Land at Melbourne Road, Teddington, TW11 9QX

Flood Risk Assessment

Project Ref: 24652/001

Doc Ref: Revision B

February 2012

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For and on behalf of Peter Brett Associates LLP				

Revision	Date	Description	Prepared	Reviewed	Approved
-	30/03/11	Issue to accompany planning application	RMF	BM	BM
A	21/12/11	Updated for new planning application	RMF	BM	BM
B	23/02/12	Minor amendments			

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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates (PBA) to support a planning application for two detached houses on land at Melbourne Road in Teddington, in the London Borough of Richmond upon Thames.

The report has been prepared in accordance with the guidance set out in Planning Policy Statement 25 Development and Flood Risk (PPS25), Annex E and summarises the methodology and results of the assessment.

In considering the proposals the following key issues have been addressed:-

- Vulnerability to flooding from all sources.
- Protection of residents of the new development.
- No increased flood risk to third parties as a result of the development.

The site is located within the 'High Probability' Flood Zone 3a (i.e. 1 in 100 (1%) or greater annual probability of river flooding). The proposed residential development is classified as 'More Vulnerable' development. Such development within Flood Zone 3a (ref: PPS25 Table D.3) is considered appropriate subject to the Exception Test. Both a Sequential Test and an Exception Test have been undertaken and submitted to the London Borough of Richmond upon Thames on behalf of the applicant by Cunnane Town Planning.

Mitigation is to be provided through the following:

- Elevated ground floor levels set at 7.1m AOD – 1.5 metres above the 1947 flood level, 540mm above the Environment Agency (EA) modelled 1 in 100 annual probability level and equivalent to the EA modelled 1 in 100 annual probability plus allowance for climate change level;
- Incorporation of flood resistant/resilient construction measures, with flood proofing to be provided up to a minimum of 7.4m AOD (i.e. 300mm above the EA modelled 1 in 100 annual probability plus allowance for climate change level);
- Incorporation of ground lowering, a floodable low-level void and on-site managed storage facilities to ensure no loss of floodplain storage, on a 'level-for-level' basis;
- Provision of a Flood Risk Management Plan (FRMP);
- Incorporation of a surface water SuDS management system to ensure there is no increase in surface water runoff as a result of the development.

The above mitigation measures demonstrate a robust solution that will appropriately manage the risk of flooding to the site and its occupants, and ensure the proposals do not cause an increase to flood risk to the surrounding area. As such, the proposed works comply with the guidance in PPS25 and meet part (c) of the Exception Test.

1 Introduction

1.1 Scope of FRA

Peter Brett Associates LLP (PBA) Consulting Engineers have been appointed by Elizabeth Finn Care to undertake a Flood Risk Assessment (FRA) to support the planning application for two detached houses on land at Melbourne Road at Teddington in the London Borough of Richmond upon Thames.

This Revision A of the FRA has been prepared to support updated proposals which incorporate additional flood storage measures to ensure the proposal provides 'level-for-level' floodplain compensation.

The FRA focuses on assessing the practical flood risk issues at the site as follows:

- Identification of all the potential sources of flooding at the site from all sources (i.e. fluvial, tidal, pluvial, groundwater, surface water);
- Assessment of the existing flood risk at the site and the potential impact of the proposals;
- Consideration of the flood risk implications, taking into account the potential allowance for climate change over the lifetime of the development, and the identification of the measures to mitigate flood risk.

PBA has prepared this study in accordance with paragraph E3 of Annex E of PPS25, which requires that the FRA be undertaken by competent people as early as possible in the planning process.

PBA have undertaken this FRA using experienced flood risk management staff chartered with the Institution of Civil Engineers (ICE) and the Chartered Institution of Water and Environmental Management (CIWEM). PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering.

1.2 Policy Context

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

- National policy regarding flood risk as contained within **Planning Policy Statement 25 (PPS25) 'Development and Flood Risk'** (released in December 2006, updated March 2010), issued by Communities and Local Government and the accompanying **'PPS25 Practice Guide'** (updated December 2009);
- Local planning policy contained within the London Borough of Richmond Upon Thames '**Core Strategy'**, adopted April 2009, with particular reference to the Policy 'CP3 – Climate Change – Adapting to the Effects', which states:

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

- The London Borough of Richmond Upon Thames '**Strategic Flood Risk Assessment'** (SFRA), released in June 2008 and updated August 2010;
- The **Environment Agency (EA) Flood Risk Standing Advice (FRSA)**, the latest revision of which (version 3.0) was issued in January 2011. As the site is within Flood Zone 3 and under 1 hectare in area, the FRA has been prepared in accordance with EA Guidance Note 3.

1.3 Planning Background

A planning application for the erection of two new houses on the land at 19 to 21 Melbourne Road was made in April 2011, under planning application reference 11/1164/FUL. The application was refused by the London Borough of Richmond upon Thames (see decision dated 1st June 2011 in Appendix 5) for reasons of (i) Flooding and (ii) Design. The reason for refusal on flooding grounds stated the following:

> *"The application site is 'previously undeveloped' and lies within Flood Zone 3b (functional floodplain) as defined by PPS25. The proposal fails the PPS25 Sequential Test because residential development, which is considered to be 'more vulnerable' in terms of flood risk vulnerability, is not permitted in Zone 3b. Therefore, the redevelopment for residential purposes would not be acceptable in principle as such a use is not (a) water compatible or (b) essential infrastructure. The scheme would be contrary to Policy ENV34 of the Adopted Unitary Development Plan; First Review 2005, Policy CP3 of the Adopted Core Strategy 2009; DM SD 6 of the Development Management Development Plan Document Publication Version (2010); the Approved Council Strategic Flood Risk Assessment 2010; Policies 4a.12 and 4A.13 of the London Plan (2008); Policy 5.12 of the Consultation draft replacement London Plan (2009); and PPS25 (Sequential Test Tables D.2 and D.3)."*

We strongly disagree with the above reason for refusal, which appears to be wholly on the basis that the site is within Flood Zone 3b 'functional floodplain'. The previous FRA supporting the aforementioned planning application provided justification as to why the site should be classified as Flood Zone 3a 'High Probability', and this was reiterated to the London Borough of Richmond upon Thames in subsequent correspondence (PBA letter dated 1st June 2011, a copy of which is included in Appendix 5).

The current proposals are similar to those previously proposed, but include additional flood storage measures which demonstrate that the site does not detrimentally impact on floodplain storage capacity.

2 Site Description and Location

2.1 Site Location

The 900 square metre (0.1 hectare) site is located on the land at 19 to 21 Melbourne Road in a residential area of Teddington, Greater London (postcode TW11 9QX, site centre OS grid reference 517,490m E, 170,870m N; see Figure 1 in Appendix 1).

The rectangular site is approximately 40 metres long by 23 metres wide and consists of a landscaped garden with areas of unmade ground to the south-east and north-east sides. It is bounded by a combination of masonry walls and close boarded fencing. A brick store/garage lies in the eastern corner of the site.

Photo 1: View north across site

The site lies within a residential area, with Melbourne Road running along the south-east boundary. The main River Thames channel, located 150 metres to the north-east, flows north-west past the site (with a minor channel, flowing between Trowlock Island and the right bank of the watercourse, approximately 80 metres away). The formal tidal limit of the River Thames is at Teddington Lock, approximately 700 metres downstream (north-west) of the site.

2.2 Topographic Survey

A GPS level survey of the site has been undertaken by XYZ Land Surveys and is included in Appendix 2 (Drawing no. 2010/216, dated September 2010).

The survey indicates that ground levels over the site range from 5.3m AOD to 6.3m AOD. The main lawned area of the site is between 5.3m AOD and 5.5m AOD, rising up to a second level at between 6m AOD and 6.3m AOD at the south-eastern end of the site. A stone wall, at between 6.4m AOD and 6.5m AOD, runs along this end of the site with a small gated opening in the centre.

Footpath levels along Melbourne Road (i.e. across the south-eastern boundary of the site) vary between 5.8m AOD and 6.1m AOD, rising to the south-west (away from the River Thames).

Photo 2: View north across Melbourne Road towards site

2.3 EA Groundwater Map

The EA's online groundwater source protection zone maps indicate the risk of contamination to groundwater sources such as wells, boreholes and springs used for public drinking water supply.

The map indicates that the area is outside the catchment area of groundwater sources, so infiltration (subject to suitable ground conditions) would not detrimentally impact on any such supplies.

3 Planning Policy Context

3.1 National Policy Context

National policy regarding flood risk is contained within Planning Policy Statement 25 (PPS25) 'Development and Flood Risk', issued by Communities and Local Government on 7th December 2006 and updated in March 2010.

The accompanying 'PPS25 Practice Guide' was issued in June 2008 and was updated in December 2009. The EA's latest revision of their Flood Risk Standing Advice (FRSA) (version 3.0) was released in January 2011.

The updated PPS25 Practice Guide (paragraph 2.20) states that "*LDDs should deliver national and regional policy, while also taking account of specific local issues and concerns. The Core Strategy LDD should reflect the local planning authority's (LPA's) strategic planning policies and approach to flood risk. Site allocations should reflect the application of the Sequential Test, as well as guidance on how flood risk issues should be addressed at sites allocated within flood risk areas. Flood risk should be factored into LDDs in the detailed allocation of land use types across their area.*"

3.2 The London Plan

The 'London Plan - Spatial Development Strategy for Greater London' is '*the overall strategic plan for London setting out an integrated economic, environmental, transport and social framework for the development of London over the next 20 - 25 years'*. Local Development Plans for London Boroughs are required to ensure they remain in 'general conformity' with the London Plan.

The latest version of the London Plan is dated July 2011. The London Plan policies most relevant with regard to flood risk are as follows:

Policy 5.12 – Flood Risk Management

Strategic

A. The Mayor will work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost effective way.

Planning decisions

B. Development proposals must comply with the flood risk assessment and management requirements set out in PPS25 over the lifetime of the development and have regard to measures proposed in TE2100 and Catchment Flood Management Plans.

C. Developments which are required to pass the PPS25 Exceptions Test will need to address flood resilient design and emergency planning by demonstrating that:

1) the development will remain safe and operational under flood conditions
2) a strategy of either safe evacuation and/ or safely remaining in the building is followed under flood conditions
3) key utilities including electricity, water, lifts etc will continue to be operational under flood conditions
4) buildings are designed for quick recovery following a flood.

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

effective way.

LDF preparation

E. Within LDFs boroughs should identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding.

Policy 5.13 – Sustainable Drainage

Planning decisions

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

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

LDF preparation

B. Within LDFs boroughs should identify areas where there are particular surface water management issues exist and develop actions and policy approaches aimed at reducing these risks.

3.3 London Borough of Richmond UDP

Any future development would obviously need to accord with the local policies of the London Borough of Richmond upon Thames (LBR).

Until recently, the local planning policy was provided by the LBR Unitary Development Plan (UDP), which was adopted in March 2005. This has been gradually replaced by the Local Development Framework (LDF) but continued to be utilised during the transitional period. A number of planning policies were saved accordingly following a direction issued by the Secretary of State for Communities and Local Government in September 2007, including policy ENV34 'Protection of the floodplain and urban washlands'. However, the LBR website states that *"As of November 2011, all policies contained within the UDP, with the exception of the UDP proposal sites and the policy on waste collection and disposal, have been superseded by the LDF documents".* The relevant Core Strategy policy is detailed in Section 3.4.

3.4 London Borough of Richmond Core Strategy

The Core Strategy (adopted April 2009) is a Development Plan Document (DPD) which is part of the LDF. It is the strategic policy document, which will determine the future planning policy for the Borough. Core Strategy Policy CP3 provides guidance on the flood risk requirements for new development and is stated overpage.

CP3 Climate Change – Adapting to the Effects

3.A Development will need to be designed to take account of the impacts of climate change over its lifetime, including:

- Water conservation and drainage
- The need for Summer cooling
- Risk of subsidence
- Flood risk from the River Thames and its tributaries

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

The subsequent paragraph 8.1.3.3 of the Core Strategy provides further guidance on the requirements of FRAs for new development, as quoted below:

> *"…The FRA will need to demonstrate to the satisfaction of the Council that any flood risks to the development, or additional risk arising from the proposal will be successfully managed with the minimum environmental effect, and that necessary flood risk management measures are sufficiently funded to ensure that the site can be developed and occupied safely throughout its proposed lifetime…"*

3.5 Richmond Strategic Flood Risk Assessment

PPS25 confirms that Regional Planning Bodies (RPBs) or Local Planning Authorities (LPAs) should prepare Strategic Flood Risk Assessments (SFRAs) in consultation with the EA. The SFRA will then be used to refine information on areas that may flood, taking into account other sources of flooding and the impacts of climate change, in addition to the information on the EA Flood Zone Map.

The LBR SFRA was released in June 2008 and updated in August 2010. The objectives of the LBR SFRA are as follows:

- *"To collate all known sources of flooding, including river, surface water (local drainage), sewers and groundwater, that may affect existing and/or future development within the Borough;*
- *To delineate areas that have a 'low', 'medium' and 'high' probability of flooding within the Borough, in accordance with Planning Policy Statement 25 (PPS25), and to map these:*
    - *Areas of 'high' probability of flooding are assessed as having a 1 in 100 (1%) or greater chance of river flooding, or 1 in 200 (0.5%) or greater chance of tidal flooding, in any year, and are referred to as Zone 3a High Probability;*
    - *Areas of 'medium' probability of flooding are assessed as having between a 1 in 100 fluvial, or 1 in 200 tidal, and 1 in 1000 chance of flooding (1% to 0.1%) in any year, and are referred to as Zone 2 Medium Probability;*
    - *Areas of 'low' probability of flooding are assessed as having a less than 1 in 1000 chance of flooding (<0.1%) in any year, and are referred to as Zone 1 Low Probability.*
- *Within flood affected areas, to recommend appropriate land uses (in accordance with the PPS25 Sequential Test) that will not unduly place people or property at risk of flooding*

- *Where flood risk has been identified as a potential constraint to future development, recommend possible flood mitigation solutions that may be integrated into the design (by the developer) to minimise the risk to property and life should a flood occur (in accordance with the PPS25 Exception Test).”*

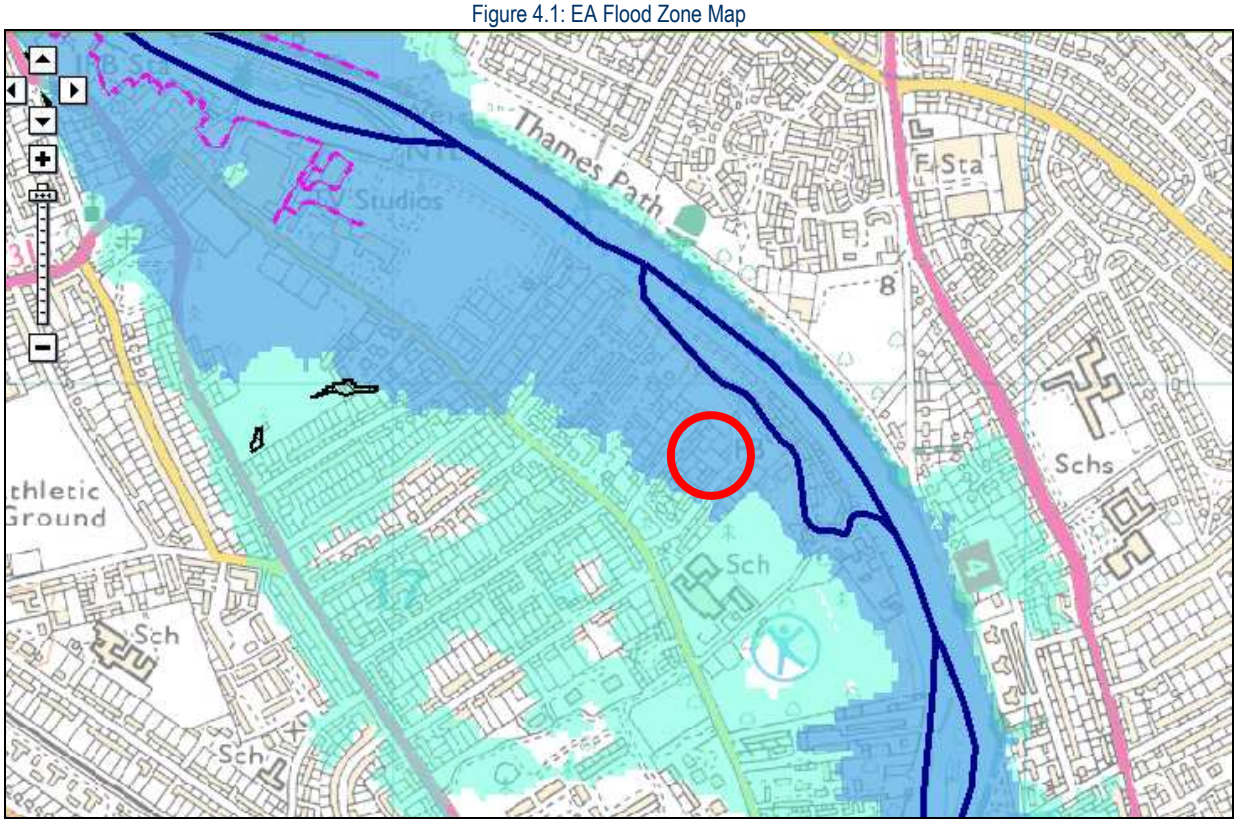
4 Assessment of Flood Risk

The primary flood risk to the site is from the River Thames and its back channel around Trowlock Island, a minimum of 80 metres to the north-east.

4.1 EA Flood Zone

The EA's website flood zone map, shown in Figure 4.1 below, indicates that the site is in Flood Zone 3 'High Probability' (i.e. land assessed as having a greater than a 1 in 100 annual probability of river flooding (>1%), or 1 in 200 annual probability of tidal flooding (>0.5%) in any year).

Figure 4.1: EA Flood Zone Map



A version of the Flood Zone map at the site was provided by the EA with their 'product 4' flood risk information (dated 25th February 2011 and included in Appendix 5). However, the extent of the light green Flood Zone 2 is significantly more extensive in the above map compared to the previously provided data. Comparison with the EA Product 4 modelled flood extents suggests that the Flood Zone maps were subsequently updated with the modelled information to result in the above Flood Zone 2 outline).

4.2 SFRA Information

As noted in Section 3.4, the LBR SFRA was released in June 2008 and updated in August 2010. The information of relevance to the site is provided below, with copies of relevant figures/maps included in Appendix 5:

- The 'Overview Map' shows the modelled flood extents across the Borough, with the area in the proximity of the site covered in more detail by Figure 7. This indicates the site lies at the edge of Flood Zone 3b 'functional floodplain' (the adjacent footpath along Melbourne Road falls into the 'High Probability' Flood Zone 3a);

- Figure 7 also shows locations of any localised drainage problems. This indicates there are no problems in the vicinity of the site, with the closest flooding record from such sources approximately 2.5 kilometres to the south-west, on the Potters Stream at Hampton Court Road;

- The SFRA states *'The geology of the Borough of Richmond is characterised to a very large degree by London Clay. The impermeable nature of the soils can increase the susceptibility of the area to surface water (or flash) flooding following periods of heavy rainfall. Immediately adjoining the River Thames, deposits of gravel overlay the London Clay, and this can lead to localised incidents of groundwater flooding.*". This is shown on Figure B, which indicates River Terrace Deposits over London Clay underlying the site;

- The SFRA confirms that Teddington Weir represents the tidal extent of the River Thames, so the area downstream of this structure is at risk from both fluvial and tidal flooding (whilst the area upstream – including the site – is principally at risk of fluvial flooding). The SFRA states *"Downstream of Teddington Weir, the Borough is protected against flooding from the River Thames by the Thames Tidal Defence (TTD) system. The TTD provides protection against flooding through a combination of raised flood defences, flood proofing to riverside properties, and the Thames Barrier. Currently the TTD provides the following standard of protection within the Borough of Richmond:*

    - *a 1 in 1000 year standard of protection against a combined tidal and fluvial flooding event from Richmond downstream (i.e. towards the City of London)…;*

  The SoP against combined flooding decreases progressively to 1 in 100 years at Teddington….

  It is important to recognise however that the probability of fluvial flooding (alone) from the River Thames within the Borough upstream of Teddington is somewhat higher than from tidal flooding. In simple terms, this means that river levels as a result of prolonged heavy rainfall within the upper catchment (including Oxfordshire and Gloucestershire as seen during the summer 2007 event) will be higher, and occur more frequently, than the combined tidal and fluvial event described above. For this reason, the standard of protection provided to property upstream of Teddington is closer to 1 in 100 years."

- With reference to the above flood defence information, Figure D 'Areas Benefitting from Defences' shows the land behind the defences downstream of Teddington Lock as being defended areas. Upstream, the defended area extends a short distance from Teddington Weir, but the site and surrounding area are outside this defended area;

- Figure D provides locations of groundwater flooding incidents across the Borough. This confirms there are no records of such flooding in the vicinity of the site, with the closest record approximately 1 kilometre west of the site;

- Figure E shows the potential change to Flood Zone 3a across the Borough as a result of climate change. The SFRA states that "*the anticipated extent of the 1% AEP (100 year) flood affected area in 2106 can be approximated by the current 0.1% AEP (1000 year) flood outline, i.e. Zone 2 Medium Probability, for planning purposes"*. A comparison with Figure 7 indicates that this causes a slight increase in the Flood Zone 3a extent in the vicinity of the site, with the floodplain extending south-west to the end of Melbourne Road;

- Figure F provides the details of the primary emergency access and egress routes throughout the Borough and identifies where those routes are above or below the 1 in 100 annual probability flood level. It confirms that the route north-west from the site is significantly affected by flooding, with up to 1.5 metres of floodwater on the A310 Teddington Road/ Strawberry Vale. The route south-west via the A308 is also impacted (although to a lesser

extent) and the most appropriate route would appear to be westwards through Twickenham and on A313 and A312.

4.3 Historic Flooding Information

Information from the Environment Agency

The EA have provided historic flooding data as part of their 'Product 4' information (dated February 2011) included in Appendix 5. The data includes the historic floodplain maps for the extreme flood events of 1947 and 2003. These indicate flooding of the corridor of land immediately adjacent to the River Thames channel, but it is noted that the site and surrounding access routes remained unaffected for both events.

Information from London Borough of Richmond upon Thames

A request for historic flooding information was made to LBR, as the land drainage and highways authority for the area. The email response dated 22nd October (see copy in Appendix 5) does not provide any specific information and instead refers to the generic guidance on the LBR website and to the EA.

The LBR SFRA has been reviewed as part of this FRA and the information contained of relevance to the site is provided in Section 4.2.

It is noted that an email enquiry was also made to Transport for London (TfL) and their response dated 25th October 2010 (see copy in Appendix 5) confirmed that LBR were the highways authority for the area.

Information from Thames Water

A request for flooding information was made to Thames Water Utilities, as the sewer utility company for the area.

The Thames Water letter dated 25th October 2010 (included in Appendix 5) indicated that Thames Water has no record of flooding at this particular site, stating '*The records held by Thames Water indicate there have been no incidents of flooding as a result of surcharging of public sewers in the vicinity of the above* [site]*'.*

Historic flood level information from Teddington/Molesey Locks

In order to obtain the most accurate view of historic flood levels at the site, annual maximum water level data has been obtained for Molesey Lock (tail) and Teddington Lock (head), upstream and downstream respectively of the site. These water levels have been interpolated to provide an accurate representation of the water levels at Melbourne Road.

The lock level data was obtained from two sources:

- The *'Thames Conservancy – Statistics of Rainfall, Flow and Levels of the River Thames above Teddington – 1883 to 1964'*, by the Thames Conservancy (May 1965); and,

- Daily maximum water levels for Teddington Lock (1989 to 2011) and Molesey Lock (1995 to 2011), provided by the EA in email dated 14th December 2011.

As such, this data covers the most severe flood events of the 19th Century (1894 event), the worst flood of the 20th Century (1947 event), as well as the recent River Thames flood events of 2000 and 2003.

The annual maxima water levels at the site are shown on the chart in Appendix 4 and the water levels in relation to the proposed development are discussed further in Section 7.1.

4.4 EA Modelled Flood Levels

Modelled flood levels were provided by the EA from their updated Reach 4 of the Lower Thames 2-dimensional modelling study, completed in December 2010 (see EA Product 4 information, reference SE21830, in Appendix 5).

The modelled flood levels at the site are provided in Table 4.1. These have been linearly interpolated between nodes 16.035 upstream and 16.028 downstream.

Table 4.1: Updated EA Flood Levels (provided Feb 2011)

Flood Event (Annual Probability)	Updated Modelled Flood Level |(m AOD)		
	Upstream node (16.035)	Site	Downstream node (16.028)
1 in 20 (5%)	5.77	**5.75**	5.73
1 in 100 (1%)	6.57	**6.56**	6.55
1 in 100 plus allowance for climate change	7.10	**7.10**	7.09

The full hydrograph for the downstream node 16.028 was obtained from the EA for the 1 in 100 annual probability plus allowance for climate change event, to provide information on the rate of rise and fall of water levels in a flood event. This is included in Appendix 4 and discussed further in Section 7.5 (in relation to advance warning arrangements).

4.5 Review of Flood Levels at Site

A detailed analysis has been undertaken at a site-specific level based on the topographic survey and the EA's modelled levels. As noted in Section 2.2, the survey indicates that ground levels vary over the site between 5.3m AOD to 6.3m AOD. As such, based on the EA modelling, reference flood events would impact the site as follows:

- **1 in 20 annual probability event**: south-eastern part of the site above flood level by up to 550mm, whilst the north-western part lies a maximum of 450mm below flood level;
- **1 in 100 annual probability event**: site impacted by a maximum of between 260mm and 1.26 metres;
- **1 in 100 annual probability plus climate change event**: site impacted by a maximum of between 800mm and 1.8 metres.

The data therefore indicates that part of the site is below the EA modelled 1 in 20 annual probability flood level.

The Richmond SFRA provides the following definition of Flood Zone 3b 'functional floodplain':

"For the purposes of the London Borough of Richmond upon Thames SFRA, Zone 3b has been defined in the following manner:

- *land where the flow of flood water is not prevented by flood defences or by permanent buildings or other solid barriers from inundation during times of flood;*

- *land which provides a function of flood conveyance (i.e. free flow) or flood storage, either through natural processes, or by design (e.g. washlands and flood storage areas);*

- *land subject to flooding in the 5% AEP (20 year) flood event (i.e. relatively frequent inundation expected, on average once every 20 years)."*

It is unusual for authors of a SFRA to alter the definition of functional floodplain from that given in Government policy (PPS25) but there had been many instances of misinterpretation of the official definition. Due to such misinterpretation, PPS25 was revised in March 2010 to help clarify the definition. Although the SFRA was revised in August 2010 it is stated to be based on the previous issue of PPS25 Practice Guide in relation to functional floodplain (ref: SFRA page vii paragraph 22).

A revised definition of Zone 3b within PPS25 Table D.1 of March 2010 states that local planning authorities, when identifying functional floodplain should take account local circumstances and not base this solely on rigid probability parameters. Land which would flood with an annual probability of 1 in 20 (5%) or greater in any year should provide a starting point for consideration and discussions to identify the functional floodplain.

We believe that this site is an example where 'local circumstances' are relevant and there are a number of reasons why the site is not considered as Flood Zone 3b as follows:

- Melbourne Road itself is above the modelled 1 in 20 annual probability flood level and potential alternative flow routes to the site are restricted, as the site is surrounded on all other sides by existing residential development (and bounded by walls and close boarded fences);

- Although the site itself is not significantly developed beyond the hard surfaced elements of the landscaped garden and the garage/ brick store, it is within a highly developed and established residential area, on an existing line of housing and with development on all sides as previously mentioned. PPS25 Practice Guide paragraph 4.91 states "*Developed areas are not generally part of the functional floodplain".*

- The information obtained from the EA and others indicates that there has been no recorded flooding on the site, even in the flood of 1947. This flood was the most severe of the 20th century.

- The most reliable information for the 1947 flood level – i.e. the recorded water levels at Teddington and Molesey Locks – provides a 1947 water level of 5.6m AOD at the site, which is 150mm lower than the EA's 1 in 20 annual probability flood level. This indicates that the EA modelling for the area results in an overestimate of flood levels, as illustrated in the 'Overview of reference Flood Levels' chart in Appendix 4.

Furthermore, the current version of the Practice Guide clarifies that "*Developed areas are not generally part of the functional floodplain"* (paragraph 4.91). The application site is clearly within a "developed area".

It is therefore considered that the site falls within Flood Zone 3a 'high probability' (greater than 1 in 100 annual probability of river flooding, or 1 in 200 annual probability of tidal flooding). PPS25 Annex D Table D.1 defines Flood Zone 3a as detailed overpage.

Zone 3a High Probability

Definition
This zone comprises land assessed as having a 1 in 100 or greater probability of river flooding (>1%) or a 1 in 200 or greater annual probability of sea flooding (>0.5%) in any year.

Appropriate uses
The water-compatible and less vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.
The highly vulnerable uses in Table D.2 should not be permitted in this zone.
The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

FRA requirements
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims
In this zone, developers and local authorities should seek opportunities to
reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
relocate existing development to land in zones with a lower probability of flooding; and
create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

5 Impact of Climate Change

Annex B of PPS25 confirms that *'there is an increasing body of scientific evidence that the global climate is changing as a result of human activity*.'

It states in paragraph B5 that '*Global sea level rise will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and west. Allowances for the regional rates of relative sea level rise shown in Table B.1 should be used as a starting point for considering flooding from the sea, along with the sensitivity ranges for wave height and wind speed in Table B.2, in preparing flood risk assessments.'*

Table 5.1: Extract from PPS25 Table B.1 - Recommended contingency allowances for net sea level rise.

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, East Midlands, London, SE England	4.0	8.5	12.0	15.0

Annex B, paragraph B9, continues to state that '*In making an assessment of the impacts of climate change on flooding from the land, rivers and sea as part of a flood risk assessment, the sensitivity ranges in Table B.2 may provide an appropriate precautionary response to the uncertainty about climate change impacts on rainfall intensities, river flow, wave height and wind speed.*'

Table 5.2: PPS25 Table B.2 - Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

The key factor is to ensure that any building floor levels are set at a height to give adequate protection should the flood risk alter as a result of climate change. The potential for increased flood risk as the result of possible climate change is addressed in terms of the recommended mitigation measures that are discussed in Section 7.

It should be noted that the 2009 UK Climate Projections (UKCP09) was published in July 2009 using the latest climate change assessment methodologies. This is referenced in the latest version of the PPS25 Practice Guide (para 3.97, 3.98), which states *"Pending further work being carried out by Defra and the Environment Agency on the differences between the UKCP09 and UKCIP02 projections, the*

Chief Planner's letter advised that whilst there is a range of projections in UKCP09 of future climate for any given variable, based on different emissions scenarios and probability levels, around the 50% probability point on the central emissions scenario the data are broadly similar to the UKCIP02 projections. As a result, there is a general expectation that the assumptions on changes in climate that LPAs have been working from remain reasonable……In line with the advice given in the Chief Planner's letter, the figures presented in Annex B of PPS25 should continue to be used until any revised guidance is issued."

However, in relation to rising sea levels PBA have actually carried out such 'further work' and it is apparent that the 4.0mm figure given in Table B.1 is an overestimate, as the actual annual increase since 1990 has been approximately half this figure. Furthermore, from the Technical Note in Appendix 6 it can be seen that adopting the above mentioned 50 percentile point on the conservative 'high emissions' scenario actually gives a rise of **0.66 metres** rather than the 1.2 metres from Table B.1, which again demonstrates a figure approximately half that generated by the sea level rise allowances in Table B.1.

Adopting the EA modelling, which is based on Table B.1, therefore represents an overly conservative estimate.

6 Detailed Development Proposals

6.1 Proposed Site Layout

The proposal is for two detached dwellings on the site, with associated access arrangements and soft landscaping, as shown in the plans by Clive Chapman Architects in Appendix 3.

6.2 Flood Storage and Flow Routes

To address any potential impact on the floodplain storage, the development has been designed in order to minimise the effective built footprint at ground level, within the constraints of the site. Furthermore, the development will incorporate ground lowering, construction on voids, provision of managed facilities to store floodwater and open (floodable) parts of the building in order to avoid any detrimental impact on floodplain storage (further details are provided in Section 7.2).

The proposed building is located in a developed area, in line with an existing row of houses, 80 metres from the River Thames and, as noted above, is constructed largely on open voids. As such, it will not detrimentally impact on potential flood flow routes.

6.3 Vulnerability and the PPS25 Sequential Test

PPS25 follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

PPS25 Annex D confirms that '*The risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding…..Within each Flood Zone, new development should be directed first to sites at the lowest probability of flooding and the flood vulnerability of the intended use matched to the flood risk of the site, e.g. higher vulnerability uses located on parts of the site at lowest probability of flooding.'*

The analysis in Section 3.4, reference to PPS25 Annex D Table D.1, indicates that the development site falls partially within PPS25 Flood Zone 3a 'High Probability', where the annual probability of flooding is greater than 1 in 100 (>1%) from fluvial sources, or greater than 1 in 200 (>0.5%) from tidal sources.

PPS25 Table D.2 confirms the 'Flood Risk Vulnerability Classification' of a site, depending upon the proposed usage. This classification is subsequently applied to PPS25 Table D.3 to determine whether:

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

The proposed residential development is classified as 'more vulnerable', which is considered acceptable within Flood Zone 3a provided the Exception Test has been passed. Both a Sequential Test and an Exception Test have been undertaken and submitted to the London Borough of Richmond upon Thames on behalf of the applicant by Cunnane Town Planning.

7 Mitigation Measures

7.1 Proposed Development Ground Floor Levels

As the site is located in a Conservation Area, there are restrictions on the roof ridge heights and floor levels in order that they correspond with adjoining properties. Clive Chapman Architects have advised the following with regard to these constraints and how they are addressed by the current proposals:

> *"This application proposes a residential development that has been positively informed by an understanding of both the context and flooding constraints of the site. This has resulted in a proposal of a high design quality, which reflects, and is compatible with the scale and character of the area, while also attempting to comply with the EA's requirements.*
>
> *The proposal elevates the ground floor level to 7.10m which is the EA modelled 1 in 100 annual probability flood level plus climate change. Below, the floodable basement and decking will ensure against loss to the current flood storage volumes.*
>
> *The design team has analyzed the maximum possible increase to the finished floor level whilst ensuring that the proposal is compatible with the scale and character of the adjoining areas. To raise the ground floor level to 7.40m (i.e. meeting current EA guidance of 7.10m plus 300mm for the ground floor slab), would result in a poor relationship with neighboring properties in terms of the detailed design of the ground floor elevations to both the front and rear. This will be particularly noticeable to the rear, with the houses set high above the garden level which is lower than the street level. This would result in a greater number of steps down to the garden level leaving a scheme that would not only be unappealing to the immediate neighbors, but also to the properties overlooking the dwellings from Trolock Ave."*

As noted in Section 4.4, the current EA modelled 1 in 100 annual probability River Thames flood level is 6.56m AOD, rising to 7.10m AOD when an allowance for climate change is considered. As such, setting the ground floor level at 7.10m AOD would provide a freeboard of **540mm** above the current EA modelled 1 in 100 annual probability level.

This should be put into context by comparison with previous maximum flood levels in the vicinity of the site, which have been established through obtaining historic flood level data from Teddington and Molesey Locks (and interpolation of the Teddington headwater level and Molesey tailwater level to provide a water level at Melbourne Road).

The 1947 flood was the worst flood in the last century and indeed the greatest flood since 1894. Since 1894 there have been significant improvements in the flow capacity of the River Thames Weirs and following the 1947 flood a further significant programme of weir improvements and channel dredging was carried out with the effect that for, repeats of such floods as 1894 and 1947, the resultant flood levels would be much reduced by comparison.

Comparison of the proposals with the recorded lock data (interpolated to provide a water level at the site) confirms the following:

- The proposed ground floor levels will be **640mm** above the water level in 1894 (6.46m AOD), which is the maximum water level on record;
- The proposed ground floor levels will be **1.5 metres** above the peak 1947 flood level, the highest water level recorded in the 20th Century (and, to date, the 21st Century).

Furthermore, flood resilient and resistant construction measures will be incorporated into the development as appropriate, up to the EA-recommended level of 7.40m AOD, being 300mm above

the modelled 1 in 100 (1%) annual probability plus allowance for climate change flood level (see Section 7.3).

The floor level of the lower level parking area is 4.55m AOD. This area is designed to be floodable and as such is intended for vehicle storage only (rather than serving any 'habitable' function). An internal staircase to the upper (ground) floor is provided as an additional safety measure in the unlikely event that an occupant is in this area when flood water begins to spill down the access ramp.

7.2 Flood Storage Arrangements

From a review of the ground levels and flood levels it is clear that it is not possible to provide compensatory floodplain storage solely through ground lowering over the site.

The impact of the development on the floodplain storage capacity has therefore been mitigated through a range of measures:

(i) Ground lowering along the southern boundary of the site, and demolition of the secure garage/store located in the south-east corner of the site

(ii) Incorporation of a floodable lower level parking area which will incorporate void openings on all sides;

(iii) A proposed floodable terrace; and

(iv) Provision of low level (tanked) storage facilities (with 2 inlets at 6.8m AOD and 7.0m AOD to ensure compliance with level-for-level requirements, outlets to soakaways via flap valves).

The level-for-level flood storage analysis is shown on the CCA drawing MR-014 in Appendix 3. This confirms that the proposals provide gains in floodplain storage capacity in all level bands as a result of the mitigation measures, and an overall improvement in floodplain storage capacity over the site of **76m^3** (i.e. a 5% improvement over the existing situation).

It is noted that the EA suggest that voids are not considered appropriate for floodplain storage as these '*become blocked over time'* and they claim that maintenance agreements can be difficult to enforce. However, we see no reason that the voids should become blocked or ineffective provided they are (i) constructed to the guidelines produced by the EA themselves, as part of a planning condition, and (ii) appropriately managed and maintained through the S106 agreement.

This approach is reinforced in the updated PPS25 Practice Guide (Paragraph 6.17), which states *"Provided there is adequate flood warning available it may be reasonable to design development with parking or other flood-compatible uses at ground level and residential or other people-intensive use above the flood level. Where developments incorporate open space beneath the occupied level, measures such as legal agreements need to be in place to prevent inappropriate use or alteration of the ground floor that would impede flood conveyance or reduce flood storage"'*

The nature of flooding from the fluvial River Thames is long lasting and the catchment slow responding, so even in a hypothetical 'worst case scenario' if the void openings had become partially blocked, there would be a significant period of time during which floodwater would permeate into the void and ensure it was fully utilised (as illustrated by the hydrograph of the modelled 1 in 100 annual probability plus allowance for climate change flood event provided in Appendix 4).

7.3 Flood Resistant/Resilient Construction

Since the ground floor levels of the development are constrained at 7.10m AOD, the buildings will incorporate flood resistant/resilient measures to provide mitigation against residual risk up to 7.40m

AOD (i.e. protecting to 840mm above the current EA modelled 1 in 100 annual probability level and 300mm above the 1 in 100 (1%) annual probability plus 20% allowance for climate change level).

It is proposed that the provision of such flood resilient/resistant measures be secured through planning condition. The measures to be incorporated are still under consideration but could include:

- Incorporation of a waterproof membrane to the external envelope of the building(s) from surrounding ground level up to the flood level;
- Removal/ sealing of ground level vents;
- Anti-flood valves fitted to all drainage runs exiting the building;
- Incorporation of removable flood gates/ barriers in doorways;
- Sealed service ducts;
- High level electrical sockets and other plant at a raised level;
- Optimise security of supplies

7.4 Safe Access Arrangements

A review of the topographic survey and the EA modelled flood levels indicates that the footpath on Melbourne Road across the frontage of the site lies at approximately 5.90m AOD; 660mm below the maximum current EA modelled 1 in 100 annual probability level and 1.2 metres below the corresponding flood event with allowance for climate change.

However, the EA's modelled flood extents (see copy in Appendix 5) indicate that the ground rises up from the floodplain within a short distance of the site; the edge of the current 1 in 100 annual probability floodplain is 50 metres from the site along Melbourne Road, whilst the limit of the climate change event is 100 metres from the site along Melbourne Road.

As noted in Section 4.2, the London Borough of Richmond upon Thames SFRA Figure F (see copy in Appendix 5) provides the details of the primary emergency access and egress routes throughout the Borough. It confirms that the main access route north-west from the site is significantly affected by flooding, with up to 1.5 metres of floodwater on the A310 Teddington Road/ Strawberry Vale (based on EA modelling). The route south-west via the A308 is also impacted (although to a lesser extent).

Beyond Melbourne Road, the area to the west of the site is fully outside the 1 in 100 plus allowance for climate change floodplain and the most appropriate evacuation route would appear to be westwards through Twickenham and on A313 and A312.

With consideration of the above, the emphasis should be on the safe management of flood risk through advance warning and the undertaking of appropriate measures in advance of a major flood event. This is discussed further in Section 7.5 below.

7.5 Flood Risk Management Plan

A Flood Risk Management Plan (FRMP) will be prepared for the proposed development, in liaison with the London Borough of Richmond upon Thames Emergency Planners. This document will ensure the occupiers are made aware of the potential flood risk at the site and of the appropriate measures if the area was to be impacted by flooding.

The River Thames at Teddington is shown as being within a 'Flood Warning Area' on the EA's website. In areas where it is possible to forecast flooding from rivers, the EA aims to give advance warning of flooding to the public using a system of flood warning codes. Flood warnings are broadcast on TV and radio weather and travel bulletins and, in designated flood warning areas, direct to the local community by siren, loudhailer or flood wardens, and in high risk areas by phone or fax.

The hydrograph in Appendix 4, based on the EA data, shows the change in water level at the site for the duration of the modelled 1 in 100 annual probability plus allowance for climate change flood event.

This illustrates the slow responding nature of the catchment and shows there would be a significant period of warning – **3 days** – between the on-set of rising water levels and when the footpath access to the site becomes affected by floodwater.

Furthermore, there would be significant warning prior to any change in water levels at Teddington, since settlements further upstream in the River Thames catchment – e.g. Reading, Oxford , Maidenhead – would be affected in advance of the Teddington area as the flood event migrates downstream.

The flood warning information on the EA website is updated every 15 minutes. All warnings are also available through the EA's 24 hour Floodline service 0845 988 1188. Furthermore, people may sign up to Flood Warnings Direct (FWD) to receive a pre-recorded flood warning message sent to their home, work or mobile phone number. The EA's flood warning service, where available, aims to minimize the risk to life and property from flooding from rivers and the sea. However, it would not claim in any way to eliminate the risk. There are limitations inherent within the operation of the flood warning system that means the issue of a timely warning is in no way guaranteed:

- Failure can occur to rain gauge and river level/flow telemetry instrumentation that results in loss of vital information on which to base a warning decision.
- The pattern and development of flooding may be inconsistent with previous events and therefore inhibit the decision making process
- Failure can occur to the Automatic Voice Message System resulting in the EA's inability to communicate a warning effectively (although contingency procedures are in place for such an occurrence, the time taken to communicate warnings will be much increased).
- The system relies on recipients being able to hear and pick up their telephone. Statistics from The EA's southeast area Automatic Voice Message Machine show that the overall success rate of flood warning voice messages is 50 to 65%.
- Recipients of warning messages may not act appropriately once they are received.

7.6 Surface Water Drainage Design

PPS25 Annex F paragraph F5 states that '*The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land.'*

PPS25 Annex F paragraph F6 states that *'Surface water arising from a developed area should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account. This should be demonstrated as part of the flood risk assessment.'*

PPS25 recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites through the use of Sustainable Drainage Systems ('SuDS'), this being complementary to the control of development within the floodplain.

The latest guidance on the use of SuDS is provided in 'The SUDS Manual' by CIRIA (ref: C697 dated March 2007). This defines SuDS as *"Surface water drainage systems developed in line with the ideals of sustainable development….the philosophy of SUDS is to replicate, as closely as possible, the natural drainage from a site before development."* As such, SuDS drainage can be in a variety of forms, including infiltration trenches, swales, permeable surfaces and green roofs.

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

i. an adequate soakaway or some other adequate infiltration system,

ii. a watercourse, or where that is not practicable,

iii. a sewer.

Any increase in the impermeable surfacing over an area would represent an increased risk of flooding by increasing the runoff potential and the rate at which surface water rainfall enters watercourses, which would be inappropriate in terms of PPS25.

The site will incorporate a SuDS surface water drainage scheme, designed to current best practice and incorporating attenuation features as appropriate to ensure that there is no increase in runoff from the site and that the flood risk is minimised, both for the development and for third parties. The proposed arrangement of the development, with an access ramp down to the lower ground floor parking area, will necessitate a pumped drainage system for this part of the site.

Given the proximity of the River Thames, it may be more appropriate to encourage direct discharge of the runoff so that such flow can be conveyed away in advance of the peak flow from the upper catchment. Whilst the impact of the site would be negligible in any case, the holding back of rainfall for slower discharge over a longer duration in these latter circumstances could potentially result in such discharge combining with and exacerbating the peak flow from the upper catchment.

8 Residual Risks

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

As noted in Section 7.1, the proposed development provides a ground floor level at 7.10m AOD, equivalent to the EA modelled 1 in 100 annual probability with allowance for climate change flood level and 540mm above the current 1 in 100 annual probability level.

Comparison with the recorded levels for major flood events from the locks immediately upstream and downstream of the site indicates an even greater freeboard provided by the proposed development; the ground floor will be 1.5 metres above the peak 1947 flood event, which is the most severe event of the 20th Century, suggesting that the EA modelled flood levels are a significant overestimate in the area.

It is not considered feasible to elevate the ground floor level any higher due to planning constraints. Therefore, to address residual risk, flood resistant/resilient measures will be incorporated up to an elevation of 7.4m AOD; i.e. 300mm above the EA modelled 1 in 100 (1%) annual probability plus 20% allowance for climate change level.

9 Conclusions

This FRA has been prepared to support proposals for two detached dwellings at the land at 19 to 21 Melbourne Road in Teddington.

The analysis undertaken within the FRA confirms that the site lies within the 'High Probability' Flood Zone 3a (i.e. land assessed as having a greater than a 1 in 100 (>1%) annual probability of river flooding, or 1 in 200 (>0.5%) annual probability of tidal flooding), as defined by PPS25 Annex D Table D.1.

The proposed development incorporates the following mitigation measures to minimise the flood risks to the occupants and third parties as follows:

- The proposed ground floor levels will be set at 7.10m AOD; equivalent to the EA modelled 1 in 100 annual probability flood level plus allowance for climate change and providing a freeboard of 540mm above the current 1 in 100 annual probability level. This is considered the maximum achievable elevation given the planning constraints of the conservation area in which the site is located;

- There are no historic records of flooding to the site, which Is shown outside the historic floodplain maps obtained from the EA (including the severe flood of 1947);

- Analysis of recorded flood levels from Teddington/Molesey Locks indicates that the EA modelled flood levels are an overestimate in the area. The proposed ground floor levels will be 1.5 metres above the peak flood level in the severe 1947 event (the worst flood of the 20th Century), and even higher above the peak level of more recent floods of 2000 and 2003;

- The buildings will incorporate flood resistant/resilient measures up to 7.40m AOD (i.e. 840mm above the current 1 in 100 (1%) annual probability level and 300mm above the 1 in 100 (1%) annual probability plus 20% allowance for climate change level);

- The proposed development has been designed to ensure no detrimental impact on floodplain storage, on a level-for-level basis, through the incorporation of a range of measures including (i) floodable voids, (ii) provision of low level storage in the floodable low level parking area, and (iii) tanked storage facilities. These measures result in a net improvement in floodplain storage capacity over the site of 76m^3.

- The access routes from the site will be impacted at the peak of the EA modelled 1 in 100 annual probability with allowance for climate change event, but the site is within 100 metres of land outside this floodplain. As such, a Flood Risk Management Plan (FRMP) will be prepared for the proposed development to ensure appropriate measures are taken ahead of any major flood event during the ample time afforded by the slow responding nature of the catchment (analysis of the EA data indicates a period of three days between the onset of water level rise and the access of the site becoming impacted by floodwater);

- The proposed development will incorporate a SuDS surface water drainage scheme.

In summary, the new dwellings will incorporate a range of mitigation measures to ensure that the occupants of the building will be safe and there would be no increase in flood risk elsewhere. Although the EA modelled flood levels are considered to be overly conservative, the ground floor levels have been designed to accommodate a 1 in 100 annual probability plus allowance for climate change flood level based on such modelled levels. It is therefore considered that the development will be safe and is compliant with PPS25.

Appendix 1 – Location Plan

- Figure 1 -1:10,000 scale location plan

Appendix 2 – Topographic Survey

- Drawing no. 2010/216 by XYZ Land Surveys, dated September 2010

Appendix 3 – Development Proposals by Clive Chapman Architects

- MR - 01 SURVEY SITE PLAN, SECTIONS & ELEVATIONS
- MR-10 - PROPOSED SITE PLAN & FLOOR PLANS - N0.19
- MR-11 - PROPOSED SITE PLAN & FLOOR PLANS - N0.21
- MR-12 – FRONT AND REAR ELEVATIONS
- MR-13 – FLANK ELEVATIONS & SECTION AA
- MR-14 – FLOOD VOLUME CALCULATIONS
- MR-15 – VISUALS

Appendix 4 – Assessment of Historic and Modelled Levels

- Interpolated Water Levels at Melbourne Road (taken from lock head/tail water levels at Teddington and Molesey Locks)
- Overview of Reference Flood Levels
- River Thames Hydrograph (1 in 100 annual probability plus allowance for climate change flood event – node 16.028)

Appendix 5 – Correspondence & Other Information

- EA 'Product 4' flood risk information (ref: SE21830, 25th February 2011)
    - Detailed Flood Zone map
    - Historic floodplain maps
    - Modelled flood extents and levels
- London Borough of Richmond Upon Thames SFRA
    - Figure 7 – Flood Map – Teddington/ Hampton Wick
    - Figure B – Geology
    - Figure D – Areas benefitting from Defence
    - Figure E – Impacts of Climate Change
    - Figure F – Flood Evacuation
- London Borough of Richmond Upon Thames email dated 22nd October 2010
- Transport for London email dated 25th October 2010
- Thames Water letter dated 25th October 2010
- PBA letter to London Borough of Richmond Upon Thames dated 1st June 2011
- Planning application reference 11/1164/FUL - decision dated 1st June 2011

Appendix 6 – Technical Note on PPS25 and UKCIP09 Sea Level Rise

- PBA Technical Note dated 21/12/11 ‘PPS25 and UKCIP09 Sea Level Rise’