4 - 6 MANOR ROAD

TEDDINGTON

FLOOD RISK ASSESSMENT

Lulworth Homes

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WATER | ENVIRONMENT

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This Flood Risk Assessment was commissioned by Lulworth Homes to investigate the risks and assess the consequences of flooding of the proposed development at No. 4 and No. 6 Manor Road, Teddington.

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Glossary

AOD	Above Ordnance Datum
BGS	British Geological Survey
CDA	Critical Drainage Area
CEH	Centre for Ecology and Hydrology
DEFRA	Department for Environment Food and Rural Affairs
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FZM's	Environment Agency Flood Zone Maps
GI	Ground Investigation
IFM's	Environment Agency Indicative Floodplain Maps
LDF	Local Development Framework
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
PPS25	Planning Policy Statement 25
ReFH	Revitalised FSR/FEH Rainfall-Runoff method
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

EXECUTIVE SUMMARY

The subject site is located at No 4 and No. 6 Manor Road, Teddington. The proposals are for addition of an extra storey to the existing apartment block at No. 4, and to demolish the existing dwellings at No. 6, replacing these with a flood-resilient block of twelve apartments.

The site is located approximately 65m west of the River Thames and is located within Flood Zone 3, as shown on the Environment Agency's latest flood maps. A full Flood Risk Assessment for the proposed development has therefore been carried out in accordance with the requirements of NPPF.

The most significant source of potential flooding on the site is from the River Thames, specifically from overtopping of the riverbank. The site is situated immediately adjacent to Teddington Lock, and therefore is at risk of flooding from both tidal and fluvial reaches of the River Thames. Detailed modelling of the River Thames, on both the tidal and fluvial reaches, has been undertaken by the Environment Agency and the latest flood water levels were made available for this assessment. This modelling confirms that the site will flood in a 1 in 100 year event, and is therefore located in Flood Zone 3a. The site is not located within the functional floodplain, Flood Zone 3b (1 in 20 year event). In addition, consideration of the Environment Agency's increased climate change allowances has been included and finished floor levels raised accordingly.

The proposed design is based on the principles established for No. 4 Manor Road, with the new building constructed on stilts above the floodplain. The soffit level of the ground floor slab will be raised fully above the modelled floodwater level and the basement level car park will be designed to flood. All habitable areas of the proposed apartments will be raised above the floodwater level, with finished floor levels set to 7.41m AOD (the modelled 1 in 1000 year flood level).

As a result of the design, the proposed building has a footprint that it entirely floodable beneath. There will be no loss in floodplain storage capacity, or obstruction of flood flows in comparison with the current scenario. Actually, since the proposed development will have a raised slab level, floodplain capacity will increase on a level-for-level. The proposals constitute an improvement in terms of floodplain capacity and unobstructed flood pathways actively contributing to a reduction in flood risk elsewhere.

Although the proposals increase the number of residential dwellings on the site, the nature of the design will ensure that properties are located above the floodplain. During an extreme flood event, the entire local area will be flooded and dry access will not be available for any local residents (current or future) at the peak of the flood event. However, the proposed development will be wholly located above the flood water level and therefore safe refuge will be available to all residents on the site. There will therefore be a decrease in the number of people at risk when compared to the existing dwellings on site.

This flood risk assessment concludes that the site is at a low risk of flooding from all sources except for fluvial flooding. However, by implementing the measures outlined in this report, it would be possible to actively reduce the consequences of flooding to future occupants when compared to the existing dwellings. Similarly, the impact on third-party landowners as a result of the development and with regards to fluvial, tidal, surface and groundwater flooding are considered beneficial.

1 INTRODUCTION

General Information and Previous Correspondence

1.1 The site is located at 4-6 Manor Road, Teddington (TW11 8BG). No. 6 is currently occupied by two semi-detached dwellings located to the rear of a new purpose-built block of flats at No 4.

1.2 This report follows a flood risk assessment (dated October 2014) which was submitted with a previous planning application for the site. The previous application for erection of five, three storey townhouses on the site of No. 6 and provision of two additional flats at No. 4. This application has now been withdrawn for reasons not related to flood risk. Plans for the site have now been revised; taking into account the comments previously provided by the Environment Agency and updates to modelled flood water levels.

1.3 The revised site plans aim to take into consideration all previous correspondence with, advice provided by and concerns raised by both the Environment Agency and London Borough of Richmond upon Thames. Correspondence in July 2015 with the Environment Agency highlighted three main concerns, which the proposed redesign and this assessment have taken into consideration:

- Ensuring use of the most up to date flood risk data to assess the risk to the site;
- Demonstration that the proposed development will not result in a loss of flood storage; and,
- Confirmation that, where safe access is not available, an acceptable emergency plan is in place.

1.4 The revised plans propose a total of 15 units; three flats to be provided within an extra storey added to the existing building at No. 4, and construction of 12 new flats on the site at No. 6 spread over raised ground, first and second floors. The existing underground car park at No. 4 will be extended beneath No. 6 to provide parking for the flats.

1.5 The site lies within Flood Zone 3 (FZ3) of the River Thames, as shown on the Environment Agency's latest flood maps. A full flood risk assessment has therefore been prepared to accompany a planning application for the development.

Scope of Study

1.6 The main objectives of this study are to:

- Assess the risk and implications of flooding on the site during a 1 in 100 year fluvial flood event and during an extreme tidal flood event prior to, and following development. Secondary sources of flooding including groundwater, surface-water runoff and artificial waterbodies are also considered;

- Provide a flood risk assessment of the site, compliant with the guidelines set out in the National Planning Policy Framework (NPPF)[1] and the Planning Practice Guidance[2] to accompany any application for planning permission;
- Provide advice on the site layout and design that will ensure safe operation of the site in an extreme flood event;
- Consider climate change over the lifetime of the proposed development; and
- Develop a Sustainable Drainage Strategy for the proposed development.

[1] Communities and Local Government (March 2012) National Planning Policy Framework

[2] Communities and Local Government - Planning Practice Guidance: Flood Risk and Coastal Change. Last accessed 09/06/2016

2 SITE DESCRIPTION

Location

2.1 The proposed redevelopment is situated on Manor Road in Teddington. The site is located approximately 65m west of the River Thames, immediately downstream of Teddington Lock, where the fluvial and tidal reaches of the River Thames meet. The location of the site relative to surrounding water and geographical features is presented in Figure 1.

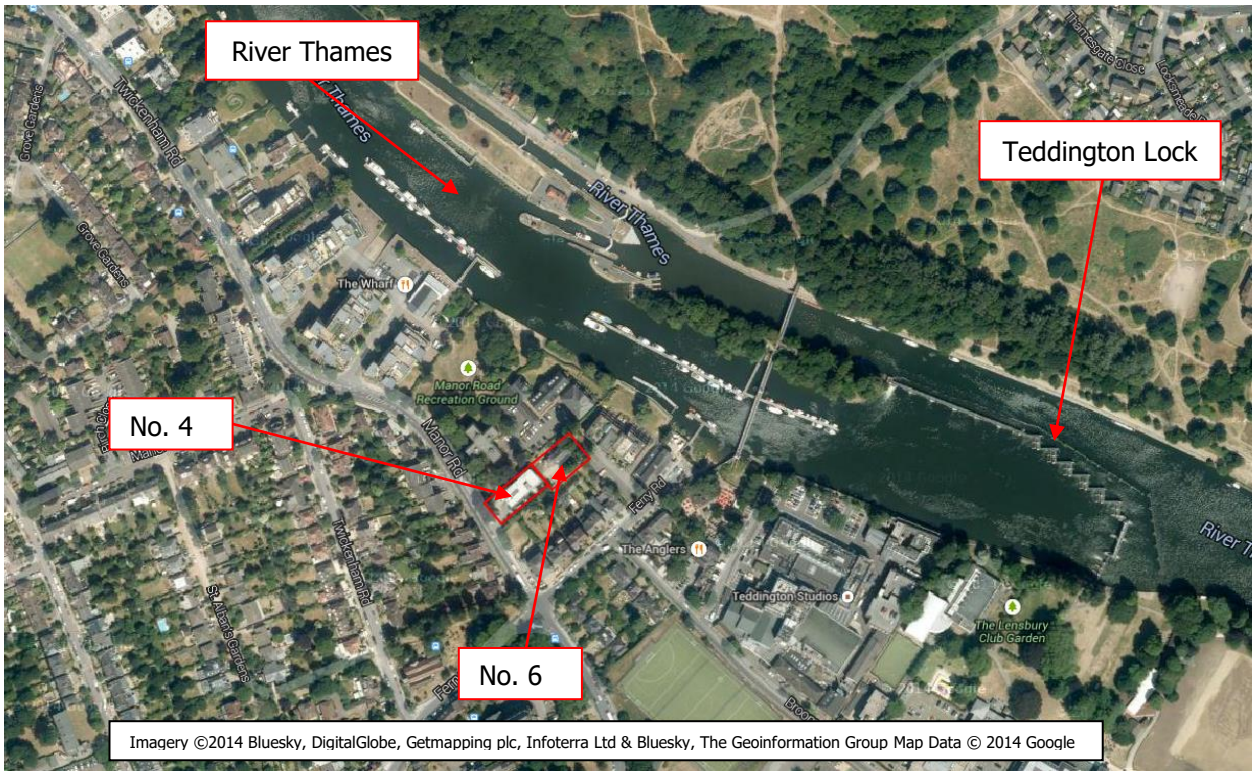

Figure 1 – Site Location

Existing Development

2.2 The site comprises of No. 4 and 6 Manor Road. The front of the site is bounded by Manor Road and the rear by a high wall separating the properties from neighbouring buildings. The existing property at No. 6 is accessed via a road alongside No. 4.

2.3 The front half of the site, No. 4 Manor Road, is occupied by a new, purpose built residential development, completed approximately 6 years ago. The building currently consists of 3 floors of modern apartments, with car parking within a semi basement level.

2.4 The rear of the site is currently occupied by a pair of semi-detached dwellings known as No. 6 Manor Road. These properties have associated hard paving, gravel and grassed areas. The total site area (of No. 6 only) is approximately 969m^2, with 23% (221 m^2) of this being impermeable area, including the existing house, sheds and

hard paved areas. The remainder of the site is grass, gravel or earth, which allow runoff to infiltrate into the ground. The built footprint of the existing properties at No. 6 is 135 m^2.

2.5 Surface water is collected from roofs and discharged via gutters and downpipes to the foul sewer system in Manor Road. Rainwater falling on the garden areas is likely to infiltrate slowly into the ground. Foul water from the site also currently drains to the public sewer.

Topographic Survey

2.6 A GPS-verified topographic survey of the site was performed by On Centre Surveys Ltd in October 2014 and is included as Drawing 1. The topographic survey is referenced to Ordnance Survey Datum. The survey included the whole site at No. 6, and the adjacent apartment block at No.4.

2.7 The topographic survey indicates that general ground levels on site range from 5.05m AOD to 5.68m AOD. Ground levels around the existing house on site are approximately 5.20m AOD to 5.35m. Levels on the site at No. 6 typically rise from south to north.

2.8 Levels in the access road adjacent to No. 4 rise from the entrance on Manor Road towards the gate to No.6, from approximately 5.12m AOD to 5.61m AOD.

Proposed Development

2.9 On the site at No. 4 Manor Road, it is proposed to add an additional storey to the property providing three additional two-bedroom flats at third floor level. All three apartments are accessed from internally from the main building.

2.10 In terms of flood risk, the development is at third floor level (15.32m AOD), substantially above any predicted flood water level (details later) and the external footprint will not change. The risk of flooding and the vulnerability of the development will not change following development of three additional apartments at the high level. For these reasons this Flood Risk Assessment focuses on the development at No. 6 Manor Road and references generally relate to No. 6 unless specified otherwise.

2.11 It is proposed to demolish the existing two dwellings located on the site at No. 6 and replace them with a new building, comprising of twelve two-bedroom apartments spread over raised ground, first and second floors. The ground-floor units have access to private garden areas. The basement car park currently beneath No. 4 will be extended beneath the new building at No. 6, providing car and bike parking for the properties.

2.12 The proposed building at No. 6 is designed to be built on stilts with the soffit of the ground slab level raised fully above the modelled floodwater level. The design includes extension of the semi basement car park under No. 4 beneath the proposed building at No. 6. The partial basement level will be excavated to 4.2m AOD, 1.1m beneath ground level (5.3m AOD) and 2.6m beneath the proposed ground floor slab level. Proposed plans are included in Drawing 2 and 3.

2.13 The proposed development is shown to have a total built footprint of 411m^2, with the remainder of the site (garden areas, paths and driveway) being permeable. The proposed development has an increase of 276 m^2 in impermeable area from the existing site.

3 PLANNING POLICY

National Planning Policy Framework

3.1 The NPPF was released in March 2012 and sets out the Governments' planning policies for England and how these are expected to be applied. The NPPF states that:

> *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."*

3.2 In addition to the NPPF, online Planning Practice Guidance was released in March 2014 to clarify planning aspects of flood risk management. The Planning Practice Guidance supersedes the Technical Guidance to the NPPF and clarifies which development types are considered appropriate within each flood zone.

3.3 The proposed development can be described as 'Buildings used for dwelling houses' which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be 'More Vulnerable'. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be 'More Vulnerable'. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that the Exception Test is required for 'More Vulnerable' development in Flood Zone 3a.

Local Planning Policy

3.4 The site is located within the jurisdiction of The London Borough of Richmond upon Thames. The Flood and Water Management Act 2010 designated all London Boroughs as Lead Local Flood Authorities (LLFA), and therefore Richmond are responsible for leading on management of local flood risk within the borough from all sources including; surface water, groundwater and ordinary watercourses. Flooding from main rivers, including the Thames, remains under the responsibility of the Environment Agency.

3.5 The London Borough of Richmond upon Thames adopted the Core Strategy[3], as part of the Local Plan in April 2009. The Core Strategies place a focus on spatial planning for a sustainable future. The strategy states that;

> *"In this Borough one impact of climate change will be an increased likelihood of flooding from the Thames and other tributaries as sea levels risk and climate patterns alter – the preferred approach is to prevent new development in areas of high flood risk and if practicable increase the capacity of the floodplain through restoration and return of wetlands."*

3.6 Core Policy, CP3 Climate Change – Adapting to the Effects, states that the development will need to be designed to take account of the impact of climate change over its lifetime, including *"flood risk from the River Thames and its*

[3] London Borough of Richmond upon Thames (April 2009) *Local Development Framework, Core Strategy*

tributaries". The policy also states that *"in accordance with PPS25 the Council will apply the Sequential Test and Exception Test to any Site Allocations when dealing with applications in areas of flood risk"*[4]. In addition, the FRA for any development site within the floodplain must demonstrate that any flood risks will be successfully managed, and necessary management measures ensure that the site can be developed and occupied safely through its lifetime.

3.7 CP3 will be implemented through control of new developments, and sustainable drainage, and other mitigation measures will be promoted through "the Core Policy on Sustainable construction and the operation of the Sustainability Checklist SPD". All new developments are to comply with CP3.

3.8 The London Borough of Richmond upon Thames adopted its Development Management Plan (DMP) in November 2011 which builds upon the Core Strategy and includes more detailed policies for managing development. Policy DM SD 6 covers Flood Risk. The policy confirms that development will be guided to areas of lower risk by applying the Sequential Test. For site in Flood Zone 3a, a full FRA will be required and the sequential and exception tests will be required, unless exceptions apply.

3.9 Policy states that around 16% of properties within the borough are in Flood Zone 3, many of which are located in and around town centres and DM SD 6 states that *"relocating development from and around these centres (400m is considered to be walking distance from the town centres) is not realistic and in order to sustain the continuing role of these centres, development can be used as a way to help manage and reduce flood risk in these areas"*. Policy DM SD 6 reinforces the importance of these town centres by confirming that small-scale residential development proposed within Flood Zone 3a is not required to pass the Sequential Test. The site at 4 - 6 Manor Road is located within the designated 400m Teddington town centre buffer zone and its development for a net additional 13 new homes will therefore help to sustain the continuing role of the town centre. However, since the proposed development is classed as major development a Sequential Test is required.

3.10 Policy DM SD 6 also states that *"in addition to the Environment Agency's normal floodplain compensation requirement, attenuation areas to alleviate fluvial and/or surface water flooding must be considered where there is an opportunity" and in areas of flood risk, "all proposals on sites of 10 dwellings… or more are required to submit a Flood Warning and Evacuation Plan".*

3.11 With regard to drainage, Policy DM SM 7 – Sustainable Drainage states that;

> *"All development proposals are required to follow the drainage hierarchy when disposing of surface water and must utilise Sustainable Drainage Systems wherever practical. Any discharge should be reduced to greenfield run-off rate wherever feasible."*
>
> *"When discharging surface water to a public sewer, developers will be required to provide evidence that capacity exists in the public sewerage network to serve their development."*

[4] PPS25 superceded by the NPPF although the principles remain similar.

3.12 Being within a London borough, the development is also subject to the requirements of the Mayor of London's strategic plan, 'The London Plan'[5]. Policy 5.13 (Sustainable Drainage) of the London Plan states that:

> *"Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so."*

3.13 The London Plan Supplementary Planning Guidance[6] states that the 'Mayor's Priority' is that *"developers should maximise all opportunities to achieve greenfield runoff rates in their developments",* with a minimum expectation to *"achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times."* The document also states that "on previously developed sites, runoff should not be more than three times the calculated greenfield rate."

3.14 A local planning guidance document detailing sustainable urban drainage requirements for the borough was released in February 2015[7]. This builds on the requirements of DM SD 7 and this provides guidance to developers on how to include SuDS within their schemes.

Preliminary Flood Risk Assessment

3.15 The London Borough of Richmond upon Thames Preliminary Flood Risk Assessment (PFRA)[8] was published in May 2011. The PFRA was produced as part of the Drain London project and reports historic flood events and future flood risk within the borough.

3.16 The PFRA includes records of historical flood events from all sources, including; surface water and fluvial incidents, groundwater flooding incidents, and sewer flooding incidents (in the DG5 Register provided by Thames Water in June 2010).

3.17 There were surface water flood events within the borough in July 2007, many of which had significant harmful consequences. Whilst parts of Teddington were affected, Manor Road is not listed as an area to have been flooded. The PFRA also includes maps of historic surface water and fluvial flood events. There are 4 recorded flood events north of the site at Manor Road, on Twickenham Road and Strawberry Vale (A310). These are located adjacent to the River Thames along the fluvial reach downstream of the site, and the site itself was not affected.

3.18 The site is not within an area considered to have Increased Potential for Elevated Groundwater (IPEG) and there are no reported groundwater flooding incidences close to the site, although there are a few in Teddington generally. The site is located in postcode area "TW11 8" and the DG5 records confirm that that have been 6-10 incidences of sewer flooding within that postcode, as of June 2010.

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[5] Greater London Assembly (July 2011), *The London Plan*.

[6] Mayor of London (April 2014), *Sustainable Design and Construction Supplementary Planning Guidance*.

[7] London Borough of Richmond upon Thames (Feb 2015) *Planning Guidance Document, Delivering SuDS in Richmond*

[8] Capita Symonds for London Borough of Richmond upon Thames (May 2011) *Preliminary Flood Risk Assessment, Version 5 Final Report*

3.19 The PFRA reports information about future flood risk using the Environment Agency's Flood Map for Surface Water (FMfSW). Based on this information, it is estimated that *"22,100 residential properties and 2,800 non-residential properties"* in the borough are at risk of surface water flooding greater than 0.1m deep during a 1 in 200 year rainfall event. Of these properties, 3,400 houses are at risk of flooding deeper than 0.3m. Although some surface water flooding is predicted within Manor Road, the site itself is not considered to be a risk of flooding in this dataset.

Strategic Flood Risk Assessment

3.20 The London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA) was first produced in June 2008, before being updated in August 2010[9]. The SFRA was produced to collate information on flood risk to the borough from all sources, and to ensure future development is carefully planned, steering it away from areas most at risk of flooding. The Richmond SFRA has been developed in accordance with PPS25.

3.21 The SFRA emphasises that it is essential for developers to consider the change in flood risk over the lifetime of the development as a result of climate change. For guidance, *"residential development should be considered for a minimum of 100 years".* There should also be consideration of any residual risk of flooding to the development as a result of; flooding which exceeds the design of the local drainage system, residual danger as a result of the failure of flood defences, and general uncertainties in prediction of flooding.

3.22 Taking a conservative approach, the SFRA confirms that *"finished floor levels should be situated a minimum of 300mm above the 1% AEP (100 year) fluvial or 0.5% (200 year) tidal (whichever is greater) plus climate change flood level".* The SFRA report also confirms that any FRA supporting a proposed development within FZ3 should provide a summary of how the *"proposed (re)development has contributed to a positive reduction in flood risk within the Borough".*

3.23 According the SFRA mapping, the site at Manor Road is considered to be within an area defined as "Zone 3b Functional Floodplain"[10]. There are also localised drainage issues identified within Manor Road and Ferry Road. The Flood Evacuation mapping included within the SFRA confirms that the only route of access to the area would be along Manor Road, and this emergency evacuation route is currently below the 100 year flood level since flood depth is up to 1.5m along Manor Road.

3.24 The Areas Susceptible to Surface Water Flooding maps indicates that the site and Manor Road are considered to be "low" susceptibility. The site is also located within an area considered to be at risk of the impacts of climate change, and therefore these will be considered in detail in the relevant sections of this report.

[9] London Borough of Richmond upon Thames (August 2010) *Strategic Flood Risk Assessment, Level 1 SFRA (Update)*

[10] This designation is based on old flood data and has been superceded by more robust modelling since the document was published. The site is no longer considered to be in Flood Zone 3b as detailed in the relevant sections of this report.

Surface Water Management Plan

3.25 A Surface Water Management Plan (SWMP) was previously produced as a joint venture between the London Borough of Richmond upon Thames and Royal Kingston as part of the Drain London Project in August 2009. This has since been updated and produced as a standalone document for Richmond in 2011[11].

3.26 It has been agreed, in conjunction with the Environment Agency and Council members, that the Drain London Surface Water Management Plan (SWMP) will form the locally agreed surface water information for the London Borough of Richmond. The SWMP highlights areas which have historically flooded from surface water in the past and identifies areas considered to be at high risk. These are defined as "Critical Drainage Areas" (CDAs).

3.27 The site is located within a Critical Drainage Area, "Group8_006 Teddington". In July 2007 the Council collected records of flooding at ten locations in Teddington, some of which included raw sewage. Surface water modelling indicates that flooding between 0.1 and 0.25m deep could be expected on the site and immediately outside on Manor Road, in a 1 in 100 chance of rainfall event. This is contrary to the results included in the PFRA highlighting the uncertainty in predicting surface water flood extents and depths.

Sequential Test

3.28 The NPPF recommends that a risk-based Sequential Test should be applied to development with consideration of flood risk in order to steer new development to areas at the lowest probability of flooding (Flood Zone 1). Further, the online Planning Practice Guidance: Flood Risk and Coastal Change, released in March 2014 to clarify aspects of flood risk management, confirms that "only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 […] be considered, taking into account flood risk vulnerability of land uses and applying the Exception Test if required. Local Plans should avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impact of climate change."

3.29 In this case, an existing residential development of two properties with accommodation located at ground level in an area at significant risk of flooding, will be replaced a block of 12 new residential dwellings which are to be raised safely above the design flood water level. Although increasing the number of units on site, the proposed development will decrease the people and property within the area at risk of flooding.

3.30 Future development in Flood Zone 3a and Zone 2 will only be considered if there has been a Sequential Test applied in accordance with the NPPF, however the London Borough of Richmond upon Thames have applied some exceptions to this. Local policy and the SFRA (section 219) state that:

[11] Capita Symonds (September 2011) *Surface Water Management Plan for the London Borough of Richmond upon Thames, Version 2 Final Report.*

"The Sequential Test will not be required if is not a major development and at least one of the following applies:

- *It is a LDF proposal site that has already been sequentially tested, unless the use of the site being proposed is not in accordance with the allocations in the LDF*
- *It is within a town centre boundary as identified within the LDF (Richmond, Twickenham, Teddington, Whitton and East Sheen)…*
- *It is for residential development or a mixed use scheme and within the 400m buffer area identified within the LDF surrounding the town centres referred to above…*
- *It is for the redevelopment of an existing single residential property*
- *It is for a conversion or change of use.*

The Sequential Test will be required in all other cases."

3.31 This site is located within 400m of Teddington town centre. However, as a result of the total number of units proposed, the site is considered to be "major" development and therefore the Sequential Test must be applied.

3.32 The SFRA confirms that the site lies within Character Area R6 (Strawberry Hill & Teddington Lock). Whilst section 7.5.6 acknowledges that there are existing housing and sports facilities between the A310 (Manor Road) and the River Thames at risk of flooding, the document also states that *"giving due consideration to the existing development, a pragmatic approach to future redevelopment is permitted in accordance with Section 7.4 [application of the Sequential Test] above".*

3.33 It would be inappropriate to prohibit development of this site since the proposed development will reduce the risk of flooding to residents, compared to the existing situation. Nevertheless, in order to comply with the requirements of the NPPF and SFRA, a full detailed Sequential Test has been undertaken for this development and submitted with the Planning Application as a separate document.

3.34 The Sequential Test report[12] details the methodology followed and provides evidence of the full sift of sites within the London Borough of Richmond upon Thames. With respect to the proposed development site at 4-6 Manor Road, only two available sites of a similar size were found to be potentially sequentially preferable to the proposed site in terms of flood risk. These alternatives were considered in detail in terms of planning and other restrictions, and architectural sketches were produced to ascertain whether or not the alternative sites were able to accommodate the proposed development. The study concludes that due to onsite restrictions, neither alternative is able to accommodate a similar number of apartments, with similar size, style and quality to that of Manor Road, whilst providing the required parking, cycle and refuse storage, balconies and amenity spaces. As a result, neither of the identified alternatives is considered to be a reasonably available alternative for the development proposed at Manor Road.

[12] Water Environment Ltd (June 2016) *4 – 6 Manor Road Teddington, Sequential Test, Final*

4 POTENTIAL FLOODING ON SITE

Historic Information

4.1 The Environment Agency holds records of a historic fluvial flood event affecting the site on March 6th 1947. The recorded flood extents provided by the Environment Agency are included as Drawing 4.

4.2 During the planning application process for the existing residential development at 4 Manor Road, a detailed flood risk assessment was undertaken by Bettridge Turner & Partners (BTP)[13]. As part of this assessment, anecdotal information was collected from neighbours and former residents of the site, who could account for many decades of site history.

4.3 Three reports of flooding on or close to the site from the tidal part of the River Thames were recorded between approximately 1960 and 1982. These events were prior to the construction of the Thames Barrier. Since the barrier construction in 1982, there were no further reports of tidal flooding on site.

4.4 There were no anecdotal records of fluvial flooding reported since 1960. This is consistent with Environment Agency records which indicate that although flooding on site was recorded in 1947, the site was not flooded in significant recent events during 1988 or 2000.

4.5 The existing residents' of one of the houses on the site have lived in this location for 15 years and have confirmed that their property has not experienced any flooding on the site during this period. This includes recent flooding events in the Thames catchment in 2003, 2007, 2012 and 2014.

Flood Sources

Flooding from Rivers and the Sea

4.6 In October 2004, the Environment Agency released floodplain maps for the UK based on the 'JFLOW' project, a two-dimensional hydraulic modelling project. Figure 2 shows the internet flood map local to the site based on this work. The floodplain indicated in dark blue is the area that may be affected by the 1 in 100 year fluvial flooding event, neglecting the influence of any flood defences in the area. This is categorised by the Environment Agency as Flood Zone 3. The light blue colour shows the additional extent of an extreme flood (land affected by the 1 in 100 to 1 in 1000 year fluvial flood), and is categorised as Flood Zone 2.

4.7 The site is shown on the latest Environment Agency flood map in Figure 2.

[13] BTP Bettridge Turner & Partners (Jan 2006), 4 Manor Road Teddington Flood Risk Assessment, Rev A.

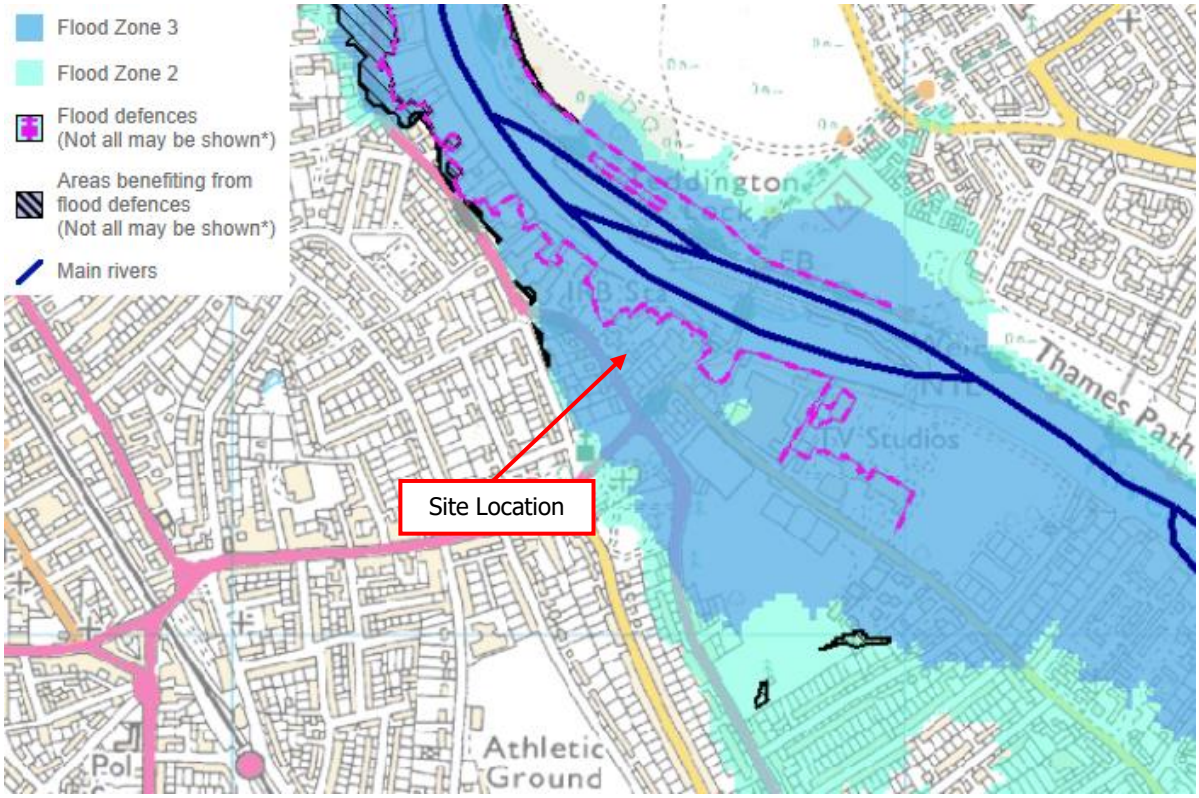

Figure 2 - Environment Agency Floodplain Map

4.8 The site is shown to lie in Flood Zones 3 indicating that it may be affected by 1 in 100 year and 1 in 1000 year events in the River Thames.

4.9 The location of this site in Teddington is unique in that it is at risk of flooding from both fluvial and tidal reaches of the River Thames, since it is immediately adjacent to Teddington Weir. The site is at risk of fluvial flooding approach from the south-east, emerging upstream of Teddington Weir, and from tidal flooding from north of the site. Flood defences are in place along the tidal section, and therefore some protection is offered from tidal flooding event originating downstream of the weir. These flood defences, however, do not offer protection from fluvial flooding originating upstream of the site.

4.10 The risk of fluvial and tidal flooding is considered in more detail in a dedicated chapter (Section 5).

Risk of Flooding from Surface Water

4.11 Flooding from surface water arises during intense rainfall events when flood waters are unable to infiltrate into the ground or discharge into local ditches or artificial drainage infrastructure. In an urban environment, the risk of flooding from surface water and from overloaded sewers is closely related, and both are included in the relevant surface water flooding datasets. Flooding events are typically of short duration (unless there is a drainage system blockage), but can be severe.

4.12 The Environment Agency's online surface water flood maps indicate the likely extent of overland flooding in the area and highlight natural flow paths. For urban areas, like

that surrounding the site, typically low points are along roads, which provide pathways for surface water. The surface water map for the area surrounding the site is shown in Figure 3.

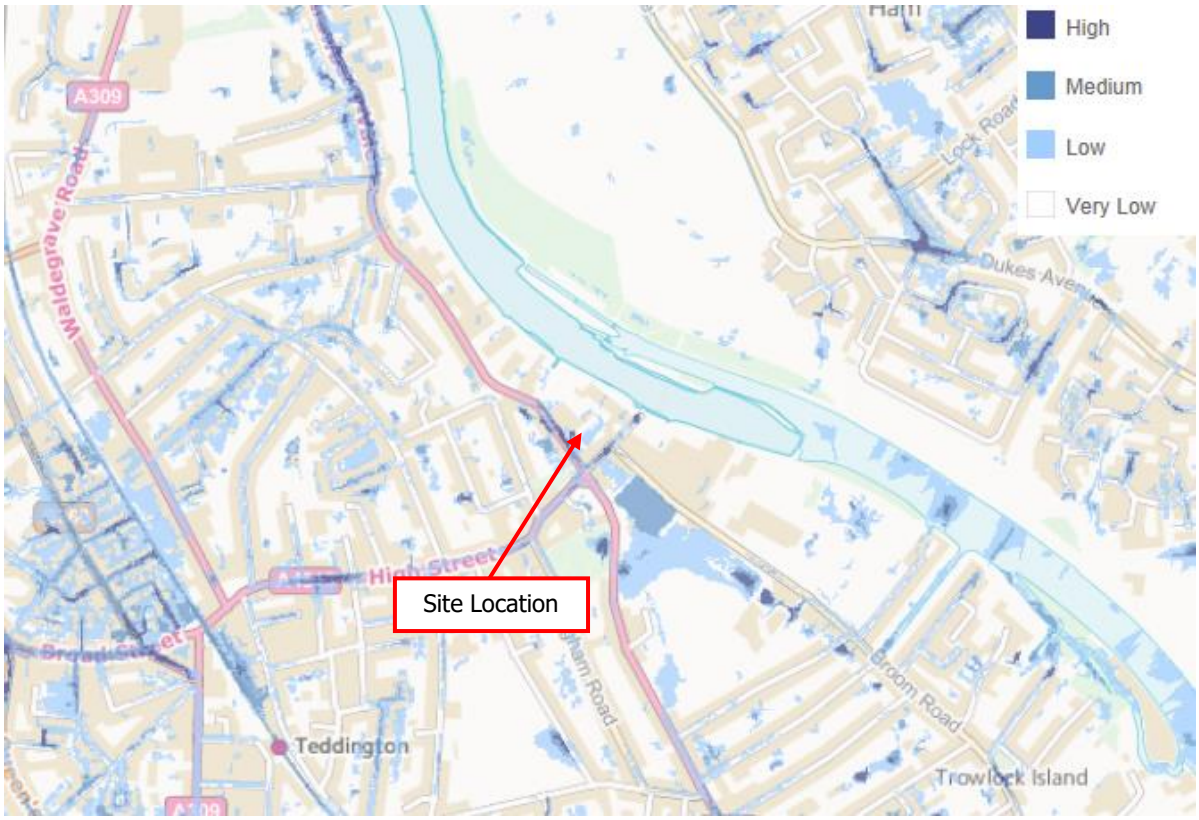

Figure 3 – Environment Agency Surface Water Flood Map

4.13 The Environment Agency's surface water flood maps show that the site is considered to be at "low" risk of flooding from surface water. An area of "low" risk is also recorded outside the site on Manor Road, with some "medium" and "high" risk ponding seen to the north, indicating a localised topographic low within the road. These maps agree with information reported within the SWMP.

4.14 Surface water flooding on site is expected to be "shallow" (<300mm) to "medium" (300-900mm) in depth, where risk is considered "low". This is categorised as an area which has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) and is beyond typical design requirements.

4.15 Where possible, all built developments should adhere to published guidelines and should be raised above surrounding ground levels in accordance with recommendations in the CIRIA document "Designing for exceedance in urban drainage"[14] to resist the ingress of water in the event of overland surface water flows on site. Given more predominant risk of fluvial and tidal flooding on site, finished floor levels will be raised significantly above surrounding ground levels which will prevent internal flooding of the dwellings from surface water.

[14] CIRIA, C625 Designing for exceedance in urban drainage – good practice, 2006

4.16 Based on the Environment Agency's maps, overland flooding may be seen on site and within Manor Road during an extreme surface water flood event. Due to the design, the car parking area within the basement provides the lowest point on site and, as a result, may flood in such events. The existing basement has a dedicated drainage system discharging to soakaway so water can drain naturally back into the ground. In the proposed development, the extension to the parking area will either implement the same strategy or have a pumped drainage system to join the surface water runoff discharging to the sewer. Due to the design of the proposed development there would be no risk to the dwellings on the site. Therefore, the risk of flooding from surface water is considered to be low.

Flooding from Sewers

4.17 Any site within an urban is potentially at risk from surcharging sewers in the event of extreme rainfall event within the road. Any flooding that does occur in the vicinity of the site as a result of sewer surcharge will pond or follow the topography, collecting in Manor Road.

4.18 Thames Water information obtained during this assessment confirms that the flooding records held indicate that there have been no incidents of flooding in the area as a result of surcharging public sewers.

4.19 As described above, due to the raised ground floor design of the proposed site, surface water will not cause internal flooding of the proposed dwellings.

Flooding from Groundwater

4.20 The Environment Agency's online map shows that the site is located within are area designated as "Principal" superficial aquifer. This indicates that the drift deposits within the local geology have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river baseflow on a strategic scale. The bedrock beneath the site is not classified as an aquifer, and the site does not lie within a Source Protection Zone.

4.21 The Environment Agency's groundwater vulnerability maps indicate that the superficial aquifer beneath the site is classified as "Major Aquifer High" as shown in Figure 4. This classification covers the entire Teddington area, indicating that groundwater levels are likely to be high across the wider area.

4.22 The British Geological Survey (BGS) online 1:50,000 maps provide more detail on the geology beneath the site. In terms of superficial deposits, the site sits above a boundary between Alluvium, which runs along the entire River Thames corridor, and Kempton Park Gravel. Bedrock geology consists of London Clay beneath the entire wider area. The combination of permeable superficial deposits above impermeable London Clay supports the Environment Agency information. Information obtained from local boreholes indicates that groundwater levels in the wider area are typically 2.8 – 3.5m below ground level (BGL), within the gravel, confirming relatively shallow groundwater levels in the area.

4.23 A previous study on the site shows boreholes confirming a typical succession of a thin layer of Made Ground, over clay and silt (to approx. 1.2m BGL), followed by sands and gravels. Both borehole logs confirm the presence of clay at 5.5m BGL, before the

boreholes end. The succession of clay/silt with sands and gravels is typical of Alluvium and confirms the BGS mapping. Both boreholes report a standing water level at 1.70m AOD. This is shallower than data obtained from a selection of publicly available boreholes and may depict a period of particularly high groundwater levels.

4.24 Given the site's proximity to the Thames, water levels in the sands and gravels are likely to vary in conjunction with water levels in the Thames. The site is therefore more likely to be affected by fluvial or tidal flooding from the Thames than by groundwater flooding.

4.25 In predominantly urban areas, any groundwater which does emerge at the surface will drain overland before being collected by the surface water drainage system. In order to mitigate against the primary risks of flooding on site, the proposed development will feature a raised ground floor level. Thus any groundwater which does emerge at the surface will not pose risk of flooding within the proposed building. Overall the risk of flooding from groundwater is considered to be low.

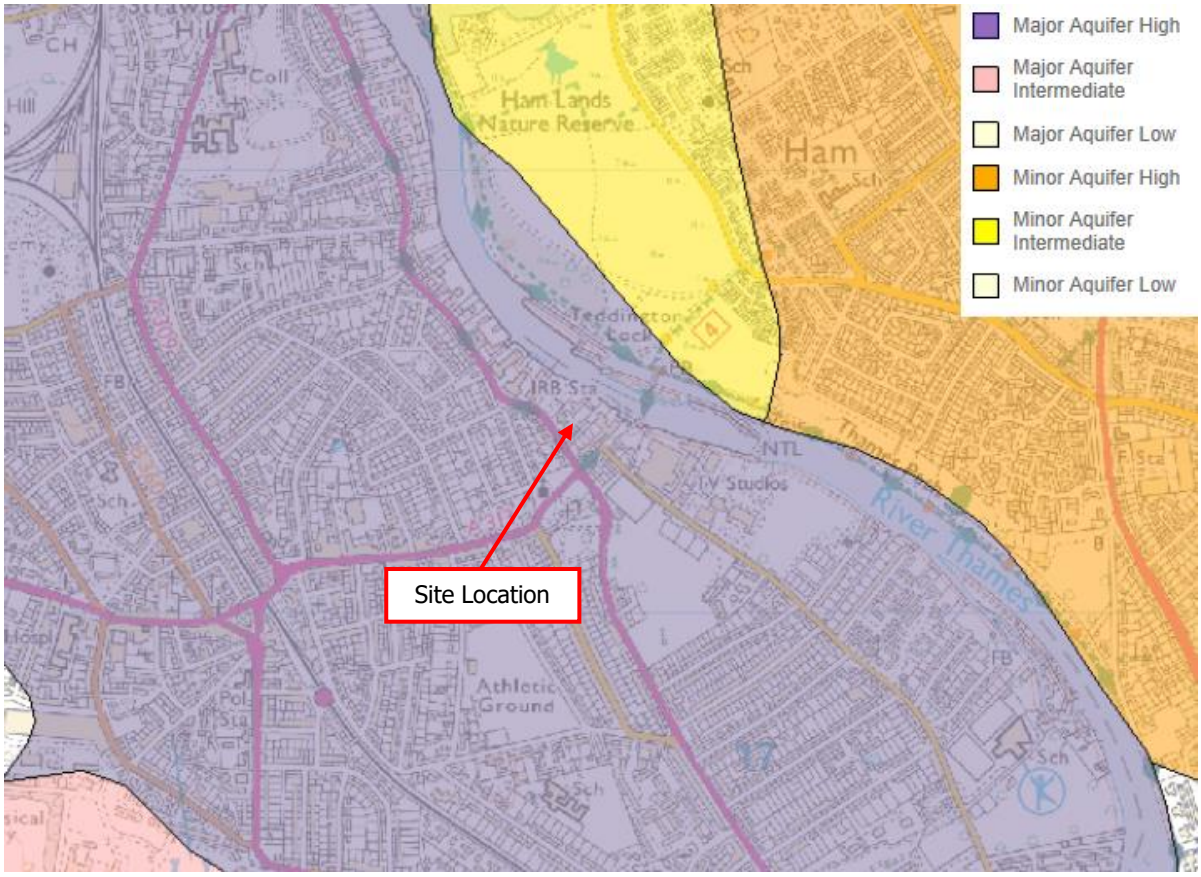

Figure 4 – Environment Agency Groundwater Vulnerability Map

Flooding from Artificial Water Bodies

4.26 The Environment Agency's online maps show that the site could be affected by reservoir flooding in the unlikely event of a breach. The extent of area at risk is included in Figure 5.

4.27 Eight reservoirs are named as potential sources of risk; King George VI, Walton Bessborough, Queen Mary, Wraysbury, Island Barn, Walton Knight, Queen Elizabeth II and Queen Mother. These are all owned and managed by Thames Water Ltd.

4.28 These reservoirs are known as national critical infrastructure and are actively managed to meet a high level of safety standards. This includes an ISO 9000 accredited reservoir surveillance management process and regular inspections to the requirements of the Reservoirs Act[15] by suitably qualified panel of engineers, making a breach extremely unlikely.

4.29 Moreover, the site is a considerable distance from any one of these reservoirs, and the proposed development will feature raised ground floor levels. As such the risk of reservoir flooding is considered to be low.

Figure 5 – Environment Agency Reservoir Inundation Map

Structures which may Influence Local Hydraulics

4.30 The site is at risk of fluvial and tidal flooding from the River Thames. The Thames is a managed watercourse, with locks and weirs controlling heads and flows along the majority of its length for navigational purposes. When the Thames floods, it is heavily controlled by the Environment Agency and as a result, flooding is often less severe than would be the case on a natural river, particularly on the lower reaches.

[15] The Reservoirs Act 1975

4.31 There are several hydraulic structures on the River Thames which will influence local hydraulics, including bridges which span this section of the river. All of these are accounted for in the Environment Agency hydraulic model of the Thames.

Climate Change

4.32 The projected impacts of climate change are likely to cause long term variations in the probability and risk of flooding. Risk of flooding from groundwater is likely to be reduced, but risks from other sources are likely to increase. This will affect the site in terms of the likelihood of flooding from rivers and sewers. The impact of climate change is considered in more detail for these sources in the relevant sections of this report.

Flood Defences

4.33 There are formal flood defences on the River Thames along this reach of the river, which provide protection to the site from tidal flooding. The existing defence levels is 6.10m AOD, with plans to increase the high of defences to 6.45m AOD between 2065 and 2100, and increase again to 6.90m AOD by 2100.

4.34 The tidal defences along the River Thames, together with the Thames Barrier, form the Thames Estuary defences. The Environment Agency is committed to ensuring that operation of the Thames Barrier and levels of defences along the river are increased accordingly in the future to maintain the level of protection to the city of London. It is the riparian owners' responsibility to ensure that they are maintained to crest levels stated above, however the Environment agency inspect them twice a year to ensure they remain intact and fit for purpose. The current condition of defences in the area is Grade 2 (Good), on a scale of 1 (Very Good) to 5 (Very Poor).

4.35 The unique position of this site in Teddington means that although tidal defences are in place to protect against extreme water levels within the tidal reach, they do not necessarily provide protection from fluvial flooding. The combined nature of this flooding means that the site is not wholly protected by the presence of flood defences close to the site.

4.36 The Environment Agency has stated that they are currently working on the Lower Thames Strategy, which "proposes measures to reduce the risk of flooding to the 15,000 properties which are currently at risk from flooding in the area from Datchet to Teddington". These measures include construction of flood diversion channels and improvements to weirs and to Teddington Lock. It also includes community based measures for improving resistance and resilience to flooding and improved mapping information for emergency evacuation plans.

5 ASSESSMENT OF FLOOD RISK

Modelled Flood Water Levels

5.1 The Environment Agency JFLOW model used to generate the Flood Zone maps is a coarse scale 2-D model using LiDAR data and point inflows. The Environment Agency has confirmed that the model is used only to define Flood Zones, and is not suitable for making Development Control decisions. Thus, in order to determine the fluvial flood risk to the site more detailed flood risk information is required.

5.2 The Environment Agency have provided detailed modelling data from both the Thames Estuary TE2100 tidal model and the Thames (Lower) Reach 4 fluvial model from Sunbury to Teddington Lock. The Environment Agency have confirmed that the fluvial modelling has not been updated since information was obtained for the previous application and therefore Product 4 information provided in October 2013 is still current. The tidal modelling data has been updated since the flood risk assessment was submitted for the previous application in October 2014, with new breach modelling undertaken. As such, updated information was obtained from the Environment Agency in October 2015. This detailed model information has been used to inform this report and to set the design flood water level for the development.

Flood Water Levels

Tidal Flooding

5.3 The detailed tidal floodplain in shown in Drawing 5 and covers the site and entire wider area. The provided information includes detailed present day and future floodwater levels for Node 2.01 and Node 2.1. Due to the unique location of the site immediately adjacent to Teddington Lock, where fluvial and tidal reaches of the River Thames meet, the information provided includes one node from above the lock (Node 2.01) and one from below the lock (Node 2.1). Node 2.01 therefore reports information from the Thames Reach 4 fluvial model, and will be discussed in a subsequent section.

5.4 The closest tidal node level to the site is therefore Node 2.1 and modelled floodwater levels are reported in Table 1. Upstream of the Thames Barrier, the levels provided are the highest levels permitted by the Barrier.

Table 1 – Modelled in-channel levels for the tidal River Thames adjacent to the site

Node Reference	Present Day Water Level (m AOD)	Future 2065-2100 Water Level (m AOD)	Future 2100 Water Level (m AOD)
2.1	6.13	None	6.63

5.5 The future tidal floodwater level closest to the site is 6.63m AOD. The site would be protected from this by an increase in the Thames tidal defence walls, to 6.90m AOD

by 2100. However, in West London there is a heavy influence from upstream fluvial levels. Flood defences in the area are built to manage tidal flood risk only, and with very high fluvial flows, in-channel levels in the area could be above the tidal defence levels.

Fluvial Flooding

5.6 A detailed fluvial floodplain for a number of return periods is shown in Drawing 6, and shows mapped output from the Thames Lower Reach 1D-2D linked model. The Environment Agency has provided both 1D in-channel floodwater levels, and 2D levels within the wider floodplain.

5.7 The closest 1D node to the site is 063TH01_MN_2.01, whilst the closest 2D floodplain node is Point C. Modelled flood water levels are reported in Table 2 and Table 3.

Table 2 – Modelled in-channel levels for the fluvial River Thames close to the site

Node Label	Flood Levels (m AOD)				
	20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20%)	0.1% AEP
063TH01_MN_16a.011	4.85	5.59	6.41	6.99	7.64
063TH01_MN_16a.011D	4.85	5.59	6.41	6.99	7.64
063TH01_MN_16a.002	4.85	5.58	6.40	6.99	7.64
063TH01_MN_2.01	4.73	5.55	6.38	6.97	7.63
063TH01_MN_2.02	4.50	5.30	6.08	6.63	7.24

5.8 The closest in-channel water level for the 1 in 100 year plus climate change event is shown to be 6.97m AOD. However, since floodwater would spread widely across the local area, the water level within the 2D grid cell nearest to the site is 6.66m AOD.

5.9 The mapped output confirms that although the site is located within an area at risk of flooding in the 1 in 50 year event, it is located outside the 1 in 20 year functional floodplain (Flood Zone 3b). Therefore, based on the latest available information, the site is designated as Flood Zone 3a and not Flood Zone 3b as reported in the SFRA. This Flood Zone 3a designation was confirmed in the pre-application response received from London Borough of Richmond dated 24th March 2016.

Table 3 – Modelled floodplain levels for the fluvial River Thames within the area

2D grid cell Reference	Flood Levels (m AOD)				
	20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20%)	0.1% AEP
Point A				6.35	7.14
Point B			6.29	6.61	7.33
Point C			6.30	6.66	7.41
Point D					7.45
Point E			6.33	6.71	7.47
Point F			6.34	6.72	7.49

Mechanism of Flooding on Site

5.10 According to the modelled information, the site is located within the floodplain and is within the extent of flooding for events of 1 in 50 year and greater return periods. The site would flood as a result of the Thames overtopping its banks along the fluvial section, upstream of the defences, and spreading out over the wider area. Alternatively, flooding could come from the tidal section as a result of high fluvial levels increasing in-channel levels sufficiently enough to overtop the tidal defence walls.

5.11 Due to the existence of the Thames Barrier, events of a purely tidal nature are be managed and are therefore unlikely to overtop the defence walls.

Residual Risk

5.12 The modelled tidal information provided by the Environment Agency also includes information on the residual risk of flooding from both the Thames Tidal Breach Model and the Thames Upstream Inundation Model. Both the inundation and breach models were updated by CH2M HILL in March 2015, which supersedes previous breach modelling data for the area. The latest data was obtained from the Environment Agency in October 2015 and used to inform this assessment. The information provided confirms that whilst the future TE2100 in-channel levels remain as before (a maximum of 6.63m AOD nearest to the site), the water level on site as a result of a breach in the tidal defences has increased.

5.13 The Thames Upstream Inundation Model assumes that the Thames Barrier is operational but all linear defences have been removed. This is clearly an unrealistic scenario. Nevertheless, modelled floodwater levels provided at the site are 6.452m and 6.6m AOD for the year 2065 and year 2100 events respectively.

5.14 The Thames Tidal Breach Modelling simulates the impact of flooding in the event of a major breach in the linear flood defences close to the site. For hard defences breaches are set to 20m wide; for soft defences the breaches are 50m wide. The breaches were modelled for the 2065 year epoch and the 2100 year epoch. Based on the Environment Agency's latest data, the maximum water level close to the site is shown from "Twck01".

5.15 The information provided confirms that whilst the future TE2100 in-channel levels remain as before (a maximum of 6.63m AOD nearest to the site), the water level on site as a result of a breach in the tidal defences has increased. The maximum breach flood level on site is now shown to be 6.77m AOD. This appears to be an anomaly in the modelling as the water level on the site resulting from a breach of the tidal defences is higher than the tidal water level in the river for the node nearest the site. Extensive discussions have been held with technical advisors in the Modelling and Forecasting team at the Environment Agency who have confirmed that in this location the tidal breach model uses an inflow hydrograph which also takes into account the fluvial model at Node 2.01 upstream of Teddington Weir. As a result, worst case floodwater levels close to the site are shown to be 6.641m and 6.769m AOD for the 2065 and 2100 events respectively.

5.16 Breach modelling also includes hazard mapping, which considers the level of flood hazard (in terms of flood depth and velocity) to people in the area should there be a breach in the Thames defences. Mapped output for the area surrounding the site is included in Drawing 7. Despite relatively low flood water velocities (0.3 – 1.0 m/s maximum), flood depths on site are shown to be up to 1.5m deep. As a result, the flood hazard rating on site is considered to be "Danger for Most", with a rating of "Danger for All" seen in Manor Road outside the development. The hazard mapping only considers the peak of a flood event.

Climate Change Allowances

5.17 The project impact of climate change is to increase the likelihood of flooding from most flood sources. The predicted increase in frequency and severity of rainfall events will increase the risk of flooding from rivers, land and sewers. The NPPF diverts to the Environment Agency for climate change recommendations.

5.18 On 19th February 2016 government released new climate change allowances. This recommends allowances for increases in river flows, sea levels and rainfall intensities to be considered to account for the impact of climate change.

5.19 The range of allowances is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below the allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flow fall below it and half fall above it. The:

- central allowance is based on the 50th percentile
- higher central is based on the 70th percentile
- upper end is based on the 90th percentile

5.20 The Environment Agency anticipated changes in extreme rainfall intensity for the River Thames catchment are outlined in Table 4.

Table 4 – Peak river flow allowances for the Thames river basin district

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	25%	35%	70%
Higher Central	15%	25%	35%
Central	10%	15%	25%

5.21 In order to use and apply the peak river flow allowances for flood risk assessments, consideration must be given to the flood zone and appropriate flood risk vulnerability classification of the development. For a more vulnerable (e.g. residential) development in Flood Zone 3a, the guidance advises use of the "higher central and upper end to assess a range of allowances". The planned lifetime for the proposed development has been assumed to be 100 years and therefore, the residential development at 4-6 Manor Road is required to consider a 35% and a 70% peak uplift in river flows.

5.22 The existing modelled 1 in 100 year + climate change fluvial flood water level takes into account a climate change uplift of 20%. For the site at Manor Road, this equates to a floodwater level of 6.66m AOD. The new climate change factors are higher than before, and therefore any new modelling would need to assess a 35% and 70% uplift in peak flow to take into account potential climate change. However, in situations such as this, the assessment is wholly reliant on levels output from the Environment Agency's models. Remodelling of the River Thames models will be a lengthy process and therefore the Environment Agency has produced draft guidance on how to interpret the climate change factors from existing models.

5.23 The guidance document[16] provides supporting information to the new external Environment Agency guidance. It advises on the new peak river flow allowances for the Thames Basin and provides further guidance on determining which allowances to use for flood risk assessments and the appropriate design flood level. This information is intended to provide a guide only.

5.24 As per the main Environment Agency guidance, residential development (more vulnerable) within Flood Zone 3a should utilise Higher Central and Upper allowances for the assessment. However, the guidance document gives further advice that whilst both should be considered, the Higher Central allowance should be used for the

[16] Environment Agency, Revised Climate Change Allowances (A guidance document for Herts & North London), February 2016

design flood. This is used to set finished floor levels for the proposed development, and in the case of Manor Road equates to an uplift of 35%.

5.25 The guidance provides information on the level of assessment to use, with regard for the scale of the development and the development vulnerability. A development of 10-30 dwellings, such as Manor Road, is considered to be "small-major development". Small-major development, which is more vulnerable, within Flood Zone 3a is required to undertake an "intermediate" modelling approach.

5.26 The intermediate approach confirms that "where it is not reasonable to re-run an existing hydraulic model, the relationship between increased in peak flow and increased in stage can be used to determine peak flood levels for a given climate change allowance". As such, existing modelled flood and flow data can be used to construct a stage-discharge rating curve for the catchment, and interpolate an increased flood level for the +35% and +70% events.

5.27 However, in the case of the River Thames catchment in the vicinity of Manor Road, this is not possible. The fluvial reach at Teddington is at the downstream end of a very large catchment. At present, the existing modelling includes a 20% uplift for climate change. This is included in the model as a 20% increase in flow applied to the hydrology at the top end of the catchment. This effect is diluted down the length of the catchment as water is stored temporarily within the floodplain during extreme events. As a result, the 20% increase in flow applied at the upstream end, does not equate to a 20% increase in flow at the downstream end. In the case of the River Thames at Teddington, at the nearest in-channel node (2.01) the difference in flow between the 1 in 100 year (688.86 m^3/s) and 1 in 100 year plus 20% (760.48 m^3/s) is approximately a 10% increase in flow.

5.28 As a result, increasing the 1 in 100 year value at the downstream end of the River Thames by 35% or 70% would result in a significantly over-inflated flow. In fact, at the 1 in 1000 year flow is only 22% higher than the 1 in 100 year event. Therefore, inflating climate change at the nearest fluvial node to 35% uplift would result in a flow considerably in excess of the 1 in 1000 year event and beyond the available dataset. Based on the upstream to downstream relationship, it appears that the any increase in inflow at the model is diminished by half by the time it reaches Teddington Weir. Assuming a linear relationship, it can logically be assumed that a 22% difference between 1 in 100 and 1 in 1000 year flows at the downstream end equates to approximately a 44% uplift in inflow at the top of the catchment. This is above the required 35% uplift for new climate change allowances.

5.29 Given that the River Thames hydraulic models are extensive and likely to take a significant period of time to be remodelled, the conservative and reasonable approach in this case is to set the finished floor levels to the 1 in 1000 year flood water level. This is 7.41m AOD based on flood water levels within the floodplain close to the site (Point C). This is the highest level for which we have modelled data and specifying any greater increase in finished floor levels would be without scientific basis.

Flood Levels in Relation to the Site

5.30 The maximum *modelled* 1 in 100 year plus climate change fluvial flood water level (6.66m AOD) indicates that the site will flood to a maximum depth of approximately 1.5m. The site is located within the 1 in 50 year flood extent, and a shallower depth of flooding during this more frequent event. The site is not expected to flood in the 1 in 20 year event and therefore the site is located outside of the functional floodplain (Flood Zone 3b).

5.31 Flooding on site, from the tidal Thames, is also shown to occur as a result of a breach in the local defences. This would result in a depth of flooding on site of approximately 1.6m AOD. This breach scenario represents a residual risk and therefore this depth of flooding is extremely unlikely.

Finished Floor Levels

5.32 The revised design has elevated the building, with the finished floor being the primary constraint.

5.33 It is intended to set finished ground floor levels of the proposed development at 7.41m AOD, based on the 1 in 1000 year event, the highest level of modelled data available in order to account for the increased climate change allowance (+35%). This provides a freeboard of 640mm above the peak tidal flood water level and 750mm above the 1 in 100 year + 20% flood water level.

5.34 A preliminary slab depth and service void of 600mm has been determined, setting the soffit of the slab at 6.81m AOD. This is 40mm above the modelled breach level. The maximum modelled fluvial level (6.66m AOD in the 1 in 100 year plus climate change event) would typically be used as the design floodwater level to assess any obstruction to flood flows or loss of floodplain storage. The breach tidal level is not typically used to set the soffit level as this is a residual risk and should not occur under normal operating conditions. However, in order to be as conservative as possible the proposed development has opted to set the finished floor level at the 1000 year fluvial flood water level. As a result, the soffit level of the slab will be above both the fluvial and tidal design flood water levels. This represents the most up to date information available and the "worst-case" scenario.

5.35 The proposed development includes sleeping at raised ground floor level as a result of the apartment style design. These would be safe for events up to and including the maximum modelled 100 year plus (20%) climate change fluvial event, with floor levels set at the 1000 year event. Based on scaled analysis, this finished floor level would also be above the 100 year plus 35% climate change event. In addition, as a result of the conservative approach taken the accommodation will also be 640mm above the maximum breach tidal level on site.

Consequences of Flooding on Site

5.36 The proposed development has been designed to remain safe in the 1 in 100 year fluvial event (including an allowance for climate change) and as floor levels will be set at 7.41 AOD (1 in 1000 year flood level). This is 750mm above the available modelled

design flood level of 6.66m AOD. In addition, finished floor levels are set 640mm above the 2100 breach water level.

5.37 The site itself will flood during a flood event greater than the 1 in 50 year, however due to raised floor levels the risk of internal flooding is considered to be low.

Risk to Residents from Flooding

5.38 There will be no internal flooding of the proposed building in the 1 in 100 year fluvial flood event including an allowance for climate change, nor any residual breach event. Finished floor levels will be set to the 1 in 1000 year level, the highest modelled level available.

5.39 The site lies within a designated flood warning area for "River Thames from the River Crane to Teddington Weir including St. Margaret's, Eel Pie Island, Strawberry Hill and East Teddington". The Flood Warning Service could therefore provide residents with early warning of flooding in the catchment, and will provide notice to implement precautionary measures where required.

5.40 The full Environment Agency flood warning service comprises four staged warning codes, each indicating the severity of flooding and the level of danger. These are; All Clear, Flood Watch, Flood Warning and Severe Flood Warning. The flood status of an area is updated at 15 minute intervals on the internet and is also available by telephone on a 24 hour Floodline.

5.41 Subscribers to this service are eligible to receive free warnings by telephone, mobile, email, SMS text message or fax, whichever is most convenient. It is recommended that future occupants of this property subscribe to this warning service. This can either be done online via the Environment Agency's Webpage or by calling Floodline on 0845 988 1188. Residents who sign up for the telephonic service, for instance, will receive an automated message via the phone telling them that flooding is expected and giving advice as to what actions should be taken.

5.42 Given the nature of the Thames Catchment, is it anticipated that residents would have sufficient warning to evacuate the premises. The Thames catchment is approximately 10,000km^2 at Teddington and a 1 in 100 year event would take several days for the flow to peak. The site is situated in an urbanised area surrounded by residential development. The development also consists of multi-storey accommodation with several people on the site. This is not a single, isolated property. All this considered, there will be days of warning of a significant flood event in the Thames catchment with automated messages provided by the Environment Agency to each dwelling. It is likely that an event of his magnitude would be broadcast widely on local and national news. It is therefore exceptionally unlikely that any of the residents would be caught unaware of an impending fluvial flood event in the River Thames thereby required emergency evacuation. Nevertheless, since the development will be raised out of the floodplain, the safest action for occupants of the development would be to seek safe refuge and remain their home if the site has flooded.

5.43 Future residents should be made aware that the basement car park has been designed to flood. Where possible, vehicles parked within the car park should be relocated out of the floodplain once flood warning is received, however once water is

seen on site, the basement level is likely to flood quickly and residents should not attempt to enter the car park.

Emergency Plan

5.44 As per the previous submission, it is acknowledged that safe, dry access will not be available to residents at the peak of a flood event. This is the same situation as the existing properties at No. 6, the recent development at No. 4 and true of all of the local area. Therefore, as confirmed acceptable by the Environment Agency, where safe access and egress cannot be achieved an emergency flood plan will be prepared and submitted to London Borough of Richmond upon Thames. It has been agreed with the council that an emergency flood plan can be conditioned for completion post-planning consistent with the approach taken at planning for the consented scheme at No. 4 Manor Road. The principles of flood management will therefore be the same as those for the existing adjacent development at No. 4.

5.45 Both sites will have the same freeholder and building manager. As a result, the previously accepted emergency flood plan already in place for residents at No. 4 will be updated into a new and up to date emergency flood plan that will apply to the existing residents and new residents alike. All residents will be required to sign up for the Environment Agency's flood warning service and will be advised to remain inside the building during a flood event. All residents, whether owners or tenants, will be required to read and acknowledge the emergency flood plan upon occupation of any property on the site.

5.46 The existing roller garage door at No. 4 is designed such that the building manager can ensure that it will remain open at all times during a flood event, and the connected basement at No. 6 will therefore be able to flood freely in the event of floodwater entering the site from Manor Road. Given that the site is surrounded on all other sides by high brick walls and/or neighbouring properties, the most likely mechanism of flooding is via Manor Road. The entrance driveway naturally slopes into the basement garage. The proposed lift to the basement has been designed to take into account its floodable location and the building manager can switch off the ability for the lift to go lower than the raised ground floor level. All electrics in the basement car park can be isolated.

Effect on the Risk of Flooding Elsewhere

5.47 Although the site is within the area at risk of flooding, the open design of the basement car parking area means that the non-floodable footprint on site will decrease significantly following development.

5.48 As a result, there will be no increase in the risk of flooding to third party landowners or property. Compared to the existing property which is a solid construction situated entirely within the floodplain, the proposed development provides an increase in floodplain storage and therefore a reduction in non-floodable footprint within Flood Zone 3.

5.49 As a key issue for the development, floodplain storage in compensation has been discussed at length with the Environment Agency as part of pre-application correspondence and full details are included in Section 6.

Exception Test

5.50 The site lies in undefended Flood Zone 3, and will increase additional units into the floodplain. As a result, following the acceptance of the Sequential Test, the council have confirmed that the Exception Test should be satisfied. The following considerations indicate that the Exception Test would be passed for this development:

- This FRA has concluded that the development will remain safe in the 1 in 100 year flood event including an allowance for climate change as recommended within the NPPF and local policy. This presents an improvement on the existing property which is located within the area at risk;
- The design of the site is such that floodplain capacity will be increased by allowing the entire basement car park level to flood, thus improving upon the existing scenario and decreasing the non-floodable footprint on site. The development therefore actively contributes to reducing flood risk elsewhere to the benefit of the wider community;
- The replacement dwellings are designed to be resilient to flooding and are located above the flood water level. Despite an increased number of residents on site, the overall number of people at risk is therefore reduced;
- The proposed development provides much needed additional new housing within Teddington town centre which will be more sustainable than the existing dwellings; and
- The development is designed to be as sustainable as possible and achieves an 'A' rating based on the Richmond Sustainable Construction checklist. A development rates as 'A' is considered to make "a major contribution towards achieving sustainable development in Richmond".

6 FLOODPLAIN STORAGE AND COMPENSATION

6.1 The proposed development at No. 6 Manor Road will replace the existing semi-detached dwellings with a single building including 12 units. As a result of the development the footprint of the building will increase.

6.2 Previous correspondence with the Environment Agency regarding this site has stipulated that they require confirmation that the development will not result in a loss of floodplain storage. Any loss of flood storage must be compensated for at the level from which it was lost, and therefore calculations have been revised for the proposed design and undertaken on a volume for volume and level for level basis. All calculations use the maximum breach water level (which is higher than the modelled 100 year plus 20% climate change fluvial floodwater level by 110mm). This approach was chosen in order to be as conservative as possible within reasonable limits, despite the fact that floodplain compensation is not required for a loss of floodplain storage in tidal breach (residual risk) flooding scenarios.

6.3 The strategy detailed below was presented to the Environment Agency in the form of an extended letter in December 2015. The response received (19 February 2016) confirms that the development proposed is unlikely to result in a loss of flood storage and that, in principle, the Environment Agency are satisfied with the approach.

Existing

6.4 The existing dwellings at No. 6 have a total of 135.0m^2 built footprint. Based on a typical ground level of 5.30m AOD and a maximum extreme tidal flood water level at 6.77m AOD, this equates to a maximum flood depth on site of 1.47m. As a result, the existing built, non-floodable volume within the floodplain is calculated to be 198.5m^3. The building is uniform between the ground level and floodwater level, and therefore can be split into 7 x 200mm slices plus an additional 7mm to reach the flood level. This equates to a total of 27.0m^3 of non-floodable volume within each 200mm slice.

6.5 It is accepted that because of the total volume of water resulting from a storm surge up the Thames estuary any loss of storage resulting from individual development in the floodplain, or in combination with other developments, would have a negligible impact on peak flood water levels and/or displacement of floodwater. In addition, in this case, the flood water level being used is as a result of a breach in the defences and this type of flooding event should not occur under normal operating conditions.

Proposed

6.6 The proposed development has been designed based on the principles established at No. 4 Manor Road, with the entire development raised above the flood water level. The proposed development at No. 6 actually improves upon the design of No. 4, with a larger portion of the building being open to flooding as a result of larger openings and narrower support columns. The design of the car park below, with openings along all sides, allows the footprint of the proposed development to be fully floodable in the event of flooding on site.

6.7 The proposed building has a larger overall footprint, a total of 411.2 m^2. However, this is fully raised on stilts above the maximum flood water level. The underside of the building slab will be set to 6.81m AOD, 40mm above 6.77m AOD (maximum modelled flood water level), and therefore the entire area beneath the building will be floodable. As a result, the only non-floodable volume within the floodplain is due to the presence of support columns beneath the building and the lift shaft. Although the building includes a partial basement level which will be open and available for storage of floodwater, excavation of storage below the existing ground level is not typically considered adequate floodplain compensation. Direct level for level must be provided between 5.30m AOD (ground level) and 6.77m AOD (flood level). A drawing showing a section through the proposed building, highlighting the basement car park, is included as Drawing 8.

6.8 The total combined footprint of the support columns and the lift shaft below the floodwater level is 12.5 m^2. Based on a flood depth of 1.47m, this equates to a non-floodable volume of 18.4m^3. To illustrate the proposed design of the building below the modelled flood water level, an annotated excerpt from the proposed southern elevation drawing is shown in Figure 6.

Figure 6[17] - Proposed Development (Southern Elevation)

6.9 As per the existing scenario, floodplain compensation has been calculated on a level for level basis in 200mm slices. The proposed support columns and lift shaft are vertically uniform and can therefore be split into 7 x 200mm slices, plus an additional 7mm.

6.10 Within each of the 200mm slices, the non-floodable volume is calculated to be 2.5m^3, considerably less than the 27.0m^3 per slice calculated for the existing building on site. Therefore, despite the overall increase in building size, the elevated design ensures that there is a significant increase in floodplain storage at every level. Based on the

[17] Annotated excerpt from Brookes Architects Drawing, No. 4707|3|61, September 2015.

total proposed non-floodable volume of 18.4m^3, compared to the existing volume of 198.5m^3, the proposed development returns a total of 180.1m^3 of floodplain storage to the site between ground level and the worst-case modelled flood water level.

6.11 The proposed development has openings on three sides; north, east and south. In addition, the western elevation is connected to the building at No. 4, with the basement car parking areas fully open. The western elevation at No. 4 includes a large roller garage door, which is fitted with an automatic and manual opening mechanism. During a flood event the building manager will keep the door open to ensure that it is not damaged by the flood water. As a result, any flooding entering the basement of No. 4 via the entrance to Manor Road will also utilise flood storage available beneath No. 6 with no restrictions to flow between the two buildings. The Environment Agency did not object to the original 4 Manor Road proposals and the principles of a floodable basement. The development at No. 6 includes an extension of the existing basement and will flood in the same manner as the consented scheme.

6.12 The open design of the basement car park means that there is a significant amount of additional storage available beneath the existing ground level. The internal area of the proposed basement car park is 384.4m^2, and therefore between the base level (4.20m AOD) and the external ground level (5.30m AOD) a total of 422.8m^3 of additional volume is available. Whilst this volume is typically not considered acceptable as level for level compensation, and therefore this additional storage benefit has not been included within the calculations above, in reality this area will provide a large amount of additional storage for flood water entering the site. Taking into account the volume of storage returned to the floodplain as a result of the raised building design (180m^3) plus the volume provided within the extended basement car park (423m^3), an additional 603m^3 of floodplain storage will be provided as a result of the proposed development. Previous consultation with the Environment Agency suggested that if the volume of storage is reduced this will result in flood waters being diverted elsewhere, leading to third party detriment. It was stated that "the detriment caused by a small encroachment may not be significant, or even measureable, when taken in isolation but the cumulative effect of many such encroachments will be significant". Applying this argument in a positive sense, the calculations above show the proposed development offers the opportunity to provide a significant increase in storage, thus providing a benefit to third parties.

6.13 The Environment Agency has expressed concerns in the past regarding blockage of the openings within the external walls, and additional volume of storage lost due to cars which have not been removed from the car park by the time of a flood event. With reference to blockage, the previous design featured large voids making up 36% of the perimeter walls. The new design is for the building to be fully open and raised on support columns. The openings now occupy a total of 65% of the perimeter. This is greater than the design previously considered and considerably above the Environment Agency's requirement for 1m in 5m (20%) void ratio. In this regard the latest design should be considered as a building raised on stilts as opposed to a building with underfloor voids. Therefore the risk of blockage of any of the individual openings is unlikely and the concern of total blockage is unrealistic. In order to ensure this does not change over the lifetime of the development, conditions could be attached to the planning consent that stipulate the openings should never be

blocked or reduced. The building will be managed post-development and therefore the building manager could see that this condition is adhered to by future residents.

6.14 In the unlikely event that cars are left in the car park despite advance flood warning to residents, it is considered probable that once the basement car park is submerged, cars are likely to fill with water. In the unlikely event that cars are not flooded internally, it is possible that these could float to the top of the basement garage. There is a concern that floating cars will occupy volume allocated for floodplain compensation. However, using an approximate estimate that each car has a total internal volume of $5m^3$, even if all 15 cars (the number of spaces provided) are present and not flooded internally, this only equates to a total loss of floodplain storage of approximately $75m^3$.

6.15 The proposed calculations presented above indicate that the development actually returns in excess of $180m^3$ of storage to the site. Therefore, even in the unlikely scenario where all 15 cars are present and floating, there is still shown to be a considerable amount (approximately $105m^3$) of excess volume compared to the existing case.

6.16 The existing building on the site at No. 6 presently occupies a non-floodable footprint and poses an obstruction to flood flows at all levels, and thus floodplain capacity will be increased following development. The proposals constitute an improvement in comparison with the existing development in terms of floodplain capacity and unobstructed flood pathways actively contributing to a reduction in flood risk elsewhere.

7 SURFACE WATER MANAGEMENT

7.1 In accordance with the NPPF, surface water runoff rates and volumes should not increase as a result of development. Surface water should be managed through the implementation of Sustainable Drainage Systems (SuDS). From the 6th April 2015, sustainable drainage become a planning requirement for any 'major development'. It is now expected that SuDS form part of the management of surface for all major development sites.

7.2 The proposed development at 4-6 Manor Road includes a total of 15 residential units, and therefore SuDS will form an integral part of the surface water system. This chapter outlines principles of the surface water and SuDS on site, with the detailed design completed post-planning.

7.3 Construction of an additional storey to the existing building at No. 4 Manor Road will not result in any increase in surface water runoff, since the building footprint and roof area will remain the same. Therefore, surface water runoff and drainage will only consider the development at No. 6.

Planning Requirements

7.4 As detailed in the policy section of this report, Policy DM SM 7 states that; *"All development proposals are required to follow the drainage hierarchy when disposing of surface water and must utilise Sustainable Drainage Systems wherever practical. Any discharge should be reduced to greenfield run-off rate wherever feasible."*

7.5 The London Plan confirms that "*developers should maximise all opportunities to achieve greenfield runoff rates in their developments*", with a minimum expectation to "*achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times.*" The document also states that "*on previously developed sites, runoff should not be more than three times the calculated greenfield rate.*"

Existing Site Drainage and Runoff

7.6 The site at No. 6 covers an area totalling 969m^2 (0.097ha), and is currently occupied by semi-detached dwellings. The existing property (including conservatory) has a total built footprint of 135m^2. The site (No. 6) has a total impermeable area of approximately 221m^2, including the house, timber sheds, concrete and hard paved areas. This makes up 23% of the existing site. The remainder of the site is made up of permeable areas, including grass, earth, hedges and gravel (77%) as shown within the topographic survey (Drawing 1).

7.7 Thames Water asset plans for the area show the presence of separate foul and surface water sewers in Manor Road. The topographic survey of the site does not identify any the existing onsite surface water drainage. However, the existing building is understood to drain to a combined sewer on the site, before joining into the foul Thames Water sewer in Manor Road.

7.8 The site is predominantly flat and runoff from all other areas on site (grass and gravel) is likely to infiltrate into the ground, until it reaches saturation during an

extreme rainfall event. At this point, runoff will drain overland and be collected by the artificial drainage system on site or in Manor Road.

7.9 In order to comply with planning requirements, Greenfield peak runoff rates have been calculated using IH124 methods. This calculates runoff from the site assuming it is entirely undeveloped. On the basis of a standard average annual rainfall (SAAR) value of 600mm and soil type 2 over the whole site area (0.097 ha), the 1 in 100 year Greenfield runoff rate is 0.5 l/s.

7.10 Design rainfall intensities have been calculated using the Wallingford Procedure[18] and the resulting runoff for the existing developed site was calculated using the Modified Rational Method. This calculates runoff from the entire site area assuming 23% is impermeable and formally drained (Rational Method runoff coefficient = 0.95) and 77% is permeable until saturation (runoff coefficient = 0.4). The longest drainage path has been taken around the perimeter of the existing building to an assumed connection point at the edge of the site (40m long) with a slope appropriate to that of a pipe network (1:100). Assuming shallow concentrated flow, as would be present within a pipe network, this results in a time of concentration of 1.4 minutes. This is below the minimum critical storm duration, due to the small size of the site, and therefore a critical time of concentration of 5 minutes has been applied.

7.11 Although in reality overland flow across grass and gravel will runoff the site more slowly, this flow may be collected by the onsite drainage network. In addition the small size of the site will dictate a low time of concentration regardless. Full calculations sheets are provided in the Appendix.

7.12 Calculated runoff rates for the existing site are as follows:

- A 1-year, 5 minute critical storm (using an M5-60 of 20mm and an 'R' value of 0.4) has been applied to arrive at a critical rainfall intensity of 56.7 mm/h. The resulting runoff rate is 8.0 l/s for the 1 in 1 annual probability rainfall event.
- A 30-year, 5 minute critical storm (using an M5-60 of 20mm and an 'R' value of 0.4) has been applied to arrive at a critical rainfall intensity of 133.6 mm/h. The resulting runoff rate is 18.9 l/s for the 1 in 30 annual probability rainfall event.
- A 100-year, 5 minute critical storm (M5-60 of 20mm and an 'R' value of 0.4) has been applied to arrive at a rainfall intensity of 169.1 mm/h. The resulting runoff rate is 23.9 l/s for the 1 in 100 annual probability rainfall event.

7.13 The existing site generates a total volume rainfall runoff above Greenfield of 6.8m^3 during the 100 year, 6 hour storm.

Sustainable Drainage Systems (SuDS)

7.14 The aim of Sustainable Drainage Systems (SuDS) is to emulate natural processes with the result that watercourses and storage areas receive the hydrological profiles

[18] HR Wallingford (2000) The Wallingford Procedure for Europe – Best Practice Guide to urban drainage modelling (CD)

under which they evolved, and that water quality in local ecosystems is protected or improved. The best practice guide states that a sustainable drainage system will[19]:

- reduce the impact of additional urbanisation on the frequency and size of floods;
- protect or enhance river and groundwater quality;
- be sympathetic to the needs of the local environment and community; and
- encourage natural groundwater recharge

7.15 The "SUDS hierarchy"[20] (Figure 7) sets out a hierarchy of SuDS solutions from the most sustainable drainage methods to the least sustainable methods. This hierarchy should be adhered to in the detailed design of drainage systems for the site, in accordance with the requirements of the NPPF and local planning policies. As a minimum requirement, surface water runoff will need to be attenuated to existing rates as stated above, thus ensuring no detrimental impact on the frequency and extent of flooding elsewhere because of development. Where possible, to further reduce the risk from surface water flooding, all developments should aim to reduce runoff, as per local policy for London Borough of Richmond and the London Plan. All systems should be designed to the latest CIRIA guidelines for SuDS.

Most Sustainable	*SUDS technique*	*Flood Reduction*	*Pollution Reduction*	*Landscape & Wildlife Benefit*
	Living roofs	✓	✓	✓
↑	**Basins and ponds** - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
↓	**Permeable surfaces and filter drains** - gravelled areas - solid paving blocks - porous paviors	✓	✓	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✓		

Figure 7 – Environment Agency "SUDS Hierarchy"

[19] CIRIA C523 – Sustainable Urban Drainage Systems – Best Practice Manual

[20] Environment Agency Development Control Technical Specialists (October 2006) SUDS A Practical Guide. Development Control Thames Region

7.16 Local planning guidance provides advice on the use and integration of SuDS into proposed development. However, the suitability of the various SuDS techniques is unique to each site and development. This is dependent on the location, size and type of development proposed, and on ground conditions beneath the site. The application of the SuDS hierarchy to the proposed development is summarised in Table 5.

Table 5 – Application of SuDS hierarchy to proposed development

Most Sustainable ↓ Least Sustainable	SuDS Technique	Suitability	Justification
	Living Roofs 1. Green Roofs 2. Brown Bio-Diverse Roofs	 No No	The roof of both No. 4 and No. 6 contains photovoltaic cells, to provide other sustainability benefits. Both roof areas are small.
	Basins and ponds 3. Constructed wetlands 4. Balancing ponds 5. Detention basins 6. Retention ponds	 No No No No	 Insufficient space Insufficient space Insufficient space Insufficient space
	Filter strips and swales	Potentially	Will not be acceptable connected to the Thames Water sewer.
	Infiltration devices 7. Soakaways 8. Infiltration trenches & basins	 Potentially Potentially	Will be incorporated where feasible subject to BRE365 soakage tests.
	Permeable surfaces and filter drains 9. Gravelled areas 10. Solid block paving 11. Porous paviors	 Yes Yes Yes	Permeable surfaces are suitable for the site and will be incorporated for all hard paved areas.
	Tanked Systems 12. Over-sized pipes/tanks 13. Box storage systems	 Yes Yes	Suitable space on the site for tanked storage with a flow control device if required.

7.17 Large traditional surface storage and filtration SuDS such as settlement ponds and wetlands are not appropriate for this site due to the site area, proximity of the site to the river, and the location of the site within the 1 in 100 year floodplain.

7.18 Infiltration devices such as soakaways and filter strips/swales may be feasible on the site and these options should be considered at detailed design stage once onsite infiltration testing has been completed. It is also recommended that groundwater monitoring is undertaken in order to determine the groundwater level and any fluctuations due to the tidal influence of the River Thames. Although a desktop study suggests that ground conditions are expected to be favourable for infiltration (sands

and gravels), previous studies revealed made ground underlain by silt and clay before sand was reached at 1.2m BGL. In addition, groundwater levels are expected to be reasonably shallow and therefore the feasibility of deeper infiltration techniques (including soakaways) will need to be investigated in more detail. Soakaways are included in the previous development at No. 4 and therefore this technique will be used on the site at No. 6 provided appropriate ground conditions have been confirmed.

7.19 In the absence of conclusive evidence that soakaways are feasible, an alternative strategy has been developed reusing the existing connection to drain runoff from the proposed building. This shows that there is a viable solution for draining surface water from the site even if the preferred option of using soakaways is not feasible.

7.20 The proposed development will include permeable paving under all paved surfaces, including the driveway, paths and patio areas (190m^2). These area will be fully infiltrating, via a shallow gravel sub-base, and will be designed to restore the 1 in 100 year plus climate change rainfall event. As such, no runoff from these areas will be allowed to leave the site post-development.

7.21 In addition, the proposed landscaping plan illustrates the presence of water butts within each of the private gardens. These will collect runoff from rainwater downpipes, with overflow into the drainage network. These water butts can be used for watering of private and communal garden areas, and aim to promote water reuse throughout the development. There is no guarantee that the water butts will be empty at the time of a large storm event and therefore the precautionary principle has been applied and the water butts have not been included within the drainage calculations.

Proposed Surface Water Runoff

7.22 Surface water will be actively managed on the site through the provision of a new surface water drainage system, incorporating the use of SuDS on the site where possible. It is required by the NPPF that developments do not increase flood risk to others. Therefore, the site is required, as a minimum, to implement SuDS on the site retain surface water runoff and volumes to existing rates.

7.23 Local policy and the London Plan dictates that, where possible, runoff should be reduced to Greenfield rates or on previously developed sites three times the Greenfield rate. However, calculated Greenfield runoff rates from the proposed site are very low at 0.5 l/s for the 100 year event. Even three times this rate (1.5 l/s) is significantly lower than recommended for a pipe network and flow restrictors. Therefore, a minimum limiting discharge rate of 5 l/s has been applied. This is the minimum rate required in order to maintain self-cleansing velocities within the pipes and prevent siltation of the flow restrictor.

7.24 The proposed development at No. 6 will result in a gross increase in the built footprint since the new building is appropriately 411m^2. This also forms the extent of the proposed impermeable area, since the remainder of the site will be garden, paths and patios. All paved areas will be permeable, in accordance with the SuDS hierarchy, Policy DM SM 7 and the London Plan.

7.25 The areas of permeable paving will be designed to ensure that the sub-base is capable of fully containing the 100 year event, including an uplift to allow for climate change. As a result, runoff from the permeable paving will infiltrate fully and will not contribute to runoff to the offsite network. Therefore, the total area of permeable paving (190m^2) will not be drained and can be omitted from the runoff calculations. The proposed building will drain to the surface water sewer in Manor Road via attenuation facilities and a flow restrictor.

7.26 As a result of the proposed increase in building size, surface water runoff rates and volumes are likely to increase following development. The surface water system will be designed in accordance with local planning policy and will be designed such that runoff from the 100 year rainfall event plus climate change allowance is fully retained on the site and discharged at the controlled rate of 5 l/s. Full drainage design will be completed as part of the detailed design, however preliminary drainage calculation for the proposed development are as follows:

- For the 1-year critical storm, the resulting runoff rate is 8.5 l/s. With 30% uplift to allow for climate change over the lifetime of the development (100 years), this runoff rate increases to 11.0 l/s.
- For the 30-year critical storm, the resulting runoff rate is 20.0 l/s. With 30% uplift to allow for climate change over the lifetime of the development (100 years), this runoff rate increases to 26.0 l/s.
- For the 100-year critical storm, the resulting runoff rate is 25.3 l/s. With 30% uplift to allow for climate change over the lifetime of the development (100 years), this runoff rate increases to 32.9 l/s.

7.27 These calculations are based on a longest drainage path of 68m, defined as the likely pipe-run around the new building from the existing connection. This assumes a 1:100 slope within the pipe network. It is considered that 100% of runoff from the proposed building (411m^2 – 53% of the site) is discharged from the site with runoff coefficient of 0.95. Of the permeable areas (558m^2 – 47% of the site), only 66% (368m^2) contribute to runoff due to omission of the permeable paved areas.

7.28 Therefore, as a result of the proposed development there is a small increase in runoff rates from the site, despite inclusion of the permeable paving. During the 100 year event the proposed runoff rate is 25.3 l/s, 1.4 l/s greater than the equivalent existing runoff rate. The largest impact however is as a result of climate change over the lifetime of the development as a factor of 30% has been applied to these post-development calculations. This increases the runoff rate to 32.9 l/s in the future 100 year event.

7.29 The site in its existing state has a runoff rate of 23.9 l/s and post development has a predicted runoff rate of 32.9 l/s due to the implications of climate change and the proposed development design. Therefore, the post development the site increases surface water runoff in the design event by 9.0 l/s. For the site to restrict this runoff rate to 5.0 l/s, the minimum practicable rate, a total of 12.9 m^3 of storage will be required. This equates to a 79% reduction compared to the existing runoff rate. The London Plan requires that development achieves a minimum of a 50% reduction, with the preferred policy for a 100% reduction. Due to the site size, 100% reduction

to Greenfield rates is not possible and therefore a 79% reduction to the minimum practicable rate of 5 l/s is the maximum reduction possible.

7.30 The post-development site has been calculated to have an unmitigated above Greenfield volume of 11.8m^3 of runoff for the 100 year rainfall event plus climate change. This is an increase of 5.1m^3 from the existing site due to the implications of climate change on the calculations. Mitigation is already included within the calculations as a result of exclusion of the areas of permeable paving. This will be designed to ensure that the sub-base is capable of fully storing the 100 year rainfall event prior to infiltrating into the ground.

Proposed Surface Water Drainage

7.31 This development will seek to satisfy surface water runoff requirements with soakaways, however in the event that further investigations conclude this is not a realistic option, a connection will be sought to the surface water sewer in the road. The existing site at No. 6 makes use of a combined sewer, which ultimately discharges into the foul sewer within Manor Road. The development will therefore provide a benefit in separating surface water and foul water, thereby reducing the burden on the foul sewer network.

7.32 Discharge to the Thames Water sewer will be limited to 5 l/s, for all events up to an including the 100 year plus climate change event. Attenuation storage will be provided on site in the form of tanked or crated storage, and there is sufficient room to accommodate this under communal areas. This limited discharge represents a betterment on the existing scenario and results in reduced rates and volumes of runoff leaving the site post development.

7.33 Permeable paving will be included beneath all paved areas and further options to increase the use of infiltration SuDS onsite will be considered following further investigation. Full drainage design will be completed at detailed design stage however, the principles set out within the report confirm that any proposed drainage scheme for the development will reduce runoff rates and volumes from the site, compared to the existing scenario. As a result, there is will be a reduction in the risk of flooding elsewhere.

7.34 In accordance with Richmond guidance documents, the Design Assessment Checklist and SuDS Risk Assessment Checklists have been completed for the scheme proposed. These can be found within Appendix B. The proposed SuDS landscape plan and preliminary surface water drainage strategy are shown in Drawings 9 and 10.

SuDS Management and Maintenance

7.35 Management and maintenance of the drainage network will be the responsibility of the freeholder of the site. Management and maintenance agreements and plans will be arranged prior to completion of development.

7.36 Management and maintenance of the tanked storage and permeable paving (if included) should be carried out in accordance with the supplier's guidance and specification.

Foul Sewer Connections

7.37 Thames Water asset plans confirm that there is a 300mm diameter foul sewer within Manor Road. Subject to a capacity check and agreement with the statutory undertaker, existing connections to the off-site public sewer will be utilised where possible. Foul water infrastructure will be dealt with as part of the detailed drainage design, and the Water Industry Act 1991 (as amended) applies.

8 SUMMARY OF FLOOD RISK ASSESSMENT

8.1 Table 6 illustrates the points, which should be addressed for all developments located within Flood Zone 2 or 3[21].

Table 6 - Summary of Flood Risk Assessment based on the guidelines set out in NPPF

Requirement	Assessment
Plans	
Location plan that includes geographical features, street names and identifies catchment, watercourses or other bodies of water in the vicinity	Figure 1 shows the location of the site, geographical features and the nearby watercourses.
A plan of the site showing: i. existing site; ii. development proposals; iii. identification of any structures, which may influence local hydraulics.	The existing site is presented in the topographic survey, included as Drawing 1. The proposed development plans are shown in Drawing 2 and Drawing 3. Drawings 4 to 7 show the River Thames, with Teddington Lock, which is the main hydraulic structure in the area.
Surveys	
Site levels related to Ordnance Datum, both existing and proposed	A topographic survey of the existing site is included in Drawing 1. The proposed site plan is included as Drawing 2.
Appropriate cross-section(s) of the site showing finished floor levels or road levels, or other relevant levels relative to the source of flooding, and anticipated water levels and associated probabilities of flooding	The elevation of the proposed development is presented in Drawing 8, showing the finished floor level of the proposed building at No. 6 Manor Road relative to existing ground levels. Modelled fluvial floodwater levels at the site are presented in Table 3.
Assessments	
Consideration of whether the site falls within the functional flood plain and if so, demonstration that the development meets the vulnerability criteria set out in table 1 of the technical guidance to the NPPF	The Environment Agency's fluvial hydraulic modelling of the Lower Thames shows that the site lies outside of the functional floodplain (1 in 20 year event)
Flood alleviation measures already in place, their state of maintenance and their performance	There are linear formal flood defences along the reach of the Thames adjacent to the site, however these only protect against tidal events. There is no protection to the site from fluvial events from upstream of Teddington Lock.

[21] Environment Agency, FRA Guidance Note 3 v3.1, April 2012

Requirement	Assessment
Information about all potential sources of flooding that may affect the site – from rivers and the sea, streams, surface water run-off, sewers, groundwater, reservoirs, canals and other artificial sources or any combination of these.	The dominant risk of flooding to the site is from the River Thames. Comparatively, the risk of flooding from surface water, sewers and groundwater is considered to be low. Habitable floor levels will be raised above surrounding ground.
The impact of flooding on a site including: iv. the likely rate or speed of surface water run-off with which flooding might occur; v. the order in which various parts of the location or site might flood; vi. the likely duration of flood events; vii. the economic, social and environmental consequences of flooding on occupancy of the site; viii. information on the extent and depth of previous flood events or on flood predictions.	The site is expected to flood in the 1 in 100 year plus 20% climate change and the 1 in 1000 year events. However, the raised floor levels will ensure that the proposed development on site will not flood in a 1 in 1000 year event. The River Thames is known to have a long response time in this area (days). Although the site is expected to flood in an extreme flood event, the proposed development is set back from the watercourse and is within a heavily built up area. The flood velocities are therefore expected to be low. There are known historical flood events that have affected the site as shown in Drawing 4. As a result of the design, the economic, social and environmental consequences of flooding on occupants of the development are therefore low. Residents will be made aware that the basement level car park is designed to flood, and therefore where possible personal possessions (cars and bicycles) should be moved outside of the floodplain as a precautionary measure when flood warning is issued.
An assessment of how users of the development can avoid exposure to hazardous flooding in and around the development, including whether safe access and exit can be provided for routine and emergency access under both frequent and extreme flood conditions.	Safe access to and from the development is not available at the peak of a fluvial flood event, in events with a return period of 50 years or greater. As the development will be raised out of the floodplain, should safe evacuation not be possible, residents should remain safe within the property to wait for emergency services to arrive. It is recommended that the occupants of the property sign up to the Environment Agency flood warning service to have adequate time to leave the property before the flood waters arrive.

Requirement	Assessment
An assessment of how the layout and form of development can be used to reduce or minimise flood risk.	The site and development is at risk of flooding in a 1 in 100 year + 20% event however the new development on site is designed to be wholly floodable. Habitable finished floor levels will be raised approximately 2.2m above surrounding ground levels to minimise the risk of internal flooding from a range of flood sources. The car park level will be partially submerged at basement level, with the raised ground floor entrance above. The building is raised on support pillars and the car park is designed with large open entrances to allow floodwater on site to enter the car park. This design therefore provides a reduction in non-floodable area on site, compared to the existing dwellings.
An assessment of the capacity of any drains or sewers, existing or proposed, on the site during various flood events.	The proposed development is to demolish the existing semi-detached dwellings at No. 6 and construct a new block of apartments on the site. The existing site drains to the Thames Water sewer network in Manor Road. Connections will be reinstated for the proposed development. Surface water runoff from the proposed site will be limited to a maximum of 5 l/s for all return period events, a significant improvement on the existing scenario. Additional storage will be provided to ensure there is no increase in runoff rates or volumes following development.
An assessment of the volume of surface water run-off likely to be generated from the proposed development.	Surface water runoff rates and volumes are expected to increase given the increase of footprint of the proposed development. The proposed dwellings will reuse the existing surface water connections. A detailed drainage strategy will be required at post-planning stage, however calculations within this report confirm that runoff rates and volumes to the public sewer will not increase following development.

Requirement	Assessment
Proposals for surface water management according to sustainable drainage principles, with the aim of not increasing, and where practicable, reducing the rate of runoff from the site as a result of the development.	A detailed drainage strategy and surface water management plan will be required at post-planning stage to ensure there is no increase in runoff. This development will seek to satisfy surface water runoff requirements with soakaways, however in the event that further investigations conclude this is not a realistic option, a connection will be sought to the surface water sewer in the road. In accordance with the London Plan and local policy, the runoff rates should be reduced to Greenfield rates where possible. Calculations confirm that reduction to Greenfield runoff rates is not possible since this is below the recommended minimum rate to ensure self-cleansing velocities within pipes. Therefore, runoff rates will be set to 5 l/s. This presents a significant reduction on the existing scenario (79%). All proposed hard paved areas will be constructed using permeable paving to allow infiltration into the ground. The gravel sub-base will be designed to store the 1 in 100 year plus climate change rainfall event, and therefore no runoff from these paved areas will leave the site.
The likely impact of any displaced water on third parties caused by alterations to ground levels or raising flood embankments.	As a result of the floodable nature of the proposed car park design, the proposed development will result in an increase in floodplain storage. As such, there will be a reduction in displaced water on third parties.
The potential impact on form and structure of rivers or coastal areas, and the likely longer-term stability and sustainability of existing defences.	The site is also at risk of tidal flooding as a result of its location adjacent to Teddington Lock. The site is protected from tidal flooding by the linear defence walls and the presence of the Thames Barrier.

Requirement	Assessment
Estimates should be made of how climate change could affect the probability and intensity of flood events. The assessment should include details of how the development remains safe without increasing flood risk elsewhere for its design life. The hydrological analysis of flood flows and definition of defence standards needs to include the allowances for increased rainfall, flows and sea levels rise contained within the technical guidance to the NPPF.	Climate change has been taken into account in assessing the future risk of flooding to the site and the proposed development in accordance with the NPPF. Modelled fluvial flows have been increased by 20% to account for climate change and consideration has been given to the Environment Agency's revised climate change allowances. As a result, finished floor levels have been increased to the 1 in 1000 year level (7.41m AOD). The Environment Agency have provided tidal flood water levels for a range of future scenarios which incorporate sea level rise.
The remaining (known as residual) risks to the site after the construction of any necessary defences and the means of managing those.	Although the site does benefit from protection from tidal flooding as a result of the flood defences, these do no provide formal protection from fluvial flooding which overtops the river banks upstream of Teddington Lock. The Environment Agency have provided modelled breach and inundation mapping for the tidal reach, and this assessment confirms that the finished floor levels will be significantly above any residual flood level. The proposed development has been designed to remain safe and dry up to the 1 in 1000 year event, which represents the worst flooding from all sources and mechanisms. This includes consideration for the Environment Agency's revised climate change allowances.
Consideration of the proposal relative to any existing Strategic Flood Risk Assessment carried out by the local authority.	The SFRA was updated in 2010, and the site is shown to be within Flood Zone 3a. This reports pays due consideration to all flood risk policy documents. Development of the site is in accordance with all relevant flood risk related planning policies.

Exception Test (where applicable)	
An assessment of on and off site opportunities for reducing flood risk overall. This will include an appraisal of the strategic flood risk management measures to which the development can contribute.	Detailed hydraulic modelling confirms that the site is located within Flood Zone 3a; however the proposed design will raise all habitable development out of the floodplain. The development will therefore remain safe during an extreme flood event. The raised design of the building will ensure that there is a reduction in displacement of floodwater as a result of the proposed development. The open basement car park increases floodplain storage volume compared to the existing case, providing a wider benefit. This will therefore reduce the number of residents within the area at risk of flooding when compared to the existing dwellings on site.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 The site is located at 4-6 Manor Road, Teddington (TW11 8BG) and is currently occupied by semi-detached residential dwellings (known as at 6 Manor Road) behind an apartment block at No 4. The site is located approximately 65m west of the River Thames and is located within Flood Zone 3, as shown on the Environment Agency's latest flood maps. A full Flood Risk Assessment for the proposed development has therefore been carried out in accordance with the requirements of NPPF.

9.2 It is proposed to add an additional storey to the existing building at No. 4 Manor Road, providing three additional two-bedroom flats at third floor level, and to demolish the existing two dwellings located on the site at No. 6. These will be replaced with a new building, comprising of twelve two-bedroom apartments spread over raised ground, first and second floors. The basement car park currently beneath No. 4 will be extended beneath the new building at No. 6, providing car and bike parking for the properties.

9.3 The proposed design is based on the principles established for No. 4 Manor Road, with the new building built on stilts above the floodplain. The soffit level of the ground floor slab will be raised fully above the modelled floodwater level and the basement level car park will be designed to flood. All habitable areas of the proposed apartments will be raised above the floodwater level, with finished floor levels set to 7.41m AOD (the modelled 1 in 1000 year flood level).

9.4 The most significant source of potential flooding on the site is from the River Thames, specifically from overtopping of the riverbank upstream of Teddington weir. The site is unusual in that it is situated immediately adjacent to Teddington Lock, and therefore the site is at risk of flooding from both tidal and fluvial reaches of the River Thames. Detailed hydrological and hydraulic modelling of the River Thames, on both the tidal and fluvial reaches, has been undertaken by the Environment Agency and flood water levels were made available for this assessment. This modelling confirms that the site will flood in a 1 in 100 year event, and is therefore located in Flood Zone 3a. The site is not located within the functional floodplain, Flood Zone 3b (1 in 20 year event).

9.5 The Environment Agency modelling has concluded that the greatest risk to the site is as a result of fluvial flooding, since levels upstream of Teddington Lock are greater than the tidal levels downstream. The 1 in 100 year modelled flood water level on site is 6.66m AOD, including an uplift of 20% to allow for the influence of climate change. The onsite modelled 1 in 1000 year fluvial level is 7.41m AOD.

9.6 There are formal flood defences on the River Thames along this reach of the river which provide protection to the site from tidal flooding. The existing defence level is 6.10m AOD, which will be increased to 6.90m AOD by 2100. However, these defences do not provide formal protection from fluvial flooding emerging upstream of Teddington Lock, and therefore the combined nature of flooding means that the site is not wholly protected by linear defences. The Environment Agency have confirmed that there are plans to introduce measures to reduce risk in the future, and these include the construction of flood diversion channels and improvements to weirs and Teddington Lock. However, delivery of these alleviation measures is not confirmed

and the replacement dwellings has been designed without relying on any future protection measures.

9.7 In addition, the Environment Agency have provided modelled output from the revised Thames Tidal Breach Modelling, which simulated the impact of flooding on site in the event of a major breach in the linear defences. This presents the residual risk of flooding to the site in the unlikely event of a high tidal flood event coinciding with failure of the defences. Breached floodwater levels on site have increased to 6.77m AOD during the 2100 event.

9.8 On 19th February 2016 the government released new climate change allowances. This recommends allowances for increases in river flows, sea levels and rainfall intensities to be considered to account for the impact of climate change. For the fluvial River Thames, a residential development in Flood Zone 3a is required to consider a 35% peak uplift in flows in order to set finished floor levels. The existing modelled 1 in 100 year plus climate change fluvial flood water level takes into account a climate change uplift of 20% (6.66m AOD on the site). However, in situations such as this, the assessment is wholly reliant on levels output from the Environment Agency's models. The site is considered to be a "small-major" development and it is therefore acknowledged that it is not reasonable to re-run an existing hydraulic model to ascertain climate change increases. Therefore, existing modelled flood and flow data can be used to interpolate the increased flood water level.

9.9 Following review of the available modelled information, a conservative approach has been taken and finished flood levels of the residential development have been set to the 1 in 1000 year flood water level. This is 7.41m AOD based on flood water levels within the floodplain close to the site. This is the highest level for which modelled data is available and specifying any greater increase in finished floor levels would be without scientific basis.

9.10 Although the proposed development has a total plan area greater than the existing dwellings, the floodable design of the basement and elevation of the building on stilts means that the proposed development has a significantly smaller footprint within the floodplain than the existing site. The raised slab level is set above the highest modelled flood water level and the area beneath will be a single, continuous open void which will allow floodwater to freely flow in the basement. The external walls have a void ratio of 65%, significantly above the Environment Agency's requirements. Blockage of any of the openings is considered highly unlikely and blockage of all openings impossible. As a result floodplain capacity will be increased at all levels compared to the existing property. In addition to the level-for-level floodplain compensation requirements, the extension of the basement car park below ground level also provides new storage volume within the floodplain. The proposals constitute an improvement in comparison with the existing development in terms of floodplain capacity and unobstructed flood pathways actively contributing to a reduction in flood risk elsewhere.

9.11 There will be an overall increase in impermeable area on the site as a result of the proposed development, and therefore runoff rates and volumes from the site will slightly increase. Rates increase further once the impact of climate change is taken into account over the lifetime of the development. In accordance with requirements of the NPPF and local policy, surface water runoff from the site will be actively managed via the use of SuDS and the runoff rates and volumes will be reduced.

9.12 This development will seek to satisfy surface water runoff requirements with soakaways where possible, however in the event that further investigations conclude this is not a realistic option, a connection will be sought to the surface water sewer in the road. Discharge to the Thames Water sewer will be limited to 5 l/s, for all events up to an including the 100 year plus climate change event. Attenuation storage will be provided on site in the form of tanked or crated storage, and there is sufficient room to accommodate this under communal areas. This limited discharge represents a betterment on the existing scenario and results in reduced rates and volumes of runoff leaving the site post development.

9.13 Permeable paving will be included beneath all paved areas and will be designed to ensure that the sub-base is capable of fully containing the 100 year event, including an uplift to allow for climate change. As a result, runoff from the permeable paving will infiltrate fully and will not contribute to runoff to the offsite network. Full drainage design will be completed at detailed design stage however, the principles set out within the report confirm that any proposed drainage scheme for the development will reduce runoff rates and volumes from the site, compared to the existing scenario. As a result, there is will be a reduction in the risk of flooding elsewhere.

9.14 Although the proposals increase the number of residential dwellings on the site, the nature of the design will ensure that properties are located above the floodplain. During a 1 in 100 year + 20% fluvial flood event the local area will be flooded and safe, dry access will not be available for any local residents (current or future) at the peak of the flood event. The site is located in an area that can receive free flood warnings via the Environment Agency's "Flood Warnings Direct" service. In addition to this, the Thames catchment has a response time of several days at this location. Occupants of the new dwellings are therefore likely to have sufficient time to safely evacuate their properties in the event of a flood. A full, detailed emergency flood plan will be provided for all new residents prior to occupation, as per the precedent set by the adjacent development at No. 4 Manor Road.

9.15 The proposed development will be wholly located above the flood water level and therefore safe refuge will be available to all residents on the site. Therefore, there will be a decrease in the number of people at risk when compared to the existing dwellings on site.

9.16 This flood risk assessment concludes that the site is at a low risk of flooding from all sources except for fluvial flooding. However, by implementing the measures outlined in this report, it would be possible to actively reduce the consequences of flooding to future occupants when compared to the existing dwellings. Similarly, the impact on third-party landowners as a result of the development and with regards to fluvial, tidal, surface and groundwater flooding are considered beneficial.

APPENDIX A – DRAWINGS

Drawing 1 – Topographic Survey

On Centre Surveys Ltd, Land & Building Surveyors, Drawing No: 16907A/1-R2, Oct 2006

Topographic survey, with levels referenced to Ordnance Survey datum, showing existing site layout

Drawing 2 - Proposed Ground Floor Plan

Brookes Architects, Drawing No. 4707|3|52

This drawing shows the proposed ground floor plan for the development at No. 6 Manor Road.

Drawing 3 - Proposed First and Second Floor Plans

Brookes Architects, Drawing No. 4707|3|53

This drawing shows the proposed floor plans at first and second floor levels.

Drawing 4 – Environment Agency Historic Flood Map

Environment Agency, Reference WT11733 (Historic Flooding Map)

This drawing presents recorded historic flood events.

Drawing 5 – Environment Agency Tidal Flood Map

Environment Agency, Reference HNL48872/AS (Tidal Flood Map)

This drawing presents the tidal flood extent with node locations shown.

Drawing 6 – Environment Agency Fluvial Flood Map

Environment Agency, Reference WT11733 (Modelled Fluvial Flooding Map)

This drawing presents modelled fluvial flood extents, with in-channel and floodplain node locations.

Drawing 7 – Environment Agency Breach Hazard Map

Environment Agency, (Thames Tidal Breach Hazard Mapping)

This drawing presents modelled hazard, depth and velocity output from a breach of the defences.

Drawing 8 - Proposed Elevations

Brookes Architects, Drawing No. 4707|3|32

This drawing shows the proposed side elevation for No. 6, illustrating finished floor levels.

Drawing 9 – Proposed SUDS Landscape Plan

Brookes Architects, Drawing No. 4707|3|55

This drawing illustrates the proposed SUDS landscape plan, with areas of permeable paving marked.

Drawing 10 – Proposed Preliminary Surface Water Strategy

Water Environment Ltd, Drawing No. 13078-SK01

This drawing indicates a preliminary surface water drainage strategy for the proposed development

APPENDIX B – RICHMOND SUDS CHECKLISTS

Design Assessment Checklist: Scheme

From Appendix 1 of London Borough of Richmond upon Thames, Planning Guidance Documents – Delivering SuDS in Richmond, February 2015

SUDS Risk Assessment Checklist

From Appendix 2 of London Borough of Richmond upon Thames, Planning Guidance Documents – Delivering SuDS in Richmond, February 2015

STATION	EASTINGS	NORTHINGS	LEVEL	TYPE
ST04	516608.998	171418.563	5.474	pin
ST05	516620.414	171429.757	5.195	pin
ST10	516599.689	171427.794	5.384	peg
ST12	516612.719	171438.953	5.169	hilti
ST13	516612.856	171417.497	5.399	pin
ST14	516582.890	171386.669	5.257	pin
ST15	516562.414	171375.904	5.287	pin
ST16	516547.308	171398.696	5.303	pin
ST17	516625.603	171418.702	5.248	hilti
ST18	516611.781	171402.125	5.332	pin

Notes

THIS SURVEY HAS BEEN PREPARED WITH A SCALING ACCURACY FOR A PLOT AT A SCALE OF 1/100

ALL LEVELS ARE IN METRES RELATED TO AN ORDNANCE DATUM LOCATED ON A BRICK WALL ON THE CORNER OF MANOR ROAD AND FERRY ROAD (value 5.83m).

THE CO-ORDINATE GRID IS RELATED TO NATIONAL GRID VALUES BY RESECTION USING ORDNANCE SURVEY DIGITAL DATA

ALL TREE HEIGHTS AND SPREADS ARE APPROXIMATE

WE HAVE TRIED TO IDENTIFY TREE TYPES, HOWEVER IF TREE SPECIES ARE CRITICAL SPECIALIST ADVICE SHOULD BE GAINED.

DRAINAGE PIPE SIZES HAVE BEEN MEASURED FROM THE SURFACE, CHAMBER ACCESS HAS NOT BEEN GAINED FOR SAFETY REASONS, THERFORE SIZES SHOULD BE REGARDED AS APPROXIMATE

bl bed level
cl cover level
il invert level
tl threshold level
utl unable to lift
wl water level

MANOR ROAD
tarmac

No's 4 -6
(flats 1 to 8)

No 2
brick building

No 1
brick building

CONSERVATORY

GARAGES (brick)

garden
No 3, FERRY ROAD

garden
No 9, FERRY ROAD

garden
No 11, FERRY ROAD

garden
No 13, FERRY ROAD

garden
No 15, FERRY ROAD

garden
No 17, FERRY ROAD

Electricity Sub Station

GRID NORTH

R1:- SURVEY UPDATED 9/10/2013
R2:- DRAWING UPDATED 25/10/2013

JG/AS/MJM ACAD

job
No.2 MANOR ROAD
TEDDINGTON
TW11 8BG

client
Mr K. M. Symes

title	dwg no.
LAND SURVEY	16907A/1-R2
scale	date
1/100	26/10/06

ON CENTRE SURVEYS LTD.
LAND & BUILDING SURVEYORS
GEODETIC ENGINEERS
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E-MAIL: info@oncentre.co.uk
A member of The Survey Association

Do not scale from this drawing

1 00 Ground Floor

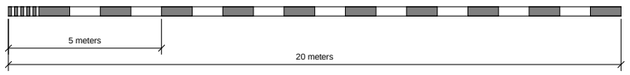
1 : 100

Gross Internal Area. (Approx)		
Number	Area m²	Area ft²
Flat 3A	64 m²	694 ft²
Flat 9	71 m²	768 ft²
Flat 10	71 m²	769 ft²
Flat 11	75 m²	811 ft²
Flat 12	72 m²	779 ft²
Flat 13	73 m²	786 ft²
Flat 14	70 m²	753 ft²
Flat 15	75 m²	812 ft²
Flat 16	72 m²	779 ft²
Flat 17	73 m²	786 ft²
Flat 18	70 m²	753 ft²
Flat 19	75 m²	812 ft²
Flat 20	72 m²	779 ft²
Flat 21	73 m²	786 ft²
Flat 22	70 m²	753 ft²
	1080 m²	11622 ft²

Area Schedule of Amenity (Approx)		
Number	Area m²	Area ft²
Communal Amenity	302 m²	3248 ft²
Flat 3A Balcony Amenity	9 m²	94 ft²
Flat 9 Balcony Amenity	8 m²	88 ft²
Flat 10 Balcony Amenity	7 m²	75 ft²
Flat 11 Balcony Amenity	7 m²	76 ft²
Flat 12 Private Garden Amenity	26 m²	277 ft²
Flat 13 Private Garden Amenity	56 m²	604 ft²
Flat 14 Private Garden Amenity	84 m²	902 ft²
Flat 15 Balcony Amenity	7 m²	76 ft²
Flat 16 Balcony Amenity	7 m²	75 ft²
Flat 17 Balcony Amenity	7 m²	77 ft²
Flat 18 Balcony Amenity	7 m²	76 ft²
Flat 19 Balcony Amenity	7 m²	74 ft²
Flat 20 Balcony Amenity	7 m²	75 ft²
Flat 21 Balcony Amenity	7 m²	76 ft²
Flat 22 Balcony Amenity	7 m²	77 ft²
	554 m²	5968 ft²

Communal Areas Gross Internal Areas (Approx.)		
Number	Area m²	Area ft²
4 Manor Road - New Third Floor	12 m²	134 ft²
6 Manor Road - Basement Car park	390 m²	4202 ft²
6 Manor Road - Ground, First + Second Floors	107 m²	1157 ft²

Scale Bar



PLANNING

Rev	Description	Issued	Dwn	Chk

Client
4 Manor Road and Lulworth Homes

Project
4 + 6 Manor Road
Teddington
TW11 8BG

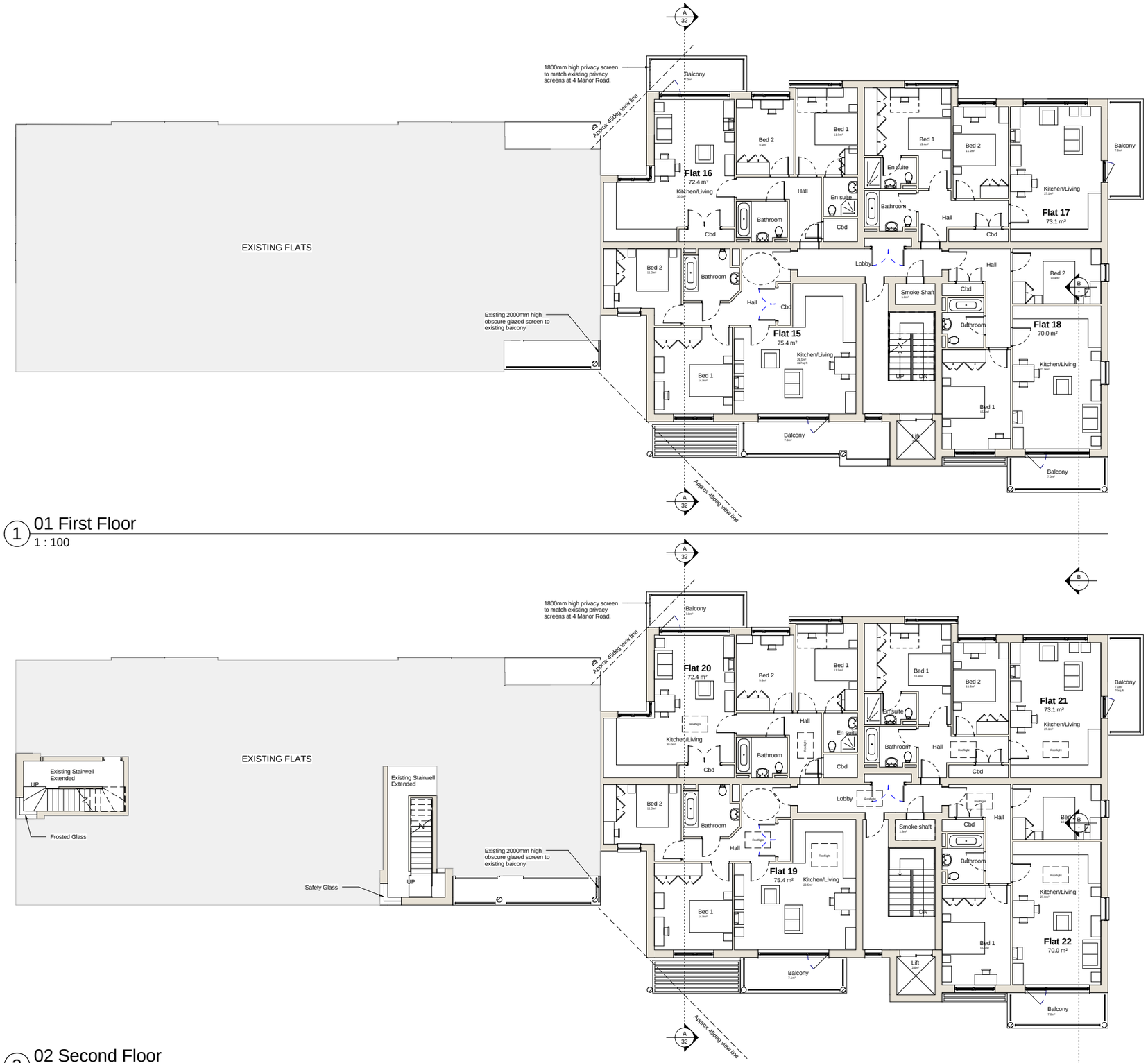
Drawing
Ground Floor Plan

Scale	Date	Drawn	Checked
1 : 100@A1	Apr '16	AWS	IF

BrookesArchitects
Upstairs at The Grange
Bank Lane, London SW15 5JT
T 020 8487 1223
F 020 8876 4172
E info@brookesarchitects.co.uk
www.brookesarchitects.co.uk

Drawing No.		Rev. No.
4707	3 52	

Do not scale from this drawing



1 01 First Floor
1 : 100

2 02 Second Floor
1 : 100

PLANNING

Rev	Description	Issued	Dwn	Chk

Client
4 Manor Road and Lulworth Homes

Project
4 + 6 Manor Road
Teddington
TW11 8BG

Drawing
First and Second Floor Plans

Scale	Date	Drawn	Checked
As indicated@A1	Apr' 16	AWS	IF

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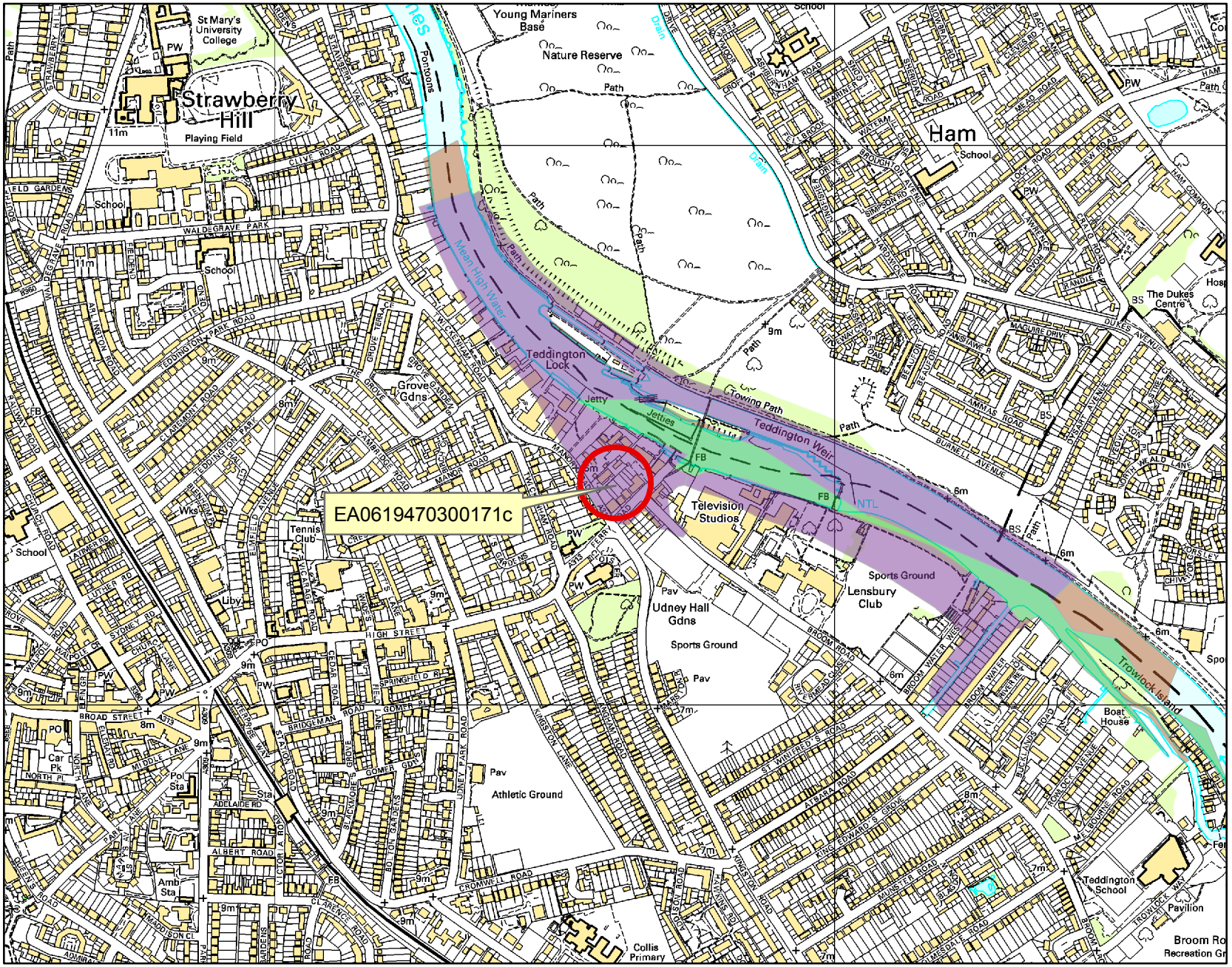
Drawing No.			Rev. No.
4707	3	53	

Map centred on Manor Road, Teddington TW11 8BG
Created 09/10/2013 - REF: WT11733



Environment Agency

Kilometres
0 0.15 0.3
N

Legend

Site

Historic Flood Extent

<all other values>

year

1947

1988

2000

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk