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**Executive Summary**

This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the development of approximately 200 hectares of site into a mixed use development to include commercial, residential and leisure units, and the creation of the Eastern Link Road (ELR(S)) on the Aylesbury Woodlands development, to the east of Aylesbury in Buckinghamshire.

The Eastern Link Road (south) (ELR(S)) is classified as Essential Infrastructure and the PBA Sequential Test Report demonstrates that it satisfies the Sequential Test. As the road crosses the two watercourses and the floodplain, a flood mitigation scheme is required to ensure the ELR(S) meets the requirements of the Exception Test and national planning policy and does not increase flood risk to third parties.

The Flood Zones following the implementation of the ELR(S) flood mitigation scheme have been used to advise the masterplanning of the Aylesbury Woodlands site and the sequential approach advocated by NPPF has been followed. All More Vulnerable and Less Vulnerable land uses are proposed within Flood Zone 1 ‘Low Probability’ (less than 1 in 1000 (0.1%) annual probability of fluvial flooding), with only Water Compatible Development and Essential Infrastructure located within areas with a higher probability of flooding.

Thus the Sequential Test and Exception Test have been met for the development.

Hydraulic modelling has been carried out to quantify the impact of the ELR(S) and its Flood Mitigation Scheme on flooding within the site and surrounding area.

In considering the proposals, the following key aspects have been addressed:

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

Flood risk will be appropriately mitigated through measures including:

- Development will be located within the Flood Zones in which they are most appropriate.
- The ELR(S) Flood Mitigation Scheme (FMS) ensures that there is no increase in flood risk offsite as a result of the construction of the ELR(S) and model results indicate a small (<20mm) reduction in extreme flood levels on the Bear Brook downstream of the site.
- Proposed ground floor levels set a minimum of 300mm above the modelled 1 in 100 (1%) annual probability plus climate change level, in accordance with EA and AVDC requirements;
- Continuous safe access arrangements provided at the modelled 1 in 100 (1%) annual probability plus climate change flood level.
- Surface water drainage strategies for the ELR(S) and the development, based around on-site attenuation measures and controlled discharge rates, designed to the 1 in 100 (1%) annual probability plus 30% allowance for climate change storm event.

As such, the FRA confirms that the development is safe, it does not increase flood risk and does not detrimentally affect third parties, in accordance with the objectives of the NPPF.
1 Introduction

1.1 Scope of Flood Risk Assessment (FRA)

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the development of approximately 200 hectares of site into a mixed use strategic development to include commercial, residential and leisure units, and the creation of the Eastern Link Road (ELR(S)) on the Aylesbury Woodlands development, to the east of Aylesbury in Buckinghamshire.

1.1.2 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, canal breach);
- 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.

1.1.3 PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering.

1.2 Sources of Information

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

- Environment Agency (EA) online flood maps (http://maps.environment-agency.gov.uk/wiyby/);
- The Buckinghamshire County Council (BCC) Preliminary Flood Risk Assessment (PFRA) (May 2011);
- The Aylesbury Vale District Council (AVDC) Strategic Flood Risk Assessment (SFRA) Level 1 Report (April 2007 and updated 2012);
- The AVDC Aylesbury Town Level 2 SFRA (April 2009);
- PBA Aylesbury Woodlands Eastern Link Road (South) Design Option Modelling Report (January 2016)

1.3 Policy Context

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

- National policy regarding flood risk as contained within the National Planning Policy Framework (NPPF) (March 2012) and the Planning Practice Guidance (PPG) ‘Flood Risk and Coastal Change’ (March 2014);
‘Saved’ local planning policy contained within the Aylesbury Vale District Local Plan (AVDLP) adopted in 2004 (In 2007, the law changed, meaning that the policies in the AVDLP ceased to have effect unless ‘saved’ by a Direction from the Secretary of State);

The Vale of Aylesbury Local Plan (VALP) Local Development Scheme (December 2014)

Vale of Aylesbury Local Plan call for sites (site is listed as SHLWTVO18 in the call for sites which are due to be discussed in Spring 2016)

The AVDC Strategic Flood Risk Assessment (SFRA) Level 1 Report (April 2007, updated 2012) and the AVDC Aylesbury Town Level 2 SFRA (April 2009);

The Buckinghamshire County Council (BCC) Preliminary Flood Risk Assessment (PFRA) (May 2011); and

The DEFRA Flood Risk Standing Advice and the Climate Change Allowances for Planners – Guidance to support the National Planning Policy Framework (September 2013).

1.4 Caveats/Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF and Local Planning Policy. Any recommendations regarding floor levels are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

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

1.4.3 PBA do not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.
2 Existing Site and Proposals

2.1 Site Description

2.1.1 The Aylesbury Woodlands site is shown in Figure 2.1 and is located to the east of Aylesbury, Buckinghamshire. The site is south of the Grand Union Canal (GUC) and north of the A41, the Bear Brook forms most of eastern boundary and College Road North lies along the western boundary of the site. To the west is the existing urban edge of Aylesbury, including the village of Broughton.

2.1.2 The current site boundary covers an approximate area of 200 hectares and is a largely flat green field site mostly in agricultural use (Figure 2.2)

Figure 2.1: Site Location Plan

Contains Ordnance Survey data © Crown copyright and database right 2010
2.2 Site Proposals

2.2.1 This FRA accompanies an outline planning application, the proposed development is described as an;

‘Outline application with means of access to be considered for up to 102,800 sq m employment (B1/B2/B8), up to 1,100 dwellings (C3), 60 residential extra care units (C2), mixed-use local centre of up to 4,000 sq m (A1/A2/A5/D1), up to 5,700 sq m hotel and Conference Centre (C1), up to 3,500 sq m Leisure facilities (A1/A3/A4), up to 16 ha for sports village and pitches, Athletes Accommodation (10 x 8 apartments), and up to 2 ha for a primary school (D1), with a strategic link road connecting with the ELR (N) and the A41 Aston Clinton Road, transport infrastructure, landscape, open space, flood mitigation and drainage.’

2.2.2 An Illustrative Masterplan is shown in Figure EDP2524/45/P in Appendix B. This masterplan has been developed to respond to the fluvial flood risk and to accommodate floodplain.

2.2.3 The ELR(S) is essential transport infrastructure required for Aylesbury as part of its future transport strategy; however it is the Aylesbury Woodlands development which is the delivery mechanism for the scheme to occur. The ELR(S) crosses the Bear Brook and Burcott Brook and the floodplain and therefore requires mitigation to ensure it does not increase flood risk to third parties or obstruct the existing flow mechanisms.

2.2.4 To enable the ELR (S) to satisfy the Exception Test and to be compliant with national planning policy, a flood mitigation scheme (FMS) has been designed to mitigate any negative flood risk from the ELR (S). The FMS is detailed further in Section 5.1.

2.2.5 The development will be constructed in a number of phases which will be progressed to ensure that phased infrastructure and associated capacity match built development delivery as well as market demand and associated viability.
2.2.6 This approach is essential for planned and sustainable growth at Aylesbury Woodlands and any development that may be considered for progression out of sequence will need to be considered carefully.

2.2.7 The first phase of the development will see the construction of highway access at College Road North and employment land use supported by associated infrastructure works. The ELR(N) is required to be completed no later than 5 years after commencement of development of the Aylesbury East site and with development having commenced in January 2016, this would indicate the latest completion of the ELR(N) as January 2021. Therefore to ensure a complete Eastern Link Road (ELR) delivery the ELR(S) is likely to be in place by January 2021, establishing a north-south connection across the site with additional accesses at the Grand Union Canal Bridge (enabling linkage northwards to the ELR(N)) and southwards to the Aston Clinton Road (A41). It is anticipated that flood alleviation, informal open space and associated landscape works would be in place at this stage to release subsequent Phases of the development (residential, local centre, leisure and education land uses) which will then take place generally from west to east from the ELR (S) to College Road North.

2.3 Topography

2.3.1 A topographical survey of the site and access routes has been undertaken by Greenhatch Group - see Drawing 21652 OGL Revision 4 (April 2015) in Appendix A. Contours lines are shown on the drawing at 5m and 10m intervals.

2.3.2 The survey was undertaken to the OSGPS network (Ordnance Survey OSGB36 national grid).

2.3.3 The survey indicates that ground levels over the site range from 82.0 m AOD to 87.9 m AOD. The highest part of the site is in the south east, north of the A41 road, where ground levels reach 87.9 m AOD (with surrounding levels typically between 87.2 m AOD and 87.7 m AOD). The site gently slopes from the A41 north towards the canal.

2.4 Watercourses and Flood Defences

2.4.1 The Bear Brook (Fig 2.1) is the principal watercourse in the area, flowing in a broadly east to west direction immediately to the south of the A41 and through part of the south-western area of the site. It then flows south of Aylesbury Town Centre and joins the River Thame west of the town. The Bear Brook rises to the south of Aston Clinton, approximately 2 km to the south-east of the site.

2.4.2 The River Thame flows east to west, located approximately 3km to the north of the site where it flows north of Aylesbury Town Centre.

2.4.3 The Grand Union Canal (Aylesbury arm) (GUC) runs east-west along the northern boundary of the site. It terminates in Aylesbury, with flows passing into the California Brook within the town centre, approximately 3km west of the site. The is the responsibility of the Canal and River Trust (CRT)

2.4.4 The Burcott Brook or Burcott Stream (Fig 2.1) flows through the north-western part of the site and passes beneath the GUC by means of a syphon. The ‘head’ of the Brook is located at the western boundary of the site and is ‘perched’ above the Bear Brook. Although mapping indicates connection between the Bear Brook and Burcott Brook there is a clear separation, as shown in Figure 2.4 below.
2.4.5 The **Drayton Mead Brook** (Fig 2.1) is located to the east of College Farm Road, draining the Arla Dairy site and discharging into the Grand Union Canal.

2.4.6 The **Halton Brook**, also known as the **College Farm Ditch**, drains the area in the vicinity of College Farm. The Brook passes beneath the canal via a syphon and forms a tributary of the **Thistle Brook**, located approximately 2 km to the north of the canal.

2.4.7 Several smaller ditches exist within the site itself. Named ditches include the **A41 Toe Ditch** and **Canal Toe Ditch**. Ditches identified during surveying (for PBA hydraulic modelling purposes) are shown in Figure 2.4.
2.5 Existing Drainage Arrangements

2.5.1 The site comprises undeveloped greenfield land served by an extensive network of ditches and watercourses which run through the site (as discussed previously) and through infiltration into the soil.

2.5.2 The Grand Union Canal bounds the site to the north at a level higher than that of the development site. Ground levels across the site generally fall from the south towards the north where the canal toe ditch receives surface water run-off and links to the culverts beneath the canal.

2.5.3 There are two main locations at which surface water run-off from the canal toe ditch is culverted beneath the canal. The third location to the east of the site receives water from the College Farm Ditch for conveyance underneath the canal.

2.5.4 The proposed development site splits into three catchment areas that utilise the aforementioned outfall points which have all been checked for capacity. Details of the on-site drainage are included in Section 6.

2.6 Geology and Groundwater

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

- Bedrock: ‘Gault Formation and Upper Greensand Formation (undifferentiated) – Mudstone, Siltstone and Sandstone’

- There are no superficial deposits

2.6.2 The Cranfield University online ‘Soilscapes’ website provides an overview of the drainage potential of land across Britain. This indicates the following information on the land:
2.6.3 The EA groundwater Source Protection Zone (SPZ) maps indicate the site does not lie within the catchment of groundwater sources.

2.6.4 The SFRA states that:

‘The lower part of the Bear Brook catchment contains a mixture of limestone, sandstone, clay and alluvium, which produce much less permeable conditions and therefore generates a higher rate of runoff.’

This is likely to have an effect on the type of Sustainable Drainage Systems which can be implemented to control surface water on the site.
3 Overview of Flood Risk

3.1 EA Flood Maps

EA Flood Zone Map

3.1.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Zone maps. This provides an initial indication of the extent of the Flood Zones, which is refined by the use of a more detailed site-specific level survey and modelled flood levels. The site area is shown on the EA Flood Zone Map in Figure 3.1 (site outline shown in red).

3.1.2 The EA Flood Zone Map indicates that most of the western half of the site is located within Flood Zone 3 ‘High Probability’ (greater than a 1 in 100 (1.0%) annual probability of fluvial flooding – dark blue shading) with some areas at the far west of the site located out of Flood Zone 2 and 3. The eastern part of the site is located mostly in Flood Zone 1, however a pathway of Flood Zone 2 ‘Medium Probability’ (between a 1 in 100 (1.0%) and a 1 in 1000 (0.1%) annual probability of fluvial flooding – light blue shading) exists through the east of the site, south to north.

Flood Risk from Surface Water Map

3.1.3 The EA ‘Surface Water Flood Risk Map’ shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event (Figure 3.2, site outline shown in red).

3.1.4 It should be noted that these are generated using a broad methodology suitable for application on a national scale. The model utilises generalised information on infiltration, sewerage, rainfall events and catchment topography to route rainfall over a ground surface model. As such, the analysis does not take account of any general site characteristics which would be expected to influence surface water flood depths and extents, but does provide a guide to potentially vulnerable areas based on the general topography of an area.
3.1.5 This map shows that the north, south and west of the site has a low to medium risk (between a 1 in 30 (3.3%) and 1 in 1000 (0.1%) annual probability) of surface water flooding, with some localised areas of high risk (greater than a 1 in 30 (3.3%) annual probability) of surface water flooding.

3.1.6 The EA provide maps showing the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs (over 25,000 cubic metres of water).

3.1.7 The ‘Flood Risk from Reservoirs’ map is reproduced in Figure 3.3 overleaf (site outline show in red) and shows that the site is located within a residual risk zone of the ‘Weston Turville’ reservoir, which is located 4km upstream of the site to the south. This reservoir is owned and maintained by the Canal and River Trust (CRT).

3.1.8 It should be emphasised that the probability of a reservoir breach occurring is very small in any case; the EA are the enforcement authority for the Reservoirs Act (1975) and all large raised reservoirs are inspected and supervised by reservoir panel engineers.
3.2 Aylesbury Vale District Council Information

Strategic Flood Risk Assessment

3.2.1 Aylesbury Vale District Council (AVDC) released a Level 1 Strategic Flood Risk Assessment (SFRA) updated in 2012 and a Level 2 SFRA in April 2009, which provide an overview of flood risk and flood history within the Borough. The information relevant to the site is outlined below:

- **Level 1 SFRA Map Figure 5** 'Flood Map for Aylesbury, 26 July 2012', showing the EA Flood Zones 2 and 3(a), and the Functional Floodplain (Flood Zone 3b). Consistent with the EA Flood Maps (shown in Figure 3.1), the west of the site is mostly located within Flood Zone 2 and 3, with a large area classed as Flood Zone 3b Functional Floodplain. An extract of the map is shown in Figure 3.4 (site outline highlighted in black) and is available in Appendix C.

Flood Zone 3b has been defined within the SFRA as:

> As defined in PPS25, the Functional Floodplain (i.e. Zone 3b) comprises land where water has to flow or be stored in times of flood. It includes the land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes.'
Figure 3.4: Level 1 SFRA Map – Defended 5% annual probability flood outlines

- **Level 1 Figure 10** ‘Historic Flood Map for the District, 26 July 2012’, showing the historic flood map for the area and historic local flood events (surface water, groundwater, fluvial and unknown sources). The map is not of a high enough resolution to highlight specific locations. Level 1 SFRA Figure 11 provides some information on historic flooding at the west of the site. It shows some flooding from Burcott Stream.

- **Level 2 SFRA Figure 7** shows the ‘Flood Hazard from the present day 5% annual probability’ to the site. The west of the site is designated as ‘Low Flood Hazard – Caution – “Flood zone with shallow flowing water or deep standing water”’. An extract of the map is shown in Figure 3.5.
Level 2 SFRA Figure 51 shows the ‘Rapid Inundation Zone for present day 1% annual probability’ (map extract shown in Figure 3.6). It shows that an area to the north of the site is within the zone. This is the area surrounding the GUC – Aylesbury Arm.

Figure 3.6 SFRA Map ‘Rapid Inundation Zone for present day 1% annual probability’ (site boundary in green)
3.3 Buckinghamshire County Council Information

Preliminary Flood Risk Assessment

3.3.1 Buckinghamshire County Council (BCC) released their Preliminary Flood Risk Assessment (PFRA) in May 2011. The figures are available in Appendix C.

- **Figure B4** and **B6** (site split between 2 figures) in the PFRA (Appendix C) show that no historic flooding events have been reported at the site.

- **Figure E4** and **E6** (‘Locally Agreed Surface Water Flooding’) show that only small parts of the site are affected by surface water flooding. It should be noted that the maps in the PFRA are based on the previous EA surface water flood mapping (Flood Map for Surface Water (FMfSW)) and have been superseded by the more recent ‘Updated Flood Map for Surface Water’ (uFMfSW) which is illustrated in Figure 3.2.

3.4 Information from Canal and River Trust

3.4.1 PBA consulted with the CRT in February 2015 and submitted a data request for asset records, including (i) details of the culverts/syphons beneath the canal that convey surface water flows from the site to the watercourses/ditches/drains to the north of the canal, (ii) details of the waste weirs that control canal pound level, (iii) cross-sections of the canal pound adjacent to the site, defining hard and soft bed level and tow path level and (iv) asset inspection/survey reports. The data provided is presented in Appendix D.

3.4.2 This data, together with the topographic survey undertaken by Greenhatch in April 2015 (Appendix A), has been used as the basis for the hydraulic modelling analysis (discussed in Section 3.6 below).

3.4.3 During a site walkover undertaken on 20 January 2016, the Project Ecologist noted that water was spilling from the canal, across the tow-path and into the ditch at the toe of the canal embankment. The depth of over-topping was relatively shallow, confined to an approximately 1m wide section of tow-path and the flow readily accommodated within the toe ditch (i.e. spill water was not inundating the site itself). As discussed in Section 3.6, the volume flooding from the Canal in a breach event has a lesser impact than a fluvial event on the site in terms of flood depths and extents, and thus the volume overtopping this low reach of bank will pose a lower risk than both the fluvial flooding and the canal breach scenario.

3.5 Historic Flooding

3.5.1 Information provided in the SFRA Level 1 and 2, and the PFRA have been used to investigate historic flooding at the site and this is summarised above. There is little recorded evidence of flooding to the site.

3.5.2 Anecdotal evidence from the farmers on the site indicates that the site has not flooded to the extent indicated in the Flood Zone maps historically or in the areas indicated.

3.6 PBA Modelling

Revised Fluvial Baseline Modelling

3.6.1 Peter Brett Associates LLP (PBA) was commissioned by Buckinghamshire Advantage to carry out hydraulic modelling of the Bear Brook and Burcott Brook for the proposed Aylesbury Woodlands development, to the east of Aylesbury in Buckinghamshire.

3.6.2 The existing EA model of the Bear Brook and River Thame in Aylesbury has been updated to refine the Flood Zones on the proposed Aylesbury Woodlands development site. The EA
model has been updated to improve definition and accuracy of the modelled flood extents, through reducing model cell size and use of topographic survey rather than LiDAR data. The hydrological method used in the existing model has been deemed appropriate for use in the updated modelling with only minor amendments based on the site topographic survey. The Aylesbury Woodlands Baseline Hydraulic Modelling Report Revision A (PBA, January 2016) is provided in Appendix E. The modelled flood extents are discussed in Section 4.2 of the modelling report.

3.6.3 Figure 3.7 (Figure 32113_MI019_Rev_B in Appendix F) shows the comparison between the original EA modelled flood extents and the updated PBA modelled flood extents of the 1 in 100 (1%) annual probability event. The comparison indicates that in some areas such as the far south and west, the flood extents closely align, however in the north east of the flood extent, a decrease is clearly shown between the EA extents and the PBA extents. Further comparisons between the EA and PBA baseline flood extents are shown in Figures 32113_MI019_Rev_B and 32113_MI020_Rev_C within Appendix F.

3.6.4 It is important to note that EA flood extents were truncated north of the GUC so comparison of the modelled flood extents in that area should not be considered.

3.6.5 The modelled flood levels for the 1 in 100 (1%) annual probability flood event (Figure 3.7) indicate that the refined baseline model produces lower flood levels on site, with the changes in the modelled water level being around 100-300mm lower than the EA modelled levels for the 1 in 100 (1%) annual probability flood event. The modelled flood depths on the floodplain are relatively shallow, in general <150mm, with larger depths at the GUC where the water ponds against the embankment.

3.6.6 The updated modelling has resulted in a reduction in flood levels on site for a number of reasons. Principal causes are the additional capacity and improvements to the 1d conveyance routes in the modelling provided by including the drains and ditches onsite. The conveyance under the canal has been increased through the use of improved survey data and connecting the inverted siphons under the canal to the drains and ditches added to the model.

Figure 3.7: EA and PBA model comparison of extents and flood levels (m AOD) for the 1% AEP flood event
### 3.6.7 Figure 3.8 shows that the west of the site is located within the modelled 1 in 100 (1.0%) annual probability flood extent (Flood Zone 3 ‘High Probability’). Small parts of the site are shown to be located within the modelled 1 in 1000 (0.1%) annual probability flood extent (Flood Zone 2 ‘Medium Probability’) and the east of the site is located out of any of the modelled flood extents shown (Flood Zone 1 ‘Low Probability’). The modelled 1 in 20 (5%) annual probability flood extent should be the starting point in defining the likely extent of Flood Zone 3b ‘Functional Floodplain’, as defined in Section 3.2.1. The map is available in Appendix F as PBA Drawing 32113_MI022_Rev_C.

![Figure 3.8: 5%, 1% and 0.1% AEP PBA baseline flood extents](image)

**Canal Breach Modelling**

3.6.8 As part of the wider scope of modelling work of the Bear Brook at Aylesbury Woodlands the EA requested that PBA investigate and quantify the impact of a breach of the GUC to the site. The main purpose of this modelling was to demonstrate that the development is safe in the event of a breach failure of the Grand Union Canal. It was agreed with the EA that the results of this modelling would not be used to advise the masterplanning and zoning but would only be used to inform an allowance for residual risk in setting finished floor levels.

3.6.9 The topography on site slopes down to the north from the Bear Brook, towards the GUC and beyond. It is assumed that any breach will also flow south from the breach onto the site initially but will not reach the Bear Brook, instead ponding along the low ground along the south of the GUC before eventually outflowing north via the inverted siphons.

3.6.10 It was proposed and agreed that a coarse conservative modelling approach be adopted to simulate a breach in the canal. The modelling approach was therefore to build a simple 1D model using ISIS modelling software.

3.6.11 The modelling for the canal breach modelling is described in the technical note 32113-4009-TN01A which is included in Appendix G. The results from the canal breach modelling were compared against the revised baseline Flood Zones modelling (Aylesbury Woodlands Baseline Hydraulic Modelling Report Appendix E). Table 3.1 below compares the results from the simple 1d breach model to the PBA baseline fluvial model.
3.6.12 This coarse, conservative modelling of a breach in the canal indicates that the flood level in the event of a breach is less than the design fluvial risk, with the 1 in 100 (1%) plus adjustment for climate fluvial flood levels adjacent to the canal being greater than the peak breach flood level.

3.6.13 Therefore, any mitigation designed (e.g. finished floor levels) based on the fluvial flood risk will manage the residual risk of flooding from the unlikely event of a canal breach.

### 3.7 Impact of Climate Change

3.7.1 In considering flood risk to the site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures. PPG Section 7 states that ‘residential development should be considered for a minimum of 100 years’ (up to 2115).

3.7.2 The EA’s ‘Climate Change Allowances for Planners’ guidance provided contingency allowances for potential sea level rise in Table 1, whilst potential increases in peak river flow and rainfall intensity are provided in Table 2 (previously Tables 4 and 5 respectively within the now superseded NPPF Technical Guidance). This has been used in design for this outline application.

3.7.3 The potential for increased flood probability as a result of possible climate change has been addressed through the use of 20% allowance in the PBA hydraulic modelling to take into account potential increases in peak river flows. A 30% allowance for increased rainfall intensity as a result of climate change has also been included within the proposed outline surface water drainage strategy.

3.7.4 This guidance was withdrawn on 19th February 2016, following the publication of Flood Risk Assessments: climate change allowances – Detailed guidance (19th February 2016). The new document provides guidance on the allowances that should be made for the impacts of climate change on river flow, rainfall intensity and sea level rise. The peak river flow allowance that should be applied varies according to geographical location, flood zone and proposed land use. In terms of drainage, it is recommended that peak rainfall should be increased by 20% and 40% to understand the impacts.

3.7.5 This FRA demonstrates that the development will be safe and does not increase the flood risk to third parties, as required by national policy, and demonstrates that a scheme is deliverable. During the detailed design of the ELR(S) and the development as a whole, it is recommended that the allowances within the latest guidance be used to determine road crest levels, the design of bridges and culverts and finished floor levels. The design of the ELR(S) is driven by other constraints and, as demonstrated in Table 5.1, significant freeboard is provided in the outline design of the Bear Brook and Burcott Brook bridges. As such, adopted the increased allowances within the latest guidance is likely to be accommodated within the design readily.

3.7.6 It is further recommended that the new guidance be used in the detailed design of the surface water systems. Our recommended approach is that the ‘central estimate’ of 20% should be used for design purposes to assess the performance of the drainage system and ensure it can cope with the critical duration design rainfall event and the ‘upper end’ of 40% should be used in sensitivity analysis to assess the potential flood risk implications both on and off-site in...
terms of flow routes, flood hazard and freeboards. This approach will be agreed with the Lead Local Flood Authority at the beginning of the detailed design stage.
4 Proposed Development and Sequential Test

4.1 Proposed Development

4.1.1 This FRA accompanies the outline application with means of access to be considered for up to 102,800 sq m employment (B1/B2/B8), up to 1,100 dwellings (C3), 60 residential extra care units (C2), mixed-use local centre of up to 4,000 sq m (A1/A2/A5/D1), up to 5,700 sq m hotel and Conference Centre (C1), up to 3,500 sq m Leisure facilities (A1/A3/A4), up to 16 ha for sports village and pitches, Athletes Accommodation (10 x 8 apartments), and up to 2 ha for a primary school (D1), with a strategic link road connecting with the ELR (N) and the A41 Aston Clinton Road, transport infrastructure, landscape, open space, flood mitigation and drainage.

4.1.2 The Illustrative Masterplan Extract is included in Appendix B (EDP2524/45/P). The masterplan has been developed to respond to the nature of flood risk associated with the Bear Brook and accommodate floodplain.

4.1.3 National planning policy requires that there is no negative flood risk impact as a result of any development, and that development is safe. As a result, PBA undertook hydraulic modelling to assess the impacts of the development on flood risk (outlined in Section 5.1).

4.1.4 The design and delivery of the ELR(S) is a key element of the proposed development. The road will improve north south connection by providing a link between the A41 and A418. It will also provide a radial route to the east of Aylesbury Town Centre.

4.2 Flood Risk Vulnerability

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

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

4.2.2 The proposed development is classed as follows:

- ELR(S) – ‘Essential Infrastructure’ (‘Essential transport infrastructure which has to cross the area at risk’).
- Residential - ‘More Vulnerable’ development (‘Buildings used for dwelling houses’).
- Commercial – ‘Less Vulnerable’ development (‘Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the ‘More Vulnerable’ class; and assembly and leisure’).
- Leisure – ‘Water Compatible’ development (‘Outdoor sports and recreation and essential facilities such as changing rooms’); and ‘Less Vulnerable’ development (‘Buildings used for leisure’)
- Open Space – ‘Water Compatible’ development (‘Amenity open space, nature conservation and biodiversity’).
4.3 **NPPF Sequential Test**

4.3.1 The NPPF 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.

4.3.2 A flood risk Sequential Test has been undertaken (Sequential Test Report, PBA, February 2016) and is included in Appendix H.

4.4 **NPPF Exception Test**

4.4.1 The ELR(S) is shown on the Flood Zone maps as falling partially within Flood Zone 3a ‘High Probability’ and Flood Zone 3b Functional Floodplain. The Exception Test is required to be passed for the ELR(S). The Exception Test has been carried out in accordance with the NPPF to demonstrate the significant benefits of the proposed development. The NPPF paragraph 102 states:

"...For the Exception Test to be passed:

it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and

a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."

4.4.2 The first part of the Exception Test is addressed within the Sequential Test Report (Appendix H).

4.4.3 The details provided within this FRA address the second part of the Exception Test and demonstrate that the ELR(S) is safe for its lifetime.

4.4.4 In conclusion, the provided information confirms that the Exception Test has been passed and the proposed redevelopment is appropriate, in flood risk terms.
5 Flood Mitigation Measures

Flood mitigation measures are considered for the following elements of the development in turn:

- Eastern Link Road (South) ELR(S)
- Aylesbury Woodlands development
- Phase 1
- Sports facilities

5.1 Potential Scheme for the Eastern Link Road (South)

Outline only – Potential scheme option levels

5.1.1 At this Outline Planning stage, a potential flood mitigation scheme has been developed which demonstrates that it is possible to construct the ELR(S) without increasing flood risk to third parties and thus the proposed development is deliverable. As detailed design progresses and reserved matters applications are submitted, the scheme will evolve.

5.1.2 As it crosses over the Burcott Brook, the ELR (S) rises to approximately 86.5 m AOD. This provides over 4m clearance above the surveyed ground levels at the Burcott Brook. The ELR also rises up to cross the Grand Union Canal. The road level of the ELR is approximately 87.9 m AOD - more than 5m clearance over the surveyed ground levels south of the Grand Union Canal.

5.1.3 It is recommended that where the ELR(S) crosses the floodplain the road crest be set at a minimum of the 1:100yr flood level including a 20% increase in flow allowance for climate change. Given the need to elevate the road to cross the Bear Brook, Burcott Brook and Grand Union Canal and to provide clearance over the required flood relief culverts and underpass, it is likely that this will be achieved as a matter of course.

5.1.4 The ELR bank slopes have an assumed 1:3 gradient to minimise the impact on the floodplain.

Flood mitigation scheme

5.1.5 The ELR(S) lies partially within the floodplain of the Bear Brook and Burcott Brook. The outline of a potential scheme to mitigate impacts from the ELR (S) has been developed. The outline scheme demonstrates that it is possible to achieve a mitigation regime within the site boundary that does not increase flood risk to third parties.

5.1.6 The components used in the scheme are as follows:

- Lowering a short reach of the right bank of the Bear Brook by approximately 400mm.
- A preferential conveyance corridor that runs approximately parallel to the east of the ELR (S). This corridor will be created by graded land lowering (excavation generally 400-600mm or less in depth) to create shallow ‘scrapes’.
- Landscaping to contain flood waters within the preferential conveyance corridor.
- Land lowering to the west of the ELR(S) to provide additional floodplain storage.
- Culverts under the ELR(S) and the slip roads into the development to maintain flood flow conveyance.
- Retention / realignment of some of the existing ditches, as indicated in Figure 5.1 (32113_MI034_Rev_B, Appendix F). Other ditches are not necessary for the FMS and can be retained or infilled as appropriate.
- Flood defence consents will be required for the bank lowering work, the culverts and bridge crossings and potentially some of the excavations.
- An illustrative cross section has been prepared of the ELR(S), conveyance corridor, ridge and edge of development. This is shown in Figure 5.2 (Figure 32113_MI031_Rev_B, Appendix F).
- The proposed flood mitigation scheme will involve excavating material; however it is thought that this material can be reused on site or for the ELR.

Figure 5.1: Outline FMS for the ELR(S)

5.1.7 It is assumed that the retained ditches of the potential scheme can be realigned without impacting the efficacy of the design solution. This would be confirmed at the detailed design stage through modelling. Any watercourse realignment solution would need to be designed to ensure that there would be no offsite detriment and provide the same level of protection as the existing watercourses. Opportunities to provide ecological or morphological improvements on the existing situation would also be explored.
5.1.8 The baseline hydraulic model (described in Section 3.6) has been used to develop this potential flood mitigation scheme and demonstrates that the flood impacts of the ELR(S) can be mitigated to a suitable level. The modelling to support the FMS is summarised in the Aylesbury Woodlands Eastern Link Road (South) Design Option Modelling Report (Appendix I).

**Flow routes**

5.1.9 The watershed for the Bear Brook lies very close to the right bank of the watercourse. Once out of bank, flood waters from the Bear Brook flow north into the Burcott Brook and its series of ditch tributaries before passing under the canal via siphons. The FMS described above has been designed to maintain this mechanism and to not increase the flow within the Bear Brook or to obstruct flood flows such that out of bank flow returns to the Bear Brook, as this would cause an increase in flood risk to receptors downstream of the site.

5.1.10 A number of flood relief culverts are proposed under the ELR(S) embankment to convey flow. These are illustrated in Figure 5.1 and 32113_MI034_Rev_B, Appendix F.

5.1.11 The detailed design, number and exact location of these culverts will be determined at detailed design stage, but at this stage it is assumed that these will be 1m wide rectangular culverts. To accord with best practice design of culverts these will be 1.2 m high from existing ground level to allow maintenance access. Flood depths through the culverts, as modelled, are approximately 200-400mm. The EA recommends that the soffits should be set at 1:100yr plus climate change plus 600mm and this will therefore be met as a matter of course but confirmed at a later stage. An indicative design of these flood relief culverts can be seen in Figure 32113/4001/003 (Appendix F).

5.1.12 The design of the Bear Brook and Burcott Brook bridges will accord with EA requirements as set out within the Environment Agency, West Thames Area, South East Region technical Specifications and Guidance for works affecting watercourses (EA, June, 2012) Appendix J. At this outline design stage the structures are proposed to have the following geometry (Table 5.1) below, although this is subject to change as detailed design progresses: Indicative general arrangements for these structures are presented in Appendix B (drawings...
Table 5.1: Summary of dimensions of ELR bridges (based on the indicative general arrangements)

<table>
<thead>
<tr>
<th></th>
<th>Burcott Brook bridge</th>
<th>Bear Brook bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height above bank (m)</td>
<td>3.95</td>
<td>1.80</td>
</tr>
<tr>
<td>Width (m)</td>
<td>9.35</td>
<td>13.50</td>
</tr>
<tr>
<td>Approximate Soffit Level</td>
<td>86.16 m AOD</td>
<td>87.45 m AOD</td>
</tr>
<tr>
<td>(based on 3.95 m height and 82.21 m AOD topographic survey level)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate freeboard on</td>
<td>3.75 m (82.39 m AOD)</td>
<td>2.01 m (85.41 m AOD)</td>
</tr>
<tr>
<td>1 in 100 year flood level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Water Level in brackets)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.1.13 The bridges should be clear span with a capacity of at least the 1 in 100 year flood flow plus an additional 20% for climate change. The soffit should be set 600mm above the 1:100yr plus climate change flood water level to allow clearance from debris and wave action, and a further 300mm to allow for changes in water level due to climate change. Based on the indicative arrangements for these structures, this will be achieved as a matter of course.

**Safe access**

5.1.14 As stated in Paragraph 5.2.3 the ELR(S) road will be set above the 1:100yr plus climate change level through the site and therefore the road will be safe, as set out in FD2821, along the stretch through the site. Safe access is therefore available onto the A41, ELR(N) and the wider road network.

**Hydraulic modelling**

5.1.15 The ELR(S) FMS has been designed in order to mitigate the impacts of the ELR(S) on flood risk. The flood extents for the post ELR(S) FMS are shown in Figure 5.3 (Figure 32113_MI033 Revision C in Appendix F). Further detail can be found in the Aylesbury Woodlands Eastern Link Road (South) Design Option Modelling Report in Appendix I.
5.1.16  Figure 5.4 (Figure 32113_MI036 Revision A in Appendix F) shows the impacts of the ELR(S) FMS on the 1 in 100 (1%) annual probability plus climate change event. This indicates areas of detriment are confined to the Aylesbury Woodlands red line boundary and the scheme creates minor betterment off-site on the Bear Brook downstream of the site.

5.1.17  The blue areas in Figure 5.4 (below) show the areas where there is a recorded reduction in the flood level of 1 mm or greater. The red areas show where there is an increase in the flood level by 1mm or greater. The yellow areas are where the variation between the baseline and the post ELR flood level is within 1mm and considered a negligible impact or within the tolerance of the model.
5.2 Aylesbury Woodlands Development

Ground floor levels

5.2.1 Standard guidance is for finished floor levels of new residential development to be set at a minimum of 300mm above the modelled fluvial 1 in 100 (1%) annual probability plus allowance for climate change flood level. It is recommended that this target is achieved across the development. As the flood levels vary throughout the site, the finished floor level will depend on the location within the site. The earthworks strategy for the outline application has been devised such that these minimum floor levels are met. A preliminary earthworks drawing is included in Appendix B (32113_2016_SK04 Revision B).

Flood storage

5.2.2 Following the construction of the ELR(S) and its flood mitigation scheme, all of the More Vulnerable and Less Vulnerable built development will be located within Flood Zone 1. As such, there will be no impact on flood storage.

5.2.3 Phase 1 will progress in advance of the ELR(S) and this is discussed in more detail in Section 5.4 below.

5.2.4 Some sports facilities are proposed within the floodplain. These are considered in Section 5.5 below.

Flow routes

5.2.5 All of the built development will be located within Flood Zone 1 following the construction of the ELR(S) and its flood mitigation scheme. As such, there will be no impact on flood flow routes.

5.2.6 There will be roads crossing minor watercourses and ditches, such as the access road from College Farm Road into the east of the site and the access roads which connect the...
development with the new ELR(S). These have potential to impact on flood flow routes and will need to conform to existing guidance (Appendix J). It is recommended that these are clear span structures - subject to wider constraints. These structures will be designed with soffits set above the 1:100yr flood level plus 20% increase in flows to allow for climate change and including a freeboard in line with the EA guidance. Should any flood relief culverts be necessary to provide additional conveyance, these should be designed in accordance with standard design guides such as CIRIA C689. PBA have included indicative drawings for flood relief culverts for an outline flood mitigation scheme in Figure 32113/4001/003 (Appendix F).

5.2.7 The requirement for any bridges or culverts will be confirmed during reserved matters applications and will also require flood defence consent.

5.2.8 The illustrative masterplan incorporates some canalside development, with access from the towpath in the north-east corner of the site. To achieve this, a small parcel of land would be raised and it would be necessary to reroute the toe ditch adjacent to the canal. At this outline stage this has been incorporated into the hydraulic model to demonstrate that this has no detriment in terms of flood risk. This will be further developed at detailed design.

**Safe access**

5.2.9 It is necessary to consider and incorporate safe access arrangements as part of the mitigation, to ensure the occupants of the development are safe in times of flooding and can achieve access/egress to/from the wider area safely.

5.2.10 The revised Flood Zone map (which incorporates the ELR(S) FMS) in Figure 5.3 illustrates that the west and the south of the site are affected in a major flood event. The most appropriate route out of the floodplain would be via the completed ELR(S) onto the elevated A41 to the south or to the land north of the GUC (future development).

5.2.11 It is proposed that there will be a number of junctions from the ELR(S) into the Aylesbury Woodlands site – the exact number and design of these junctions has not yet been established. Further access to the site will be provided from College Road North adjacent to the existing Arla access. The current proposed vehicular and pedestrian routes and access points to the site are shown in Figure 5.5.

5.2.12 It is recommended that where access roads are proposed to cross the floodplain or a watercourse they are set above the 1:100yr plus climate change flood level, for the post-ELR(S) scenario. As any culverts or bridge crossings will need to be set at the 1:100yr plus climate change flood level including a freeboard it is likely that this is achieved as a matter of course.
5.2.13 All More Vulnerable and Less Vulnerable development will be located within Flood Zone 1 Low Probability and therefore safe access need only be considered from the Water Compatible Development located within the floodplain.

5.2.14 Consideration of the safety of any pedestrian route has been based on the guidance in the EA document ‘Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1’. Figure 5.6 is an extract from this note. Due to the developed nature of the area, it is assumed that velocities would be very low, in which case the pedestrian routes would still be considered a ‘Very Low Hazard’ for depths up to 250mm.

5.2.15 The ‘hazard to people’ classification has four ratings:

- **Very low hazard** – caution (Flood Hazard Rating (‘FHR’) less than 0.75)
- **Danger for some** – i.e. children, the elderly and infirm (FHR between 0.75 and 1.25)
- **Danger for most** – includes the general public (FHR between 1.25 and 2.0)
- **Danger for all** – includes the emergency services (FHR greater than 2.0)
5.2.16 FD2320 states that ‘The outputs of the Flood Risk to People project indicate that flood depths below 0.25 m and velocities below 0.5 m/s are generally considered low hazard. When designing safe access and exit routes, the combinations of depth and velocity on the routes should correspond to the white boxes in the above diagram. As flood depth and/or velocity increase the hazard to people increases. Combinations of depths and velocities in the white boxes (below the ‘danger for some’ class) are ‘very low hazard’, but a hazard does remain.’

5.2.17 This confirms that continuous pedestrian safe access is available from the site.

5.2.18 It is recommended that consideration be given to how safe access and evacuation measures might be provided prior to occupation. This might include signage along footpaths or the proposed cycle underpass and flood response plans are recommended for the sports facilities within the floodplain.

5.3 Phase 1

Ground floor levels

5.3.1 The Phase 1 (commercial) construction will be likely to progress in advance of the construction of the ELR(S) and FMS. This must be designed to be safe in advance of the FMS, through raised finished floor levels. For these plots, the baseline 1:100yr plus climate change flood levels must be used to set finished floor levels if these are greater than the post ELR(S) flood level in the 1:100yr plus climate change flood levels. An outline development platform figure is included in Appendix B (32113_2016_SK04 Revision B).

Flood storage

5.3.2 It is unlikely that any of the Phase 1 built development will located within the 1:100yr plus climate change baseline floodplain. However, if it is, level for level compensation storage should be provided to ensure no detriment to third parties.

Flow routes

5.3.3 There will be no impact on flood flow routes as a result of the Phase 1 development.

Safe access

5.3.4 Safe access will be provided, as per the recommendations for the wider Aylesbury Woodlands development. It is recommended that if access roads for Phase 1 are proposed to cross the
floodplain or a watercourse they are set above the 1:100yr plus climate change flood level, for the baseline scenario if this is greater than the post-ELR(S) scenario.

5.4 Sports facilities

Ground floor levels

5.4.1 The sports facilities within the floodplain are Water Compatible Development. These areas will be at risk of flooding and this will be considered in design.

5.4.2 No minimum floor levels for the internal sports facilities such as changing rooms will be set. Consideration will be given during detailed design to water resilient design if internal flooding is expected. If it is decided to raise the buildings higher, compensation storage will need to be provided. Best practice will be used in the design of these facilities.

Flood storage

5.4.3 At this outline stage, the exact volume of lost floodplain is not known. However, there is ample space to provide compensation flood storage based on the illustrative masterplan.

5.4.4 The velodrome will be floodable. The central area will be available for flood storage as the seating stands will not be a continuous structure, and facility will be made for water ingress to the central area, reducing the volume of storage lost from the floodplain.

5.4.5 Assumptions have been made at this outline stage regarding the areas lost from the floodplain (such as from the velodrome and the BMX track) to show that there is sufficient space to mitigate for the loss of floodplain. This is indicated within Figure 32113/4001/002 (Appendix F). During detailed design, level for level volume calculations or detailed calculations for alternative mitigation will be provided to demonstrate that the proposed mitigation is adequate.

Flow routes

5.4.6 Much of the sports facilities proposed will be open and flood flow routes will be unimpeded. Where land is proposed to be raised, such as the BMX track, or buildings such as changing rooms are proposed, these will be small and have only a local impact on flood flow routes. However, consideration in design will be given to reducing the impact on flow routes whilst also according to the design requirements and specifications for the sports facilities.

Safe access

5.4.7 Continuous safe dry access will not be provided to all the sports facilities, as to do so would have detrimental impacts on flood flow routes and floodplain storage volumes.

5.4.8 It is recommended that flood response and evacuation procedures are prepared for the sports facilities prior to them becoming operational.
6 Surface Water and SuDS

6.1 Overview of Surface Water Drainage Policy Requirements

6.1.1 As the proposals are considered ‘major development’, any future planning application is required to include a strategy outlining the proposed disposal of surface water from the new development, and evidence of existing and proposed runoff rates to demonstrate that the proposed development does not increase flood risk elsewhere.

6.1.2 The consultant team is working closely with the EA and BCC (as the Lead Local Flood Authority) to ensure that the function of the floodplain and the existing surface water drainage regime are not adversely affected by the Aylesbury Woodlands development.

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

6.1.4 As of April 2015, the LLFA has become a statutory consultee on planning applications for surface water management. As the LLFA, BCC are responsible for the approval of surface water drainage systems within new development and such guidance will play a key role in determining the acceptability of surface water drainage measures in new development.

6.1.5 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:

1) an adequate soakaway or some other adequate infiltration system,
2) a watercourse, or where that is not practicable,
3) a sewer.

6.1.6 The first priority is to consider infiltration drainage. The geology of an area is likely to have an effect on the type of Sustainable Drainage Systems which can be implemented to control surface water on the site. The SFRA states that:

‘The lower part of the Bear Brook catchment contains a mixture of limestone, sandstone, clay and alluvium, which produce much less permeable conditions [than the upper catchment] and therefore generates a higher rate of runoff.’

There is also evidence of high groundwater levels across the site which will need to be confirmed by further ground investigation and detailed design will respond to this.

6.1.7 The second preference in the aforementioned hierarchy is discharge to a watercourse, and a site walkover confirmed the presence of a number of outfalls into the surrounding watercourses, suggesting this is the current primary method of disposal over the site – either via an established below-ground drainage system or via overland flow routes.

6.2 Outline Surface Water Drainage Strategy

6.2.1 The preliminary development areas as shown on Illustrative Masterplan EDP2524/45/P (Appendix B) has been divided into 3 catchments to reflect existing catchment areas within the site with routes of drainage channels taking surface water run-off to their respective outfall locations at the toe ditch that runs parallel to the Grand Union Canal to the north of the site. PBA drawing 32113/2016/001 contained within Appendix K shows the aforementioned outfall locations together with the Outline Surface Water Management Strategy.
6.2.2 The strategy for the site comprises a conventional, gravity piped drainage system for each development parcel that will collect and convey surface water run-off to open drainage channels with a retained water depth which will be designed to provide attenuation for and conveyance of surface water flows to the existing outfall locations as described. Typical cross sections through these channels (EDP Draft Channel Types, Figs 25, 33 and 34) are contained within Appendix K. Plot levels for development parcels will be derived from the requirement to drain the development by gravity. It is anticipated at this outline stage that all surface water attenuation will be provided above ground.

6.2.3 Two balancing ponds are proposed which will provide additional surface water storage with direct linkage to the surface water drainage channels. One will be located to the west of the existing woodland in the south of the site which will provide attenuation if required for surface water run-off arising from the Western Catchment, with the second located in the north east of the development which will be split into two attenuation basins which will provide storage for the Central and Eastern Catchments respectively.

6.2.4 There are three culverts located along the toe drain that runs alongside the Grand Union Canal which convey surface water beneath the Grand Union Canal and to the wider drainage network, referenced to correspond to the respective catchment areas.

6.2.5 In the case of the central catchment where the existing greenfield run-off rate currently exceeds the capacity of the culvert (passing beneath the canal) during the 1 in 100 year event by approximately 23%, run-off from the development will be limited to a lower rate and additional attenuation will be provided on site to accommodate this shortfall in conveyance capacity. This is discussed further in section 6.3.4.

6.2.6 The proposals include a range of sustainable measures to control surface water runoff. This means that the amount of water entering the watercourses around the site will be carefully controlled so that the drainage regime ‘replicates’ that of the existing site. Sustainable drainage systems, or SuDs, also provide added benefits in terms of habitat creation and amenity and contribute to improved water quality and pollution control.

6.2.7 Further refinement of the size, form and location of the SuDS attenuation measures will be required as part of the detailed development design at the reserved matters stage.

6.3 Design Parameters

6.3.1 This section of this note sets out the design parameters that will be used in the design of the surface water drainage pipe networks and surface water attenuation measures serving the proposed development.

Limiting/Allowable Discharge Rate

6.3.2 The existing greenfield run-off rates have been estimated using the institute of Hydrology Report 124 (IoH 102) ‘Flood Estimation for Small Catchments (1994)’ methodology and catchment specific rainfall parameters derived from the Flood Estimation Handbook (FEH).

6.3.3 The mean annual greenfield run-off rate is 3.29 l/s/ha. This has been derived using the IH124 method of flood estimation for small catchments and analysis has been undertaken using MicroDrainage software. The results are contained within Appendix K. At this preliminary stage, the surface water drainage strategy has been configured assuming that surface water outflows are to be limited to the mean annual run-off rate (Qbar) for all storm events up to and including the 1 in 100 year probability rainfall event (plus climate change).

6.3.4 In addition to the limiting/allowable discharge rates estimated for the site, the capacity of the existing culverts beneath the Grand Union Canal that convey surface water flows to the wider area presents potential for further constraint on flows generated from the site.
6.3.5 Table 1 below shows a summary of the greenfield areas draining to each existing culvert passing underneath the Grand Union Canal and the capacity of each culvert (data taken from the Tables for the Hydraulic Design of Pipes, Sewers and Channels). With regard to the central catchment, capacity at the culvert was found to be approximately 23% less than the existing greenfield run-off rate. An allowance for which will be made within the overall amount of attenuation provision for this catchment.

6.3.6 This allowance has been made by limiting the run-off rate to that which can be conveyed by the culvert beneath the canal and providing additional attenuation on site to contain additional volumes arising. This will improve the current situation where the existing culvert cannot convey existing flows providing overall betterment for the site.

<table>
<thead>
<tr>
<th>Culvert</th>
<th>Existing Catchment Area</th>
<th>Existing Greenfield Run-off Rate (Qbar = 3.25 l/s/ha)</th>
<th>Capacity of culvert</th>
<th>% under capacity</th>
<th>Impermeable Area</th>
<th>Limited Discharge from Impermeable Area per Catchment</th>
<th>Storage Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>88.11 ha</td>
<td>286.4 l/s</td>
<td>523.0 l/s</td>
<td>21.2ha</td>
<td>69.7 l/s</td>
<td>69.7 l/s</td>
<td>17,400 m³</td>
</tr>
<tr>
<td>Central</td>
<td>25.12 ha</td>
<td>81.6 l/s</td>
<td>62.4 l/s</td>
<td>23%</td>
<td>16.9ha</td>
<td>55.7 l/s</td>
<td>13,900 m³</td>
</tr>
<tr>
<td>Limited discharge reduced by 23% to provide additional storage:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42.9 l/s</td>
<td>14,700 m³</td>
</tr>
<tr>
<td>Eastern</td>
<td>18.25 ha</td>
<td>59.3 l/s</td>
<td>451.3 l/s</td>
<td>9.5 ha</td>
<td>31.2 l/s</td>
<td>31.2 l/s</td>
<td>7,800 m³</td>
</tr>
</tbody>
</table>

(Calculations are included within Appendix K for information)

Flood Estimation Handbook

6.3.7 At this outline stage, the design of the surface water attenuation provision has been undertaken using catchment specific rainfall parameters derived from the Flood Estimation Handbook (FEH), a copy of which is included within Appendix K for information. At detailed design stage, appropriate rainfall data will be selected (FEH or FSR) to reflect the size and nature of the development areas to be drained.

Volumetric Run-off Coefficient for the Design of the Attenuation Provision

6.3.8 A volumetric runoff coefficient (Cv) of 0.85 has been utilised in the sizing of the surface water attenuation provision to be consistent with emerging stakeholder requirements and to provide a more robust estimation of attenuation required by simulating greater surface water run-off from less porous ground conditions.

Climate Change

6.3.9 The outline surface water drainage strategy has been designed to accommodate the effects of climate change in accordance with the recommended contingency allowances as set out in Table 2 of the Environment Agency’s “Climate Change Allowances for Planners” guidance with an allowance of 30% extra for increased rainfall intensity. At detailed design stage, the appropriate climate change will be applied depending on the nature of the area of the site to be drained;

- Residential – 30%
- Commercial – 20%
Impermeable Areas

6.3.10 For this outline strategy, the development areas on site have been taken from the illustrative masterplan and the following has been assumed:

- Commercial/Amenities: 95% Impermeable
- Residential: 65% Impermeable

At detailed design, actual permeable areas will be derived from the development proposals being brought forward for reserved matters.

Piped Surface Water Drainage System

6.3.11 The proposed surface water drainage network for each development parcel which will convey surface water from individual plots to the proposed channel arrangement will comprise a network of pipes which will be designed and constructed in accordance with BS EN 752, the requirements of Sewers for Adoption and Building Regulations Part H.

6.3.12 Drainage associated solely with highways will be designed in accordance with the requirements of the Local Highways Authority.
Surface Water Attenuation

6.3.13 As set out above, it is currently envisaged that attenuation for all catchments will be provided above ground within surface water channels and complementary balancing ponds. Each surface water channel will typically have the following parameters:

- Retained water depth of 0.5m;
- Maximum water depth of 1.5m (including retained water depth);
- Minimum width of 2.5m;
- Minimum freeboard of 300mm; and
- Hard canalised channels or softer side slopes or a combination of both. (Please refer to figures 1 and 2 contained in Appendix K for Cross Section Types)

6.3.14 Balancing ponds have been provided for all three catchments to supplement attenuation provided within the channels. The balancing pond for the western catchment is located to the west of the existing woodland area in the south of the site. The central and eastern catchments will utilise one pond to the north east of the development. This pond will be split to ensure flows remain separate. Each pond will be designed using the following typical parameters:

- Retained Water depth of 0.5m;
- Maximum water depth of 1.5m (including retained water depth); and
- Minimum freeboard of 300mm.

6.3.15 All surface water outfalls have been set at 0.5m above the existing outfall level at each of the receiving culverts given on the topographical survey drawing no. 21652 OGL undertaken by Greenhatch Group (May 2015) and contained within Appendix A. The receiving culverts are located along the Grand Union Canal bounding the northern boundary of the site and are referenced on the topographical survey as follows:

- Western Culvert – GU2
- Central Culvert – GU4
- Eastern Culvert – GU5

To minimise the potential land take of the surface water channels, steps have been provided along their alignment to accommodate the rise in ground levels as the site slopes upwards towards the south.

6.3.16 All sustainable drainage system (SuDS) features will be designed in compliance with best practice and in accordance with guidance set out by the Lead Local Flood Authority.

6.4 Overland Flows

6.4.1 Any rainfall event with intensity in excess of that of the design capacity of the development surface water drainage network may result in temporary above ground flooding, potentially giving rise to overland flows.

6.4.2 The surface water management strategy for the development will ensure that overland flows in excess of the capacity of the positive drainage system are routed away from buildings towards the surface water attenuation provision (channels and ponds) via site highways and ultimately towards the western, central and eastern outfalls.

6.4.3 As the existing topography of the site falls from the south to the north towards the toe ditch which runs parallel to the Grand Union Canal along the northern boundary of the site, it is unlikely that overland flows will run from the site onto land outside the development boundary. Measures will however, be put in place to prevent overland flows from the site running off towards land outside the site boundary to the south east of the site. These flows will instead
be retained on site and directed towards the surface water attenuation provision. Such matters will be addressed at the detailed design stage.

6.5 Water Quality and Pollution Control

6.5.1 Diffuse pollution will be controlled by incorporating trapped highway gullies within the highway drainage system.

6.5.2 Provision for oil interceptors will be made where required. In addition, the creation of ponds and surface water channels provides a mechanism for treating stormwater run-off prior to discharge to existing watercourses allowing the settlement of suspended solids, thereby assisting with the control of diffuse pollution and maintaining the water quality of receiving waters.

6.5.3 Planting within the surface water channels and ponds will further provide filtration of diffuse pollution by removing harmful substances before run-off reaches the existing Burcott Brook, Halton Brook and an unnamed water course to the north of the development.

6.5.4 Pollution control will generally be provided as part of the surface water ‘management train’ (also referred to as the ‘treatment train’), as set out in CIRIA C753 – The SuDS Manual.

6.6 Maintenance and Adoption

6.6.1 In respect of adoption and maintenance, it is envisaged that the developer will maintain both the drainage sewers and the surface water channels and ponds until such a time that the maintenance period has passed and sufficient sewer flows are recorded in order that sewers can be brought forward for adoption.

6.6.2 All sewers on the site will be designed to BS EN 752 and adoptable standards (Sewers for Adoption) in order that the sewer infrastructure can be brought forward for adoption by the Statutory Undertaker, Thames Water.

6.6.3 Ultimately, the drainage infrastructure will be maintained as follows:

- Highway drains will be adopted and maintained by the Highway Authority (Buckinghamshire County Council)
- Surface water sewers will be maintained by Thames Water
- Surface water channels and balancing ponds will likely be maintained by a Private Management company

6.6.4 As the Floods and Water Management Act and associated legislation come into force, opportunities will be sought for the Local Suds Authority to undertake the management of the surface water channels and balancing ponds.

6.6.5 Further details of adoption and maintenance provisions will be set out as part of reserved matters submissions.

6.7 Proposed Development Levels

6.7.1 Ground levels across the site will be profiled as far as possible so that levels fall away from the buildings, to convey surface water towards gullies/channels or to the site roads/parking areas which will be designed to drain freely to a positive drainage system.

6.7.2 Preliminary development platform and finished floor levels have been determined taking into account existing flood levels, existing ground levels and the requirement to provide a gravity drainage solution. However, development levels will be considered further as part of the detailed design of the surface water drainage system together with detailed consideration of
overland flow routing associated with exceedance conditions. This will be addressed as part of a reserved matters submission.

6.8 **Water Supply and Foul Sewerage**

6.8.1 The engineering solution to water supply and sewerage services is likely to be to extend the existing networks, with any necessary reinforcement to increase the capacity of the system.

6.8.2 The most appropriate solution for the proposed development and the associated extent of work will be determined by confirming local points of connection and completing network capacity assessments in conjunction with Thames Water prior to progression of detailed design.

6.8.3 Thames Water has undertaken a Foul Water Sewerage Impact Study (February 2016) to assess the capacity of both the existing foul water sewer network and the receiving Aylesbury Water Treatment Works (WwTW).

6.8.4 Hydraulic modelling has confirmed that reinforcements to the existing foul water network are not required to enable the connection of the proposed site to the existing foul water sewer network and that there will be no detrimental effect on capacity at the WwTW from an increase in foul water flows from the proposed development. However, necessary measures will be undertaken to ensure that foul water sewers on site are adequately protected against surface water ingress.

6.9 **Surface Water Drainage of ELR(S)**

6.9.1 Surface water drainage of the ELR(S) has been considered separately and an outline drainage strategy has been prepared for the ELR(S) by Jacobs. The Aylesbury Eastern Link Road (Southern Section), Buckinghamshire Advantage - A41 ELR (South) Concept Drainage Strategy (3rd February 2015) is contained within Appendix K. Options for attenuation include the use of oversized pipes located beneath the highway or attenuation ponds will be provided, located within the highway corridor. If attenuation ponds need to be located within the floodplain, it will necessary to protect these with embankments to ensure that they are isolated from the floodplain, which would thus reduce the floodplain storage volume. This would therefore require compensation measures to ensure no increase in fluvial flood risk. The detailed drainage strategy will be confirmed during the detailed design of the ELR(S).

6.9.2 It is noted that the detail of the A41 junction has been amended since the completion of the ELR(S) outline drainage strategy. However, the assumptions based on the previous design are ‘worst case’ as the size of the new junction is smaller than the previous design. As such, the volume calculations are conservative.
7 Residual Risk

7.1.1 It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, it is practicable to minimise the risk by allowing a suitable freeboard (safety margin) and by using suitable construction and management techniques.

7.1.2 To minimise residual risks to users, such as climate change and other uncertainties, floor levels of proposed units will be set a minimum of 300mm above the modelled 1 in 100 (1%) annual probability plus allowance for climate change flood level for the post ELR(S) scenario, in accordance with EA and AVDC requirements.

7.1.3 The EA guidance indicates that the ELR(S) and any access roads are recommended to be set above the 1:100yr flood level including allowance for climate change for the post ELR(S) scenario. The proposed ELR and access slip roads are all above the proposed guidance levels.

7.1.4 The development provides continuous safe access for all residents at the modelled 1 in 100 (1%) annual probability plus allowance for climate change flood level and will include a Flood Risk Management Plan (FRMP), prepared in liaison with AVDC Emergency Planners. Consideration of what appropriate measures, such as signage and flood evacuation procedures, are recommended for the water compatible land uses.

7.1.5 There is a risk that the flood mitigation scheme for the ELR(S) might not operate to its design standard due to a blockage of culverts or obstructions to the preferential conveyance channel. Regular maintenance and inspection procedures will be in place to manage this risk.

7.1.6 In the unlikely event of a blockage of a siphon under the canal, the freeboard recommended on the minimum finished floor levels will reduce the potential impact on the development.

7.1.7 The proposals include a surface water drainage strategy that demonstrates a reduction in peak runoff rates generated by the site.

7.1.8 As such, the residual risk will be minimised.
8 Conclusion

8.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the development of the approximately 200 hectare site into a mixed use strategic development to include commercial, residential and leisure units, and the creation of the Eastern Link Road (ELR(S)) on the Aylesbury Woodlands development, to the east of Aylesbury in Buckinghamshire.

8.1.2 This FRA concludes that:

- The site and surrounding area lies within Flood Zone 1 ‘Low Probability’ (less than a 1 in 1000 (<0.1%) annual probability of river flooding), Flood Zone 2, ‘Medium Probability’ (between a 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding), Flood Zone 3a ‘High Probability’ (greater than a 1 in 100 (>1%) annual probability of river flooding), and Flood Zone 3b ‘Functional Floodplain’ (an area of land where water has to flow or be stored in times of flood).

- The ELR(S) is classified as Essential Infrastructure. It has to pass through Flood Zone 3a and 3b and the Sequential Test is passed.

- The ELR(S) requires mitigation measures to ensure that there is no increase in flood risk to third parties as a result of its construction, and a flood mitigation scheme has been proposed which demonstrates that this is achievable. Thus the Exception Test is passed.

- The proposed flood mitigation scheme causes no increase in flood risk beyond the Aylesbury Woodlands site, thus the road has no detriment to third parties and is compliant with national policy. The scheme results in a small reduction in peak water levels downstream of the site towards Aylesbury on the Bear Brook, of the order of 20mm.

- The post ELR(S) Flood Zones have been used to advise the masterplanning of the Aylesbury Woodlands development site. A sequential approach has been adopted, such that all More Vulnerable and Less Vulnerable land uses will be located within the post ELR(S) Flood Zone 1, with only Essential Infrastructure and Water Compatible Development located in areas at higher probability of flooding.

- The Sequential Test for the Aylesbury Woodlands site is shown to be passed in the Sequential Test Report.

- Breach modelling of the GUC confirms that the flood level in the event of a breach is significantly less than the fluvial risk, therefore, any mitigation designed (e.g. finished floor levels) based on the fluvial flood risk will more than adequately manage the residual risk from the canal.

- The proposed residential units will have a minimum ground floor level set 300mm above the EA modelled 1 in 100 (1%) annual probability plus allowance for climate change flood level in accordance with EA and AVDC guidance.

- It has been demonstrated that safe access to the development can be maintained throughout a 1 in 100 (1%) plus allowance for climate change flood event. As commercial and residential development will only take place within Flood Zone 1, the risk only exists for leisure and open space land use, and appropriate measures will be put in place to ensure fast evacuation of these areas during times of flood.

- An outline surface water drainage strategy has been developed for the site incorporating SuDS measures where appropriate and in accordance with the Building...
Regulations hierarchy and the requirements of BCC as the Lead Local Flood Authority (LLFA). The strategy has been designed to the 1 in 100 (1%) annual probability plus 30% allowance for climate change event and demonstrates a reduction in peak runoff rates from existing.

- During the detailed design of the development, it is recommended that the allowances within the latest climate change guidance be used.

8.1.3 In conclusion, the future occupants of the site will be safe and there will be no increase in flood risk elsewhere; thus meeting the requirements of the National Planning Policy Framework (NPPF).
Appendix A - Existing Site Survey Information

A.1 Topographic Survey Drawing 21652 OGL by Greenhatch Group (April 2015)