Grundon Waste Management Depot, Banbury

Flood Risk Assessment

On behalf of **Grundon Waste Management Ltd.**

Project Ref: 33390/4001 | Rev: A | Date: October 2017

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A	03/10/17	Updated for new proposals and new climate change guidance	[redacted]		

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This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the proposed residential redevelopment on the Grundon Waste Management Depot site in Banbury site.

The Environment Agency (EA) Flood Zone map shows the site lies partly within Flood Zone 3 'High Probability' of the River Cherwell, defined as follows:

> **Flood Zone 3 'High Probability' (greater than 1 in 100 (1.0%) annual probability of river flooding, or greater than 1 in 200 (0.5%) annual probability of sea flooding)**

The Flood Zone classification ignores the presence of flood defences. However, the detailed EA flood data confirms that the site is offered up to a 1 in 200 year (0.5% annual probability) standard of protection from the Banbury Flood Alleviation Scheme (Banbury FAS), which opened in 2012.

The proposal consists of the construction of a 200-unit residential development which, as a 'More vulnerable' use is considered appropriate within Flood Zone 3a subject to the Sequential Test and Exception Test being passed. This was undertaken in the Cherwell District Council (CDC) in the document 'Sequential Test and Exception Test (Flooding) - Strategic Sites' (October 2014).

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:

- Proposed ground floor levels set a minimum of 300mm above the modelled 1 in 100 (1.0%) annual probability +35% allowance for climate change level, in accordance with EA and CDC requirements;
- Continuous safe access arrangements provided at the modelled 1 in 100 (1.0%) annual probability +35% allowance for climate change event and provision of safe refuge within all dwellings;
- Provision of flood compensation measures to ensure no detrimental impact on floodplain storage capacity;
- A surface water drainage strategy, based around on-site attenuation measures and controlled discharge rates, providing a significant reduction in runoff from the site and designed to the 1 in 100 (1.0%) 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), on behalf of our client, Grundon Waste Management Ltd, to support an outline planning application for a 200-unit residential redevelopment of the CEMEX and Grundon Waste Management Depot site in Banbury.

1.1.2 The original FRA was issued in October 2015 and submitted to accompany planning application reference 16/00472/OUT in 2016. However, in the intervening time the new EA climate change guidance was released and the EA objected to the scheme on the basis that the scheme did not apply the new climate change allowances. This 'Revision A' of the FRA has been prepared for a new application, following further discussions with the Local Authority, and to incorporate hydraulic modelling of the new climate change scenarios to inform the mitigation strategy.

1.1.3 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.

1.1.4 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/);
- EA **Product 4 flood risk data** (EA reference THM_31184, dated December 2016) and the 'River Cherwell Modelling Study' (2015) hydraulic model for the Banbury Flood Alleviation Scheme As-Constructed investigations, provided by the EA;
- The Oxfordshire County Council (OCC) **Preliminary Flood Risk Assessment** (PFRA) dated June 2011;
- The Cherwell and West Oxfordshire **Level 1 Strategic Flood Risk Assessment** (SFRA), dated April 2009;
- The Cherwell District Council **'Sequential Test and Exception Test (Flooding) - Strategic Sites'** (October 2014).

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)** dated March 2012, issued by Communities and Local Government, and the **NPPF Planning Practice Guidance (PPG)** released in March 2014;

- The **EA 'Flood risk assessment – climate change allowances'** guidance (released February 2016);

- Local planning policy contained within the '**Cherwell Local Plan 2011-2031'**, formally adopted by Cherwell District Council in July 2015, which provides the strategic planning policy framework and sets out strategic site allocations for the District to 2031. Policies of particular relevance to flood risk and surface water drainage include 'Policy ESD 6: Sustainable Flood Risk Management' and 'Policy ESD 7: Sustainable Drainage Systems (SuDS)'.

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

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

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

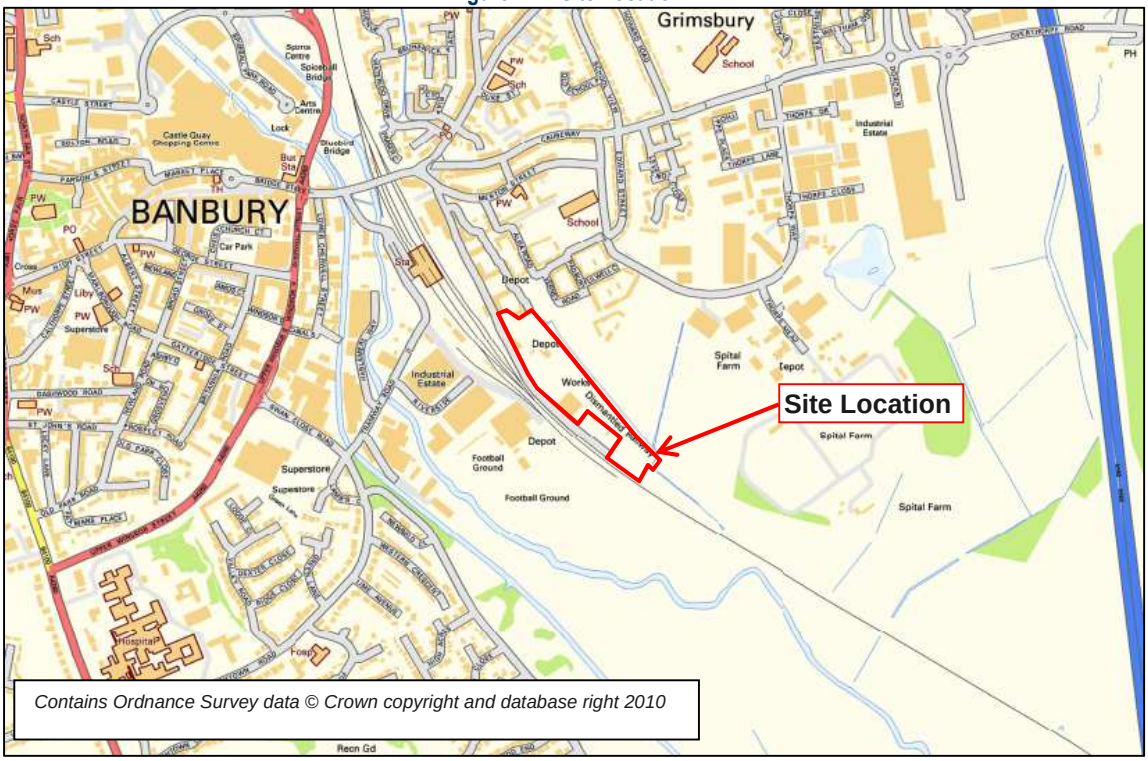
2 Existing Site and Proposals

2.1 Site Description

2.1.1 The 3.05 Hectare (Ha.) site consists of an approximately rectangular area to the south-west of the centre of Banbury in Oxfordshire (OS grid reference 446,480m E, 240,160m N, see Figure 2.1).

2.1.2 Banbury lies within the administrative boundary of Cherwell District Council (CDC).

Figure 2.1: Site Location



2.1.3 The north-west corner consists of a former concrete plant owned by CEMEX UK. This area has been cleared and was previously used as a site compound for the construction of the nearby multi-storey car park adjacent to the station.

2.1.4 The remainder of the site consists of a former gas works currently in operation by Grundon as a Refuse and Waste Collection Depot. This area comprises further hard standing and scrubland but also accommodates a number of structures (warehouses, workshops and offices) with a total footprint of 19,885sqft.

2.1.5 The combined site is bounded by the Chiltern Mainline Railway to the south-west, the existing residential development (by Kings Oak and Barteak Developments) to the north and playing fields and allotments to the east.

2.1.6 The site is accessed off Higham Way, which until recently comprised part of the wider land holding. The ownership of this access, however, was transferred to Oxfordshire County Council in January 2013 and since this time, the highway has been upgraded to adoptable standards.

Figure 2.2: View south-east at site entrance

2.2 Topography

2.2.1 A topographical survey of the site has been undertaken by GWP Consultants - see Drawing BANB1301 in **Appendix A**.

2.2.2 The survey indicates that ground levels over the site range from 89.0m AOD, on the boundary near the southern end of the site, up to 91.9m AOD in the northern corner of the site.

2.2.3 General ground levels over the majority of the site are between 89.6m AOD and 91.0m AOD, with the site on a plateau elevated typically 1.0m to 1.5m above the fields to the immediate north.

2.3 Watercourses and Flood Defences

2.3.1 The **River Cherwell** flows in a south easterly direction a minimum of approximately 200m west of the site.

2.3.2 The **Oxford Canal** lies parallel to the River Cherwell and is a further 100m west.

2.3.3 A small drainage channel runs southwards along the eastern boundary of the site. The 1:10,000 scale mapping suggests this passes under the railway line to the south-east of the site to outfall into the River Cherwell.

2.3.4 The EA Product 4 data in **Appendix C** states the following:

> *"This location is offered protection from the Banbury Flood Alleviation Scheme. This consists of a large flood storage area to the north west of the town, as well as various bunds and walls throughout the town. These are maintained by the Environment Agency and some private owners. The site will be offered up to 1 in 200 year protection (0.5% chance of occurring annually). There are no other planned defences in this area."*

2.3.5 The Banbury Flood Alleviation Scheme was finalised subsequent to the release of the SFRA and, as such, is not discussed in detail within the report.

2.4 Geology and Groundwater

2.4.1 A 'Ground Investigation at Merton Street, Banbury' report by Hydrock (May 2009) was provided to inform the ground conditions at the site. This summarises the ground conditions as follows:

> *"Made Ground- variable granular and cohesive strata characterised by predominantly granular demolition materials, foundry discards and cohesive re-worked Alluvial clay;*
>
> *Alluvium- clay and sandy clay with occasional sand and gravel horizons;*
>
> *River Terrace Deposits- gravelly sand and sandy gravel; and*
>
> *Lower Lias clay (Jurassic)- stiff grey clay."*

2.4.2 The report confirms that the Lower Lias clay is a non-aquifer and does not lie within a groundwater Source Protection Zone (SPZ).

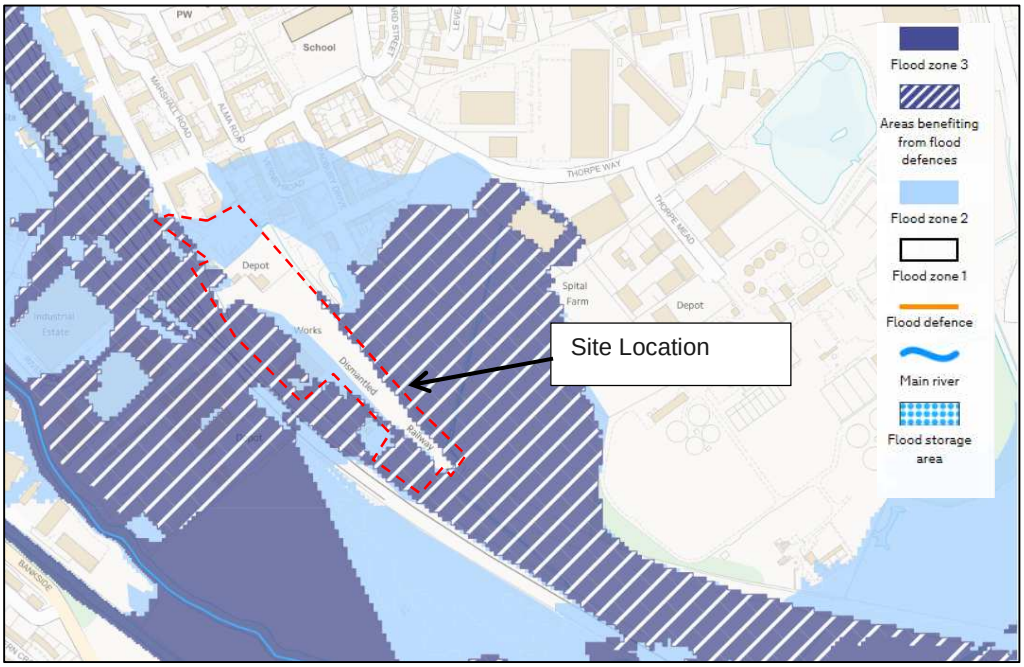
3 Overview of Flood Risk

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.

Figure 3.1: EA Flood Zone Map



3.1.2 The Flood Zone map indicates that:

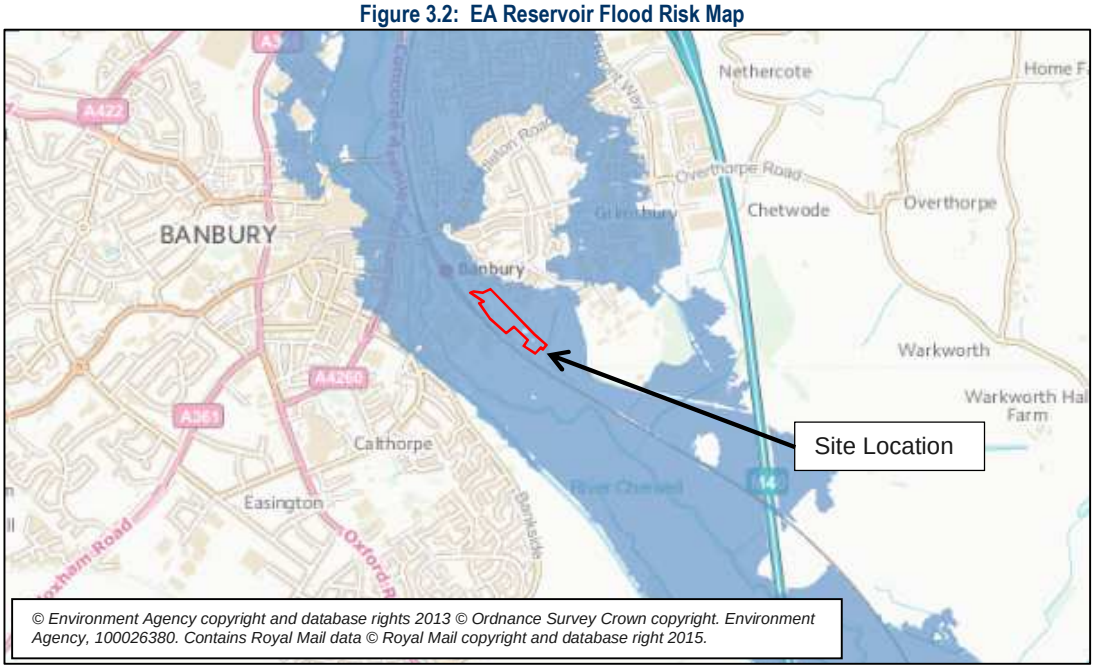
- The central and norther side of the site lies in **Flood Zone 1 'Low Probability'** (unshaded – less than 1 in 1000 (<0.1%) annual probability of river flooding).
- The north-western end of the site and parts of the southern side of the site lie in **Flood Zone 2 'Medium Probability'** (between 1 in 100 (1.0%) and 1 in 1000 (0.1%) annual probability of river flooding).
- A smaller area on the southern side of the site lie in **Flood Zone 3 'High Probability'** (greater than 1 in 100 (>1.0%) annual probability of river flooding).

3.1.3 The Flood Zone classification ignores the presence of flood defences. As discussed in **Section 2.3**, the EA Product 4 flood data indicates that the site is protected up to 1 in 200 year (0.5% annual probability) standard by the Banbury Flood Alleviation Scheme, and the hatching over the area denotes it is a location benefitting from flood defences.

EA Flood Risk from Reservoirs Map

3.1.4 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).

Figure 3.2: EA Reservoir Flood Risk Map



3.1.5 These maps indicate the site is in an area at risk of such flooding if a breach occurred to the reservoir that forms part of the Banbury Flood Alleviation Scheme.

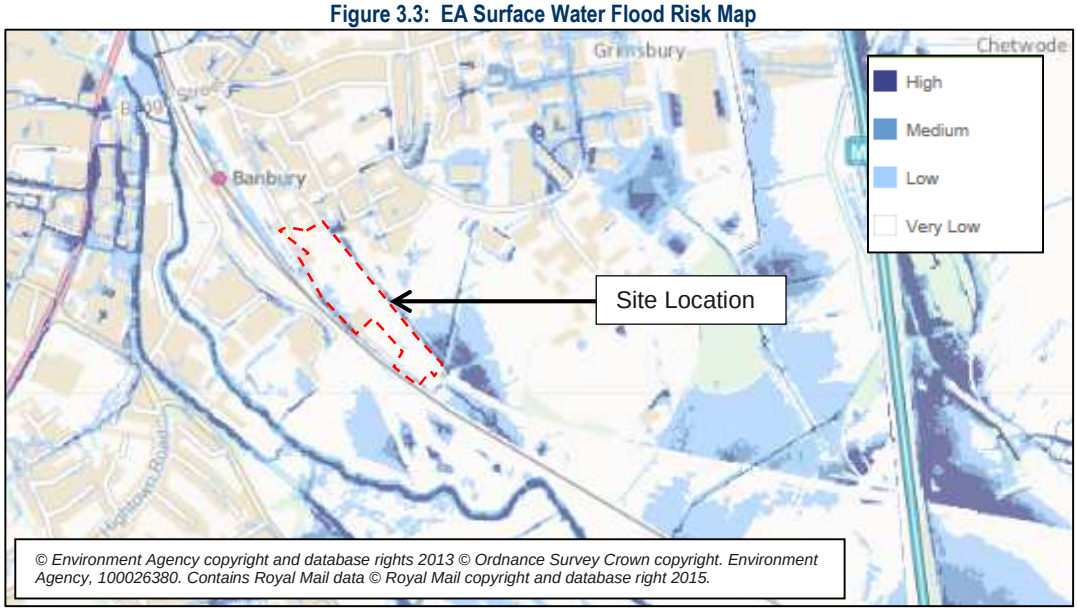
3.1.6 Despite the potential flood risk indicated on the mapping, it should be emphasised that the actual risk of flooding from reservoir breach is very small; the EA are the enforcement authority for the Reservoirs Act (1975) and all large raised reservoirs – especially those which form an integral flood alleviation function – are inspected and supervised by reservoir panel engineers.

EA Flood Risk from Surface Water

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

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

Figure 3.3: EA Surface Water Flood Risk Map



3.1.9 **Figure 3.3** indicates that the majority of the site lies in the 'Very Low' risk of surface water flooding (unshaded – less than 1 in 1000 (<0.1%) annual probability of flooding). A small area along the south-west boundary lies in the 'Low' risk area (between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of flooding).

3.1.10 It is notable that there are more extensive areas at 'High' and 'Medium' risk of surface water flooding in the fields to the north and east of the site, which are at a lower elevation than the site.

3.2 OCC Preliminary Flood Risk Assessment

3.2.1 Oxfordshire County Council (OCC) is defined as a 'Lead Local Flood Authority' ('LLFA') under the Floods and Water Management Act 2009. The first step of the Flood Risk Regulations is for LLFAs to produce a 'Preliminary Flood Risk Assessment' ('PFRA'), providing a high level overview of flood risk from all sources within a local area, including consideration of surface water, groundwater, ordinary watercourses and canals.

3.2.2 A PFRA was prepared for OCC and released in June 2011. An overview of relevant flood risk information for the site – with an emphasis on the recorded instances of flooding in the July 2007 flood event - is discussed below.

- **PFRA Map 1 'Past flooding – surface water in July 2007'** indicates the Banbury area was impacted by surface water flooding in 2007, although the colour coding indicates the number of properties flooded internally by ordinary watercourse/drainage sources was between 1 and 5 (flooding from fluvial sources is discussed further in the SFRA – see Section 3.3);

- **PFRA Map 2 'Past flooding – Surface water in other events'** does not show any other recorded surface water flooding in the Banbury area;

- **PFRA Map 3 'Past flooding – groundwater'** indicates that Banbury was not impacted by groundwater flooding, based on the recorded instances of flooding in 2—1;

- **PFRA Map 3 'Past flooding – Canal flooding in 2007'** indicates that there were many locations along the length of the canal where overtopping occurred in the 2007 event, and the report states that *'there are five overtopping locations in Banbury that may have contributed to the main river flooding that occurred there during the event'*. It should be

noted that both the River Cherwell and the railway line lie between the site and the canal (approximately 300m to the west), providing a buffer should any significant overtopping or breach occur in the vicinity of the site. The PFRA indicates 2 locations where breaches occurred, with the nearest approximately 3km south of the site;

- **PFRA Map 5 'Flood Map for Surface Water'** provides an approximate extent of flooding for a 1 in 200 annual probability rainfall event. The site and surrounding area are not shown to be affected, and due to the coarse nature of the mapping the EA surface water mapping is assumed to take precedence (see Section 3.1). The associated **PFRA Map 6a** shows the numbers of people affected in the same rainfall event, and highlights that the main urban areas – including Banbury – would become hotspots of pluvial flooding when considering the population concentrations;

- **PFRA Map 7 'Areas Susceptible to Groundwater Flooding'** shows the District-wide susceptibility to groundwater flooding (based on the proportion of each 1km grid square considered susceptible to groundwater emergence). The Banbury area is identified as low risk ('<25%') of groundwater flooding.

3.3 Cherwell and West Oxfordshire Strategic Flood Risk Assessment

3.3.1 The Cherwell and West Oxfordshire 'Level 1' Strategic Flood Risk Assessment (SFRA) was issued in April 2009 and provides an overview of the flood risk information on a district-wide scale. Due to the common sources of data, there is some replication between the SFRA and the PFRA and where data is already discussed from the PFRA in Section 3.2 it is not replicated below). The information of specific relevance to the site is as follows:

- **SFRA Figure A-1** 'Overview of Potential Development Constraints' provides an overview of the Flood Zones over the district, specifically for comparison purposes for the sites submitted at that time for allocation. The large scale of the mapping makes it difficult to verify the impacts at the site, and it is notable that the Flood Zones would have been updated based on the latest EA mapping to those displayed in **Figure 3.1**;

- **SFRA Figure A-3** shows the records of 'total sewer flooding' from the Thames Water DG99 register (this indicates areas that have experienced flooding over the previous 10 years, based on 5-digit postcode regions). This indicates the site is in a postcode area where no previous internal or external sewer flooding had been recorded.

3.4 EA Modelled Flood Level Data

3.4.1 The updated EA Product 4 data (reference THM_31184) provides modelled flood extents and levels of both defended and undefended scenarios for the area from the 'River Cherwell Modelling Study' completed in September 2015 for the Banbury Flood Alleviation Scheme As-Constructed investigations.

3.4.2 This replaces the previous information provided as part of the original FRA from the 2011 River Cherwell Modelling Study.

3.4.3 The EA modelled undefended and defended scenario flood extents are displayed in **Figure 3.4** and **Figure 3.5** respectively.

Figure 3.4: EA Modelled Undefended Flood Extents

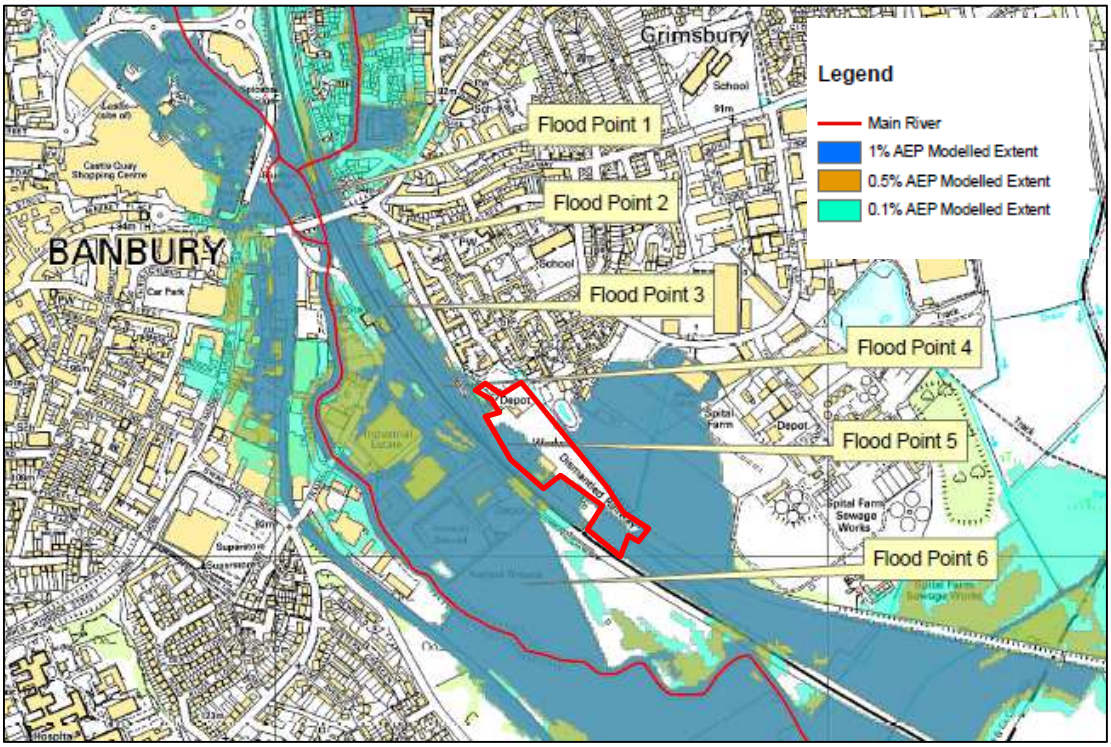
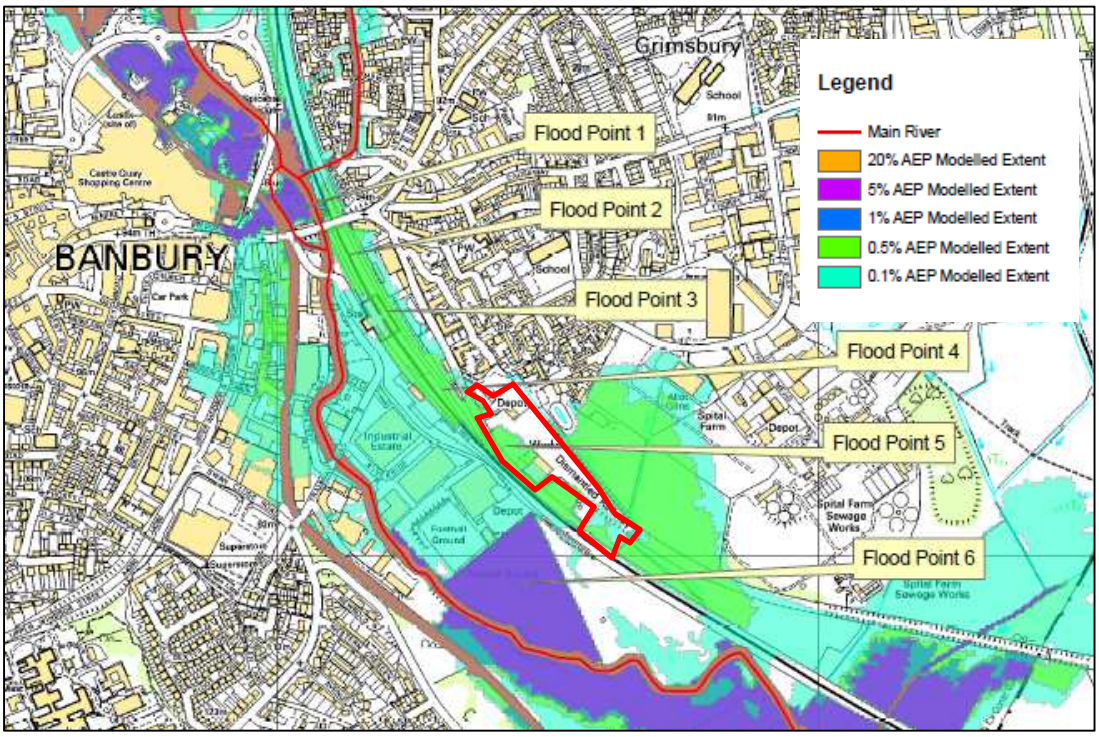


Figure 3.5: EA Modelled Defended Flood Extents



3.4.4 The modelling outputs indicate that, if the flood defence measures in the area were ignored, the south-western side of the site would be impacted in the 1 in 100 annual probability flood event. The north-eastern side of the site is unaffected in all modelled flood events.

3.4.5 The original EA modelling provided as part of the 2015 FRA indicated that the site was defended for all scenarios except the extreme 1 in 1000 annual probability event. In the updated modelling

of the 'defended' scenario, the south-western side of the site is now indicated as being affected in the 1 in 200 annual probability scenario.

3.4.6 The EA have also provided the base hydraulic model and outputs from the River Cherwell Modelling Study, which has been interrogated to provide greater on the modelled flood levels over the site. Results have been extracted from this model to provide the modelled flood levels in **Table 3.1** (undefended scenario) and **Table 3.2** (defended scenario).

Table 3.1: EA Modelled Flood Levels – Undefended Scenario

Flood Event (Annual Probability)	Modelled Flood Level (m AOD)		
	South-western boundary (node 1)	South-eastern boundary (node 5/6)	North-east channel (node 2)
1 in 100 (1%)	90.46	90.08	90.07
1 in 200 (0.5%)	90.51	90.15	90.14
1 in 1000 (0.1%)	90.58	90.19	90.16

Table 3.2: EA Modelled Flood Levels – Defended Scenario

Flood Event (Annual Probability)	Modelled Flood Level (m AOD)		
	South-western boundary (node 1)	South-eastern boundary (node 5/6)	North-east channel (node 2)
1 in 100 (1%)	n/a	n/a	n/a
1 in 200 (0.5%)	n/a	89.69	89.39
1 in 1000 (0.1%)	90.56	90.16	90.15

3.4.7 A comparison of the level survey and the EA flood levels has been used to derive the detailed flood extents over the site on the following PBA drawings (see **Appendix E**):

- **PBA Drawing 33390/4001/001A** – Undefended Modelled Extents – A corridor of land along the northern boundary and a wider zone along the south-west boundary falls within the 1 in 100 annual probability floodplain. A nominal ridge running along the centreline of the site lies outside all modelled flood events, up to and including the extreme 1 in 1000 annual probability scenario;

- **PBA Drawing 33390/4001/002A** – Defended Modelled Extents – The site is unaffected in the 1 in 100 annual probability flood event. The majority of the site is also unaffected in the 1 in 200 annual probability flood, although the southern end of the site and isolated areas along the northern boundary are impacted. The extreme 1 in 1000 annual probability floodplain is more extensive along the southern boundary, but there remains an unaffected corridor of higher land through the centre of the site.

3.5 Impact of Climate Change

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

3.5.2 In February 2016 the EA released new guidance on the application of climate change allowances in flood risk assessments:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

3.5.3 This guidance provides contingency allowances for potential increases in peak river flow in Table 1, for potential increases in rainfall intensity in Table 2 and for sea level rise allowances in Table 3.

3.5.4 The peak river flow allowances table provides a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The provided allowances are also subject to the vulnerability classification of the proposed use and the river basin district of the site.

3.5.5 The peak river flow allowances to be considered as part of the FRA for the proposed 'More Vulnerable' development at the specified location are as detailed in **Table 3.3**.

Table 3.3: Climate Change – Peak River Flow Allowances

River Basin District	Flood Zone	Vulnerability	Range of Climate Change Allowances requiring consideration (2115 design horizon)		
			Central	Higher Central	Upper End
Thames	*3a*	*More Vulnerable*	*-*	*+35%*	*+70%*

3.5.6 The EA's River Cherwell Modelling Study (2015) hydraulic model completed in September 2015 was obtained by PBA and re-run to incorporate the updated climate change allowances of +35% ('Higher Central') and +70% ('Higher Central') for 2115.

3.5.7 The methodology of re-running the model and the results are detailed in 'Updated Climate Change Modelling' Technical Note, reproduced as **Appendix E**. This analysis provides the following modelled peak climate change flood levels at the site:

Table 3.4: PBA Modelled Climate Change Flood Levels – Defended Scenario

Flood Event (Annual Probability)	Modelled Flood Level (m AOD)		
	South-western boundary (node 1)	South-eastern boundary (node 5/6)	North-east channel (node 2)
1 in 100 annual probability +35%	90.45	90.09	90.08
1 in 100 annual probability +70%	90.53	90.15	90.15

3.5.8 Flooding in the vicinity of the site occurs from the north-west, with the main corridor of flooding to the south-west of the site. The floodwater then backs up from the south-east along the land drainage channel on the north side of the site, with a constant peak level observed along this channel adjacent to the site (lower than the flood levels on the south-west side of the site).

3.5.9 Comparison of the climate change flood levels with the site topographic survey indicates that the central spine through the site is unaffected by flooding in both defended climate change scenarios, but areas along the south-western side of the site are impacted by up to 500mm and 600mm in the +35% and +70% scenarios respectively, as shown on **PBA Drawing 33390/4001/003 rev B** in **Appendix E**.

3.5.10 The modelled 1 in 100 annual probability +35% allowance for climate change event has been used as a basis for mitigation measures, with the estimated 1 in 100 annual probability +70% allowance for climate change event considered in relation to residual risk. This is an inherently conservative approach as it is on the basis that the flood defence measures protecting the area are not upgraded in line with the increased risk caused by climate change.

4 Proposed Development and Sequential Test

4.1 Proposed Development

4.1.1 This FRA accompanies an outline planning application for the residential redevelopment over the site, for 200 units.

4.1.2 The proposals by JSA Architects is provided in **Appendix B**.

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 residential development is classed as 'more vulnerable' development ('*Buildings used for dwelling houses'*).

4.2.3 The analysis within **Section 3** confirms that the site is located partly within (defended) Flood Zone 3a 'High Probability'. Such development is acceptable in this Flood Zone subject to the Sequential Test and the Exception Test – see **Sections 4.3** and **4.4** respectively.

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 by Cherwell District Council in the document 'Sequential Test and Exception Test (Flooding) - Strategic Sites' (October 2014). The site, described as 'Higham Way' is considered in Sections 5.10 to 5.13 and confirms the site passes the Sequential Test

4.4 NPPF Exception Test

4.4.1 The site is shown on the EA Flood Zone maps as falling within Flood Zone 3a 'High Probability'. 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 – provision of wider sustainability benefits – is detailed in the points set out under Section 5.13 of the Cherwell District Council in the document 'Sequential Test and Exception Test (Flooding) - Strategic Sites' (October 2014).

4.4.3 The details provided within this FRA address the second part of the Exception Test and demonstrate that the site 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 Strategy

5.1 Ground Floor Levels

5.1.1 Standard guidance is for ground floor levels of new residential development to be set at a minimum of 300mm above the modelled 1 in 100 (1.0%) annual probability plus allowance for climate change flood level.

5.1.2 It is proposed that the floor levels are set a minimum of 300mm above the PBA modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario flood level over the site, implying a minimum floor level of between 90.45m AOD (at the south-east end of the site) and 90.85m AOD (at the north-west end of the site).

5.1.3 It should be noted that a significant number of the proposed units are to incorporate undercroft areas, so the floor level of these units will be considerably higher than the minimum level identified above.

5.1.4 It is also proposed that ground floor levels include a suitable freeboard (min. 150mm) above surrounding ground levels to prevent the egress of surface water during an extreme rainfall event. The redevelopment of the site will include appropriate landscaping to redirect overland flow routes away from properties during an extreme rainfall event.

5.1.5 These levels will also minimise residual risk by ensuring any future development is also above all reference modelled levels in the precautionary scenario, assuming no improvement in the current standard of flood defence provided by the Banbury Flood Alleviation Scheme, irrespective of an increase flood risk due to climate change.

5.2 Flood Storage Analysis

5.2.1 Any new development located in Flood Zone 3 should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage over a site; either of which could potentially cause an increase in flood levels on site of elsewhere. This is considered up to the 1 in 100 annual probability +35% allowance for climate change fluvial floodplain.

5.2.2 The EA data and modelled flood extents confirm that the site lies fully outside the defended 1 in 100 (1.0%) annual probability floodplain, but is partially impacted by more severe events, including the modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario.

5.2.3 Should the potential impacts of climate change become a reality, then it is assumed that the flood defences in the area would be improved to ensure the standard of protection is maintained (stated to be 1 in 200 (0.5%) annual probability – see **Section 2.3**). However, when considering the floodplain storage impacts a conservative approach has been taken and assumed no change in the defences from the current situation.

5.2.4 A flood storage analysis has been undertaken to confirm the impacts of the proposed development in the reference flood event – see **PBA drawing 33390/4001/004** in **Appendix E**. Through the siting of development outside the floodplain where feasible, and the incorporation of floodable undercroft areas for development within the floodplain, the scheme ensures no detrimental impact on floodplain storage capacity.

5.3 Safe Access Arrangements

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

5.3.2 The site lies fully outside the 1 in 100 (1.0%) annual probability floodplain due to the protection provided by the Banbury Flood Alleviation Scheme. As such, the proposed development will have continuous safe access up to and at this flood event.

5.3.3 The development provides continuous safe access for all residents in the PBA modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario and safe refuge would be available within all dwellings.

5.3.4 In the unlikely event of a reservoir breach or other failure of the Flood Alleviation Scheme, the proposed ground floor levels are set above both the defended and undefended extreme 1 in 1000 (0.1%) annual probability flood levels, ensuring 'safe refuge' would be available within all dwellings for the duration of any flood event.

6 Surface Water and SuDS

6.1 Overview of Surface Water Drainage Policy Requirements

6.1.1 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites. 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.

6.1.2 As of April 2015, the LLFA has become a statutory consultee on planning applications for surface water management. As the LLFA, OCC 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.

6.1.3 The key relevant local planning policy from the Cherwell Local Plan 2011-2031 in relation to SuDS is as follows (***emphasis*** added for key design criteria):

Policy ESD 6: Sustainable Flood Risk Management:

"…Flood risk assessments should assess all sources of flood risk and demonstrate that:

- *There will be* ***no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)***

- ***Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.***

Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that the development will not increase flood risk elsewhere, including sewer flooding."

Policy ESD 7: Sustainable Drainage Systems (SuDS):

"All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.

Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.

In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features".

6.1.4 Further to the requirements above, the pre-application advice from Cherwell District Council (Cherwell reference: 15/00161/Pre-App) indicated that surface water drainage should be

attenuated to greenfield runoff rates (the response also identified that receiving drainage ditches would need to be cleared as part of any redevelopment).

6.1.5 The following section provides an overview of the proposed strategy for the management of surface water from the new development.

6.2 NPPF PPG Drainage Hierarchy

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

6.2.2 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the NPPF PPG states the following (consistent with the Building Regulations H3 hierarchy):

> ***...the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:***
>
> ***- into the ground (infiltration),***
>
> ***- to a surface water body,***
>
> ***- to a surface water sewer, highway drain or another drainage system,***
>
> ***- to a combined sewer***

Consideration of Infiltration Drainage

6.2.3 Based on the aforementioned hierarchy, the preferred method for disposal of surface water from the new development is via infiltration drainage.

6.2.4 An assessment of the potential for infiltration drainage has been made in the Hydrock Ground Investigation discussed in Section 2.4. That report concludes "*Due to the low permeability of the Lower Lias, pervasive contamination in the Made Ground and the depth to groundwater at the site, soakaway drainage is considered unfeasible and is not recommended*".

6.2.5 As such, the use of infiltration drainage at the site has been discounted.

Consideration of Discharge to Surface Water Body

6.2.6 Where infiltration is not appropriate, the next preference in the hierarchy is discharge to a surface water body (i.e. lake,pond or river).

6.2.7 A drainage channel runs in a southwards direction along the eastern boundary of the site, flowing south-east to eventually discharge into the River Cherwell. As such, this is considered the most appropriate route for the disposal of surface water.

6.3 Runoff Rate Assessment

6.3.1 The existing site is conservatively estimated to be 65% impermeable with a total impermeable area of 1.98ha. The remaining 1.07ha of the site is soft landscaping/amenity area.

6.3.2 The existing brownfield runoff rates have been calculated using the Modified Rational Method and the greenfield runoff rates have been calculated within MicroDrainage (v. 2015.1), and are provided in **Table 6.1**.

Figure 6.1: Existing Runoff Rates

Annual Probability Rainfall Event	Existing Brownfield Runoff Rate (1.98ha) (l/s)	Existing Greenfield Runoff Rate (1.07ha) (l/s)	Total Existing Runoff Rate (3.05ha) (l/s)
1 in 1 year	322.7	1.7	324.4
1 in 30 year	754.7	4.4	759.1
1 in 100 year	931.7	6.2	937.9

6.3.3 Post re-development of the site, the extent of impermeable area will be reduced from 1.98ha (65%) to 1.6ha (52%).

6.3.4 As mentioned in Section 6.1, the pre-application enquiry to Cherwell District Council advises that the runoff rate from the proposed development should be restricted to greenfield runoff rates. The equivalent greenfield runoff rates for the proposed impermeable area and proposed brownfield runoff rate (with no mitigation) is shown in **Table 6.2**.

Figure 6.2: Proposed Runoff Rates (No Mitigation/Attenuation)

Annual Probability Rainfall Event	Existing Brownfield Runoff Rate (1.98ha) (l/s)	Proposed Brownfield Runoff Rate (No Mitigation (1.6ha) (l/s)	Equivalent Greenfield Runoff Rate (1.6ha) (l/s)
1 in 1 year	322.7	260.8	2.4
1 in 30 year	754.7	609.9	6.6
1 in 100 year	931.7	752.9	9.3

6.3.5 The 1 in 1 year greenfield runoff rate is too small to attenuation as the risk of blockage of the flow control device would not be managed to an acceptable level (ref. *Preliminary Rainfall Runoff Management for Developments Rev E*). It is therefore proposed to restrict the runoff rate from the proposed development to a minimum of 5.0 l/s for the 1 in 1 year event, and up to 9.3 l/s up to the 1 in 100 (1.0%) annual probability plus climate change rainfall event.

6.4 Outline Surface Water Drainage Strategy

6.4.1 The amount of onsite storage required to provide attenuation has been considered for a range of events from the 1 in 1 year to the 1 in 100 year plus climate change rainfall event.

- 1 in 1 year rainfall event (5.0 l/s): 270 - 410m^3
- 1 in 100 year plus climate change rainfall event (9.3 l/s): 870 - 1170m^3

6.4.2 These attenuation storage volumes would be accommodated within lined permeable paving beneath parking areas, and swales and/or detention basins within the public courtyards/open spaces, which would attenuate and treat surface water runoff before it is discharged to the adjacent existing ditch.

6.4.3 The proposed SuDS attenuation facilities would be sized to accommodate the 1 in 100 (1.0%) annual probability plus 30% allowance for climate change rainfall event.

6.4.4 The surface water drainage strategy will be developed further at the detailed design stage, with confirmation of the locations of outfalls and agreed discharge rates.

6.4.5 The proposed redevelopment of the site will reduce the coverage of impermeable areas through the provision of private gardens and public open space compared to the existing site. As such, this alone will ensure there is a decrease in total runoff rates at the site in comparison to existing.

Restricting the runoff rate to greenfield runoff rates will significantly reduce the total runoff rate from the site in comparison to existing and pollution treatment is provided through the use of the SuDS attenuation facilities.

6.5 Pollution Control

6.5.1 Pollution control measures will be included to minimise the risk of contamination or pollution entering the receiving water body from surface water runoff from the development.

6.5.2 The surface water drainage system will be designed to comply with the requirements of the SuDS treatment train as detailed in CIRIA 697 'The SUDS Manual'. Trapped highway gullies will be incorporated to mitigate diffuse pollution arising from the development and all surface water will be routed through detention basins or lined permeable pavement systems.

6.5.3 In accordance with CIRIA 697, runoff from residential areas will undergo two stages of treatment. The provision of proprietary oil/silt and debris traps as part of the conventional drainage system is appropriate as the first stage of treatment. Retention in attenuation features, vegetative filtering or infiltration systems would provide an appropriate second stage of treatment.

6.6 Maintenance and Adoption

6.6.1 The SuDS drainage features on the site will be maintained regularly to ensure effective operation. Typical maintenance activities would include sweeping and inspection of the permeable pavements, inspection, mowing, desilting and weeding of the surface features.

6.6.2 It is clear that such specifics would be addressed in significantly greater detail beyond the current outline planning stage; the frequency and the responsible persons for undertaking the maintenance will be confirmed at the detailed design stage when the proposed SuDS drainage features (and therefore the specific maintenance requirements) will be confirmed.

6.7 Designing for Exceedance

6.7.1 The NPPF requires that surface water drainage systems should cope with events that exceed the design capacity of the system. 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. This excess water should be safely stored or conveyed from the site without adverse impacts to the development proposals, adjacent existing development or downstream.

6.7.2 The site levels will be designed to ensure that any overland flows are routed away from building towards the less vulnerable highways, open space and surface water drainage channel.

6.7.3 In addition, each attenuation feature will be designed with an appropriate freeboard to limit the risk of overtopping in severe rainfall events.

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 substantial 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 PBA modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario flood level over the site, implying a minimum floor level of between 90.45m AOD (at the south-east end of the site) and 90.85m AOD (at the north-west end of the site). Floor levels will include a suitable freeboard above surrounding ground levels to prevent the egress of surface water during an extreme rainfall event.

7.1.3 As the increase in flood level from the +35% climate change allowance event to the +70% event is less than 100mm, the proposed freeboard also ensure the development is safe for the range of climate change scenarios to be considered.

7.1.4 The development provides continuous safe access for all residents in the PBA modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario and safe refuge would be available within all dwellings.

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

7.1.6 As such, the residual risk is considered to be acceptable for the lifetime of the development.

8 Conclusion

8.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support an outline planning application for a 200-unit residential development on the Grundon Waste Management Depot site in Banbury.

8.1.2 This FRA concludes that:

- The site lies partly within Flood Zone 3a 'High Probability' (greater than a 1 in 100 (>1%) annual probability of river flooding);
- The Flood Zone classification ignores the presence of flood defences. The EA indicate the site and surrounding area is protected by the Banbury Flood Alleviation Scheme to the 1 in 200 (0.5%) annual probability standard, although the latest modelling suggests protection is to the current 1 in 100 (1%) annual probability standard.
- A Sequential Test has been carried out by Cherwell District Council. The Test also set out the 'wider sustainability benefits' of the development to address part (i) of the Exception Test. This FRA demonstrates part (ii) of this Test has been passed.
- The ground floor levels are proposed to be a minimum of 300mm above the PBA modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario flood level over the site, implying a minimum floor level of between 90.45m AOD (at the south-east end of the site) and 90.85m AOD (at the north-west end of the site). Floor levels will also incorporate a suitable freeboard (min. 150mm) above surrounding ground levels (to prevent the egress of surface water during an extreme rainfall event) and there will be appropriate landscaping to redirect overland flow routes away from properties during an extreme rainfall event.
- A floodplain storage analysis has been undertaken, conservatively based on the modelled extreme 1 in 100 annual probability +35% allowance for climate change 'defended' scenario (i.e. allowing for increases due to climate change but no improvements in defences from existing) which demonstrates the proposed development will not detrimentally impact on the floodplain storage capacity.
- Continuous safe access is available for the proposed dwellings and 'safe refuge' would be available within all units.
- An outline surface water drainage strategy has been developed for the site incorporating on-site attenuation and controlled discharge to greenfield runoff rates to the adjacent drainage channel. The outline strategy has been designed to the 1 in 100 (1.0%) annual probability plus 30% allowance for climate change event and demonstrates a reduction in peak runoff rates from existing.

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 Site Survey

- GWP Consultants Topographic Survey Drawing BANB1301 (February 2013)

Appendix B JSA Proposals

- JSA Drawing GMSB-PL-112 – Proposed Heights and Parking Layout
- JSA Drawing GMSB-PL-113 – Phasing Plan
- JSA Drawing GMSB-PL-114 – Land Use Plan
- JSA Drawing GMSB-PL-123 – Illustrative View of Proposal

Appendix C EA Product 4 Flood Data

- EA Product 4 Flood Data (EA reference THM_31184, dated December 2016)
    - Flood Zone Map
    - Flood defence information
    - Model information
    - Modelled flood extents
    - Modelled flood levels
    - Historic flood map
    - Historic flood data

Appendix D PFRA and SFRA Data

- OCC Preliminary Flood Risk Assessment (PFRA) Figures
    - PFRA Map 1 ‘Past flooding – surface water in July 2007’
    - PFRA Map 2 ‘Past flooding – Surface water in other events’
    - PFRA Map 3 ‘Past flooding – groundwater’
    - PFRA Map 4 ‘Past flooding – Canal flooding in 2007’
    - PFRA Map 5 ‘Flood Map for Surface Water’
    - PFRA Map 6a ‘People affected by flooding in a 1 in 200 rainfall event’
    - PFRA Map 7 ‘Areas Susceptible to Groundwater Flooding’

- Cherwell and West Oxfordshire Strategic Flood Risk Assessment (SFRA) Figures
    - SFRA Figure A-1 ‘Overview of Potential Development Constraints’
    - SFRA Figure A-3 shows the records of ‘total sewer flooding’

Appendix E PBA Drawings and Tech Notes

- Drawing 33390/4001/001A - Modelled Flood Extents – Defended Scenario
- Drawing 33390/4001/002A - Modelled Flood Extents – Undefended Scenario
- Drawing 33390/4001/003B - Modelled Flood Extents – +35% and +70% climate change scenarios (defended)
- Drawing 33390/4001/004 – Floodplain Storage Analysis
- 'Updated climate change modelling' Technical Note