8.10 FLOOD RISK ASSESSMENT

Proposed Works at Marble Hill Park, Twickenham

Flood Risk Assessment

On behalf of **English Heritage**

ENGLISH HERITAGE

Project Ref: 40611/4001 | Rev: - | Date: March 2017

Office Address: Caversham Bridge House, Waterman Place, Reading, Berkshire RG1 8DN
T: +44 (0)118 950 0761 F: +44 (0)118 959 7498 E: reading@peterbrett.com

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	Name	Position	Signature	Date
Prepared by:	Charlotte Cullimore	Assistant Engineer	Cullimore	17/3/17
Reviewed by:	Naomi Ashcroft	Associate	N Ashcroft	17.3.17
Approved by:	pp Chris Downs	Director	JN Pp JN	17/03/17
For and on behalf of Peter Brett Associates LLP				

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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the proposed works at Marble Hill Park in Twickenham. The proposals include extending the existing café and internal remodelling of the Stables, landscaping improvements across the park and internal remodelling of Marble Hill House and the Sports building.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), the FRA demonstrates that:

i. The development is safe in terms of flood risk;

ii. The development does not increase flood risk; and

iii. The development does not detrimentally affect third parties.

The Environment Agency (EA) Flood Zone map shows the majority of the site is within Flood Zone 1 'Low Probability' and the south and southwest of the site lies partly within Flood Zone 3 'High Probability' of the River Thames (as defined in NPPF Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' Table 1) as follows:

Flood Zone 1 'Low Probability' (less than 1 in 1000 (0.1%) annual probability of river flooding, or greater than 1 in 200 (0.5%) annual probability of sea flooding).

Flood Zone 3 'High Probability' (greater than 1 in 100 (1%) annual probability of river flooding, or greater than 1 in 200 (0.5%) annual probability of sea flooding).

Detailed analysis of topographical survey and EA modelling data confirms the probability of flooding and Flood Zone classification. The SFRA and PFRA mapping aligns with the EA mapping.

The proposals for the café extension constitute a 'less vulnerable' land use, which is considered appropriate within Flood Zone 1, and the landscaping works constitute a 'water compatible' development, which is considered appropriate in Flood Zone 2 and 3 (reference NPPF PPG Tables 2 and 3).

The Sequential Test is passed as the works are associated with extending an existing café and landscaping works to enhance the existing contour arrangement. Therefore, this development cannot be located anywhere else.

The flood risk mitigation strategy for the development consists of the following elements:

- A flood compensation scheme provides an increase of 204 m^3 in floodplain storage capacity over the site, on a level-for-level basis, up to the Maximum Likely Water Level (MLWL) for 2100 advised within the EA modelling.
- Continuous safe access from the site is provided at the 1 in 100 annual probability plus climate change flood level via Richmond Road.
- The additional impermeable areas associated with the café service yard and infilling the carriage circle lawn will drain via infiltration into the adjacent ground.

In summary, the FRA demonstrates that the proposed development is safe in terms of flood risk and in accordance with the requirements of national and local planning policy.

1 Introduction

1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA), on behalf of our client, English Heritage, to support a planning application for proposed works at Marble Hill Park in Twickenham.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.2**, and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FRA is consistent with the 'Site-specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance:

https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section

1.1.3 The required content of the checklist is detailed below along with specific cross-reference to the content in the FRA as follows:

1) **Development site and location –** see Section 2;
2) **Development proposals** – see Section 4;
3) **Sequential Test** – see Section 4;
4) **Climate change** – see Section 3.5;
5) **Site-specific flood risk** – see Section 3;
6) **Surface water management** – see Section 5.3;
7) **Occupants and users of the development** – see Section 4;
8) **Residual Risk** – see Section 6;
9) **Flood risk assessment credentials** – PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

1.2 Sources of Information

1.2.1 The FRA has been prepared based on the following sources of flood risk information:

- The **Environment Agency (EA) online flood maps** at https://flood-map-for-planning.service.gov.uk/ and https://flood-warning-information.service.gov.uk/long-term-flood-risk.
- EA **Product 4 Data** (HNL38511JH), dated 07/03/17.
- London Borough of Richmond-Upon-Thames (Richmond) **Preliminary Flood Risk Assessment** (PFRA), dated March 2011.

- Richmond **Strategic Flood Risk Assessment** (SFRA), dated March 2016.
- Richmond **Local Flood Risk Management Strategy** (LFRMS), dated August 2015.
- PBA **Flood Risk Investigation**, dated September 2005.
- Shakespeare, Pullen & Slade Ltd. (SPS), **Initial Assessment "The Flood Risk Investigation" Report**, December 2016.
- J & L Gibbons, **Round 2 Report**, dated October 2016.

1.3 Policy Context

1.3.1 This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy contained within the **National Planning Policy Framework (NPPF)** dated March 2012, issued by Communities and Local Government, with reference to Section 10 'Meeting the challenge of climate change, flooding and coastal change';
- The **NPPF Planning Practice Guidance (PPG)** released in March 2014 ('Flood Risk and Coastal Change' section);
- Regional planning policy contained within **The London Plan** ('Consolidated with alterations since 2011' dated March 2016), with particular reference to Policy 5.12 'Flood Risk Management' and Policy 5.13 'Sustainable Drainage';
  - Policy 5.12 Flood Risk Management states:

"…B - Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated Technical Guidance on flood risk over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 (TE2100 – see paragraph 5.55) and Catchment Flood Management Plans.

C - Developments which are required to pass the Exceptions Test set out in the NPPF and the Technical Guidance will need to address flood resilient design and emergency planning by demonstrating that:

a) the development will remain safe and operational under flood conditions

b) a strategy of either safe evacuation and/ or safely remaining in the building is followed under flood conditions

c) key services including electricity, water etc. will continue to be provided under flood conditions

d) buildings are designed for quick recovery following a flood.

D - Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourses and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way".

  - Policy 5.13 Sustainable Drainage states:

"Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. *store rainwater for later use*
2. *use infiltration techniques, such as porous surfaces in non-clay areas*
3. *attenuate rainwater in ponds or open water features for gradual release*
4. *attenuate rainwater by storing in tanks or sealed water features for gradual release*
5. *discharge rainwater direct to a watercourse*
6. *discharge rainwater to a surface water sewer/drain*
7. *discharge rainwater to the combined sewer*

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation".

- Local planning policy contained within the Richmond's '**Core Strategy'** (adopted April 2009), with particular reference to policies CP3;

  "3.B Development in areas of high flood risk will be restricted, in accordance with PPS25, and using the Environment Agency's Catchment Flood Management Plan, Borough's Strategic Flood Risk Assessment and site level assessments to determine risk."

1.4 Caveats and Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

1.4.2 The revised Construction (Design and Management) Regulations 2015 (CDM Regulations) came into force on April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the designer's responsibilities is to ensure that the client organisation, in this instance English Heritage, is made aware of their duties under the CDM Regulations. Further information on the CDM Regulations is provided in the client guide available at http://www.hse.gov.uk/pubns/indg411.pdf

1.4.3 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and London Borough of Richmond-Upon-Thames in its role as Lead Local Flood Authority (LLFA).

1.4.4 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development.

1.4.5 The EA Product 4 flood data on which the FRA is based is valid under a 12 month licence. As such, the FRA is accurate at time of issue but we would recommend the end user reviews the validity of the flood data on an annual basis with the EA.

1.4.6 PBA do not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

1.4.7 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken to date. They relate to the current development proposals as outlined in **Section 4**.

2 Site Setting

2.1 Site Description

2.1.1 The 26.7 hectare (ha) site, Marble Hill Park, is located in the town of Twickenham in London (postcode TW1 2NL, site centre OS grid reference 517,300m m E, 173,600m N – see Figure 2.1).

2.1.2 The town of Twickenham lies within the administrative boundary of London Borough of Richmond-Upon-Thames (Richmond).

Figure 2.1: Site Location Plan (not to scale)

2.1.3 The site consists of Marble Hill House at the centre of the site, a café within the historical Stables and courtyard, landscaped gardens including terraced lawns, sports pitches and associated amenities. The landscape plans are included in Appendix A.

2.1.4 The site is bordered by Richmond Road to the north, Meadowside to the east, Orleans Road to the west and the River Thames to the south.

2.1.5 Access to the site is via Richmond Road to the north of the site.

2.2 Topography

2.2.1 A topographical survey of the site has been undertaken by Greenhatch Group (August 2016) included in Appendix B. The topographic survey indicates the ground levels across the site vary

significantly. At the southern boundary the ground levels vary from 3.70 mAOD in the south-western corner of the site rising steeply, reaching 8.45 mAOD in the vicinity of the house before falling to 6.55 mAOD at the northern boundary.

2.2.2 The Thames Path is adjacent to the southern boundary at a varying level from 4.80 mAOD to 5.01 mAOD sitting on a river embankment.

2.3 Hydrological Setting

2.3.1 The **River Thames** flows in a north-easterly direction adjacent to the southern boundary of the site before flowing north towards Richmond.

2.3.2 The **River Crane** is located 680 m to the northwest of the site, flowing north before outfalling into the River Thames approximately 1.5 km north of the site.

2.4 Existing On-Site Drainage Arrangements

2.4.1 The site consists primarily of open park land and the surface water appears to drain via natural infiltration into the underlying ground, reported to be Langley Silt Member and Kempton Park Gravel, detailed in Section 2.5.

2.4.2 The existing impermeable areas within the site are limited to the House, Stables, courtyard and road/footpaths and drain via the existing underground surface water drainage systems within the site.

2.4.3 The PBA 'Flood Investigation Report' provides the following assessment:

'The drainage records for the park are limited; however, the drainage associated with the house is recorded on the 1988 topographical survey undertaken by Engineering Surveys Ltd and is believed to drain north towards Thames Water sewers in Richmond Road.

Park staff are aware of the existence of an old sewer or drain running from the south side of the house towards the river. The line of the sewer can be clearly traced above ground level due to the slight depression and greener grass growth that is visible. The sewer is reported to be egg-shaped and constructed from brick.'

There is a penstock at the downstream end of the sewer which is believed to control the outflow of the drain to the River Thames. However from inspection of a manhole located within the embankment of the towpath *'The route towards the house is blocked by a brick wall of relatively recent construction.'*

2.4.4 Therefore, it is understood that the impermeable areas of the House, Stables and courtyard currently drain to Thames Water sewers heading north. The function of the brick sewer draining south is unknown.

2.4.5 A CCTV survey and pressure jetting was undertaken in October 2016 to determine the condition of the existing drainage system at the Stables. The findings of the survey are detailed in the 'Round 2 Report' produced by J & L Gibbons and summarised below.

2.4.6 The CCTV survey found pipes were showing signs of corrosion and minor leaks. The report recommends that the drainage runs within the Stables courtyard are replaced. Other recommended repairs include improved ventilation to the system, replacement of several manhole connection joints, and the replacement of two manholes.

2.5 Geology and Hydrogeology

2.5.1 The British Geological Society (BGS) online geology viewer provides the following information on the geology of the site:

- Bedrock: 'London Clay Formation – Clay, Silt and Sand';
- Superficial Deposits: 'Langley Silt Member – Clay and Silt' across the majority of the site with 'Alluvium – Clay, Silty, Peaty, Sandy' deposits adjacent to the River Thames.

2.5.2 A ground investigation was carried out by CET Infrastructure in the November 2016 and the report is contained within the 'Round 2 Report'. The investigation comprised of two window sampler boreholes, a single hand augured exploratory hole and a series of hand dug trial pits. Plans showing the location of the investigations are included in Appendix C.

2.5.3 The investigation found Made Ground to a maximum depth of 1.4 m, underlain with Langley Silt Member to a maximum depth of 2.5 m. The two window sampler boreholes encountered Kempton Park Gravel Formation to depths of 4.0 m, where the boreholes were terminated. The London Clay Formation was not encountered during the investigation.

2.5.4 In terms of surface water drainage, the ground investigation report notes that *'The Made Ground and underlying Langley Silt Member are likely to be unsuitable for the discharge of surface water however the granular Kempton Park Gravel Formation may be considered.'*

2.5.5 The Cranfield University online 'Soilscapes' website provides an overview of the drainage potential of land across Britain. This indicates the north of the site is within an area where the soil is defined as *'Freely draining slightly acid loamy soils'* and the south of the site is within an area where the soil is defined as *'Loamy and clayey floodplain soils with naturally high groundwater.'*

2.5.6 The EA groundwater Source Protection Zone (SPZ) maps indicate the site does not lie within the catchment of a groundwater source.

2.6 Existing Flood Defences

2.6.1 The topography of the site naturally rises from approximately 3.70 mAOD in the southwest corner to approximately 8.45 mAOD in the centre of the site at the House. This rising ground forms a natural flood defence and contains the flood water in the southwest of the site.

2.6.2 There is also a formal river defence embankment running between the southern boundary of the site and the River Thames. The Thames Path runs along the top of this embankment. See Section 3.1.5.

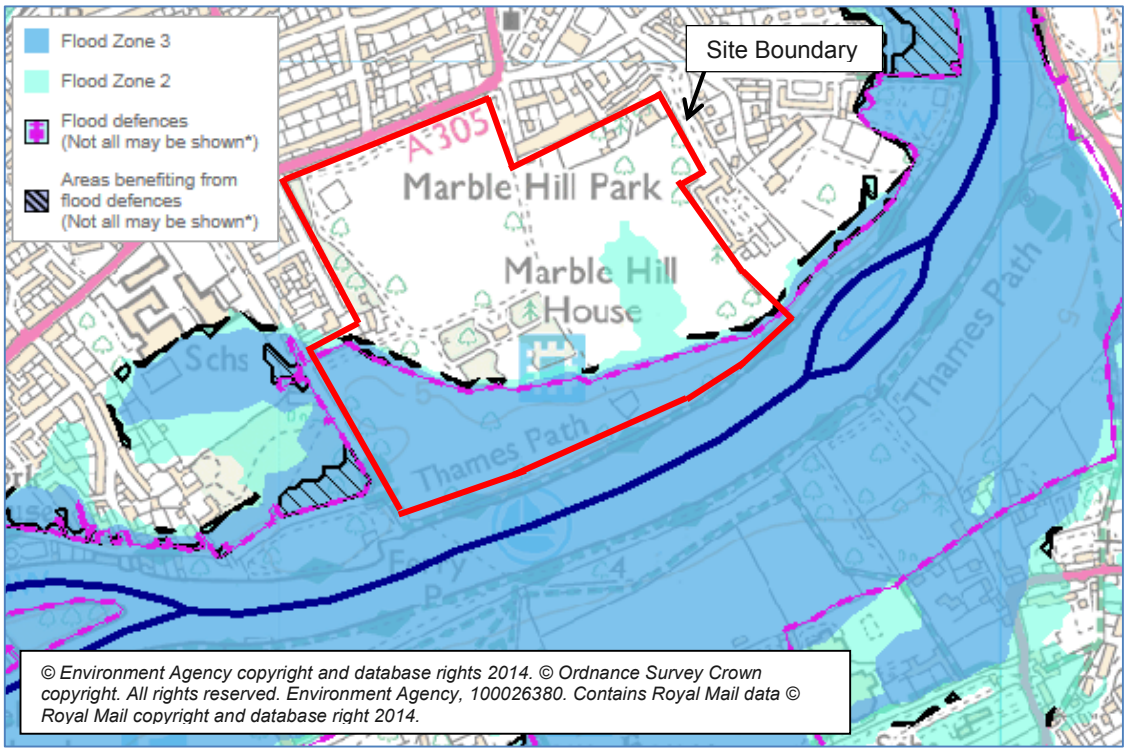
3 Overview of Flood Risk

3.1 EA Flood Maps

Flood Zone Map

3.1.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Zone maps, available on the EA's website. This provides an initial indication of the extent of the Flood Zones, which is refined by the use of more detailed site-specific level survey and modelled flood levels.

Figure 3.1: EA Flood Zone Map



3.1.2 Figure 3.1 indicates the majority of the site including the House, Stables and café are within Flood Zone 1 'Low Probability' (less than 1 in 1000 annual probability of river or sea flooding).

3.1.3 The centre of the East Meadow is shown to be within Flood Zone 2 'Medium Probability' (between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river or sea flooding).

3.1.4 The south and southwest of the site lies within Flood Zone 3 'High Probability' (greater than 1 in 100 (1%) annual probability of river flooding or greater than 1 in 200 (0.5%) annual probability of tidal flooding).

3.1.5 The map also shows that there is a flood defence dissecting the site from the southeast corner to the western boundary. It is believed that the existing ground levels within Marble Hill Park are forming the 'flood defence'.

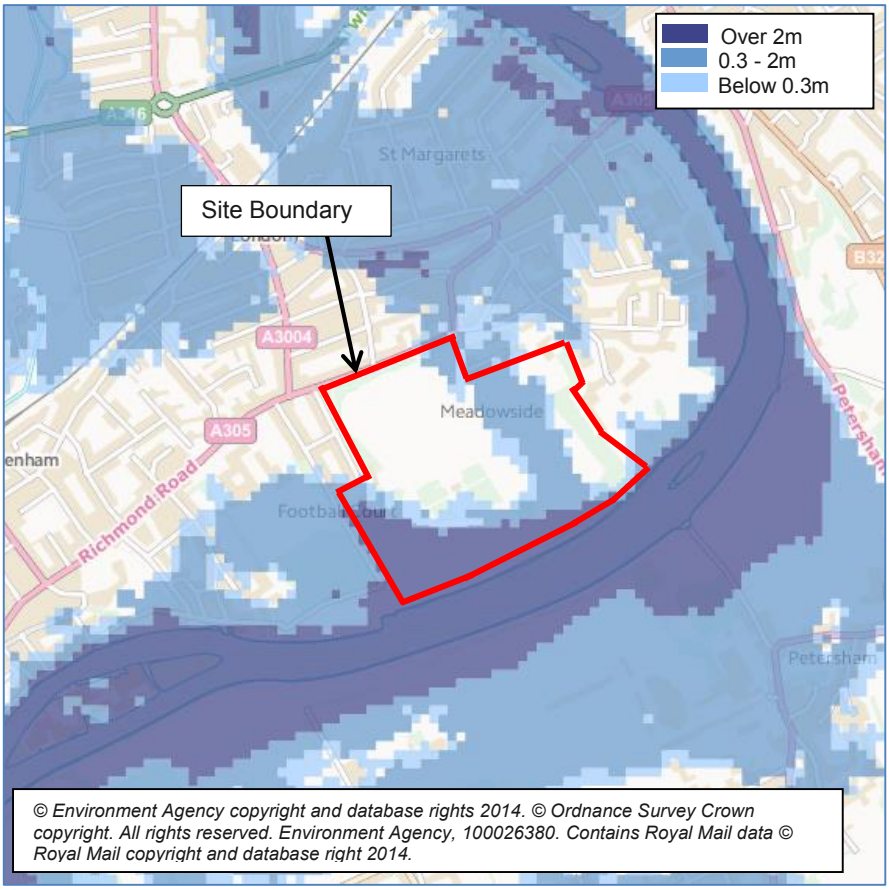
Flood Risk from Reservoirs Map

3.1.6 The EA provide maps showing the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs (over 25,000 cubic metres of water). These confirm that the site is in an area at risk of such flooding in the event that the embankments of an upstream reservoir failed and released the water it holds.

3.1.7 The mapping, see Figure 3.2, indicates a flood depth of over 2 m across the southwest of the site and 0.3 to 2.0 m across a section at the east of the site.

3.1.8 Based on this mapping the House and Stables buildings are not impacted in the event of a reservoir breach.

Figure 3.2: EA Reservoir Breach Flood Risk Map



3.1.9 It should be emphasised that the risk of flooding from reservoir breach is very small in any case; the EA are the enforcement authority for the Reservoirs Act (1975) and all large raised reservoirs are inspected and supervised by Reservoir Panel Engineers. As is stated on the EA's website:

'Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly and essential safety work is carried out'.

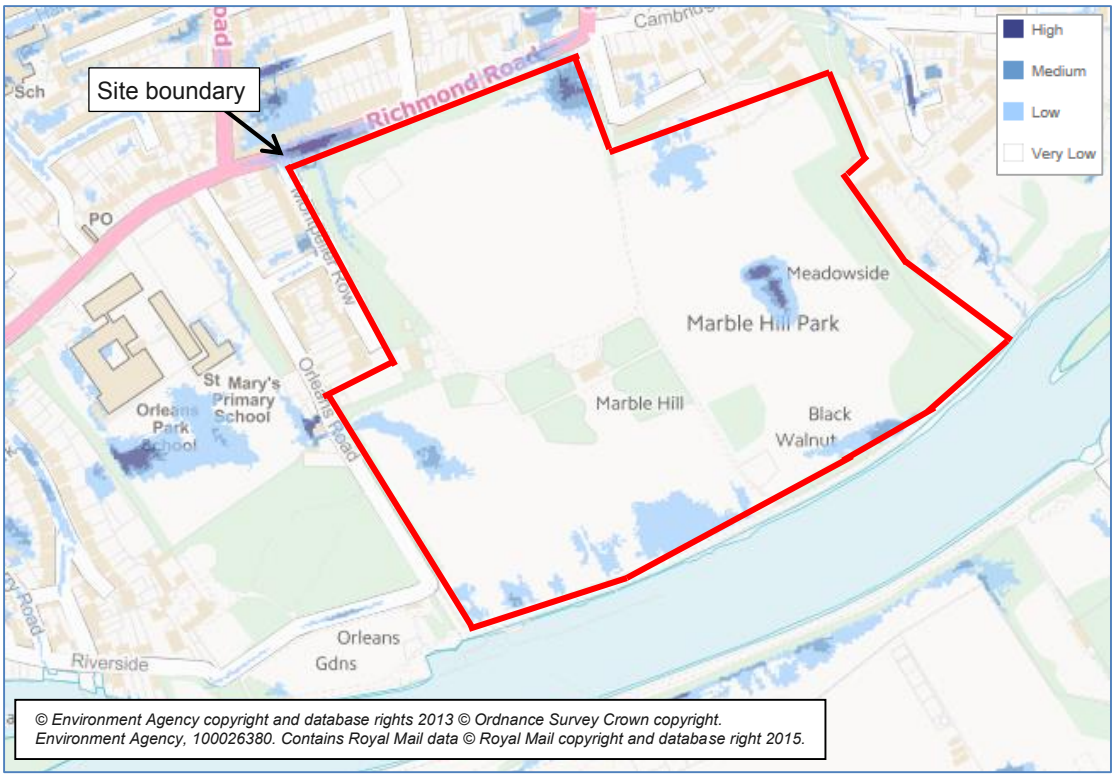
3.1.10 The risk of such an occurrence is therefore considered negligible.

Flood Risk from Surface Water

3.1.11 The EA 'Surface Water Flood Risk Map' shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event.

3.1.12 It should be noted that the surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping provides a guide to potentially vulnerable areas based on the general topography of an area.

Figure 3.3: EA Surface Water Flood Risk Map



3.1.13 Figure 3.3 indicates that the majority of the site is at 'Very Low' (less than 1 in 1000 (0.1%)) risk of surface water flooding. There are discrete areas at higher risk of surface water flooding at the southern boundary, at the centre of East Meadow, the northwest corner of West Meadow and the northern corners of the site.

Historic Flooding

3.1.14 The EA Product 4 Data, in Appendix D, holds no records of historical flood events.

3.1.15 The 'Flood Risk Investigation' produced by PBA in 2005, states '*In recent years the frequency of flooding in the park has increased. Extensive flooding across the southern extents of the park often occurs and is now reported to occur up to 20 times a year.*

3.1.16 *Flooding of the park occurs due to the river overtopping the embankment along the southern boundary. Due to this river defence being in the form of a terraced embankment, once flood water has overtopped the embankment it tends to become trapped on the park and takes time to drain away, once the flood peak has passed.*

3.1.17 *Park staff also report flooding from two other sources. Water is believed to seep through the river embankment beside the park entrance, adjacent to the black walnut tree. Flooding also occurs from overland flow originating from low ground to the west of the park.*'

3.1.18 The SPS 'Initial Assessment "The Flood Risk Investigation" Report' states '*in the past flood waters reached the lower hillock, immediately before the house, but water has not reached the house'.*

3.1.19 The mechanism of flooding is unconfirmed; whether the flood water overtops the River Thames embankment or is a result of rising groundwater.

3.2 Preliminary Flood Risk Assessment

3.2.1 The Richmond Preliminary Flood Risk Assessment (PFRA) provides a high level screening exercise which involves collecting information on historical and potential future floods for the area. The information of specific relevance to the site is as follows:

- **PFRA Figure 1** '*Surface Water Flooding Incidents and Fluvial Flooding Incidents'* does not show the site as being impacted by flooding.
- **PFRA Figure 2** '*Increased Potential for Elevated Groundwater'* shows the site is not at risk from elevated groundwater. There is a discrete area at the eastern boundary that has increased potential for elevated groundwater and an historical groundwater incident is shown to the north of the site boundary.
- **PFRA Figure 3** '*Sewer Flooding Incidents'* shows the majority of the site is in an area that has no records of sewer flooding. The western boundary of the site is in an area that has 1-5 records of sewer flooding.
- **PFRA Figure 6** '*Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP) plus climate change'* shows the majority of the site is not impacted by surface water flooding. There are discrete locations in the east of the site and at the southern boundary that are impacted by depths of 0.25 - 0.50 m.

3.2.2 Copies of the aforementioned Figures are provided in Appendix E. It should be noted that the resolution of the aforementioned map prevents a clear assessment of the locations, and the impacts, of flooding to the site as they provide a Borough-wide overview.

3.3 Strategic Flood Risk Assessment

3.3.1 As noted in Section 1.2, the Richmond Strategic Flood Risk Assessment (SFRA), dated March 2016, provides flood risk information on a Borough-wide scale, see Figures located in Appendix F. The information of specific relevance to the site is as follows:

- **SFRA Figure 1A** *'Historic Flooding'* shows the site has not been impacted by historic fluvial flooding.
- **SFRA Figure D** *'Areas Benefiting from Defences and Groundwater Flooding Incidents'* shows that the site has not been impacted by sewer, drainage or groundwater flooding.
- **SFRA Figure 5** '*Risk of fluvial and tidal flooding*' shows the majority of the site is within Flood Zone 1. A discrete area to the east of the House is shown to be Flood Zone 2 and the south of the site is in Flood Zone 3b 'Functional Floodplain'.
- **SFRA Figure C3** '*Tidal Breach Flood Hazard – River Thames and River Crane Maximum Likely Water Level – Year 2100 Tidal Profile (Twickenham)'* shows majority of the site is

rated as having a 'Low' breach hazard rating. The south of the site is shown as having an 'Extreme' breach hazard rating.

3.4 EA Modelled Flood Data – River Thames

3.4.1 The EA have also provided their detailed 'Product 4' flood risk information (EA ref HNL38511JH, dated 07/03/17, contained in Appendix D). This includes:

- Flood Map for Planning (Rivers and Sea)
- The Thames Estuary 2100 (TE2100) Flood Levels
- Thames Tidal Upstream Inundation Mapping and Levels
- Flood Defence Mapping
- Thames Tidal Breach Mapping

3.4.2 The EA have provided 'in-channel' flood levels from their Thames Estuary 2100 Study as part of their Product 4 Data. The TE2100 'in channel' flood levels at the site were taken from Node 2.3a, which is located to the south of the site, and states:

Table 3.1: EA Modelled River Thames Flood Levels (TE2100)

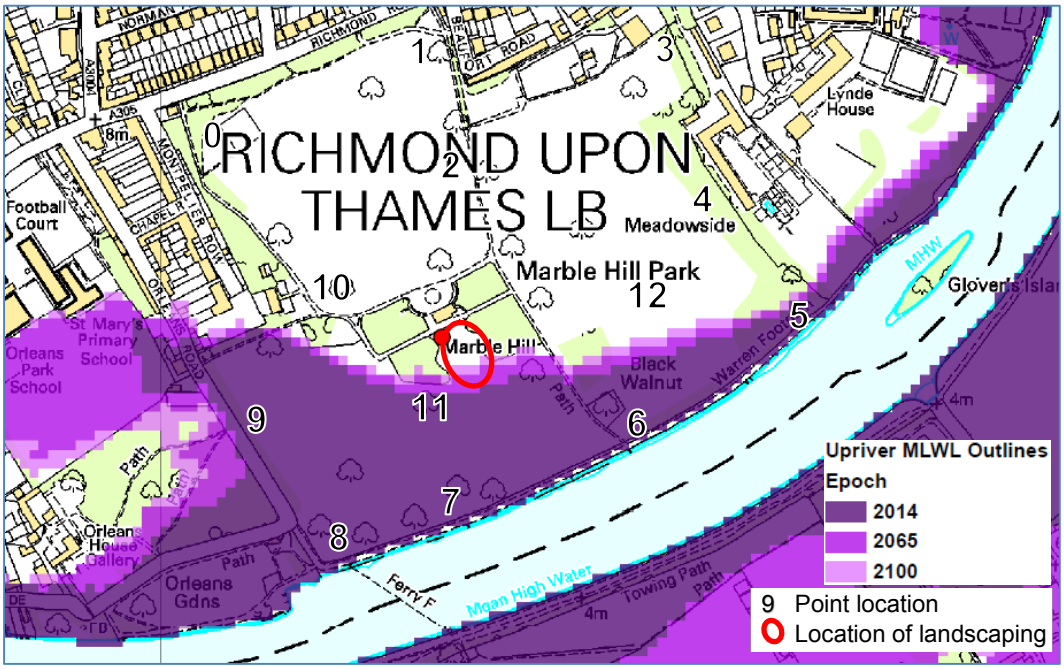
Node	Present day Water Level	Future 2065-2100 Water Level	Future 2100 Water Level
2.3a	5.77 mAOD	5.95 mAOD	6.40 mAOD

3.4.3 The water levels are the highest levels permitted by the Thames Barrier when closed and relate to the 1 in 1000 (0.1%) level. It should be noted that at the site, there is a heavy influence from upstream (fluvial) flows. The flood defences are built to manage tidal flood risk only. With very high fluvial flows, the river levels in west London could be above the tidal defence level.

3.4.4 Therefore, the EA have also provided results for the Thames Tidal Upstream Inundation Modelling Study 2015 completed by CH2M HILL in March 2015. Upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2065 and 2100 epochs were modelled on that basis.

3.4.5 The model assumes the Thames Barrier is operational but all linear defences have been removed. It uses the TE2100 in-channel levels calculated in 2008, which includes an allowance for climate change.

Figure 3.4: EA Thames Tidal Upstream Inundation Modelled Flood Extents



3.4.6 Figure 3.4 shows the modelled flood extents at the site and indicates that the majority of the site is not impacted. The south and southwest of the site is impacted in Maximum Likely Water Level (MLWL) flood events.

3.4.7 Table 3.2 below shows the flood levels across the site including in the location of the proposed landscaping works.

Table 3.2: EA Modelled River Thames Flood Levels (TE2100)

Point	Modelled Levels in Year 2100 (mAODN)	Ground Level (mAOD)	Depth of Flooding (m)
0, 1, 2, 3, 4, 5 & 11	n/a	Varies	0.0
6	6.320	4.01	2.31
7	6.324	4.09	2.25
8	6.430	4.08	2.35
9	6.420	4.81	1.61
Location of terrace works	6.370	4.50 – 7.00	0.0 - 1.87
10	6.421	7.75	0.0
12	6.775	6.04	0.735

3.4.8 This shows that the flood water depths in a MLWL event in 2100 are significant, up to 2.3 m deep at the southern boundary. Due to the nature of flooding at the site, it is anticipated that the flood waters will rise slowly and therefore users of the park will have sufficient time to evacuate the flood risk areas.

3.4.9 Point 11 is located in close proximity to the proposed terrace works, however the model output states this location does not flood, which appears to be an error in the model and has not been used in the assessment. Therefore, levels from the Point 6 and 9 have been interpolated to give a flood water level at the location of the landscaping works.

3.4.10 The site lies outside of the Thames Tidal Breach Modelling and therefore no data is available.

3.5 Impact of Climate Change

3.5.1 In considering flood risk to the site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

3.5.2 The EA's 'Climate Change Allowance for Planners' guidance (which supports the NPPF) provides contingency allowances for potential sea level rise in Table 1, and for potential increases in peak river flow and rainfall intensity in Table 2 (it is noted that these allowances are consistent with the figures previously provided in the Technical Guidance to the NPPF and, prior to this, in PPS25).

3.5.3 The potential for increased flood probability as the result of possible climate change has been addressed through the use of climate change allowances in the hydraulic modelling and will be taken into account in the consideration of mitigation measures (i.e. ground floor levels, flood storage, surface water drainage).

3.6 Summary of Flood Risk

3.6.1 The following table provides an overview of the flood risk to the site, based on the information obtained and detailed in Section 3.

Table 3.1: Summary of Sources of Flood Risk

Source of Flooding	Risk of Flooding to Site	Comment/Justification	Source of data	Mitigation requirements for new development (see Section 5)
Tidal		The site is adjacent to the tidal River Thames; however, the tidal risk is mitigated by the Thames Barrier.	EA Data (see Section 3.1)	n/a
Fluvial		The majority of the site, including the House, Stables and café, is within Flood Zone 1 'Low Probability'. The south and southwest of the site is located in Flood Zone 3 'High Probability'. There are no historic records of fluvial flooding at the site.	EA Data PFRA & SFRA (see Section 3.2 & 3.3)	Flood compensation Commercial development located outside floodplain
Land Drainage (i.e. Surface Water/ Pluvial)		The majority of the site is shown to be at a 'Very Low' risk of surface water flooding with discrete pockets at 'Medium' and 'High' risk.	EA surface water flood maps PFRA	Commercial development located in 'Low' risk areas
Ground water		The majority of the site is shown to be at 'Low' risk of groundwater flooding. Historical site observations note that the south and southwest of the site are impacted by rising groundwater.	BGS Viewer SFRA Site Observations	n/a
Reservoir, Canals, Ponds and Other Artificial Sources		The site would be impacted in the event of a reservoir breach. However, the probability of breach is negligible.	EA Data (see Section 3.1)	n/a
Sewers		The majority of the site is within an area of no historical sewer flooding incidents.	SFRA	n/a
Key:		**Low/Negligible Risk** – No noticeable impact to site and not considered to be a constraint to development		
		Medium Risk – Issue requires consideration but not a significant constraint to development		
		High Risk – Major constraint to development requiring active consideration in mitigation proposals		

4 Proposed Development and Sequential Test

4.1 Proposed Development

4.1.1 This FRA accompanies a planning application for works across the Marble Hill Park site:

- Stable Block and café:
  - Single story extension to Stables within existing courtyard
  - Surface water drainage works
  - Conversion of historical changing rooms to form café service yard
  - Access road to service yard
  - Removal of raised lawns to form café seating area
  - Internal remodelling of stables
  - Potential substation
- Marble Hill Park landscape works:
  - Sharpening of terraces
  - Carriage circle lawn centre to be infilled with hardstanding
  - Discrete areas of levelling within sports fields
  - Children play trail
  - Tree planting
  - Wetland habitat creation at the southern boundary of the East and West Meadow
  - Land drains running to existing private sewer to aid water infiltrating into the ground at the south-western sports pitches. Drainage proposals subject to further design.
  - Further investigation into the private sewer outfall arrangement including penstock required.
- Marble Hill House and Sports Building:
  - Restoration works to the House and lift installation
  - Internal works to Sports Building
  - Relevelling of landscape at Sports Building to comply with access requirements
  - Replacement of drainage sections

4.1.2 The landscape and the café proposals are included in Appendix A. The proposals lead to an overall increase in impermeable area of approximately 830 m^2; 610 m^2 at the Stables associated with the service yard access road; and 220 m^2 at the carriage circle infill.

4.1.3 The café and park are open to the general public throughout the year, with sports pitches hired to local sports teams. The House is currently open for guided tours.

4.2 Flood Risk Vulnerability

4.2.1 NPPF PPG 'Flood Risk and Coastal Change' Table 2 confirms the *'Flood risk vulnerability classification'* of a site, depending upon the proposed usage. This classification is subsequently applied to PPG Table 3 to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

4.2.2 The proposed café development is classed as 'less vulnerable' development and is located within Flood Zone 1.

4.2.3 The proposed terrace landscaping works and play equipment are classed as 'water compatible' development and are located within Flood Zones 1, 2 and 3.

4.2.4 Therefore, in accordance with Table 3, the proposed works are considered suitable for the Flood Zone that they are located within and an Exception Test is not required.

4.2.5 The Sequential Test is passed as the works are associated with extending an existing café and landscaping works to enhance the existing ground profile, and therefore cannot be located anywhere else.

5 Flood Mitigation Strategy

5.1 Flood Storage Compensation Scheme

5.1.1 Any new development located in the vicinity of a watercourse should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage over a site; either of which could potentially cause an increase in flood levels on-site or elsewhere. This is considered up to the benchmark of the 1 in 100 annual probability plus allowance for climate change fluvial flood level.

5.1.2 The proposed landscape terraces involve sharpening the existing contours to redefine the historical terraced lawns on the approach to the House. Due to the location of the proposals, being within the floodplain, a flood compensation scheme has been designed to ensure that there is a gain in flood storage as a result of the landscaping works. This has been considered up to the MLWL for the 2100 event, in the vicinity of the works, approximately 6.37 mAOD.

5.1.3 The 'Flood Compensation Drawing' (40611/4001/001), included in Appendix G, was produced using Civils 3D software to determine the flood storage volume in the vicinity of the works for the existing contours and the proposed contours. The analysis was undertaken in 100 mm bands to ensure that the proposals did not lead to a detrimental impact at lower order events.

5.1.4 The modelling indicates that the proposed terrace landscaping leads to an overall gain of 204 m^3 in floodplain storage up to the MLWL 2100 event. Therefore, the proposals lead to a benefit, providing additional floodplain storage.

5.1.5 The proposals for the play equipment across the site has not been finalised, however the volume of flood storage occupied by the equipment and impact on flood flows is expected to be negligible.

5.2 Safe Access

5.2.1 It is necessary to consider and incorporate safe access arrangements as part of the mitigation, to ensure the users/occupants of the development are safe in times of flooding.

5.2.2 The south of the site will experience flooding in the first instance. It is anticipated site staff would advise users of increased risk and take the necessary precautions during a flood event.

5.2.3 Staff and users of the park would be able to evacuate the site via the main entrance to the north of the site. The majority of the site including the House, Stables and café is located in Flood Zone 1 and therefore would not be impacted by flooding.

5.2.4 The main access/egress road, Richmond Road, is outside the flood extents and provides a routes to the wider area. Therefore, safe dry assess/egress is provided.

5.3 Surface Water Drainage

5.3.1 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.

5.3.2 The Building Regulations Requirement H3 stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

a) an adequate soakaway or some other adequate infiltration system,

b) a watercourse, or where that is not practicable,

c) a sewer.

5.3.3 The current requirements for surface water drainage in new development are set out in the DEFRA 'Non-statutory technical standards for sustainable drainage systems' (March 2015).

5.3.4 The proposed increase in total impermeable area is approximately 830 m^2 split between the café extension works and carriage circle works.

5.3.5 The additional impermeable area associated with the café's service yard is 610 m^2 and is to drain to the edges of the impermeable area and infiltrate into the ground using drainage trenches infilled with pea-shingle in a geotextile surround. This is subject to detailed design.

5.3.6 The additional impermeable area associated with reinstating the carriage circle to its historical form, with no lawn centre, is 220 m^2. This additional area is to drain via surface water runoff across the hardstanding to infiltrate into the underlying permeable ground.

5.3.7 This approach is the preferred option within the SuDS hierarchy and will have no adverse impact on others. The drainage systems will be designed to current design standards as set out in the Building Regulations.

6 Residual Risk

6.1.1 It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, it is practicable to minimise the risk by using suitable construction and management techniques.

6.1.2 The proposals for the café extension and landscaping works are classified as 'less vulnerable' and 'water compatible' land uses in terms of flood risk. As such, the residual flood risk is considered to be negligible and is acceptable for the lifetime of the development.

7 Conclusions

7.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for extending the existing café and internal remodelling of the Stables, landscaping improvements across the park and internal remodelling of Marble Hill House and the Sports building at Marble Hill Park in Twickenham.

7.1.2 This FRA concludes that:

- The majority of the site is in Flood Zone 1. The south and southwest of the site are within Flood Zone 3. This has been confirmed by the EA modelling and the SFRA.
- In the modelled MLWL 2100 flood event, the majority of the site is not impacted, however the south and southwest is impacted by flood water depths up to a maximum of 2.3 m.
- A flood compensation scheme, on a level-for-level basis up to the MLWL for 2100, was designed for the proposed terrace landscaping, which leads to a gain of 204 m^3 in flood storage.
- Continuous dry safe access from the site is provided at the 1 in 100 annual probability plus climate change flood level via Richmond Road.
- The additional impermeable areas associated with the café extension and infilling the carriage circle will drain via infiltration into the adjacent ground.

7.1.3 The Sequential Test is passed as the works are associated with extending an existing café and landscaping works to enhance the existing ground profile, and therefore cannot be located anywhere else.

7.1.4 In conclusion, the future users of the proposed development will be safe from flooding and there will be no detrimental impact on third parties. The proposal complies with the National Planning Policy Framework (NPPF) and local planning policy with respect to flood risk and is an appropriate development at this location.