level data provided by the EA*** – The EA has previously provided the model results of the Thames Estuary Breach Assessment (2018), which have been referenced as part of this appraisal.

4.1.3 ***Information contained within the SFRA*** – The Royal Borough of Greenwich SFRA (2017) contains detailed mapping showing historic flood records for a wide range of sources. This document has been referenced as part of this site-specific FRA.

4.1.4 ***Information provided by Thames Water*** – Thames Water (TW) has provided the results of an asset location search for the site. The response is included in Appendix A.2.

4.1.5 ***Site specific topographic surveys*** – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From the survey, it can be seen that the land levels on site where Building K is located, vary between 10.25m and 11.01m AODN (Above Ordnance Datum Newlyn). The land levels where Building D is proposed vary between 7.73m and 10.72m AODN. The land levels across the site fall towards the River Thames which is located approximately 100m to the north of the site.

4.1.6 ***Geology*** – Reference to the British Geological Survey (BGS) map shows that the underlying solid geology in the location of the subject site is Thanet Formation (sand). Overlying this are superficial deposits of Head (clay, silt, sand and gravel).

4.1.7 ***Historic flooding*** – No information on historic flooding in this area has been provided or revealed through desktop searches.

4.2 Potential Sources of Flooding

4.2.1 The main sources of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this development are discussed below. Table 4.1 at the end of this section summarises the risks associated with each of the sources of flooding.

4.2.2 ***Flooding from Rivers (Tidal)*** – It has been identified that the site is located approximately 100m away from the tidal River Thames, however the area where the development site is located is considered to be Flood Zone 1. This area is considered to be the lowest flood risk area which is defined as having less than 1 in 1000 annual probability of flooding (0.1% Annual Exceedance Probability AEP).

4.2.3 In addition to being located within Flood Zone 1, the EA have previously provided the results of the Thames Estuary Breach Assessment (2018) which contains detailed numerical flood modelling simulating the impact of the Thames flood defences catastrophically failing during an extreme storm event. The results of this modelling study (Figure 3.1), show that even during this extreme scenario, the site is elevated above and therefore located outside of the extent of flooding.

4.2.4 Interrogation of the mapping shows that the maximum flood level within the surrounding area is 6.6m AODN to the northeast and 6.7m AODN to the northwest. Land levels on site are comfortably above these flood levels. Whilst the basement floor level will be below the flood level, land between the site and the flood extent is all elevated above the flood level and therefore water will not be directed towards the basement. Additionally, mitigation measures have been recommended for inclusion with the basement (refer to section 6.1) as a precautionary measure to protect the subterrain element from flooding from other sources. Considering the above, it is concluded that the risk of flooding from the River Thames is *low*.

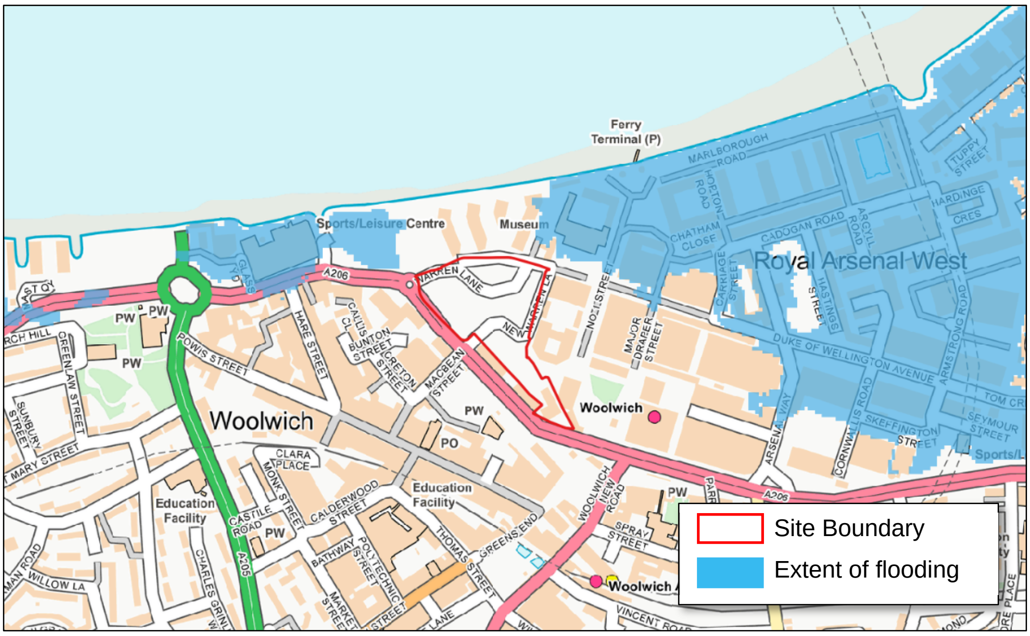

Figure 4.1- Extent of flooding following a breach in the flood defence infrastructure during an extreme event. Model results extracted from the Thames Estuary Breach Assessment (2018) (© Environment Agency 2023).

4.2.5 ***Flooding from Rivers, Ordinary or Man-Made Watercourses (fluvial)*** – Natural watercourses that have not been enmained and man-made drainage systems such as irrigation drains, sewers or ditches could potentially cause flooding.

4.2.6 Inspection of the site and surrounding area reveals that there are no fluvial rivers, non-main rivers or artificial watercourses within close proximity of the site and therefore the risk of flooding from this source is considered to be *low*.

4.2.7 ***Flooding from the Sea*** – The site is a significant distance inland and whilst the River Thames is still tidally influenced at this location, the risk of flooding from the sea is considered to be *low*.

4.2.8 ***Flooding from Surface Water*** – Surface water, or overland flooding, typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This mechanism of flooding can occur almost anywhere but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

4.2.9 The EA's 'Flood Risk from Surface Water' map (Figure 4.2) shows the development site is located within an area classified as having a 'very low' to 'high' risk from surface water flooding. However, surface water modelling has been undertaken as part of the Royal Borough of Greenwich Strategic Flood Risk Assessment (SFRA) and this shows that the proposed development is not predicted to experience flooding during extreme rainfall events. Furthermore, the SuDS options discussed in Section 8 of this report are designed to capture rain falling on the proposed development site, including the design rainfall event, thereby reducing the risk of offsite flooding as a result of the development. Considering the above, the risk of flooding from this source is concluded to be *low*.

Probability of Flooding

High – Extent of flooding from surface water that has a 3.3% (1 in 30) or greater chance of happening each year.

Medium - Extent of flooding from surface water that has between a 3.3% (1 in 30) and 1% (1 in 100) chance of happening each year.

Low - Extent of flooding from surface water that has between a 1% (1 in 100) and 0.1% (1 in 1000) chance of happening each year.

Location of Development Site

Figure 4.2 – EA's 'Flood Risk from Surface Water' map (© Environment Agency).

4.2.10 ***Flooding from Groundwater*** – Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year).

4.2.11 The underlying geology in this area is Thanet Formation (sand), with overlying superficial deposits of Head (clay, silt, sand and gravel). Inspection of BGS groundwater flood risk mapping data shows that the general area in which the development site lies is identified as being at high risk from groundwater flooding. Furthermore, mapping on groundwater emergence provided as part of the

Defra Groundwater Flood Scoping Study (May 2004) shows that the site itself is located within an area where groundwater emergence is predicted.

4.2.12 Notwithstanding this, there were no records of groundwater flooding events recorded on site during the very wet periods of 2000/01 or 2002/03, as per the Defra study, and no records were revealed during desktop searches. In addition, borehole logs from site testing on the wider area (undertaken by others) showed the groundwater level to be 7.1 – 12.2m below ground level. Taking the above into account, the risk of flooding from this source is concluded to be *low*.

4.2.13 Whilst the risk is concluded to be low, given that the proposed development includes a basement, precautionary mitigation measures are recommended within this report (refer to section 6.1), such as tanking the basement with a damp proof membrane to prevent internal flooding in the event of elevated groundwater levels. Furthermore, the use of the basement and ground floor of the proposed buildings is considered to be of a lower vulnerability classification in comparison to the sleeping accommodation on the upper floors, with no sleeping accommodation proposed in the basement. Taking the above into consideration and the proposed mitigation measures outlined later in this report, the risk of flooding from groundwater is concluded to be *low*.

4.2.14 ***Flooding from Sewers*** – In urban areas, rainwater is typically drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or has inadequate capacity; this will continue until the water drains away.

4.2.15 Inspection of the asset location mapping provided by TW (Figure 4.3) identifies that the sewers in this area are combined sewers, foul sewers and private sewer connections. Inspection of the topographic survey and aerial height data of the surrounding area reveals that the land levels fall towards the River Thames. Consequently, in the event the sewer system in this area were to surcharge, it is likely flood water would exit the network in the lower lying area towards the River Thames. Furthermore, in the unlikely event water were to exit the network along Beresford Road, floodwater would likely remain within the channel of the road and flow towards the lower lying River Thames away from the development site. Taking this into account, the risk of flooding from sewers is considered to be *low*.

4.2.16 Notwithstanding this, given that the proposals include a basement a number of mitigation measures have been recommended within section 6 of this report, including the use of non-return valves being installed on the outfall of drainage systems to prevent backflow from the sewer or other drainage systems.

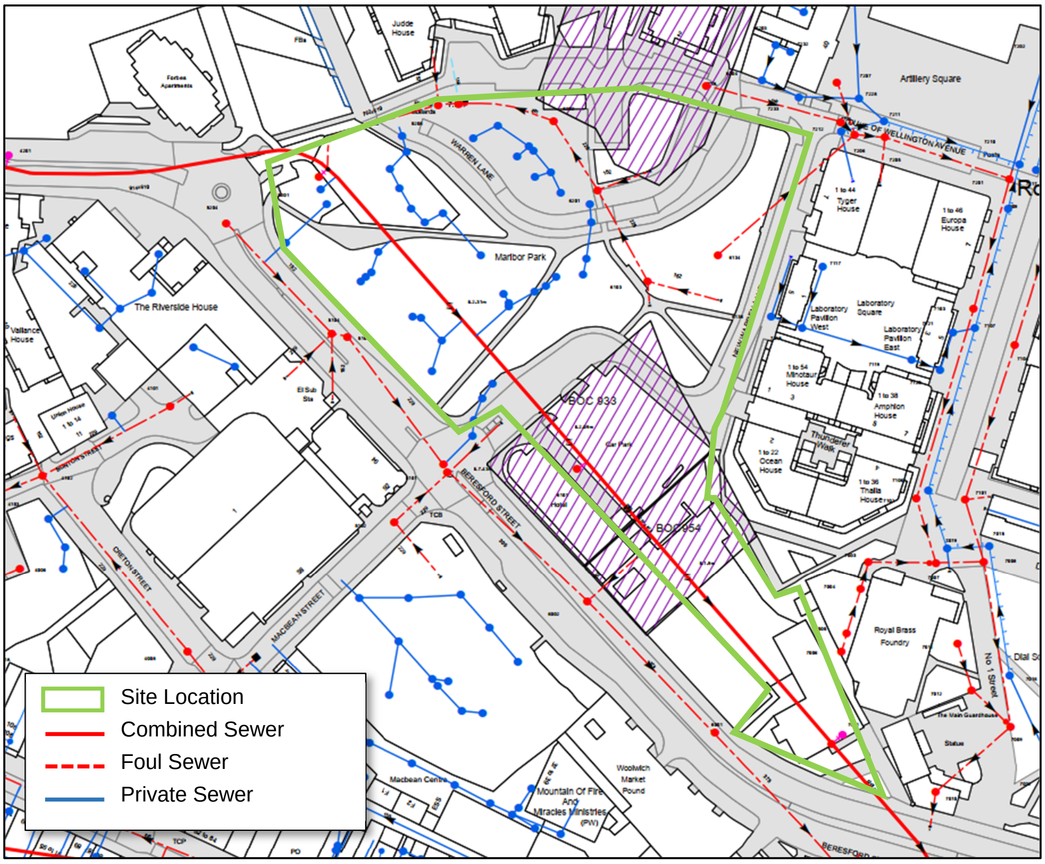

Figure 4.3 - Asset location mapping provided by Thames Water (a full scale copy can be found in Appendix A.2).

4.2.17 ***Flooding from Reservoirs, Canals and Other Artificial Sources –*** Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including mining, quarrying, and sand or gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

4.2.18 The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example, reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

4.2.19 Inspection of the OS mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the EA's 'Flood Risk from Reservoirs' map shows that the site is not within an area considered to be at risk of flooding from reservoirs. Therefore, the risk of flooding from this source is considered to be *low.*

4.2.20 A summary of the overall risk of flooding from each source is provided in Table 4.1 below.

Source of Flooding	Initial Level of Risk	Appraisal method applied at the initial flood risk assessment stage
Rivers (tidal)	Low	OS mapping and the EA's 'Flood Map for Planning'
Rivers, Ordinary and Man-Made Watercourses (fluvial)	Low	OS mapping and aerial height data
Sea	Low	OS mapping and the EA's 'Flood Map for Planning'
Surface Water	Low	EA's 'Flood Risk from Surface Water' maps, The Royal Borough of Greenwich SFRA and OS mapping
Groundwater	Low	BGS groundwater flood hazard maps, Defra Groundwater Flood Scoping Study and OS mapping
Sewers	Low	Aerial height data, OS mapping, site-specific topographic survey, asset location data provided by Thames Water
Artificial Sources	Low	OS mapping and EA's 'Flood Risk from Reservoirs' map

Table 4.1 – Summary of flood sources and risks.

5 Offsite Impacts and Other Considerations

5.1 Displacement of Floodwater

5.1.1 The construction of a new building within the floodplain has the potential to displace water and to increase the risk elsewhere by raising flood levels. A compensatory flood storage scheme can be used to mitigate this impact, ensuring the volume of water displaced is minimised.

5.1.2 The proposed development has been shown to remain unaffected under design flood conditions and is not at significant risk of flooding from any source. Consequently, the development will not displace floodwater, and compensatory flood storage will not be necessary.

5.2 Public Safety and Access

5.2.1 The NPPF states that safe access and escape should be available to/from new developments located within areas at risk of flooding. The Practice Guide goes on to state that access routes should enable occupants to safely access and exit their dwellings during design flood conditions and that vehicular access should be available to allow the emergency services to safely reach the development.

5.2.2 The risk of flooding from all sources has been shown to be *low*. Consequently, safe access/egress to/from the proposed site can be achieved and on both foot and by vehicle.

5.2.3 Notwithstanding this, in the unlikely event of a tidal breach scenario or following an extreme rainfall event, part of the area surrounding the proposed development could be subject to flooding. Therefore, it is recommended that residents and building managers sign up to the EA's Flood Warning Service and the Met Office Weather Warning's, to provide a forewarning for when this might occur (refer to section 6.2).

5.3 Proximity to Watercourse and Flood Defence Structures

5.3.1 Under the Water Resources Act 1991 and Land Drainage Byelaws, any proposals for development in close proximity to a 'main river' would need to take into account the EA's requirement for an 8m buffer zone between the river bank and any permanent construction such as buildings or car parking etc. This buffer zone increases to 16m for tidal waterbodies and sea defence infrastructure.

5.3.2 The development site is located more than 16m from the tidal River Thames and associated defences. As such, the development will not compromise any of the EA's maintenance or access requirements.

6 Flood Mitigation Measures

6.1.1 The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded.
- to ensure continued operation and safety during flood events.
- to ensure that the flood risk downstream of the site is not increased by increased runoff.
- to ensure that the development does not have an adverse impact on flood risk elsewhere.

6.1.2 The following section of this report examines ways in which the risk of flooding at the development site can be mitigated.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e., Sequential Approach)	x	It has been concluded that the risk of flooding from all sources is *low* and therefore it is not considered necessary to include these mitigation measures.
Raising floor levels	x	
Land raising	x	
Compensatory floodplain storage	x	
Alterations/ improvements to channels and hydraulic structures	x	
Flood defences	x	
Flood resistance & resilience	✓	Refer to Section 7.1
Flood warning	✓	Refer to Section 7.2
Surface water management	✓	Refer to Section 8

Table 6.1 – Appropriateness of mitigation measures.

6.2 Flood Resistance and Resilience

6.2.1 *Flood Resistance* or 'dry proofing', where flood water is prevented from entering the building. For example, using flood barriers across doorways and airbricks, or raising floor levels. These measures are considered appropriate for 'more vulnerable' development where recovery from internal flooding is not considered to be practical.

6.2.2 *Flood Resilience* or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

6.2.3 This assessment has appraised the risk of flooding across a wide range of sources and it has been concluded that the risk of flooding is *low* from all sources. However, given that the proposed development includes a basement, it is recommended that flood resilience measures are used when constructing the basement, to ensure that the risk of flooding in the unlikely event ground water levels were to become elevated is minimised as much as possible. Therefore, the following measures are recommended:

- The basement should be tanked and a damp-proof membrane installed to prevent internal flooding in the unlikely event of elevated groundwater levels.
- Non-return (one-way) valves should be installed on all connections to the sewer.
- The basement should be constructed using flood resilient construction materials (e.g. avoiding the use of stud walls and plasterboard at basement level)
- All electrical sockets to be elevated as high as possible at basement level.

6.2.4 Details of flood resilience and flood resistance construction techniques can be found in the document '*Improving the Flood Performance of New Buildings; Flood Resilient Construction*', which can be downloaded from www.gov.uk.

6.2.5 A Code of Practice (CoP) for Property Flood Resilience (PFR) has been put in place to provide a standardised approach for the delivery and management of PFR. Further information on the CoP and guidance on how to make a property more flood resilient can be accessed, and downloaded, from the Construction Industry Research and Information Association (CIRIA) Website:

https://www.ciria.org/Resources/Free_publications/CoP_for_PFR_resource.aspx

6.3 Flood Warning

6.3.1 The EA operate a flood forecasting and warning service in areas at risk of flooding from rivers or the sea, which relies on direct measurements of rainfall, river levels, tide levels, in-house predictive models, rainfall radar data and information from the Met Office. This service operates 24 hours a day, 365 days a year.

6.3.2 Whilst the probability of an event of sufficient magnitude to cause floodwaters to reach the levels discussed in this report is very low, the risk of such an occurrence is always present. With the sophisticated techniques now employed by the EA to predict the onset of flood events the opportunity now exists for all residents within the flood risk area to receive early flood warnings.

6.3.3 These warnings could forewarn conditions that might result in flooding within the area surrounding the development. It is therefore recommended that the occupants of the site and building managers sign up to the EA's Flood Warning Service either by calling 0345 988 1188, or by visiting;

www.gov.uk/sign-up-for-flood-warnings

6.3.4 Inspection of the EA's 'Flood Risk from Surface Water' map (Figure 4.2) suggests that the area surrounding the site could also experience surface water flooding following an extreme weather event. Occupants and building managers are therefore recommended to monitor the Met Office's Weather Warnings to provide forewarning of weather conditions which could result in surface water flooding:

www.metoffice.gov.uk/weather/uk/uk_forecast_warnings.html

7 Existing Drainage

7.1 Existing Surface Water Drainage

7.1.1 The existing site drainage has not been surveyed and it is currently unknown how the existing land at the site drains. It is assumed that the landscaped and planted areas which currently make up Maribor Park drain informally via infiltration, with runoff from the existing paths draining to these areas too. Inspection of the site shows that there are gullies draining the existing areas of highway and the existing car park, which will collect the surface water runoff from this area. These gullies are assumed to drain to the existing public sewer network.

7.1.2 TW has provided sewer mapping as part of their asset location data for the site and surrounding area. An extract of this mapping is provided in Figure 4.3 above and shows the location of public and private sewers in close proximity to the site. A full copy can be found in Appendix A.2. Additional investigation may be required as part of the detailed design to confirm the exact layout of the existing underground drainage network.

7.1.3 Greenfield runoff rates for the site have been calculated using the Flood Estimation Handbook (FEH) methodology and are outlined in Table 7.1 below. Discharge rates for the existing areas of hardstanding at the site have been calculated for a range of rainfall events with varying return periods, assuming they discharge at an unrestricted rate. These hydrological calculations have been undertaken using the Modified Rational Method and synthetic rainfall data derived using the variables obtained from the FEH online web service.

Return Period (years)	Greenfield runoff rate (l/s)	Peak runoff from the existing site (l/s)
2	-	273
Qbar	2.2	-
30	5.0	836
100	7.0	1100

Table 7.1 – Summary of greenfield runoff rates and peak runoff rates for the existing site.

8 Sustainable Drainage Assessment

8.1 Site Characteristics

8.1.1 The important characteristics of the site, which have the potential to influence the surface water drainage strategy, are summarised in Table 8.1 below.

Site Characteristic	**Development Site**	
Total area of site	2.372 ha	
Existing areas to be retained (and therefore excluded from analysis)	2100 m^2	
Current site condition	Brownfield	
Greenfield runoff rates (based on the FEH methodology)	1:1 yr = 1.9 l/s Qbar = 2.2 l/s 1:30 yr = 5.0 l/s 1:100 yr = 7.0 l/s	
Infiltration	Assumed unavailable as a discharge method for areas of hardstanding based on existing information. Further investigation recommended at later stage of design (see Section 8.2 below).	
Current surface water discharge method	Existing landscaped area assumed to drain informally. Existing areas of highway and parking drained by gullies, which are assumed to drain to public sewer network.	
Is there a watercourse nearby?	Yes - River Thames approximately 100m from the site	
Impermeable area	**Existing** **~ 13,940 m^2**	**Proposed** **~ 11,140 m^2**

Table 8.1 – *Site characteristics affecting rainfall runoff.*

8.1.2 Table 8.1 above shows that the proposed development will decrease the percentage of impermeable area within the boundaries of the site and consequently, this will decrease the rate and volume of surface water runoff discharged from the site. Notwithstanding this, it is recognised that the impacts of climate change should be considered as part of any new development and it is for this reason, that it is recommended that SuDS are considered. The overall rate at which surface water runoff is discharged from the site should not increase over the lifetime of the development.

8.1.3 Furthermore, the potential use of SuDS within the proposed development will be considered to assess the practicality of better replicating greenfield behaviour, in accordance with local planning policy, and S3 and S5 of the Non-Statutory Technical Standards for Sustainable Drainage Systems (NTSS).

8.2 Opportunities to Discharge Surface Water Runoff

8.2.1 Policy SI 13 of the London Plan (2021) summaries a hierarchy of options for discharging surface water runoff from developments. Policy SI 13 favours managing surface water runoff at source, by either storing it for later **re-use** or allowing it to **infiltrate** into the ground. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse.** Only if neither of these options are possible, the water should be conducted into a **public sewer** system, with a connection into a surface water sewer being preferred over the discharge into either a combined or foul sewer.

8.2.2 The following opportunities for managing the surface water runoff discharged from the development site are listed in order of preference:

8.2.3 ***Water Re-Use*** – Water re-use systems should ideally be considered to reduce the reliance on the demand for potable water. However, such systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and hardstanding area to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems can be considered for inclusion within the scheme, an alternative solution for attenuating storm water will still be required.

8.2.4 ***Infiltration*** – The underlying bedrock geology at this location is Thanet formation (sand), and the overlying superficial deposits of Head (clay, silt, sand and gravel). However, an earlier application for the adjacent site resulted in condition 67: *"No infiltration of surface water drainage into the ground is permitted other than with the express written consent of the Local Planning Authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to controlled waters. The development shall be carried out in accordance with the approved details" (ref: 507-RSK-ZZ-XX-RP-CR-00014).* Therefore, for this stage no infiltration is assumed in the drainage calculations. However, it is assumed that the drainage of the soft landscaped areas will occur naturally via infiltration, as is currently the case within the present open space.

8.2.5 It should also be noted that there are existing services and infrastructure beneath the site, including a tunnel that serves the Docklands Light Railway. Consequently, there the opportunities to infiltrate may be further limited by the presence of this infrastructure. It is recommended that infiltration testing is undertaken as part of the wider intrusive site investigations at the detailed design stage in order to determine whether infiltration could be a feasible discharge method in limited areas of the site. At the planning stage, a precautionary approach has been taken and assumed infiltration will not be a feasible method of discharging the surface water runoff from the proposed areas of hardstanding.

8.2.6 ***Discharge to a Tidal Waterbody*** – If infiltration is proven to be insufficient to accommodate surface water runoff from the site area, the next best option is to discharge into a tidal waterbody or watercourse. The site is situated approximately 100 meters from the tidal River Thames and there is an existing connection (limited to 90l/s from this development, see Appendix A.6) to the Thames via an adjacent development under the ownership of the applicant. This is likely to present the most sustainable solution for surface water discharge.

8.2.7 ***Discharge to Watercourses*** – There are no non-tidal rivers within close proximity to the site. Consequently, there is no opportunity to discharge surface water to an existing watercourse.

8.2.8 ***Discharge to Public Sewer System*** – As discussed above, a more preferable solution for managing surface water runoff discharged from the development is available and therefore a connection to the public sewer system will not be required.

8.3 Constraints and Further Considerations

8.3.1 The key constraints that are relevant to this development are listed below:

- There is limited open space to incorporate SuDS that require very large areas of land, such as wetlands and large basins.

- Inspection of the asset location mapping provided by TW (Appendix A.2) identifies that there are several public foul sewers and private sewers crossing the site, as well as a public combined trunk sewer which runs in a southeasterly direction across the site. Build over agreements will need to be obtained from TW prior to building within 3m of the public sewers. The asset location mapping also shows there is a tunnel located beneath the site which forms part of the network for the Docklands Light Railway. Although this is expected to be significantly deep to as not affect the proposed drainage network, Transport for London should be consulted prior to construction.

- In accordance with guidance from CIRIA C753, orifice diameters can be reduced to a minimum of 20mm (if used in conjunction with permeable paving) to enable very low discharge rates to be achieved. The proposed drainage system has been designed on the basis that the minimum orifice diameter will be 20mm and therefore, the rate at which surface water runoff is discharged from the site will be minimised. In this case, this approach is likely to be acceptable to both the LPA and TW.

8.4 Proposed Surface Water Management Strategy

8.4.1 The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with the results from a numerical drainage model constructed for the site, which can be used to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF and NTSS can be met at the planning stage.

Green Roofs

8.4.2 Green roofs will be located on the podium roofs of the proposed D Buildings. Rain landing on these areas will be intercepted by the green roof, which during low return period events will store and filter a large amount of runoff from the roof area within the soil substrate of the planted areas. The location and extent of the proposed green roofs are shown on Figure 8.1 (below). The design of the green roof should include an adequate drainage layer to avoid stagnation and overflow systems in case the primary discharge pipe becomes blocked.

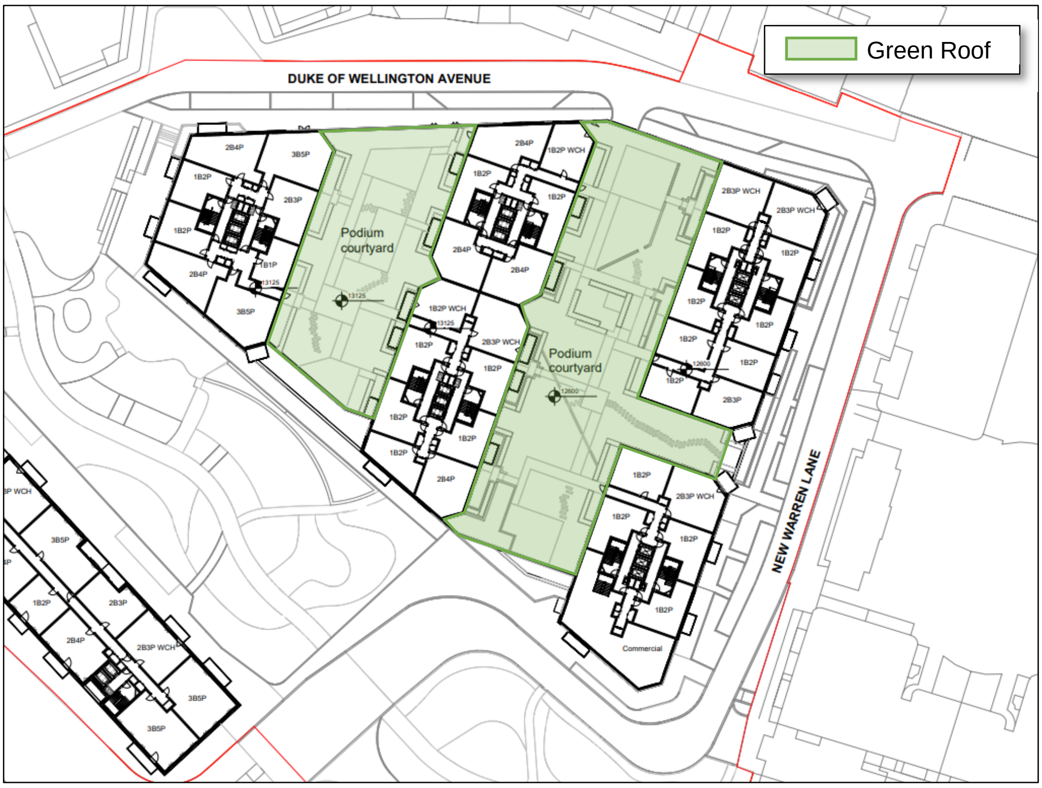

Figure 8.1 – Image showing the location of the proposed green roofs.

8.4.3 Although the incorporation of green roofs will provide a significant benefit to the quality of water discharged from the roofs under higher return period events, it is unlikely that a green roof in isolation can be designed to restrict the rate at which runoff is discharged from the site. Consequently, additional storage for storm water will be provided.

Permeable Surfacing

8.4.4 The areas of new paving within the development will be covered by permeable surfacing, which will have a layer of open graded subbase material located beneath to provide attenuation. This will cover the areas of new paving around the D and K buildings and adjacent to the existing buildings at the southwest of the site. The subbase will also provide additional benefit in terms of pollution control, acting as a filter as the runoff passes through it. Details of the necessary depths required for storage within the various areas of permeable surfacing can be found in the appended hydraulic calculations and Indicative Surface Water Drainage Layout.

8.4.5 The exception to this are the areas above the basement protruding from the D Buildings, which will not be covered by permeable surfacing due to there being insufficient cover here. Runoff from this area, to the south of buildings D3 and D4, will be collected via a channel drain or similar and drain to the permeable surfacing to the south of building D3 before discharging into a geocellular attenuation tank.

Geocellular Attenuation Tank

8.4.6 Runoff from the hardstanding above the basement will be collected by channel drains or similar before being discharged into a geocellular attenuation tank beneath the hardstanding to the west of building D3. This will attenuate the runoff before discharging into the adjacent basin. Calculations have been undertaken to determine the depth and volume of the attenuation tank required and the results can be found within the appended calculations.

Basins and Swales

8.4.7 To provide additional attenuation and to convey runoff across the site, a series of basins and swales will be used. These basins have been developed in conjunction with the landscaping plan, and the contours and details of these are being specified by the landscape architect. Runoff from the roofs and paved areas will be conveyed across the site to the attenuation basins, which will discharge to a basin adjacent to building D3. In addition, these features will further integrate water within the design of the development and provide additional pollution control benefits, as well as providing space for planting and habitats for wildlife.

Summary of Hydraulic Calculations

8.4.8 The basin adjacent to building D3 will discharge to a flow control chamber, containing a vortex flow control device (e.g. Hydro-Brake or similar). As outlined in Section 8.2, there is an existing connection into the tidal River Thames via an existing part of the Royal Arsenal Riverside Masterplan. As part of the surface water drainage design for this existing development, a maximum inflow of 90l/s was accounted for from The Ropeyards (see Appendix A.6). The vortex flow control device will restrict all discharge to a maximum of 90l/s.

8.4.9 The full set of results of the hydraulic drainage model are provided, alongside a drainage layout plan, to demonstrate how the objectives for the discharge of surface water set out in local and national planning policy can be achieved. The performance of the proposed drainage system has been tested by applying a series of rainfall events with varying return periods. A comparison of the existing and proposed discharge rates for the site can be seen in Table 8.2 below.

Return Period (years)	Greenfield runoff rate (l/s)	Peak runoff from the existing site (l/s)	Proposed discharge rates (l/s)
2	-	273	54.3
Qbar	2.2	-	-
30	5.0	836	81.9
100	7.0	1100	87.2
1:100+40%cc	-	-	89.8

Table 8.2 – Comparison of existing and proposed surface water discharge rates for the development site.

8.4.10 The appended calculations show that for all events up to and including the 1:100+40%cc event the proposed drainage system can attenuate the runoff from the entire development, before discharging at a restricted rate into the adjacent part of the Royal Arsenal Riverside masterplan which has onward connectivity to the tidal River Thames. As the proposal is to discharge to a tidal waterbody, there is no restriction on discharge rates. Notwithstanding this, the SuDS features provided will ensure that a betterment has been made compared to the existing brownfield runoff rates. Consequently, it is considered that this will be acceptable to the LPA and Lead Local Flood Authority (LLFA).

8.4.11 A full-scale copy of the indicative surface water drainage layout is located in Appendix A.4 of this report.

8.5 Management and Maintenance

8.5.1 In order for any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime. Therefore, over the lifetime of a development there is a possibility that the performance of the system could be reduced or could fail if it is not correctly maintained. This is even more important when SuDS form a part of the surface water management system, as these require a more onerous maintenance regime than a typical piped network.

8.5.2 The key requirements of any management regime are routine inspection and maintenance. When the development is taken forward to the detailed design stage, an 'owner's manual' will need to be prepared. This should include:

- A description of the drainage scheme.
- A location plan showing all of the SuDS features and equipment, such as flow control devices etc.
- Maintenance requirements for each element, including any manufacturer-specific requirements.
- An explanation of the consequences of not carrying out the specified maintenance.
- Details of who will be responsible for the ongoing maintenance of the drainage system.

8.5.3 General maintenance schedules have been included within the appendices of this report, which demonstrate the maintenance requirements of the proposed SuDS. For developments such as this, that to some extent rely on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development.

8.5.4 As the proposed SuDS are to be located in communal areas, it is likely that the management company responsible for maintaining the rest of the site will be tasked with the inspection and maintenance of these features. For some elements of the drainage system, including the green roofs and vortex flow control device, it may be necessary to use specialist contractors or have the original manufacturer inspect the features. If this is the case, the management company will need to make allowances for these inspections and works to be carried out.

8.5.5 Further details of the maintenance and management strategy should be confirmed, following the completion of a detailed drainage design for the development.

8.6 Sensitivity Testing and Residual Risk

8.6.1 When considering residual risk, it is necessary to consider the impact of a flood event that exceeds the design event, or the implications if the proposed drainage system was to become blocked.

8.6.2 To minimise the risk of the uncontrolled discharge of floodwater from the green roofs and permeable surfacing systems, an overflow pipe should be incorporated into the design of these drainage features. If the primary flow control device becomes blocked, this pipe will be used to bypass the flow control device, allowing excess water to drain directly to the basins at the centre of the site.

8.6.3 Inspection of the levels proposed as part of the landscaping plan show that the landscaped areas at the centre of the site have a lower elevation than the surrounding buildings. Consequently, if a blockage or exceedance event was to occur, runoff would be directed here, rather than towards the proposed buildings or neighbouring sites. Within this, there are also lower areas for uses such as swales and play which are lowered and would therefore provide additional storage.

8.6.4 Flooding across these lowered areas has the added benefit of providing a visual alert to residents and the management company, providing forewarning that the capacity of the drainage system has been exceeded and that a blockage of the flow control device may have occurred. In turn, this will increase the opportunity to clear the blockage before floodwater reaches properties.

8.6.5 An exceedance plan delineating the likely path of floodwater following an exceedance or blockage event can be seen in Figure 8.2 below. A full scale copy can be found in Appendix A.4.

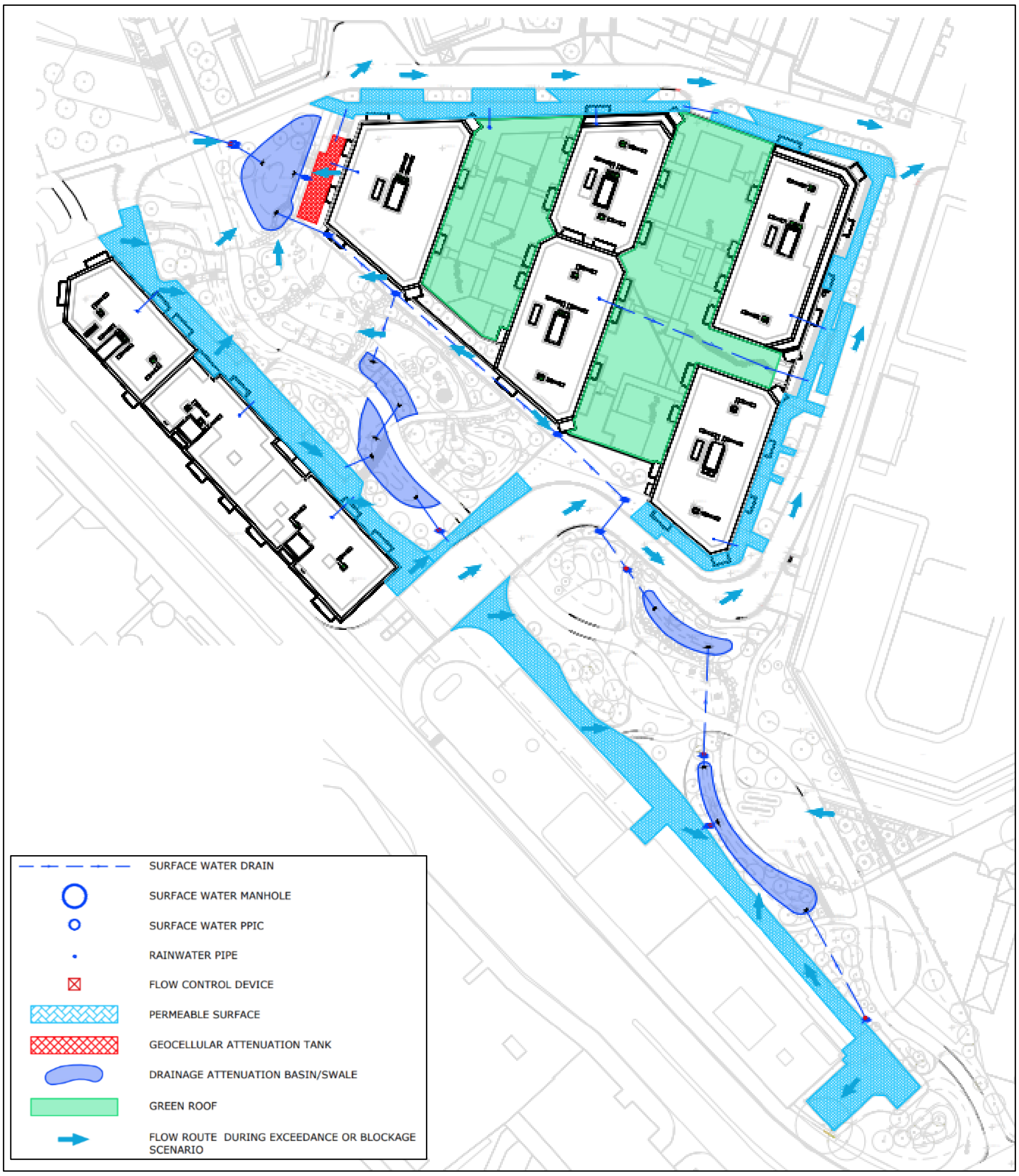

Figure 8.2 – Indicative plan of expected flow routes following an exceedance or blockage event.

8.6.6 Based on the analysis above it is therefore concluded that the proposed drainage system outlined within this strategy will not result in an increased risk of flooding to properties at the site or within the surrounding area.

9 Foul Water Management Strategy

9.1 Background

9.1.1 The objective of this foul water drainage strategy is to ensure a viable solution is available for managing foul effluent discharged from the proposed development site.

9.1.2 In general, there are two methods for draining effluent from proposed developments. The preferred solution is a connection to the public sewer network, which is controlled by the sewerage undertaker. Nonetheless, if there are no sewers near to the development site or there are particular reasons why a connection to the public sewer system would not be possible i.e., topography, cost, environmental concerns, then the use of package treatment systems or cesspits is permitted.

9.1.3 In this case, the proposed development is located within close proximity of a public foul sewer and there is an existing connection. Consequently, this will be used as the proposed discharge method for foul water produced within the development site.

9.2 Sewer Connection

9.2.1 As indicated in Figure 4.3, there is an existing public foul sewer within Duke of Wellington Avenue. At this stage, the D buildings are proposed to connect into the TW network to the northeast of the buildings, as shown in Figure 9.1 below. The foul effluent will be managed internally, with two runs leaving the footprint of the building, one draining the basement and the other for the rest of the residential and commercial spaces. These will drain via gravity to a manhole which will then connect into the TW network. The foul drainage from the basement will only be for washing down of the carpark, plantrooms, bin stores and cycle stores.

9.2.2 For the K buildings, it is proposed to connect via an existing private heading into the public foul trunk sewer which runs in a southeasterly direction parallel to the K buildings. The current proposed location of this connection can be seen in Figure 9.1 below.

9.2.3 TW have been consulted for a pre-application enquiry and discussions are ongoing. Whilst the formal response has not yet been received, TW have confirmed utilising an existing connection to the trunk sewer is feasible. This is on the condition that there is sufficient capacity and that the existing connection into the trunk sewer which will be used for the K buildings is shown to be adequate for the proposed discharge and in good condition. It is therefore recommended that this connection, as well as the location of the proposed connection for the D buildings is surveyed, and further discussions with TW undertaken, prior to more detailed stages of design commencing to ensure these connections are usable.

9.2.4 Table 9.1 shows the unit numbers and maximum occupancies for each of the residential buildings within The Ropeyards development, taken from the accommodation schedule. As per guidance from the Design and Construction Guidance (DCG), the peak design flow rates for dwellings have been considered to be 4000 litres per day per dwelling, or 0.05 litres per second per dwelling. This is a design peak flow rate not a daily average water usage, and represents the peak flow rate from a number of appliances.

Building	Number of Dwellings	Maximum occupancy	Peak design flow rate for building (l/s)
D1	83	200	4.15
D2	48	153	2.40
D3	136	474	6.80
D4	120	309	6.00
D5	101	251	5.05
D Buildings Total	**488**	**1387**	**24.40**
K4	90	360	4.50
K5	85	238	4.25
K Buildings Total	**175**	**598**	**8.75**

Table 9.1 – Unit and maximum occupancy numbers and peak design flow rates for the residential dwellings within The Ropeyards.

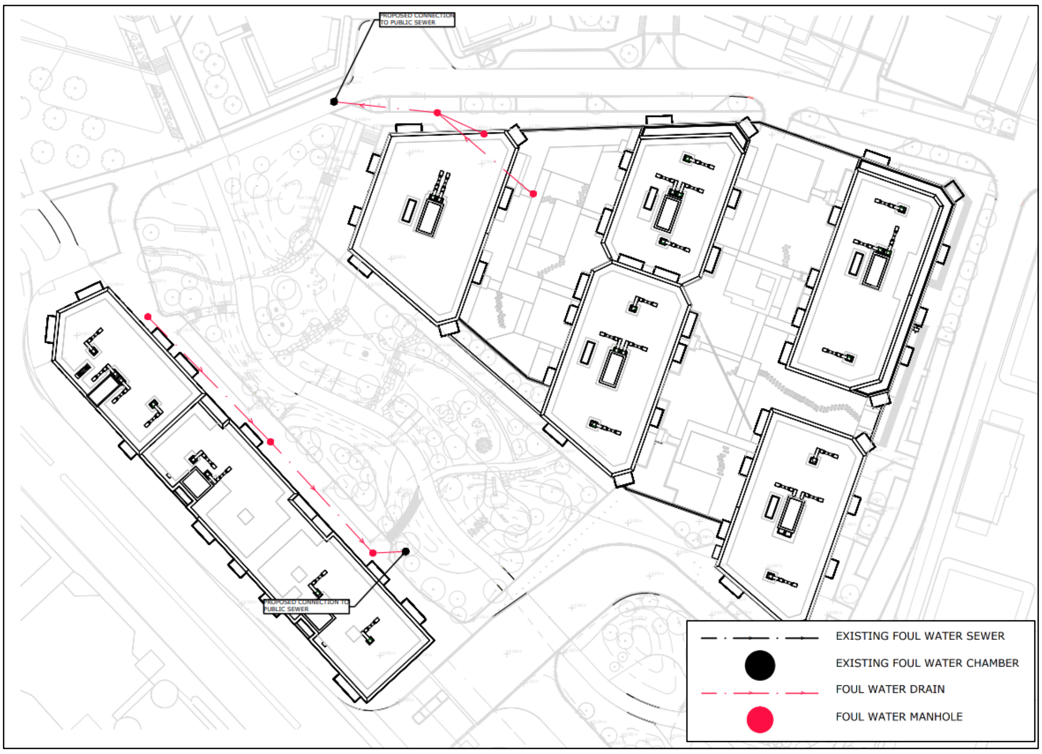

Figure 9.1 - Proposed connections to the foul sewer network.

9.2.5 A full-scale copy of the indicative external foul water drainage layout is located in Appendix A.4 of this report.

9.3 The Water Industry Act

9.3.1 The Water Industry Act 1991 provides developers with a mechanism for connecting to the public sewerage infrastructure. The type of connection depends on the type and location of the sewers in relation to the site and third-party land.

9.3.2 As the proposed development will be creating new connections into the TW network, a Section 106 application will be required covering both connection points. As part of this process, it is necessary to determine whether the sewer network will require any upgrades to accommodate effluent from the development site. It is acknowledged that the cost of a new connection and any additional works which are required to upgrade the public sewer system (to accommodate the additional foul effluent from the development).

9.3.3 Under Section 101, the sewerage undertaker must undertake any works as part of this process within a reasonable timeframe, which is typically 6 months following the agreement being made. Mitigating circumstances and Grampian planning conditions can, however, result in different timescales.

9.4 Summary

9.4.1 The opportunities for managing foul effluent discharged from the development site have been analysed and it is concluded that separate connections for the D and K buildings to the public sewer system is likely to present the most viable solution.

9.4.2 Following the award of planning permission, a full detailed design of the site layout and foul drainage system will be required as part of the Section 106 application, which will require a new connection to be requisitioned and any necessary upgrades made to the public sewer system. These upgrades are likely to be economically proportionate to the size of the development, however, it is recognised that a solution for managing foul wastewater from the proposed development will be available.

10 The Sequential and Exception Test

10.1 The Sequential Test

10.1.1 The NPPF states that the Local Planning Authority (LPA) should apply the sequential approach as part of the identification of land for development in areas at risk from flooding. The overarching objective of the Sequential Test is to ensure that lower risk sites are developed before sites in higher risk areas. When applying the Sequential Test, it is also necessary to ensure that the subject site is compared to only those sites that are available for development and are similar in size.

10.1.2 In this instance, outline planning permission has previously been granted for the site and therefore, the principle of development in this area has already been secured and the Sequential Test is not considered necessary. In any case, the proposed development is located within Flood Zone 1, which is an area defined as having a less than 1 in 1000 year probability of flooding from rivers or the sea, and this assessment has concluded that the risk of flooding from all sources is low. Consequently, the development would meet the requirements of the Sequential Test, if it were required.

10.2 The Exception Test

10.2.1 According to the NPPF, if it is not possible, consistent with wider sustainability objectives, for the development to be located in areas at lower risk, the Exception Test may have to be applied. The application of the Exception Test will depend on the type and nature of the development, in line with the Flood Risk vulnerability classification set out in the NPPG. This has been summarised in Table 10.1 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential Infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations.	✓	✓	e	e
High Vulnerability – Emergency services, basement dwellings, caravans and mobile homes intended for permanent residential use.	✓	e	×	×
More Vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education.	✓ (shaded)	✓	e	×
Less Vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants.	✓	✓	✓	×
Water Compatible Development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓

Key :

✓ Development is appropriate

× Development should not be permitted

e Exception Test required

Shaded cell represents the classification of this development

Table 10.1 - Flood risk vulnerability and flood zone incompatibility.

10.2.2 From Table 10.1 above it can be seen that the development falls into a classification that does not require the Exception Test to be applied. Notwithstanding this, Paragraph 173 of the NPPF requires all development in Flood Zones 2 and 3 to be subject to an FRA and to meet the requirements for flood risk reduction. This is therefore the primary focus of this document.

11 Conclusions and Recommendations

11.1.1 The overarching objective of this report is to appraise the risk of flooding at The Ropeyards, Royal Arsenal Riverside, to ensure that the proposals for development are acceptable and that any risk of flooding to the occupants of the proposed residential units is appropriately mitigated. In addition, the NPPF also requires the risk of flooding offsite to be managed, to prevent any increase in flood risk as a result of the development proposals. This report has therefore been prepared to appraise the risk of flooding from all sources and to provide a sustainable solution for managing the surface water runoff discharged from the development site, in accordance with the NPPF and local planning policy.

11.1.2 This assessment has identified that the site is located within Flood Zone 1 and is at *low* risk of flooding from all sources. Whilst this assessment has concluded that the risk of flooding is *low* from all sources, it is recommended that the mitigation measures outlined below are explored where possible, given that the area surrounding the development could be subject to flooding during an extreme weather event and the proposals for development include the construction of a new basement. The following mitigation measures are therefore recommended:

- **The proposed basement should be constructed using flood resilient techniques.** The use of flood resilient construction techniques such as including an impermeable membrane within the basement, raising electrical sockets and avoiding stud walls/plasterboard will ensure that in the unlikely event groundwater were to become elevated within this area, the risk of floodwater ingress into the proposed basement and subsequent risk of damage is minimised.

- **Residents should sign up to the EA's Weather Warnings.** Given that the area surrounding the proposed development could be subject to flooding during an extreme flood event, it is recommended that residents sign up to the EA's Flood Warning Service, which could provide a forewarning for when flooding in this area could occur.

11.1.3 Furthermore, this FRA has demonstrated that the development will not increase flood risk elsewhere and by incorporating appropriate mitigation measures and SuDS features within the design of the surface water drainage system, it will be possible to limit the impact with respect to surface water runoff.

11.1.4 It is concluded that the most viable solution for managing all of the surface water runoff discharged from the proposed development will be via a connection to the tidal River Thames via an existing part of the Royal Arsenal Riverside Masterplan development, which has accounted for a maximum inflow of 90l/s from The Ropeyards.

11.1.5 In order to restrict the rate at which surface water runoff is discharged offsite, various SuDS have been proposed, including; green roofs, permeable surfacing, a geocellular attenuation tank and a network of attenuation basins and swales within the central landscaped area of the site. These

SuDS will be used to store water onsite before it is discharged to the River Thames. A vortex flow control device has been specified to attenuate the rate at which surface water runoff is discharged from the site, limiting the rate to a maximum of 90.0l/s, as was specified by the existing development.

11.1.6 Details of the typical maintenance and management requirements for each element of the drainage system have been provided to ensure that the proposed drainage solution can be maintained and will continue to operate over the lifetime of the development. It is, however, recommended that an "owner's manual" containing additional product specific maintenance requirements is produced as part of the detailed design for the site and that specialist contractors are used where necessary to maintain the drainage network.

11.1.7 The opportunities for discharging foul effluent from the site have also been considered and the appraisal demonstrates that the most viable solution is to connect into the existing foul sewer network, with separate connections for the D and K buildings.

11.1.8 In conclusion, following the recommendations of this report, the occupants of the development will be safe and the development will not increase the risk of flooding elsewhere. Consequently, it has been demonstrated that the development will therefore meet the requirements of the NPPF.

12 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Thames Water Asset Location Data

Appendix A.3 – Surface Water Management Calculations

Appendix A.4 – Indicative Drainage Layout

Appendix A.5 – Maintenance Schedules

Appendix A.6 – Surface Water Drainage Scheme for Adjacent Site

Appendix A.7 – Royal Borough of Greenwich SuDS Proforma