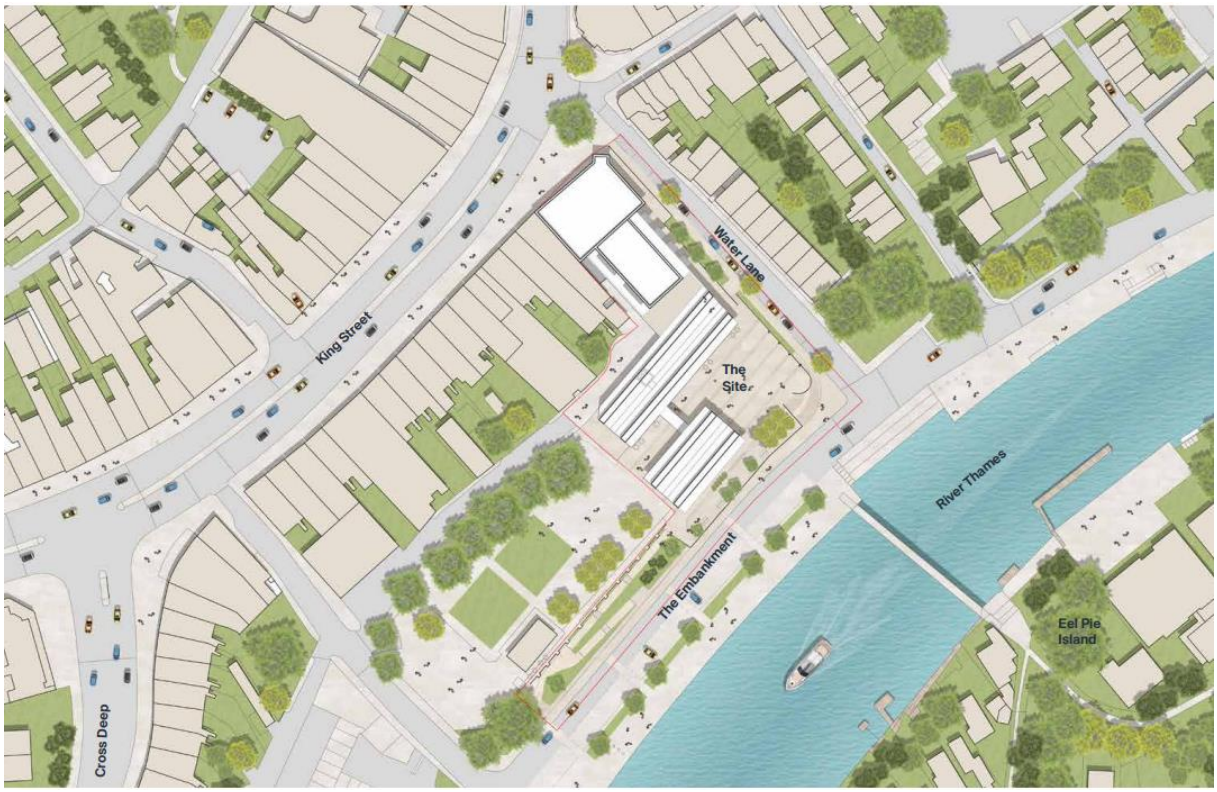
PRICE&MYERS

REPORT

Twickenham Rediscovered – Riverside Project

Flood Risk Assessment



Prepared by: Sabrina Ram MEng

Reviewed by: Dimitris Linardatos BEng MSc CEng MICE FIHE

Job Number: 25159

Date	Version	Notes/Amendments/Issue Purpose
October 2017	DRAFT	Draft for design team comment
October 2017	DRAFT	Draft for comment
November 2017	DRAFT	Draft following EA consultation
November 2017	1	Issued for planning
November 2017	2	Issued following Thames Water consultation response

Contents Page

Appendices:

Acronyms			
AEP	Annual Exceedance Probability	FRA	Flood Risk Assessment
AOD	Above Ordnance Datum	PPG	Planning Practice Guidance
CDA	Critical Drainage Area	NPPF	National Planning Policy Framework
EA	Environment Agency	SFRA	Strategic Flood Risk Assessment
FFL	Finished Floor Level	SWMP	Surface Water Management Plan
FRA	Flood Risk Assessment	TW	Thames Water

1 Introduction

Price & Myers have been commissioned to undertake a Flood Risk Assessment (FRA) to support the planning application of the proposed Twickenham Rediscovered Development, on the Embankment of the River Thames in the London Borough of Richmond upon Thames.

The proposed works include the demolition of the existing lido and associated buildings and the construction of commercial and residential accommodation, including a new town square. The proposed development will improve public accessibility to the river frontage. The proposed works will also include improvements to the flood defence line.

This FRA has been carried out in accordance with the National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG) "Flood Risk and Coastal Change", advice and guidance from the Environment Agency (EA), the Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA, Updated March 2016) and Surface Water Management Plan (SWMP, 2011), along with CIRIA documents.

The NPPF states that an appropriate FRA will be required for all development proposals of 1 ha or greater in Flood Zone 1 and for any development within Flood Zones 2 or 3.

The EA's indicative floodplain map shows that part of the site is located in Flood Zone 3, therefore this assessment will focus on the flood risk to the site from watercourses.

2 Site Description and Location

The site is situated in the London Borough of Richmond and is approximately 22m away from the bank of the River Thames. The postcode for the site is TW1 3SD and the National Grid Reference is TQ162731. The existing development forms part of the flood defence line and this maintained at a level of approximately 6.0m AOD. It should be noted that at present, there are various openings along this line, including a garage door, gate and steps. Photographs of the existing flood defence line can be found in Appendix A. The EA have classified this defence as Condition Grade 2 'Good' , on a scale of 1 (very good) to 5 (very poor).

The site location can be seen below in Figure 2.1.

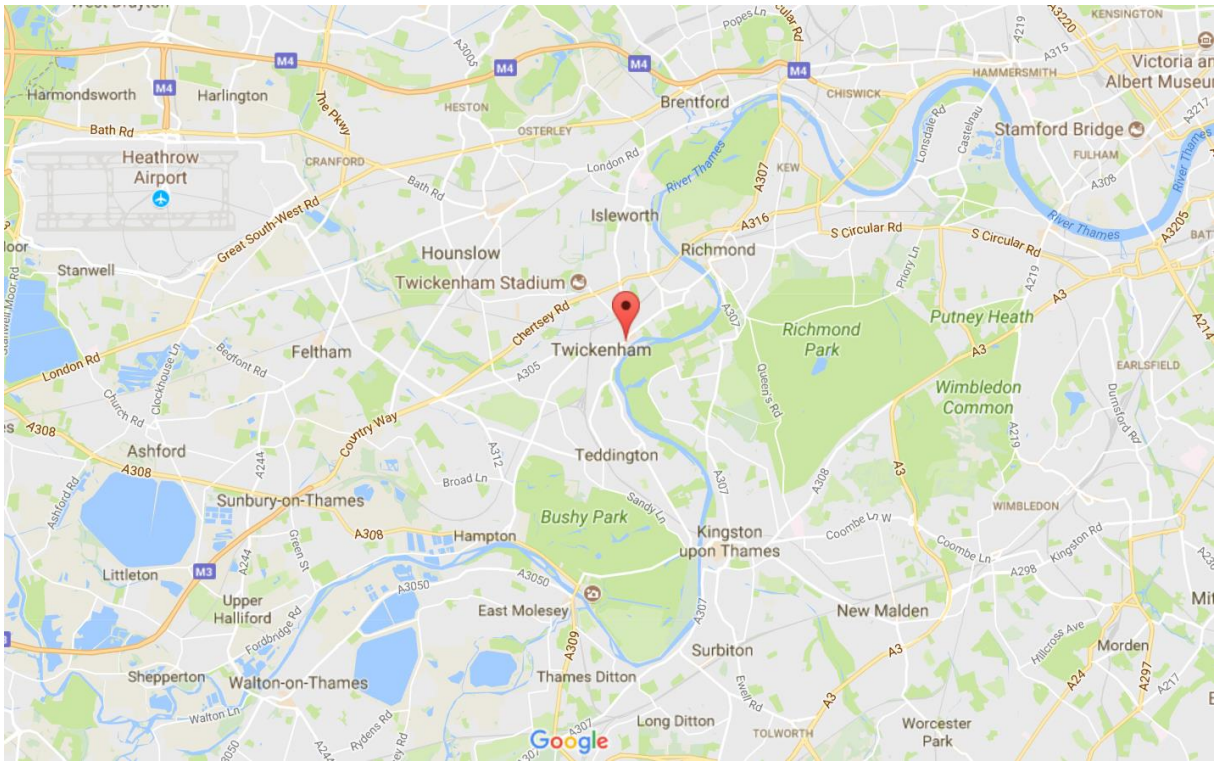


Figure 2.1: Site location, showing nearby watercourse (Google Maps, 2027)

The site is bound by Water lane to the north-east, retail units and Diamond Jubilee Gardens to the north-west, Wharf Lane to the south-west and The Embankment to the south-east. The total site area is 4,478m^2 and of this, 3,700m^2 is impermeable. Currently, the southwestern portion of the site is occupied by the Diamond Jubilee Gardens. A car park is situated to the south-east of the site and commercial buildings occupy the north-east of the site. A topographical survey of the site can be found in Appendix B.

Existing levels vary from 4.68m AOD at the junction of the Embankment and Water Lane, to 7.90m AOD at the north of the site. Figure 2.2 shows the site in more detail, including the red line boundary.

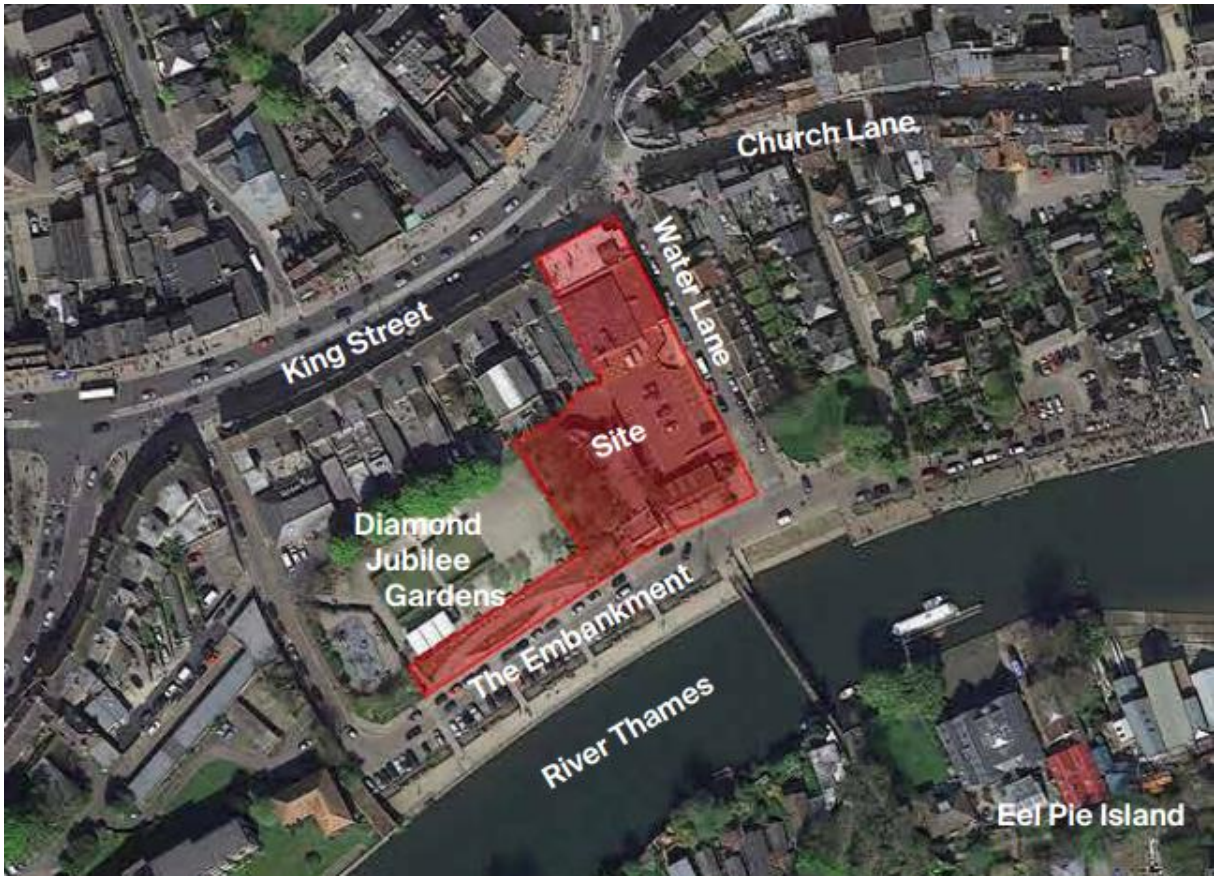


Figure 2.2: Existing site location showing the site boundary

3 Development Proposal

The development proposals include the demolition and removal of all existing buildings and structures. The redevelopment will have a mixed use on the site at 1A, 1B King Street and 2/4 Water Lane, the site of the remaining former swimming pool buildings at the corner of Water Lane and The Embankment and the river-facing parcel of land on the Embankment in front of Diamond Jubilee Gardens. The development proposals comprise of:

- Seasonal units at lower ground floor level, classified as “water compatible” uses under the PPG , such as boat hire;
- A car park at lower ground floor level;
- Restaurants and cafes at ground floor level;
- Business and retail units at ground floor level;
- 39 residential units, on first, second and third floors; and
- A new public square and areas of public realm throughout.

The Lower Ground Floor car park will have vehicular access from The Embankment and will consist of 23 car parking spaces and cycle storage. A reconfiguration of street parking in the roads immediately adjacent to the site and amended pedestrian access and landscaping to the South of Diamond Jubilee Gardens will take place. A reconfiguration of service vehicle access to the service road at the rear of Diamond Jubilee Gardens is also proposed.

Block A and Block B are accessible via the podium level. The flood defence line will be improved as part of this works and therefore a ‘Flood Risk Activity Permit’ is required from the EA.

A study of the landscape proposals show that 4279m^2 of the site will be impermeable. The development proposal can be seen in Figures 3.1 and 3.2 below. Figure 3.1 shows the podium level and Figure 3.2 shows the lower ground level, incorporating a car park. The Finished Floor Level (FFL) of the podium level is 7.9m AOD, internal areas on the ground floor will have a FFL of 8.0m AOD and the FFL of the lower ground car park will be 4.75m AOD.

The sequential approach has been applied to the development, locating “Less Vulnerable” and “Water Compatible” developments at the lower ground floor and ground floor level. The “More Vulnerable” uses of the development (residential) have been confined to the upper levels of the development (1st floor and above).

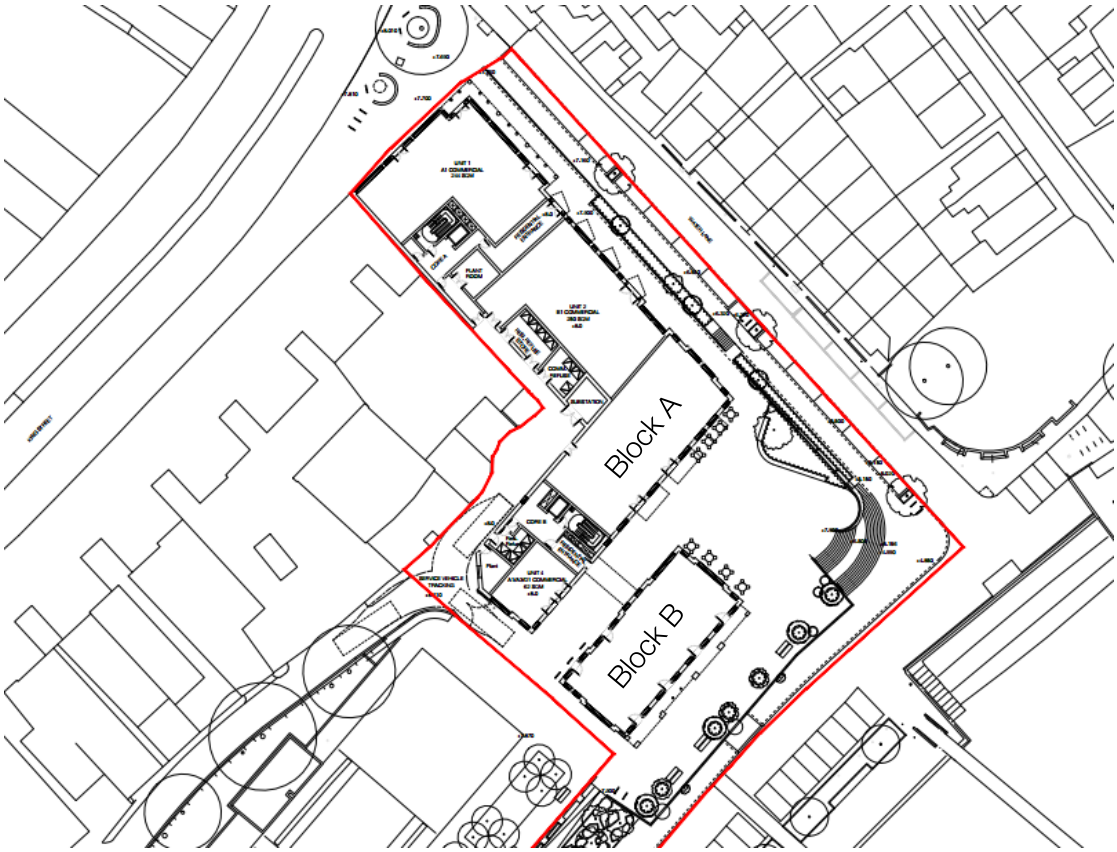


Figure 3.1: Proposed podium level layout (CJCT, 2017)

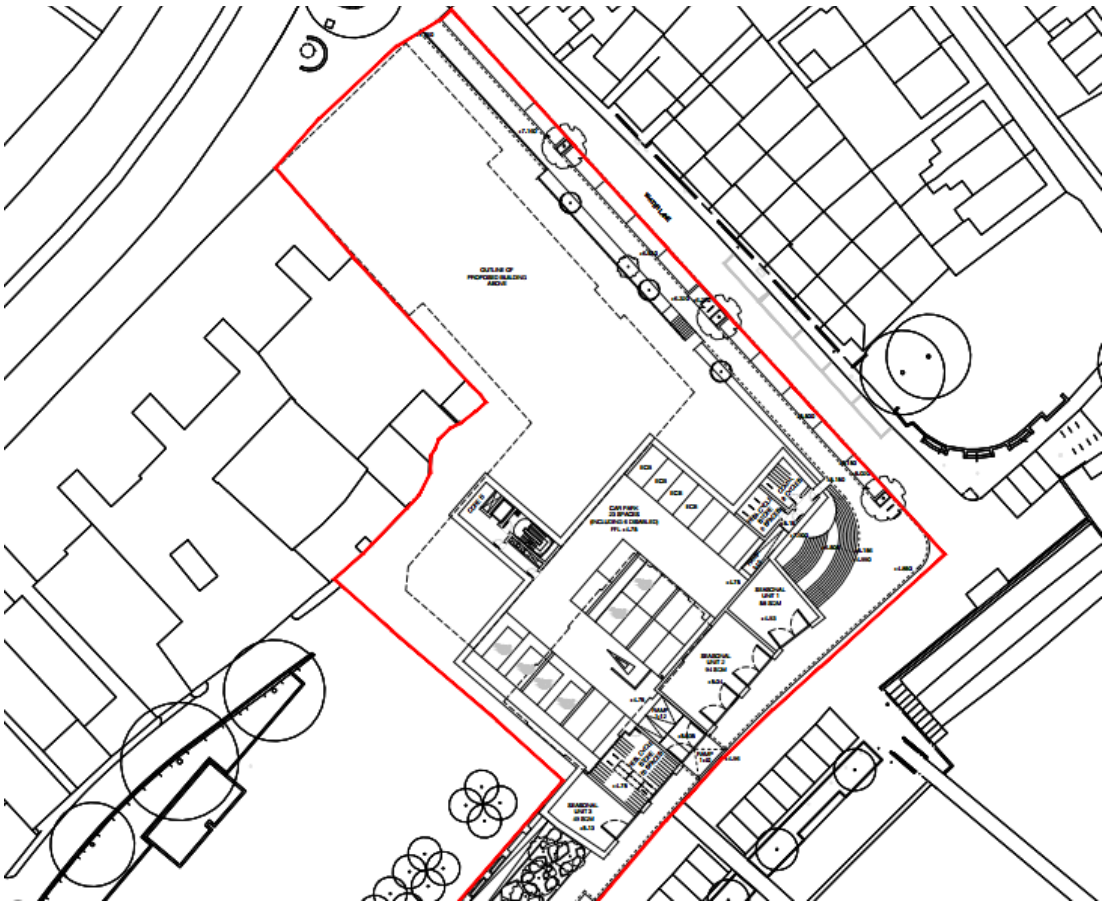


Figure 3.2: Proposed lower ground level layout (CJCT, 2017)

4 Flood Risk Assessment

4.1 Flood Risk from Watercourses

The EA's modelled floodplain map shows that part of the site is located in Flood Zone 3a and the south east corner is in 3b. Therefore, it is at risk of flooding from the River Thames. Land in flood zone 3a is assessed as having annual probability of fluvial flooding greater than 1% or tidal flooding greater than 0.5%. Flood Zone 3b is the zone that comprises of land where water has to flow or be stored in times of flood. The EA's maps suggest that the site is located in an area which benefits from flood defences, however the EA's website also states that not all defences are shown on the map. Figure 4.1 below shows an extract of the Product 4 data. The full Product 4 data can be found in Appendix C.

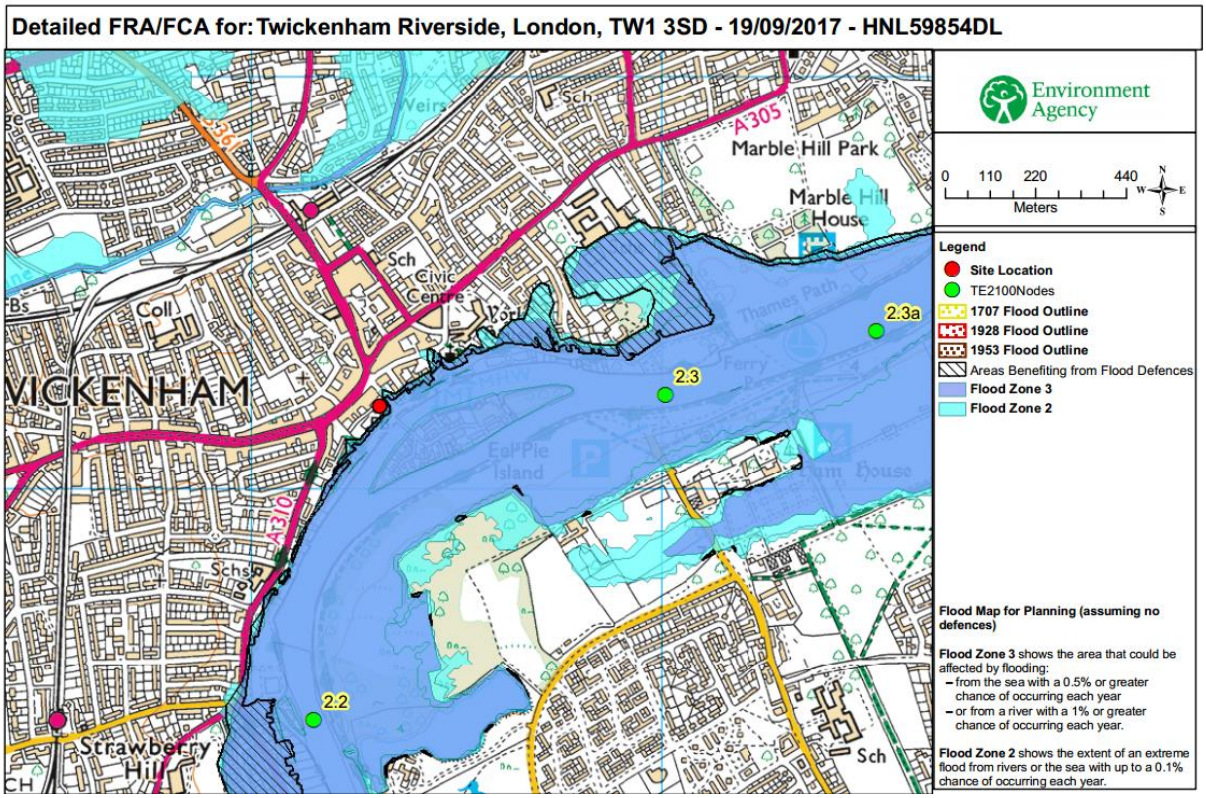


Figure 4.1:Detailed map from EA Product 4 Data (EA, 2107)

Tidal Flooding

The Product 4 data shows that the closest upstream node to the site is 2.2. The present day water level at this node is 5.95m AOD and future water level, in 2100, is 6.45m AOD. New development should either include future defence raising or demonstrate that future raising will be feasible to a level of 6.9m AOD.

The ground floor level has an FFL of 7.9m AOD and internal areas on the ground floor will have an FFL of 8.0m AOD, which provides 1m of freeboard above the TE2100 future defence level. The car park has an FFL of 4.75m AOD, however, the back of the car park will form the flood defence line and this will be fully accessible for inspection from the EA. Therefore, in a high storm or tidal event, the car park will flood. However, the new flood defence will ensure that surrounding properties are protected up to the TE2100 level of 6.9m AOD, plus an additional 1m. This new flood defence will be tied into the flood defence line at the east and west of the site. An automatic flood barrier at the entrance to the car park is proposed, which will be classified as a formal flood defence. However, this additional barrier will only protect the car park in flood events where the flood depth does not exceed 600mm. Therefore the flood water

will enter the car park after exceeding a level of 5.635m AOD, which provides an adequate level of protection considering the low vulnerability.
The EA are committed to ensuring the TE2100 defence levels of protection are maintained. The raised defences are inspected by the EA twice a year, to ensure they are fit for purpose, however it is important to appreciate that the flood defences are engineered structures and have a finite design life. Therefore the analysis that follows considers if there is an upriver breach.

The Thames Tidal Upriver Breach Modelling shows that the highest modelled flood level on site is 6.421m AOD, in the year 2100 and 5.836m AOD in the year 2065. Figure 4.2 maps the Breach analysis at the site.

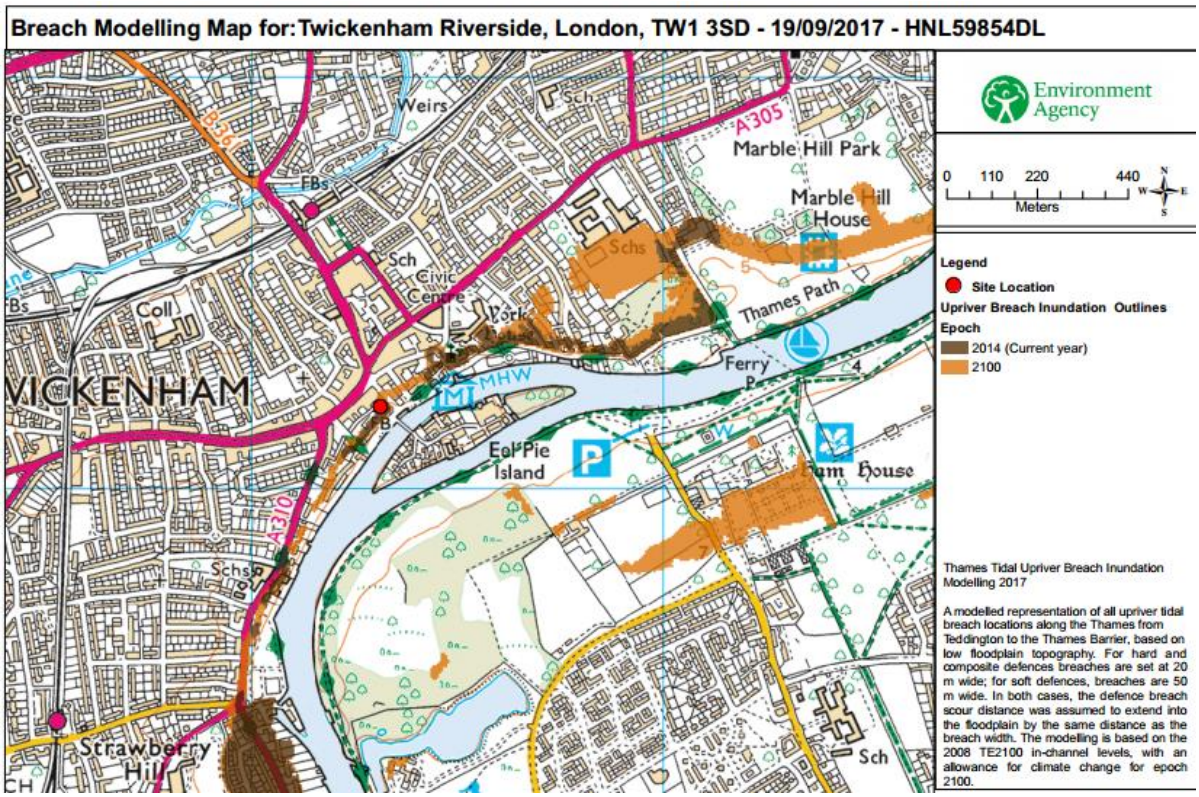


Figure 4.2: Breach Modelling map from the EA Product 4 data (EA, 2017)

The ground floor level including the town square and commercial space will be raised above this level. Therefore, these areas have a low risk of flooding in the tidal breach scenario. Furthermore, residential accommodation is above this level.

The lower ground car park will have a FFL of 4.75m AOD, with a raised table to 5.035m AOD and 600mm automatic flood barrier at the entrance, protecting the car park to a level of 5.635m AOD. Therefore, in the upriver breach scenario, the car park will flood. However, as the back of the car park will be used as the formal flood defence line, surrounding developments will be protected to the TE2100 level. It should also be noted that an upriver breach is extremely unlikely to occur.

Fluvial Flooding

Following consultation with the EA, it was concluded that the 'TH024 River Thames Reach 4 2D Modelling Study' (EA, 2010) should be used to ascertain the fluvial flood levels across the development. The information provided is taken from the Lower Thames Reach 4 2D Modelling Study which was completed in December 2010. It was modelled using a linked ISIS- TUFLOW model.

The site is situated between nodes 2.2 (516163, 172434) and 2.3 (517059, 173210). Therefore, the average value between these 2 points were used. The maximum stages and flows can be found in Table 1 for differing return periods.

Table 1 Average peak water levels and flows for the 5yr (20%), 20yr (5%), 50yr (2%), 100yr (1%), 100yr+CC, 1000yr (0.01%) AEP events for Node 2.2 and 2.3

Return period	Flow (m3/s)	Stage (m AOD)
5yr	430.6765	4.105
20yr	587.0175	4.897
50yr	688.8045	5.3585
100yr	766.0035	5.6885
100yr +20% CC	895.8265	6.256
1000 yr	1028.355	6.9025

The EA published new guidelines on Climate Change allowances in February 2016. The site is within the Thames River Basin. The lifetime of the development is 100 years and the classification of the various uses of the development are “More Vulnerable” (residential), “Less Vulnerable” (car park and commercial) and “Water Compatible” (Seasonal units).

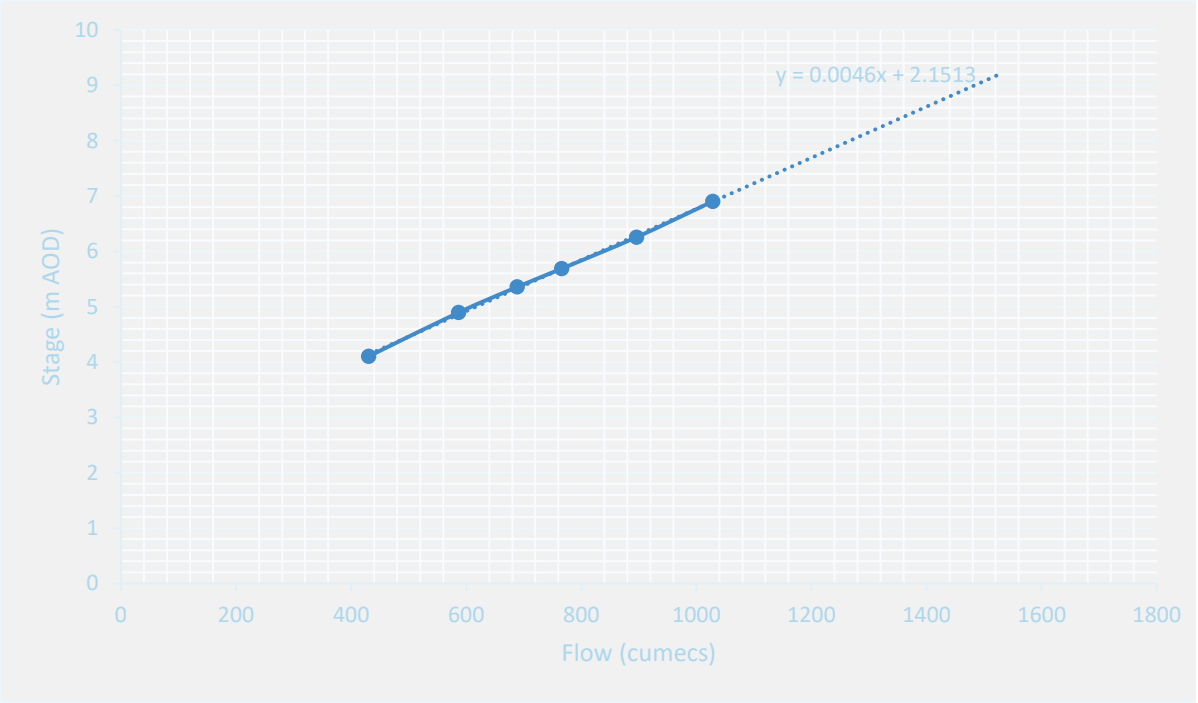
The EA’s guidelines state that:

a) The higher central and upper end allowances should be used to assess the flood risk for “More Vulnerable” and uses in Flood Zone 3a.
b) The central and higher central allowances should be used to assess flood risk for “Less Vulnerable” developments in Flood Zone 3b.
c) That the central allowances should be used for “Water Compatible” developments in Flood Zone 3b.

These allowances are 25%, 35% and 70% for the central, higher central and upper end respectively. The ground floor elements of the development (car park and Seasonal units) will flood in events greater than the 1 in 50 year (refer to Section 4.1). However, the commercial uses of the development which are classed as “Less Vulnerable” must be constructed to be safe in the 1 in 100 year plus 35% storm event.

The EA confirmed that the intermediate method will be acceptable for the climate change calculations for this development. The maximum flow was plotted against the maximum stage, for differing return periods. The line was extrapolated and the 1 in 100 year flow in cumecs was increased by 35% and 70%, in accordance with Table 1 of the Environment Agency Guidance ‘Flood risk Assessment: climate change allowances’. The flow was found to be 1034.1m^3/s and 1302m^3/s respectively.

The flood depth was then found using the extrapolated graph, shown in Figure 4.3 below. The maximum flood water level for the 1 in 100 year plus 35% climate change and 1 in 100 plus 70% climate change was found to be 6.908m AOD and 8.1405m AOD respectively.



The FFL of the ground floor podium is 7.9m AOD and the ground floor buildings have a FFL of 8.000m AOD. Therefore, in the 1 in 100 plus 35% climate change fluvial flood event, which is the design flood level, the flood level is below the ground floor FFL. Furthermore, more than 300mm freeboard is provided between the design flood level and the FFL.

The 1 in 100 plus 70% climate change flood levels should also be considered for the more vulnerable parts of the development. In this rainfall event, the lower ground floor car park and seasonal units flood. However, the "More Vulnerable" parts of the development are above this flood level, as they are proposed at first floor and above. It should be noted that the chances of this flood level to occur is very low, currently estimated at 10%.

It should also be noted that all plant rooms will be raised above the design flood levels and that there is no residential accommodation at this level. The entrance to the lower ground car park will be raised above the 1 in 50 flood level using a raised table and an automatic barrier will protect the car park up to a level of 5.635m AOD.

4.2 Sequential and Exception Tests

In accordance with the NPPF the risk-based Sequential Test should be applied at all stages of the planning process. Its aim is to steer new development to areas at the lowest probability of flooding; Zone 1. Development should not be permitted if there are reasonably available sites to accommodate the proposed development in areas with a lower probability of flooding.

Table 4.1 below states when the Exception Test is required. As the upper levels (1st floor and above) are classified as "More Vulnerable" and it is in Flood Zone 3a, the Exception Test is required. The south west corner of the site is situated in Flood Zone 3b. However, Water compatible development is proposed in this area. Therefore, this is appropriate as Table 4.4 shows.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:
✓ Development is appropriate
✗ Development should not be permitted.

Table 4.4 Flood Risk Vunerability and Flood Zone Compatability from Technical Guidance to the NPPF (March 2012)

The Adopted Twickenham Area Action Plan identifies the area for development. This plan was subject to a Sustainability Appraisal, where flood risk was considered. Therefore, the Sequential test and part A of the Exception test are not required as the site was assessed by the Local Authority and allocated within the Development Plan document for mixed use development. The development is therefore acceptable if it passes Part B of the Exception Test.

To meet part B of the Exception Test, it must be demonstrated that the development will be safe and evidence must be provided to show that the proposed development would be safe and that any residual flood risk can be overcome to the satisfaction of the local planning authority, taking account of any advice from the Environment Agency.

This site specific FRA has been prepared to demonstrate that the proposed development will be safe and residual flood risk is overcome. Building users will not be exposed to hazardous flooding from any source and the Flood Management Plan in Appendix D further details this, including access and egress arrangements. The 'Proposals for the Flood Defence Structure' report in Appendix L details the design of formal flood defence structures.

The flood mitigation and resilience measures that will be incorporated in the lower ground floor car park are:

- All below ground structures will be fully waterproofed, using all necessary engineering techniques.
- The sequential test will be adopted, locating more vulnerable elements of the development in areas at lower risk of flooding. Therefore, no habitable rooms will be below the flood water level.
- SUDs will be utilised to reduce surface water runoff rates to the Greenfield run-off rate. This will ensure the development is reducing flood risk to surrounding properties.
- Flood resilient floor finishes and wall materials will be used up to the design flood level.
- An automatically operating flood barrier will be installed at the car park entrance. This will ensure that flood water will be kept out of the car park (up to the 1 in 50 fluvial flood level). This will ensure that if a less severe storm occurs, water will be kept out of the car park.
- All electrical sockets will be raised above the fluvial and tidal flood level.

- All plant rooms will be placed above flood level, to avoid any damage in a flood scenario.
- The lower ground floor car park wall will meet the EAs flood defence construction requirements.

4.3 Works to the Flood Defence Structure

Refer to Appendix L for further information relating to the flood defence structure. A Flood Risk Activity Permit is required from the EA and all works to the flood defence line will be in accordance with the EAs flood defence guidance and specifications.

4.4 Flood Risk from Groundwater

The British Geological Survey maps indicate that the bedrock geology is formed of London Clay formations and that the superficial deposits on site are formed of Langley Silt Members.

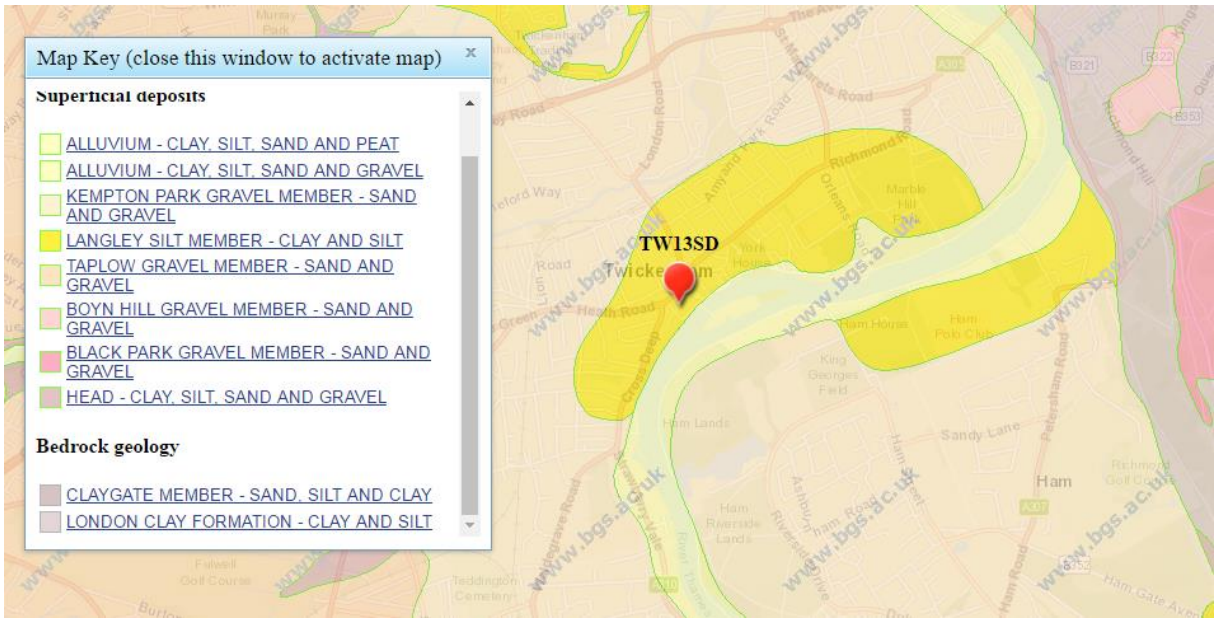


Figure 4.4: British Geological Survey Maps (BGS, 2017)

Borehole logs in close proximity to the site reaffirm the BGS maps. These show that beneath a layer of made ground, grey brown silty sandy clay was found to a level of 8.8m below ground level. This was underlain with stiff grey silty clay.

As the site is situated on impermeable strata, the site is not likely to be at risk from groundwater flooding. Furthermore, the SFRA shows that the site is not situated in an area susceptible to groundwater flooding.

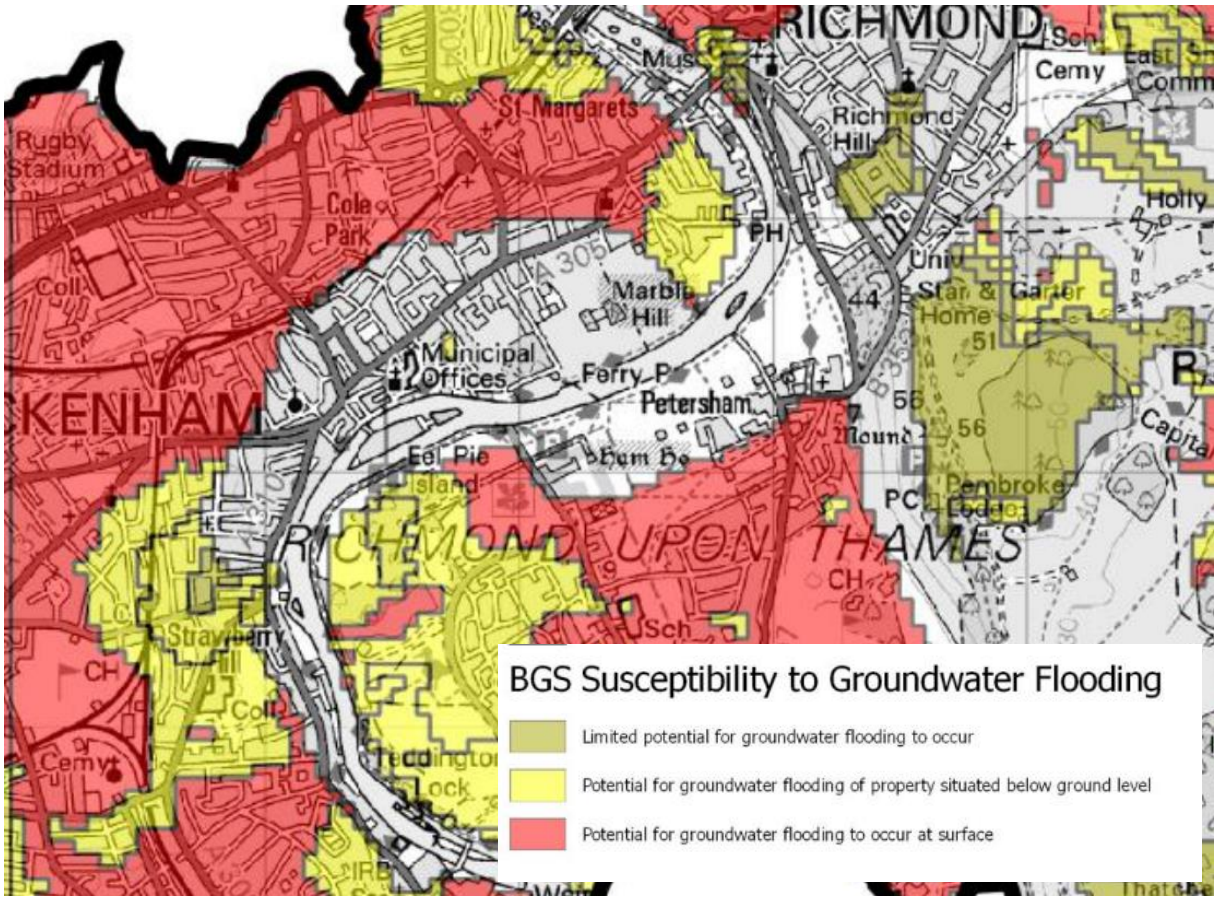


Figure 4.5: BGS Susceptibility to Groundwater Flooding (BGS, 2017)

The elements of the development surrounding by soil will be fully waterproofed. Therefore, it is concluded that the flood risk from groundwater is low.

4.5 Flood Risk from Surface Water and Overland Flows

Surface water flooding occurs when intense rainfall is unable to soak into the ground or enter a drainage system due to blockages or the capacity of the system being exceeded. Overland flows can also be generated by burst water mains, failed dams and any failure in a system storing or transferring water.

The EA's indicative Surface Water Flood Map (Figure 4.6) shows that the site is at very low and low risk of surface water flooding. The site topography shows that the local area falls towards the River Thames and therefore the site is not located in a local valley. In an extreme rainfall event, overland flows will travel to the River Thames.

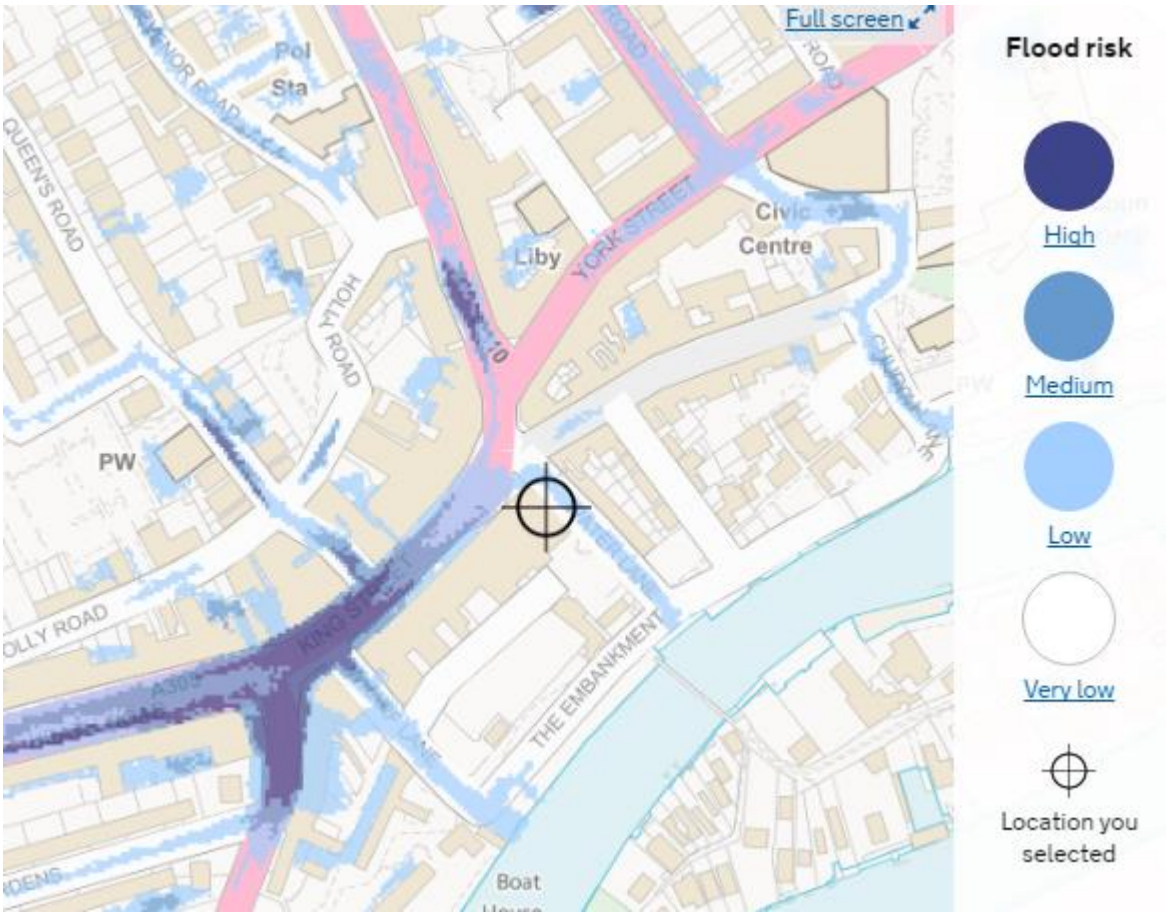


Figure 4.6 Environment Agency Surface Water Flood Risk Map (EA, 2017)

Furthermore, the site is not located in a Critical Drainage Area (CDA), as identified by the London Borough of Richmond Local Flood Risk Management Strategy (LFRMS).

4.6 Flood Risk from Reservoirs

The EA provides information on flood risk from reservoirs. The figure below shows that the north east corner of the site is at risk of flooding from reservoirs.

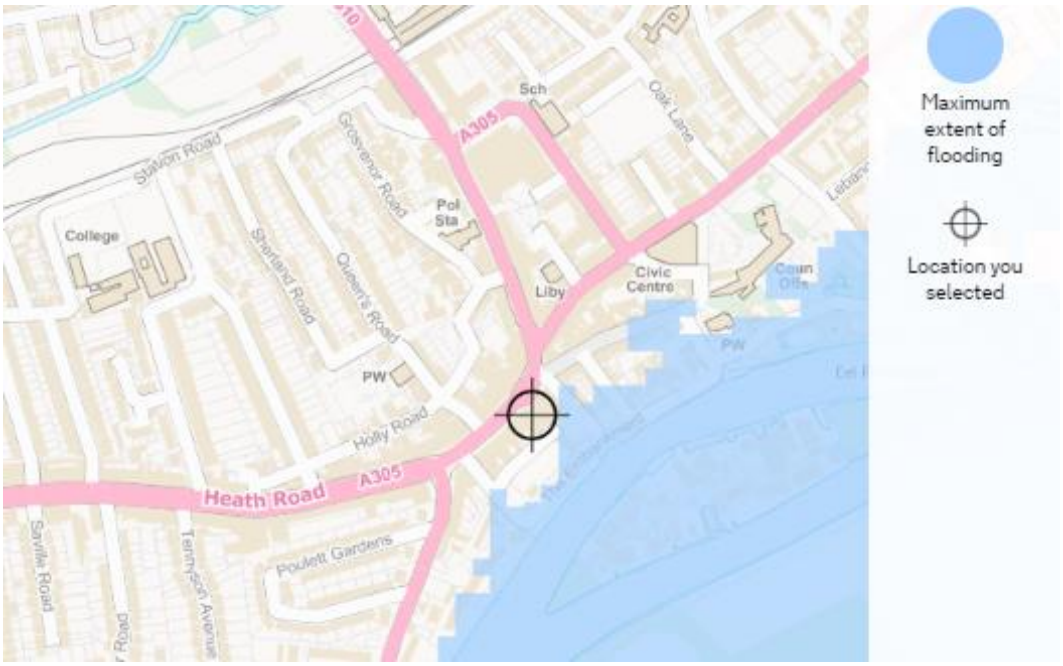


Figure 4.3 Environment Agency Risk of Reservoir Flooding Map

The EA's information states that reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. The Reservoir Act of 1975 ensures that reservoirs are inspected regularly and essential safety work is carried out.

In the unlikely event that a reservoir dam fails a large volume of water would escape at once and flooding could happen with little or no warning.

However, site users will be safe, as the flood water will not affect the car park (as the figure shows) and the podium will be above the flood level.

5 Warning and Evacuation Plan

In accordance with the SFRA and the EA's advice a Warning and Evacuation Plan must be prepared in liaison with the Local Authority and the Emergency Services to allow site users to leave the premises in the event of a flood. This Flood Warning and Evacuation plan has been prepared in accordance with the "Guidance on Producing a Flood Emergency Plan" (London Borough of Richmond, 2011) document. The full Flood Management Plan can be found in Appendix D.

The EA is responsible for monitoring flood events and for issuing warnings to people in properties and businesses at risk of flooding. In order to fulfil their responsibilities, the Environment Agency operates a coded warning system. This is a four stage warning system and each stage will trigger a set of procedures for various organisations.

Flood Alert: Flooding is possible. Be prepared	
 Is used from two hours to two days in advance of flooding.	**Following Actions:** • Watch water levels • Monitor local news and weather forecasts on radio, TV or internet • Ring Floodline on 0845 988 1188 • Make sure you have what you need to put your flood plan into action • Check flood kit is fully equipped • Alert your neighbours, particularly the elderly and less able • Reconsider travel plans • Ensure all residents are accounted for
Flood Warning: Flooding is expected. Immediate action is required	
 Is used from half an hour to one day in advance of flooding.	**Following Actions:** As with Flood Alert plus; • Move valuables and other items to safety • Prepare flood kit • Prepare to turn off gas, electricity and other services • Be prepared for evacuation • Protect yourself and others that need your help
Severe Flood Warning: Severe flooding. Danger to life	
 Is used when flooding poses a significant threat to life.	**Following Actions:** As with Flood Warning plus; • Stay in a safe place • Turn off gas, electricity and water supplies if safe to do so • Try to keep calm, and to reassure others, especially children • Co-operate with emergency services and local authorities • Prepare for evacuation • Call 999 if you are in immediate danger
Warnings No Longer In Force: No further flooding is currently expected in your area	
Is used when river or sea conditions begin to return to normal	**Following Actions:** • Keep listening to weather reports. Be careful. Flood water may still be around for several days • Only return to evacuated buildings if you are told it is safe by emergency services

Table 5.1Environment Agency Flood Warning System

The site users in the car park and ground floor will be able to evacuate to the podium level once a flood has occurred. Site users should therefore use the steps at the back of the car park. From there, they will be able to access King Street, where the levels are higher than the design flood level. Appendix D shows the proposed layouts, showing the emergency access routes.

The site will be registered with the EA's Flood Warning Service as well as having a copy of a Flood Management Plan on site. A comprehensive and effective Flood Warning and Emergency Response Plan shall be produced with recommendations for required site procedures that should be taken in response to forecasted flooding (Flood Warnings from the EA) and for any scenario where flooding starts to occur without prior warning. If flooding does occur without prior warning, the residents will be able to escape the site.

6 Run-off Assessment

6.1 Existing Surface Water Run-off

The total site area is approximately 4,478m^2,of this approximately 3,700 m^2 is impermeable.

The existing run-off rate for the 1 in 100 year storm event was calculated using the modified rational method as shown below:

Q_{100} = 2.78 x i x A

Where 'A' is the catchment area in ha and 'i' is the rainfall intensity in mm/hr as estimated from Micro Drainage software).

Q_{100} = 2.78 x 0.370 x 102.196 = 110 l/sec

6.2 Proposed Surface Water Run-off

The development will increase impermeable area on site and therefore increase peak runoff rates from the site. Refer to Appendix E that shows the proposals in more detail. The proposed run-off rate is calculated below:

Q_{100+30} = 2.78 x 0.4279 x 143.075 = 170 l/sec

It is important to note that the EA have recently updated their advice regarding climate change. The new guidance states that there is a 10% chance the peak rainfall intensity will increase by 40% or more and that there is a 50% change it will increase by 20% or more, for the years 2070 to 2115. In order to decide which allowance to use the vulnerability of the development and the 'built in' resilience measures should be considered. Therefore a 40% allowance for climate change was deemed appropriate for the development.

6.2 Foul Water Strategy

The existing foul water peak flow rate has been estimated using the topographical survey and the assumed number of foul water appliances. The Colebrook-White formula was used and it was found that the peak foul flow rate is 6.68 l/s. It should be noted that the site contains multiple building uses at present and it is likely that this is split via multiple connections to the public sewers.

The proposed foul water peak flow rate was estimated using the proposed floor plans and number of foul water appliances. The Colebrook-White formula was used and the peak foul flow

rate was found to be 19.77 l/s. The existing and proposed foul flow rate calculations can be found in Appendix G.

Existing connections to the foul water public sewers will be re-used, if possible.

6.3 Thames Water Capacity Considerations

The development proposals will attenuate surface water on site, as close as possible to the Greenfield runoff rate, without causing a risk of blockages. Therefore, surface water run off rates to the surface water public sewers are significantly reduced.

The proposals will increase peak foul water flow rates to the sewers, from 6.68l/s to 19.77 l/s. A Pre-development Inquiry has been submitted to Thames Water, to confirm if there is sufficient capacity in the foul water network. Thames Water confirmed that there is capacity for the development in both the foul and surface water sewers.

7 SUDS Assessment

In accordance with the London Plan, EA guidelines, the SFRA, and CIRIA documents, surface water run-off should be managed as close to its source as possible. The London Plan states that all new developments should aim to reduce run-off to Greenfield rates “utilising SUDS unless there are practical reasons for not doing so”.

The following drainage hierarchy was used to assess the possibility of implementing SUDS at the site:

i. Store rainwater for later use;
ii. Use infiltration techniques, such as porous surfaces in no-clay areas;
iii. Attenuate rainwater in ponds or open water features for gradual release;
iv. Attenuate rainwater in tanks or sealed water features for gradual release;
v. Discharge rainwater direct to a watercourse,
vi. Discharge rainwater to a surface water sewer/drain; and
vii. Discharge rainwater to a combined sewer.

As rainwater harvesting, infiltration systems and open water features are not suitable for the development, surface water run-off rates will be reduced to the Greenfield runoff rate, using a tanked permeable pavement system, a below ground attenuation tank and flow control device.

7.1 Rainwater Harvesting and Green roofs

The capacity of rainwater harvesting systems to attenuate rainwater depends on the water use within the building. If there is no activity in the building and the harvester is full, no attenuation will be provided during a subsequent storm event. In the worst case scenario, the rainwater harvester will provide no attenuation. Therefore, rainwater harvesting is not deemed suitable for the development.

The SUDS manual states that “the hydraulic performance of green roofs during extreme events tends to be fairly similar to standard roofs”. This means that green roofs will reduce the run-off rates in small storm event such as the annual and the 1 in 2 year events. However, these systems provide no attenuation benefits in high storm events such as the 1 in 30 year and 1 in 100 year storms which are considered in the design of surface water drainage systems. The benefits of these systems therefore cannot be considered in the design of any attenuation systems. Green roofs will be incorporated and this will decrease surface water runoff rates for less severe storms.

7.2 Infiltration Techniques

The BGS maps indicate that the ground has poor infiltration rates. Therefore, infiltration systems such as soakaways are not suitable for the site. Permeable pavements may be suitable within the site boundary, in the landscaped area to the south of the Diamond Jubilee gardens. This is subject to infiltration tests in accordance with BRE 365.

7.3 Attenuation Techniques

Part of the next preferred option is to attenuation surface water to the Greenfield runoff rate. Initial calculations in Microdrainage have shown that 240m^3 of cellular below ground attenuation is required to reduce runoff rates, as close as possible to the Greenfield run-off rate, without causing a risk of blockages. Refer to Appendix J for the initial below ground drainage sketch.

7.4 Discharge to watercourse

The site is in close proximity to the River Thames, however, surface water sewers surround the development. Therefore, attenuated surface water will be discharged to the surface water sewers.

8 Conclusions

The site falls within Flood Zone 3, in an area that does benefit from flood defences. The actual flood risk to the development is low, as flood mitigation measures will be put in place to protect the site up to the design flood level (1 in 100 year rainfall event, plus 35% climate change).

The car park is at risk of flooding for fluvial storm events with a return period greater than the 1 in 50 year return period. However, the back of the car park will form the formal flood defence line and this will tie into existing defences. Furthermore, an automatic flood barrier will protect the site up to the level of 5.635m AOD. Therefore, the car park will flood but surrounding properties will still be protected by the new flood defence line that will be tied into the existing defence structures. Adequate infrastructure will be installed to ensure that if the car park floods, flood water can be removed.

The proposed works will raise the formal flood defence to a level of 7.7m AOD, providing a significant betterment on the existing situation. A 'Flood Risk Activity Permit' is required from the Environment Agency, as the works will modify the flood defence line. Continued consultation will take place with the EA to ensure the new defence structure meets their requirements.

Surface water runoff from the development will be attenuated to 2.8l/s (as close as possible to the Greenfield runoff rate, without causing a risk of blockages). Calculations using Microdrainage have shown that 240m^3 of cellular storage is required to attenuate surface water, up to the 1 in 100 plus 40% climate change rainfall event. Surface water will then be discharged to the public surface water sewers, before being discharged to the River Thames.

The flood risk from groundwater, surface water and reservoirs is low.

Flood mitigation measures include:

- No residential use below the design flood water level;
- Flood resilient floor and wall finishes will be used below the design flood water level;
- All below ground structures will be fully waterproofed; and
- All plant rooms will be raised above the flood level.

Therefore, the proposed development has an acceptable flood risk within the terms and requirements of the NPPF.

Appendix A - Existing Site Photographs


Water Ln


The Embankment
dpd


H