8 Rectory Close, Wendlebury Flood Risk Assessment

Final Report

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This report describes work commissioned by Simon James, acting on behalf of Mr and Mrs Hooke by an email dated 11/12/2017. Anna Hastings and Aaron Barber of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Final Report for Simon James, acting upon behalf of Mr and Mrs Hooke. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

Acknowledgements

JBA would like to acknowledge Bob Hooke, Simon James and the Environment Agency for their provision of the relevant information required for this Flood Risk Assessment.

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Executive Summary

Background

JBA Consulting was commissioned by Simon James in December 2017 to undertake a Flood Risk Assessment and hydraulic modelling for the proposed development of a new dwelling on the site at 8 Rectory Close, Wendlebury, Oxfordshire.

The Wendlebury Brook watercourse flows along the northern site boundary at the bottom of the existing property's garden. Currently the site is identified on the flood maps prepared by the Environment Agency to be situated within Flood Zones 1, 2 and 3 with the proposed development being situated within Flood Zone 1 and 2.

The Cherwell and West Oxfordshire Strategic Flood Risk Assessment (2009) states that Wendlebury has had a record of flooding in the past, most notably fluvial events in 2007 and 2012. However, it is understood from our client that no flooding was recorded at the site during those events.

Methodology

A desk-based study was undertaken which involved a review of local flood risk policy as described within the Cherwell and West Oxfordshire Strategic Flood Risk Assessment (2009), Oxfordshire Flood Risk Assessment (2011), Thames Catchment Flood Management Plan (2009), Cherwell District Council North Oxfordshire Local Plan (2015) and a review of Environment Agency's data sets and other relevant policy guidance.

Additionally, the Environment Agency's Wendlebury Brook hydraulic model was acquired and re-run using the 2016 Climate Change Allowances, to assess the impact of climate change on the site for a 1% AEP flood event.

Conclusions and recommendations

The Environment Agency's Flood Map for Planning showed that the site contains areas within Flood Zones 1, 2 and 3 (low to high probability of flooding from rivers and the sea). The proposed development is situated within fluvial Flood Zones 1 and 2 (low to medium probability of flooding from rivers). The section of the proposed development which is situated within Flood Zone 2 is the south-western corner; however, reference to the model data indicates that flood depths at this location are very shallow. For instance, in the 1% AEP + 70% climate change and 0.1% AEP scenarios, depths were modelled to be <1cm. Therefore, the site plan design is based on the application of a sequential risk-based approach to minimise the flood risk to the new development.

The Environment Agency's Risk of Flooding from Surface Water flood maps showed areas of low to high flood risk within the site. The majority of the site was found to be at low risk of surface water flooding. The majority proposed development footprint was found to largely be situated within an area of medium risk of surface water flooding. The potential increase of impermeable surface area post development could increase surface water flood risk to the site and third party property. It is therefore recommended Sustainable Drainage Systems are implemented to reduce the potential surface water effect of development at the site.

The site is considered to be at low risk of sewer and groundwater flooding, and not at risk of reservoir flooding.

Updated hydraulic modelling showed that in the future, climate change would increase the flood extent and depth at the site. Flood depths within the garden were predicted to be <10cm, whereas depths within the proposed development footprint were predicted to be <1cm. The finished floor levels of the development were therefore proposed to be 600mm above the flood level making the recommended minimum floor levels 64.83mAOD so there is no property flooding under climate change conditions.

To address the residual risk for events greater than that considered in the assessment and to address the potential surface water flood risk flood resilience measures such as the implementation of flood resistant airs bricks and flood proof doors are also recommended in the construction of the proposed dwelling.

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Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CFMP	Catchment Flood Management Plan
EA	Environment Agency
FRA	Flood Risk Assessment
ISIS	Hydrology and hydraulic modelling software
LiDAR	Light Detection and Ranging
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Policy Guidance
SFRA	Strategic Flood Risk Assessment
TUFLOW	Two-dimensional Unsteady FLOW (a hydraulic model)

1 Introduction

1.1 Terms of reference

JBA was commissioned by Simon James in December 2017 to undertake a Flood Risk Assessment (FRA) and hydraulic modelling for the proposed development of a new detached residential dwelling and associated access on land within the site boundary of the existing 8 Rectory Close, Wendlebury.

This FRA provides information pertaining to the nature of flood risk at the site in order to support the full planning application of development. This FRA follows practice described in the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance (PPG) with regards to development and flood risk.

1.2 Requirements

It is a requirement for development applications to consider the potential risk of flooding from various sources to a proposed development over its lifetime and any possible impacts on flood risk elsewhere as a result of the development.

Where appropriate, the following aspects of flood risk should be addressed and the extent to which the development is designed to deal with flood risk:

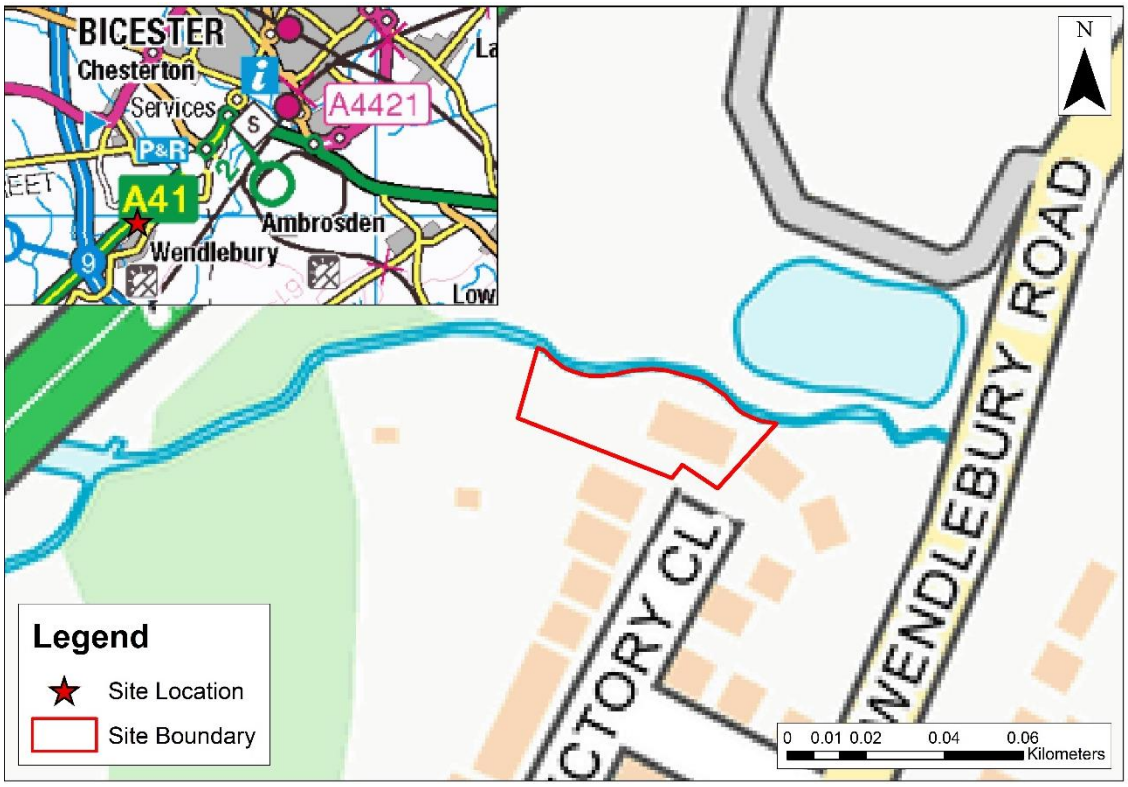
- The nature and expected lifetime of the development and the extent to which the development is designed to deal with flood risk;
- The area liable to flooding from various sources;
- The probability of the current and future flood risk;
- The extent and standard of existing flood defences and their effectiveness over time;
- The likely depth of flooding;
- The rates of predicted flows;
- The likelihood to impacts on other areas, properties and habitats;
- The effects of climate change.

Flood risk to and from the site has been determined based on the Environment Agency's (EA) Products 4, 5, 6 and 7 flood risk map and modelling data, publicly available information, a review of OS maps and the EA's 2m LiDAR.

2 Site Details

Table 2-1: Site description

Site Name	8 Rectory Close, Wendlebury
Site area	0.12ha
Existing land-use	Residential dwelling
Proposed development	New detached dwelling and associated access
Grid reference	456170, 219880
County	Oxfordshire
Local Planning Authority	Cherwell District Council
Lead Local Flood Authority	Oxfordshire County Council



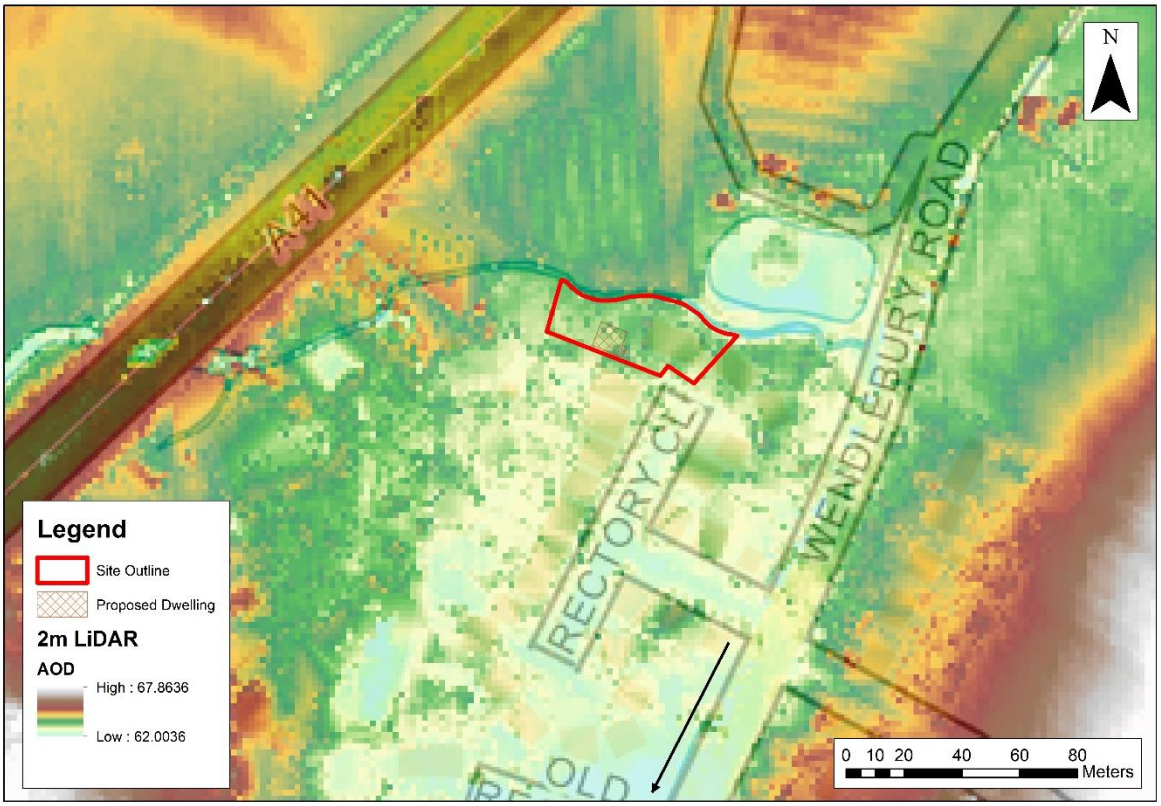
2.1 Site Description

The site is located at 8 Rectory Close, Wendlebury, Bicester, OX25 2PG. An overview of the site details is listed in Table 2-1. The property at the site is a detached residential dwelling (8 Rectory Close). The Wendlebury Brook flows along the northern site boundary - located at the bottom of the existing dwelling's garden.

2.1.1 Site topography

The site's topography is displayed within Figure 2-1. Using 2m LiDAR, topographic levels were noted to be variable across the site. Highest elevations are seen to be located around the existing dwelling, the highest value being 64.38m AOD in the centre of the site, close to the northern site boundary. From here the topography gently slopes towards the south of the site. The lowest elevation in the site are observed to be 63.28m AOD in the north east corner of the site, close to the northern site boundary.

Figure 2-1: Site topography



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2.1.2 Site geology

The British Geological Survey 'Geology of Britain Viewer'[1] was used to identify the local geology. The site and the surrounding area is underlain by the Kellaways Formation and Oxford Clay Formation which primarily consists of Mudstone, Siltstone and Sandstone and was formed approximately 165 and 160 million years ago.

2.1.3 Watercourses

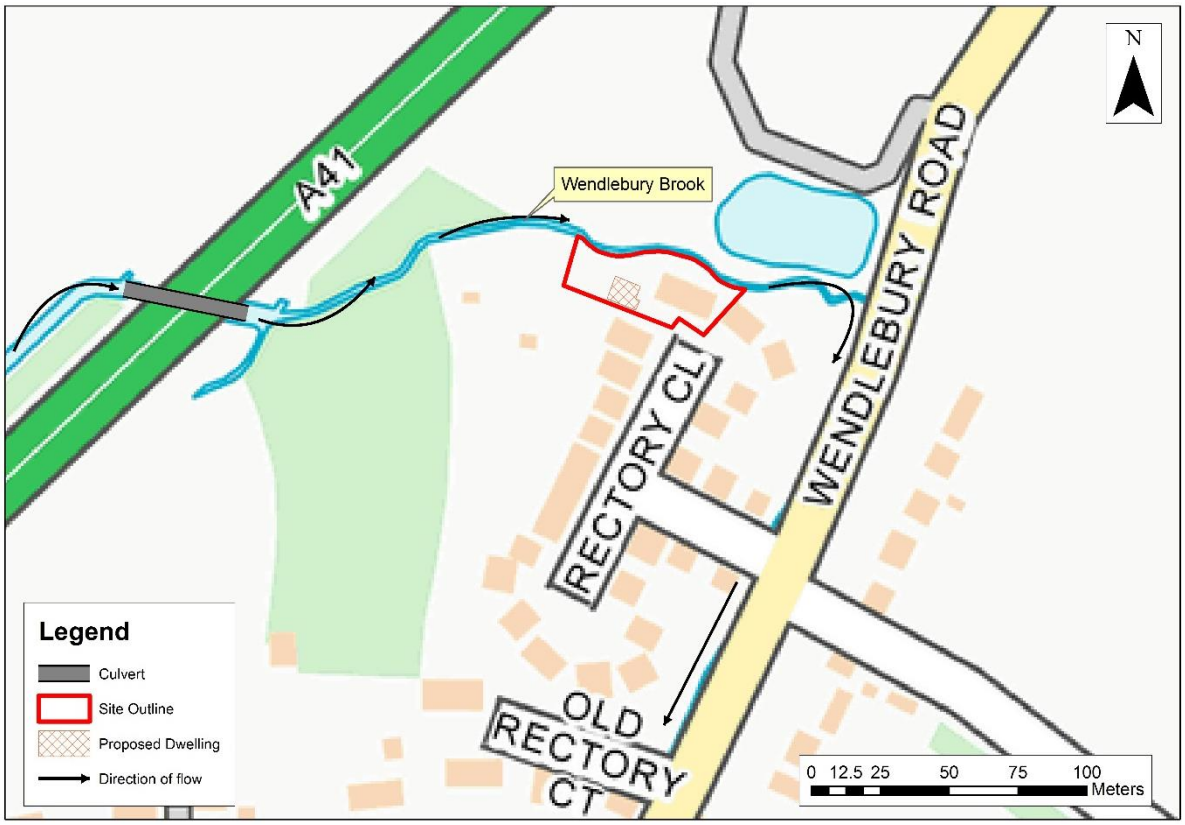
The Wendlebury Brook forms the northern property boundary and is displayed within Figure 2-2. The stream originates from numerous tributaries to the north and west of the site, which flow from Little Chesterton and from the western side of the M40. The brook then flows through a culvert under the A41 dual carriageway, before running east past the site. The stream flows past the proposed development site before turning sharply south at Wendlebury Road and meeting another tributary flowing from the north. The brook then runs south along Wendlebury Road, through Wendlebury village. The brook flows into the New River Ray 3km downstream of Wendlebury, which is a tributary of the River Cherwell.

2.2 Proposed development

The proposed development consists of the erection a new detached dwelling within the site boundary of the existing 8 Rectory Close, Wendlebury and associated driveway to Rectory Close. The proposed development outline is displayed in Figure 2-2.

1 British Geological Survey (2017), Geology of Britain Viewer, last accessed 02-08-2017

Figure 2-2: Proposed development



3 Planning policy and flood risk

3.1 Planning Context

The NPPF was introduced by the Department for Communities and Local Government in March 2012 and supersedes the Planning Policy Statements. Its technical guidance relates to development planning and flood risk using a sequential characterisation of risk based on Flood Zones and the EA Flood Map, and minerals policy. The main study requirement is to identify the Flood Zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions. The NPPF is accompanied by Planning Practice Guidance (PPG) on Flood Risk and Coastal change, which gives further information on the approaches to be adopted in the assessment of flood risk for new development.

3.2 Development site Flood Zones

The PPG states that the flood risk is a function of:

- *"The likelihood of a particular flood happening, best expressed as a chance or probability over a period of one year. For example, 1 in 100-year flood means that 'there is a 1 in 100 chance of flooding in any given year in this location'.*
- *The impact or consequences that will result if the flood occurs."*

The PPG categorise the risk into a series of Flood Zones; a definition of the Flood Zones can be found in Table 3-1. The EA has developed Flood Mapping which shows the risk of flooding in England and Wales for different return period events. The mapping provides the basis for the assessment of flood risk and development suitability. Table 3-2 in Section 3.3 shows how the Flood Zones relate to a sequential planning response as advised by the NPPF.

It is important to note that, in the majority of cases, the EA's Flood Mapping is based on broad-scale river modelling and provides an indication of the potential flood risk in the area rather than a site-specific assessment. Where appropriate, a hydraulic river modelling study is undertaken and the broad-scale river model outputs are updated using the detailed river model to represent the site-specific conditions.

It should also be noted that the EA Flood Map for Planning does not take into account flood defences or the flood risk associated with culverted blockages, sewer flooding or any other specific local conditions.

The EA's Flood Map for Planning shows that the site is located within Flood Zones 1, 2 and 3 and therefore the site has a range of risk from low to high probability. The Cherwell District Council North Oxfordshire Strategic Flood Risk Assessment situates the site within Flood Zone 3b and is therefore classified as a functional floodplain. This is discussed further in Section 4.3.

3.3 NPPF flood zones and risk tables

Table 3-1 shows how the Flood Zones relate to a sequential planning response. Advisory notes placed upon various types of development are detailed in Table 3-2 and details of the Sequential and Exception Tests are provided in Table 3-3.

Table 3-1: Flood Zones

Zone 1: low probability	
Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).	**Appropriate uses** All uses of land are appropriate in this zone. **FRA requirements** For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless factors above or other local considerations require particular attention. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.
Zone 2: medium probability	
Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.	**Appropriate uses** The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table 2 are appropriate in this zone. Highly vulnerable uses in Table 2 are only appropriate in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 3a: high probability	
Land assessed as having a 1 in 100 or greater probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	**Appropriate uses** The water-compatible and less vulnerable uses of land in Table 2 are appropriate in this zone. The highly vulnerable uses Table 2 should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2 should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to: reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; relocate existing development to land in zones with a lower probability of flooding; create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.
Zone 3b: functional floodplain	
Land where water *has* to flow or be stored in times of flood. Local Planning Authorities should identify functional floodplain and its boundaries in the SFRA, in agreement with the EA. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designated to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify functional floodplain.	**Appropriate uses** Only the water-compatible uses and the essential infrastructure listed in Table 2 that has to be there should be permitted. It should be designed and constructed to: remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows; and not increase flood risk elsewhere. Essential infrastructure in this zone should pass the Exception Test. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** In this zone, developers and local authorities should seek opportunities to: reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; relocate existing development to land with a lower probability of flooding.

Source: Table 1, PPG/NPPF Technical Guidance

Table 3-2: Flood risk vulnerability classification

Essential infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines.
Highly vulnerable	Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes and park homes intended for permanent residential use (Sequential and Exception Tests required for any change of land use to these sites). Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the faculties should be classified as "Essential Infrastructure").
More vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels Non-residential uses for health services, nurseries and educational establishments Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short-let caravan and camping, *subject to a specific warning and evacuation plan.*
Less vulnerable	Police, ambulance and fire stations which are *not* required to be operational during flooding. Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment works and which do *not* need to remain operation during times of flood. Sewerage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water compatible development	Flood control infrastructure. Water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel workings. Docks, marinas and wharves. Navigation facilities. MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category, *subject to a specific warning and evacuation plan.*

Source: Table 2. PPG/NPPF Technical Guidance

Notes:

1. This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2) and also on the need of some uses to keep functioning during flooding.

2. Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

3. The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

Table 3-3: Flood risk vulnerability and Flood Zone compatibility

Vulnerability classification	Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test	✓	✓
Zone 3a	Exception Test	✓	×	Exception Test	✓
Zone 3b	Exception Test	✓	×	×	×

Source: Table 3. PPG/NPPF Technical Guidance

✓ Development is appropriate

× Development should not be permitted

The above table does not show:

1. *The application of the sequential test which guides development to Flood Zone 1 first, then Zone 2, and then Zone 3;*
2. *Flood risk assessment requirements;*
3. *The policy aims for each flood zone.*

3.4 Planning for flood risk

3.4.1 Sequential and Exception Tests

The Sequential Test aims to promote development in low flood risk areas. The Exception Test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

The proposed development is to erect a new dwelling on land within the existing site boundary of 8 Rectory Close, Wendlebury. The NPPF classifies dwellings as 'More Vulnerable', the construction of which is compatible with Flood Zones 1, 2 and 3a, but with a requirement to perform an Exception Test in Zone 3a (Table 3-3). More vulnerable development is not compatible with Flood Zone 3b.

3.5 Environment Agency Climate Change Allowances

The NPPF and supporting Planning Practice Guidance on Flood Risk and Coastal Change explain when and how Flood Risk Assessments should be used. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account.

On 19th February 2016, the EA released updated guidance on climate change allowances to support the NPPF (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances), which superseded the TR2 guidance.

A guidance document illustrating the implications of the updated guidance provides more specific information on:

- The new peak river flow allowances for each river basin
- Determining which allowances to use for flood risk assessments
- Determining the appropriate design flood
- Determining which level of approach to use in the assessment

To provide evidence to demonstrate that the planning application for 8 Rectory Close complies with the updated guidance, the risk of flooding to and from the site has been assessed with the new applicable allowances (see Appendix C).

3.6 Regional and local policy guidance review

3.6.1 Thames Catchment Flood Management Plan (December, 2009)[2]

The Thames Catchment Flood Management Plan (CFMP) provides an overview of the flood risk in the Thames catchment and sets out the preferred plan for sustainable flood risk management over the next 50 to 100 years.

The CFMP has divided the catchment into nine sub-areas with similar physical characteristics, sources of flooding and level of risk. The site is located within sub-area 1 - Towns and villages in open floodplain (north and west).

The preferred policy option in this sub-area is Option 6; areas of low to moderate flood risk where the EA will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

3.6.2 Oxfordshire Preliminary Flood Risk Assessment (June, 2011)[3]

Under the Flood and Water Management Act 2010, a Preliminary Flood Risk Assessment (PFRA) was prepared by Oxfordshire County Council as part of their role as Lead Local Flood Authority (LLFA). The PFRA gives an overview of local flood risk in Oxfordshire and aims to identify any significant flood risk areas that meet national level significance thresholds (a total of 30,000 people or more at risk of flooding).

Based on the available and relevant data records collected for the PFRA and subsequent mapping, the areas surrounding Wendlebury are shown to be at risk of surface water and susceptible groundwater flooding in the future. However, no information regarding past or future flooding could be found specifically for the site itself within the PFRA.

3.6.3 Cherwell and West Oxfordshire Strategic Flood Risk Assessment (April, 2009)[4]

The Cherwell and West Oxfordshire Strategic Flood Risk Assessment (SFRA) was prepared and published in order to guide both individual and strategic development decisions through the Local Development Framework. It is to be used as a tool for assessing flood risk from various sources of flooding in order to prevent inappropriate development in areas at risk and make areas safe without increasing the risk elsewhere.

A review of the SFRA indicates that the site at has no record of flooding at the site itself, however Wendlebury itself has flooded in 2007 from fluvial sources. Although no other site-specific information was obtained from the SFRA, Rectory Close and properties to the south of the development site were recorded to have flooded in 2007 and 2012. It is understood from our client that the development site did not flood during these events, with the Wendlebury Brook overtopping its banks upstream of the site, in the woodland west of the site.

Based upon the mapping provided within Cherwell and West Oxfordshire's SFRA. The site is identified to cross Flood Zones 1, 2, 3a and 3b.

3.6.4 Cherwell District Council North Oxfordshire Local Plan (July, 2015)[5]

The Cherwell District Council North Oxfordshire Local Plan is the Council's central planning policy document. It sets out the core strategy for the council, which was adopted the by the council in July 2015. Flood risk is noted to be a significant concern for the district.

17 essential development policies were identified as part of the Local Plan in order to achieve its vision of the Cherwell District by 2030. The following policies included in the Local Plan aim to address the issue of flooding within the district:

- Policy ESD 1: Mitigating and Adapting to Climate Change
- Policy ESD 6: Sustainable Flood Risk Management
- Policy ESD 7: Sustainable Drainage Systems (SuDS)

2 Environment Agency, (2009), Thames Catchment Flood Management Plan: Summary Report December 2009

3 Oxfordshire County Council, (2011), Oxfordshire Preliminary Flood Risk Assessment

4 Scott Wilson (2009) Cherwell and West Oxfordshire Level 1 Strategic Flood Risk Assessment

5 Cherwell District Council North Oxfordshire (2016) Cherwell Local Plan 2011-2031 Part 1 (re-adopted Policy Bicester 12)

4 Assessment of Flood Risk

4.1 Flood risk assessment requirements

As the proposed development site is partially located within Flood Zones 1, 2 and 3, an FRA considering all sources of flooding (including fluvial, tidal, coastal, surface water and groundwater) is required. The NPPF advocates a risk-based sequential approach to flood risk management in terms of appraising, managing and reducing the consequences of flooding both to and from a development site.

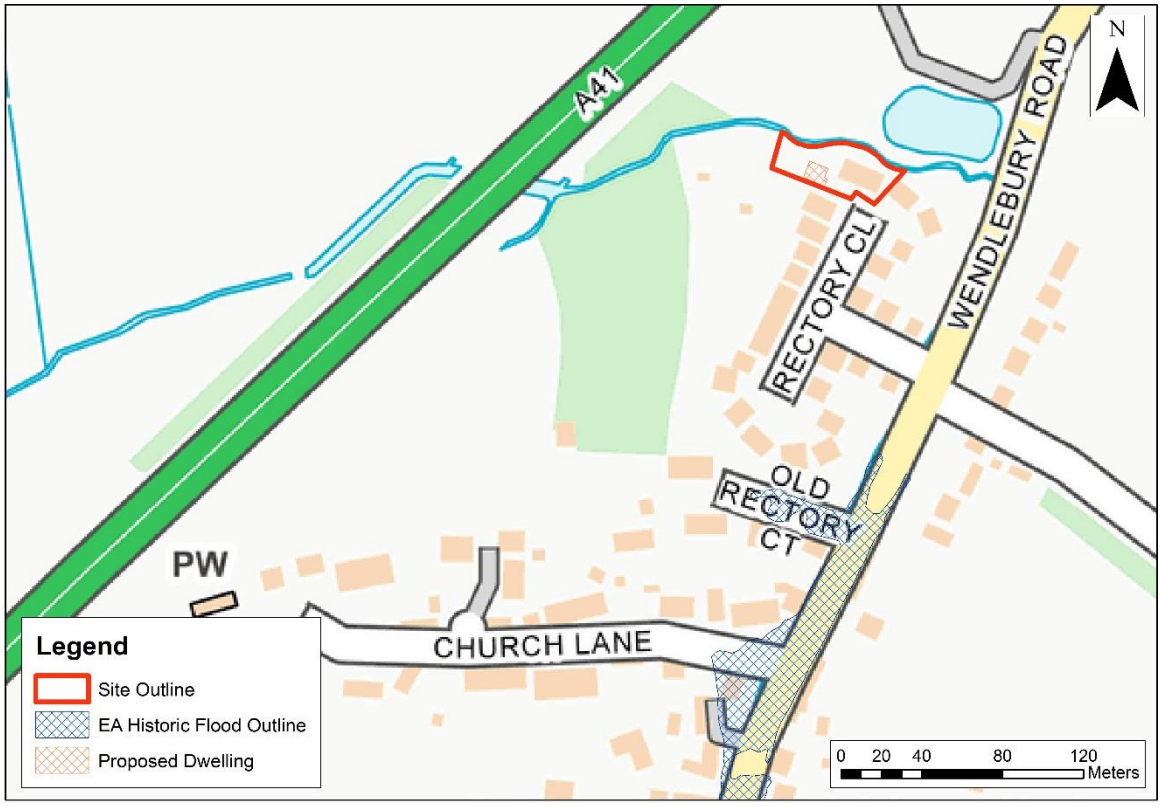
The flood risk for the site has been assessed in line with the EA's requirements and in conjunction with the Client. The primary objectives of the FRA are to determine the following:

- The risk from all forms of flooding to and from the site;
- Mitigation measures to alleviate the risk of flooding to and from the site.

4.2 Historical flooding

The EA's Historic Flood Map displays the flood extent of recorded historic events at the site and the surrounding area (Figure 4-1). As shown in Figure 4-1, the recorded events to not impact the site. However, flooding was observed 150m south of the site, at Wendlebury Road and Old Rectory Court.

Figure 4-1: EA's Historic Flood Map



The client has lived at the site for 25 years and observations provided on the basis of this witness evidence are included in the assessment. During the 2007 flood event, the water level in the watercourse adjacent to the site were observed to rise to the top of the banks, but did not overtop into the garden of the property. The highway at Rectory Close was observed to flood during this event, but at the southern portion, remote from number 8. The closest flood water has got to the site was observed during the 2012 event, when the highway of Rectory Close was flooded to a depth of one inch (25mm). However, the flood water did not reach the site. The 2012 event was understood to be caused in part by a blocked highway drain on Rectory Close.

4.3 Fluvial flood risk

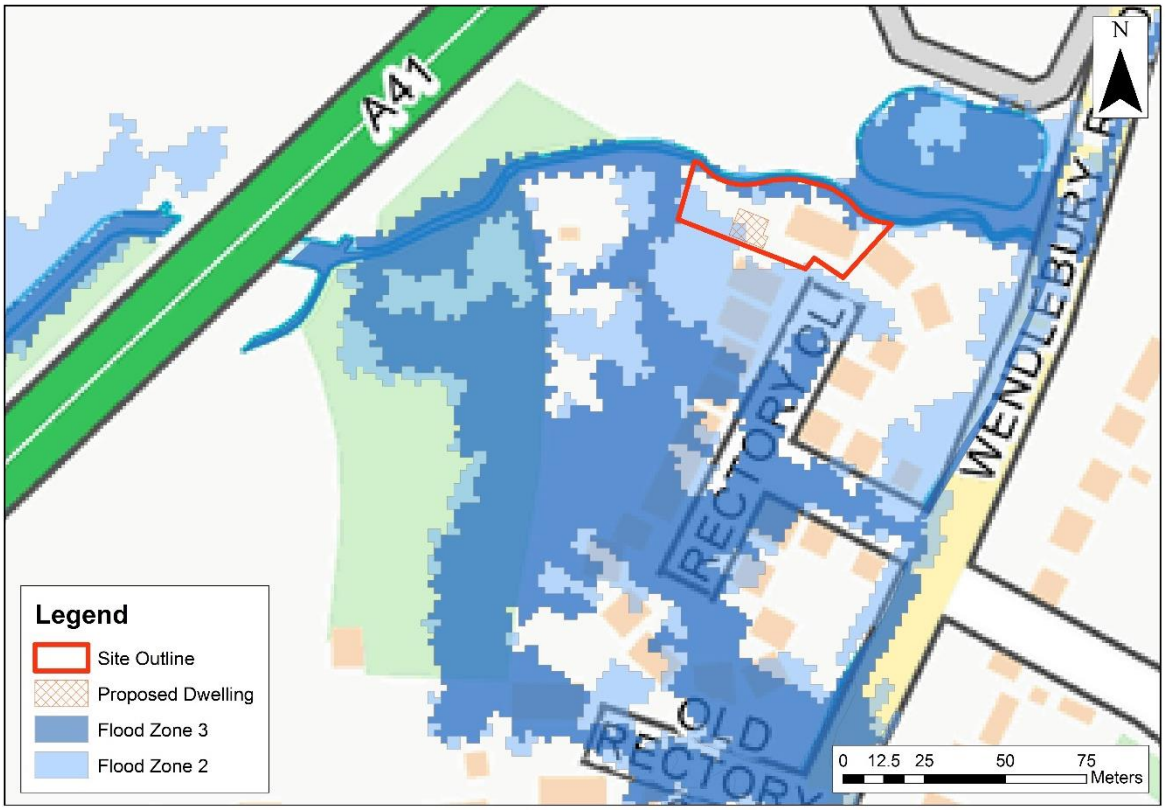
Flood Zone mapping based on detailed hydraulic modelling of the Wendlebury Brook (Figure 4-2), indicates that the site is currently located within Flood Zones 1, 2, 3a and 3b, therefore the probability of flooding occurring at the site varies from high to low.

Mapping in the Cherwell District Council North Oxfordshire SFRA shows there is potentially a small portion of Flood Zone 3b along the northern boundary of the site, along the banks of the watercourse and the pond to the north-east of the site. The extent of Zone 3b does not include the land where development is proposed.

The mapping shows the area of high risk of fluvial flooding to be constrained along the boundary of the property and expected to be the result of flood flows from the Wendlebury Brook adjacent to the site. Largely the area of medium risk of fluvial flooding follows the same pattern. However, in this more extreme flood event (1 in 1000 chance of occurrence in each and every year), a secondary flood mechanism is also predicted. As shown in Figure 4-2, the banks of the Wendlebury Brook are predicted to burst upstream of the site and the flood water is routed overland in a southward direction, reflecting the general slopes and topography of the existing ground. The majority of this flood flow bypasses the development site to the west and south, but the flood extent does reach the site and is shown to intercept the south west corner of the proposed building footprint.

Further discussion on the results of hydraulic modelling and climate change modelling is discussed in Section 5.

Figure 4-2: Fluvial flood risk to site



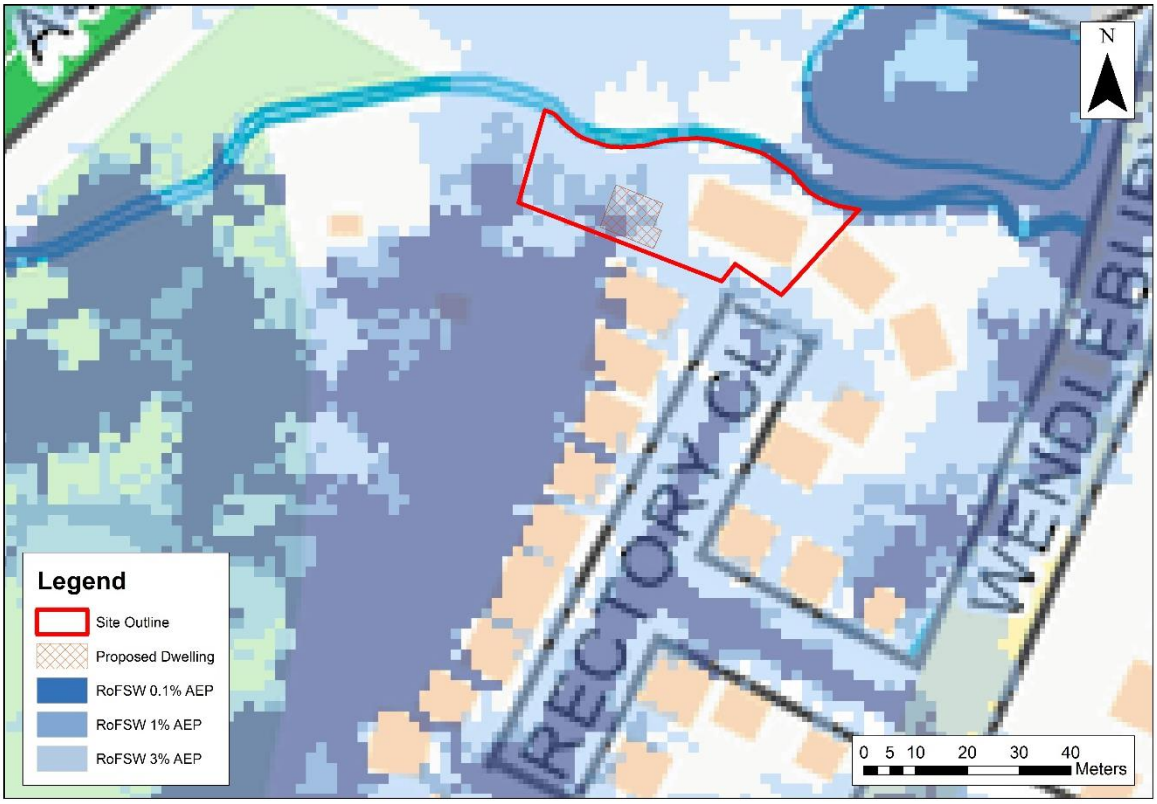
4.4 Surface water flood risk

Surface water flooding arises when rain falling on saturated ground flows overland following the local topography or is generated by runoff from impermeable surfaces such as roads and roofs. Surface water flooding and subsequent overland flow can therefore originate from a number of sources and pose a risk to both the proposed development site and the surrounding areas. In the former case, overland flow may originate from the site itself or from adjoining land at a higher elevation from which flow migrates onto the development area. In the latter case, existing

developments at a lower elevation may be subject to flooding due to overland flow originating from the site and migrating towards lower areas.

Figure 4-3 displays the surface water flood risk to the site during a 3%, 1% and 0.1% AEP event. For each return period, the existing property is shown to remain dry. However for the proposed development footprint is predicted to be at risk of surface water flooding during all events to some extent.

Figure 4-3: Surface water flood risk



The EA supplement the flood extent data with depth and velocity data, these are displayed within Appendices A and 0. During a 3% AEP surface water flood event, the maximum depth was predicted to be below 300mm. The maximum speed of surface water flow was predicted to be less than 0.25 m/s.

For a 1% AEP surface water flood event, the predicted flood depth was largely below 300mm, but in some areas depths increased to between 300 to 900mm. Peak velocities were predicted to remain less than 0.25 m/s.

During the 0.1% AEP surface water flood event, the predicted flood depth was predicted to be below 300mm to the east of the site, whereas towards the south west corner of the site, depths of between 300 to 900mm are predicted. These depths are within the footprint of the proposed dwelling. Velocities of over 0.25 m/s were predicted to occur close to the existing dwelling and west of the proposed dwelling, travelling in a north east direction towards the watercourse at the bottom of the garden.

Proposed redevelopment of the site will cause a change in site levels which could modify the route of predicted surface water flow paths. Therefore, this situation is likely to change with the new development.

Rainfall infiltration rates at the site could change as the land use changes from garden to dwelling. It recommended that the impact to the increased impermeable area is minimised by using water butts on the dwelling and permeable paving for the driveway.

As a consequence of the potential flood risk from surface water it is recommended that flood resilience measures such as the implementation of flood resistant airs bricks and flood proof doors are included in the construction of the proposed dwelling.

4.5 Groundwater flood risk

The British Geological Survey 'Geology of Britain Viewer'[6] was used to identify the local geology. The site and Wendlebury Village is underlain by the Peterborough Member, a Mudstone. Mudstones typically have a low permeability and are not usually considered as productive units for aquifers.

The site is situated on superficial deposits of Alluvium (Clay, Silt, Sand and Gravel).

The Environment Agency's Areas Susceptible to Groundwater Flooding (AStGWF) mapping shows the that the site is at low risk to groundwater flooding. This low groundwater risk is corroborated by other data as, the site is not located on a Bedrock Aquifer or within a Source Protection Zone. However, the site is situated on a secondary B superficial deposit aquifer.

No historic record of groundwater flooding has been identified to occur at the site within Oxfordshire County Council's PFRA (2011) or Cherwell and West Oxfordshire SFRA.

The superficial deposits at the site are related to alluvial deposits from the Wendlebury Brook, and groundwater levels would be expected to approximate the levels within the river. It is unlikely that groundwater flooding from the alluvium would occur without fluvial flooding from the Wendlebury Brook.

It is therefore considered that the risk of groundwater flooding to the site is low.

4.6 Sewer flood risk

The Oxfordshire County Council PFRA (2011) reports that the site not been affected by historical sewer flooding. No additional information has been provided to suggest that the site has suffered from sewer flooding previously. As such the risk of sewer flooding is considered to be low.

4.7 Reservoir flood risk

Environment Agency's Risk of Flooding from Reservoirs map has identified the proposed development site and the surrounding area of Wendlebury to not be at risk from flooding if a large reservoir were to fail and release the water it holds. As such the flood risk from reservoir breach is considered to be low.

6 British Geological Survey (2017), Geology of Britain Viewer, last accessed 02-08-2017

5 Hydraulic Modelling

5.1 Summary of modelling

The Environment Agency requested a full FRA to be completed due to the site's location within Flood Zones 2 and 3. The existing Flood Zones are based on modelling work conducted by JBA in 2014. This modelling predates the latest Environment Agency Guidance on Climate Change published in 2016. Re-runs of the 2014 modelling of the Wendlebury Brook were therefore required to take climate change into account.

5.2 Existing hydraulic model

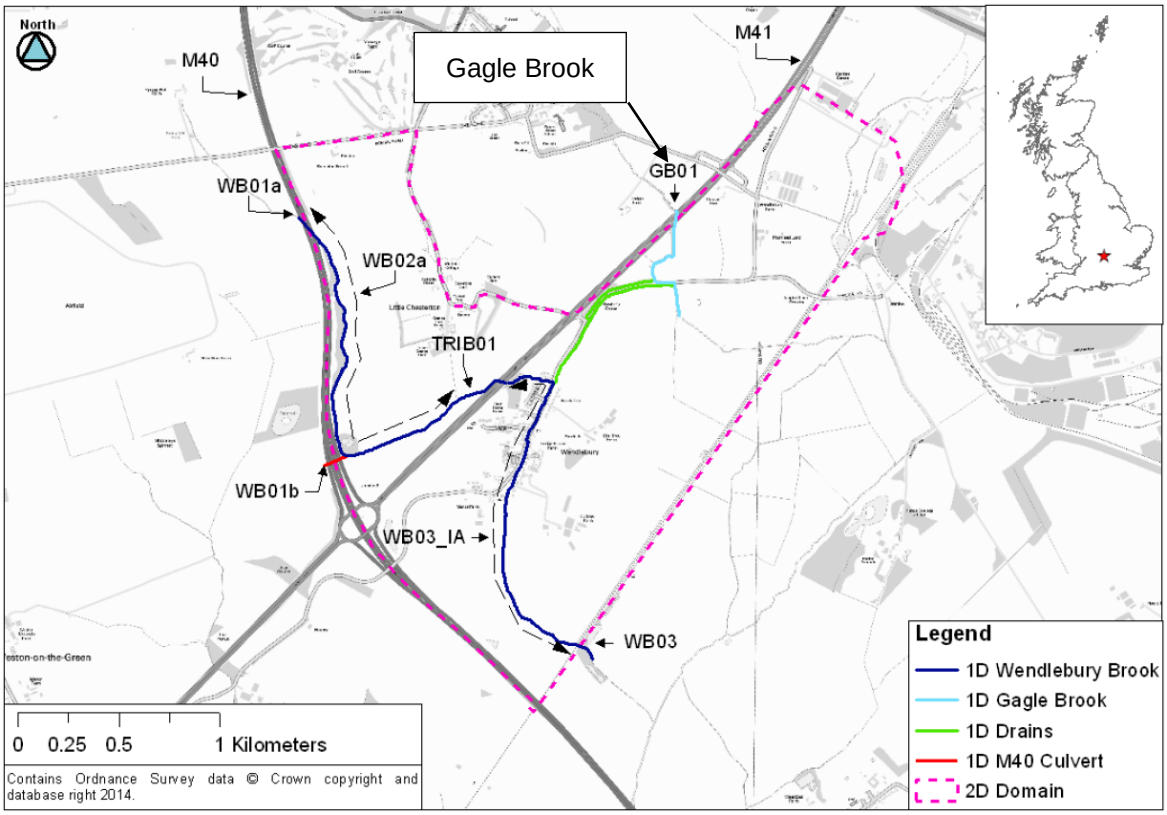
The EA's Wendlebury Brook Model was obtained and licensed for this study. The model is a hydrodynamic linked 1D-2D ISIS-TUFLOW model and was developed for the Wendlebury Brook modelling study in 2014.

The topography of the model was based on a 2013 topographic survey data supplied by the Environment Agency and further topographic survey which was collected during the study to minimise the uncertainties with LiDAR data.

5.2.1 Model schematic

Figure 5-1 displays the location and boundaries of the 1D and 2D model domains, which remained unchanged from the 2014 modelling. The 2D domain extends from Green Lane (from the M40 crossing) at the north to the Oxford to Bicester Railway Line to the south; and from the M40 at the west to east of the Gagle Brook from downstream of the A41 crossing. The model extent was defined after carrying out a number of sensitivity tests to account for the uncertainties on the connection of the upper catchment west of the M40. In addition, hydrological tests were completed to quantify the impact of the flows transferred from the Gagle Brook. Model outputs show that when the capacity of the drains is reached, flooding conveys into the Gagle Brook catchment rather than the Wendlebury Brook. Surveyed river reaches and crossings were represented in the 1D and the whole extent is linked to the 2D domain. Floodplains are represented in the 2D domain using a grid cell size of 4m.

Figure 5-1: Hydraulic model schematic



5.3 Modelling results

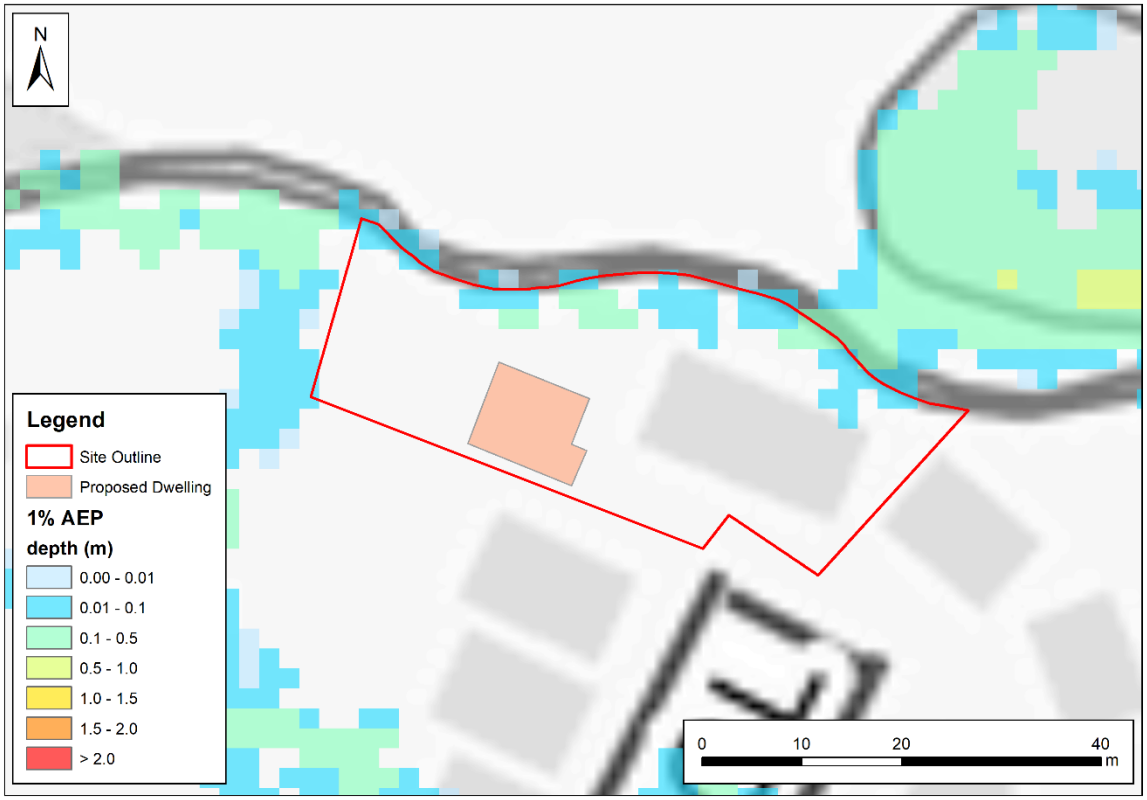
The hydraulic model developed for this study was run for the scenarios 1% AEP, 1% AEP plus 35% climate change and 1% AEP plus 70% climate change. The updated modelling outputs have determined the flood depths at the site which were used to determine the recommended minimum finished floor level options for the proposed development.

Appendix C details the technical details of the completed modelling.

5.3.1 1% AEP flood event

Figure 5-2 displays the flood extent and depths for the modelled 1% AEP event. In comparison to Flood Zone 3 (Figure 4-2), the modelled extents are shown to be the same, demonstrating that the re-run model shows comparable outputs to the original modelling. Flood depths are also displayed within Figure 5-2, depths across the flood extent are shown to be range between 0-0.5m within the site. The three areas of depths ranging between 0.1-0.5m are shown to be next to the Wendlebury Brook, away from the location of proposed and existing development.

Figure 5-2: Model flood depths for 1% AEP

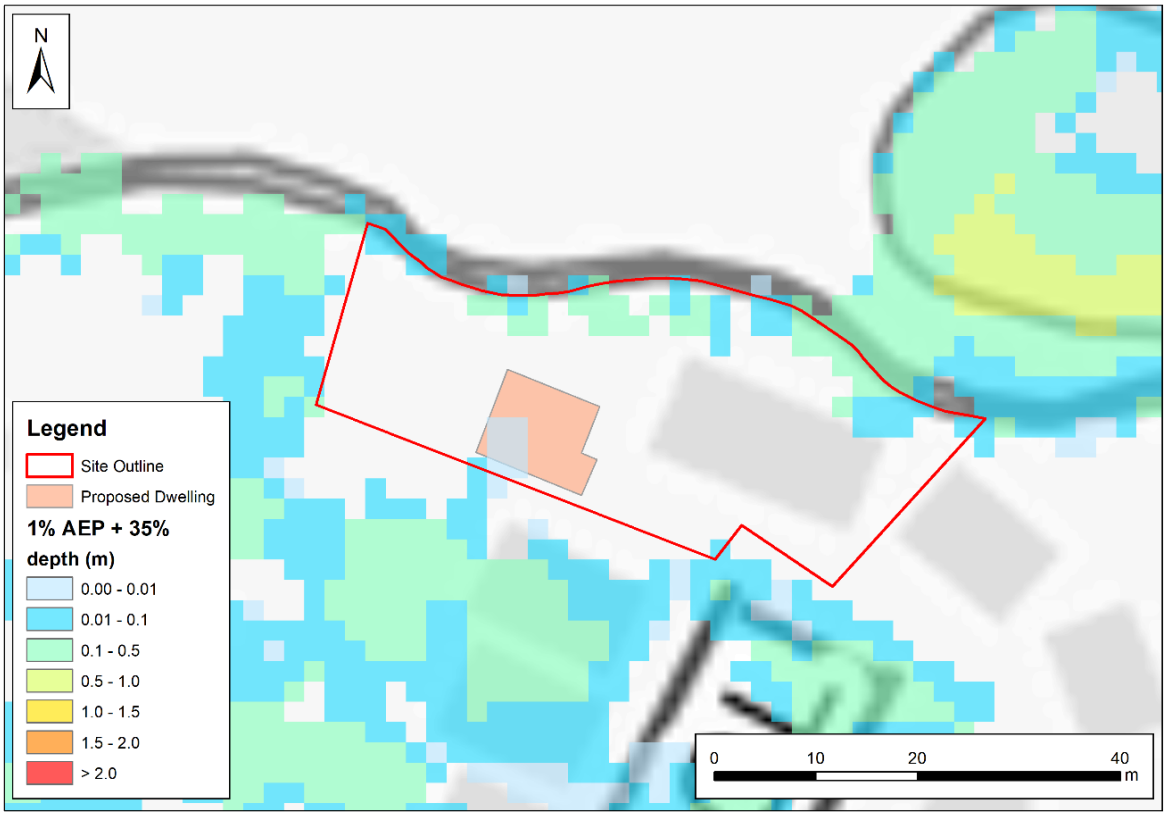


5.3.2 1% AEP flood event plus 35% climate change

Figure 5-3 displays the modelled flood extent and depths for the 1% AEP plus 35% climate change flood event. In comparison with the 1% AEP flood event, changes in both flood depth and extent can be observed. The most noticeable changes in flood extent was at the north east corner of the site. An increase in flood depth is also predicted within this located seeing a change from 0.01-0.1m to 0.1-0.5m. Another change of flood depth was noted along the northern site boundary.

Additionally, at the proposed building footprint, modelling results show the footprint partially intercepts the predicted flood outline, at the south-west corner. However, predicted flood depth is very shallow, less than 1cm. In comparison to the 1% AEP flood event, the results suggest that the proposed site would be at slightly increased risk of flooding in the future, due to climate change.

Figure 5-3: Model flood depths for 1% AEP plus 35% climate change



5.3.3 1% AEP flood event plus 70% climate change

Figure 5-4 displays the modelled flood extent and depths for the 1% AEP plus 70% climate change flood event. In comparison with the 1% AEP and 1% AEP plus 35% climate change, an increase in flood extent and depth in areas is predicted.

The flood extent along the northern site boundary is shown to increase in extent as well as depth. During the 70% climate change event, flood depths across this boundary are largely seen to increase to be between 0.1-0.5m. Flooding also is predicted to occur in the south-western corner of the site, where in previous scenarios flooding was modelled.

The modelled extent and depth of flooding within the proposed development footprint remains similar to the +35% climate change scenario, with flood depths below 1cm, indicating minimal wetting of the model cells. Flood water velocity remains below 0.2m/s within the proposed development and across the wider site, consistent with the site's location on higher land away from the primary areas of floodplain flow, and low flood depths.

Figure 5-4: Model flood depths for 1% AEP plus 70% climate change

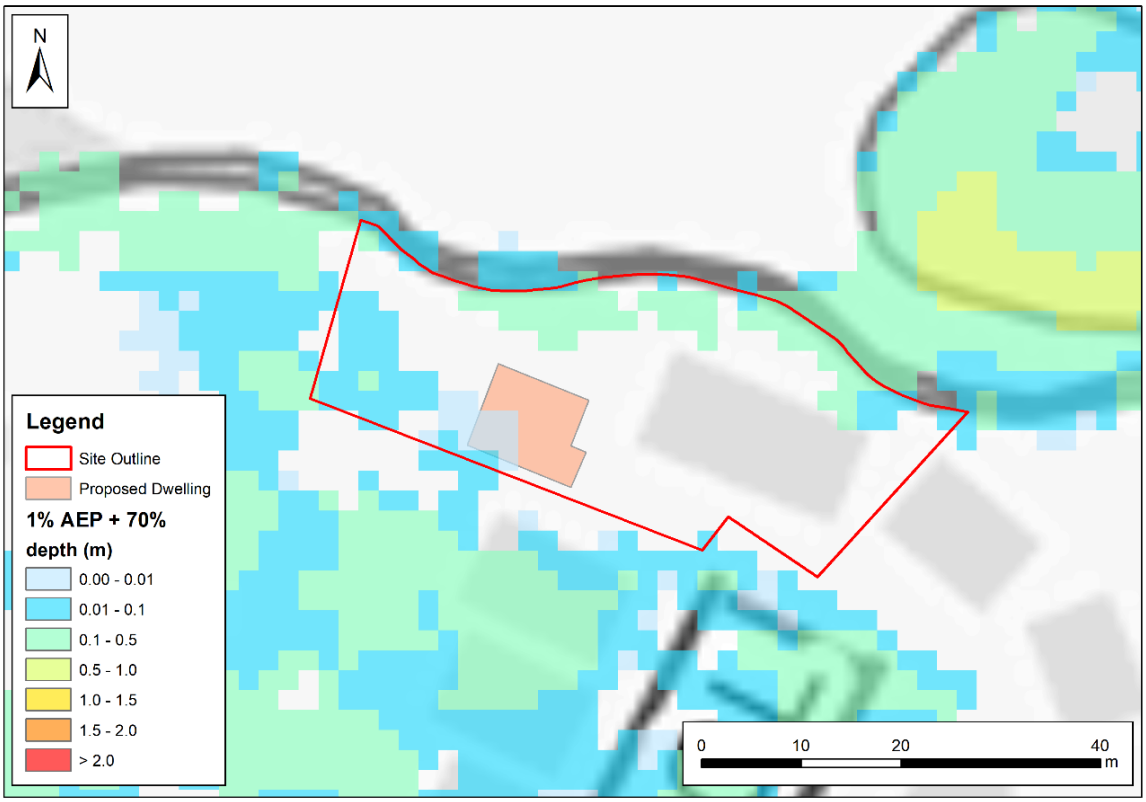


Figure 5-5: Modelled flood velocity for 1% AEP plus 70% climate change

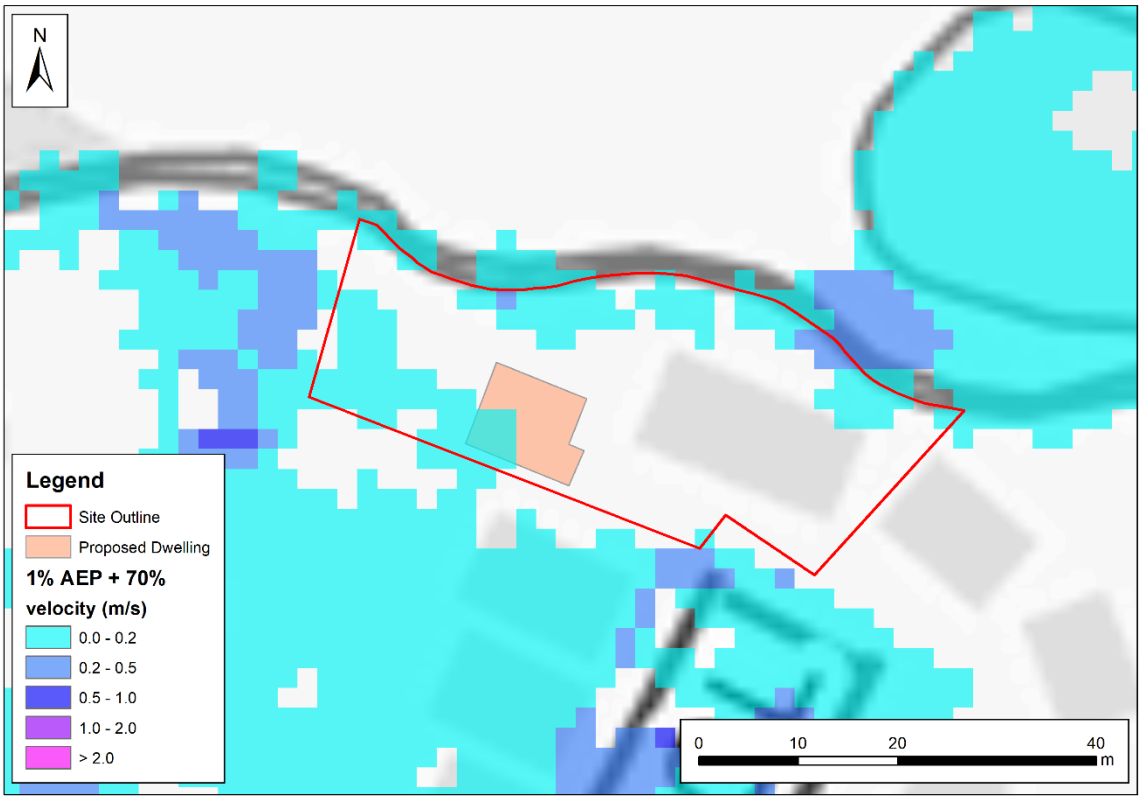
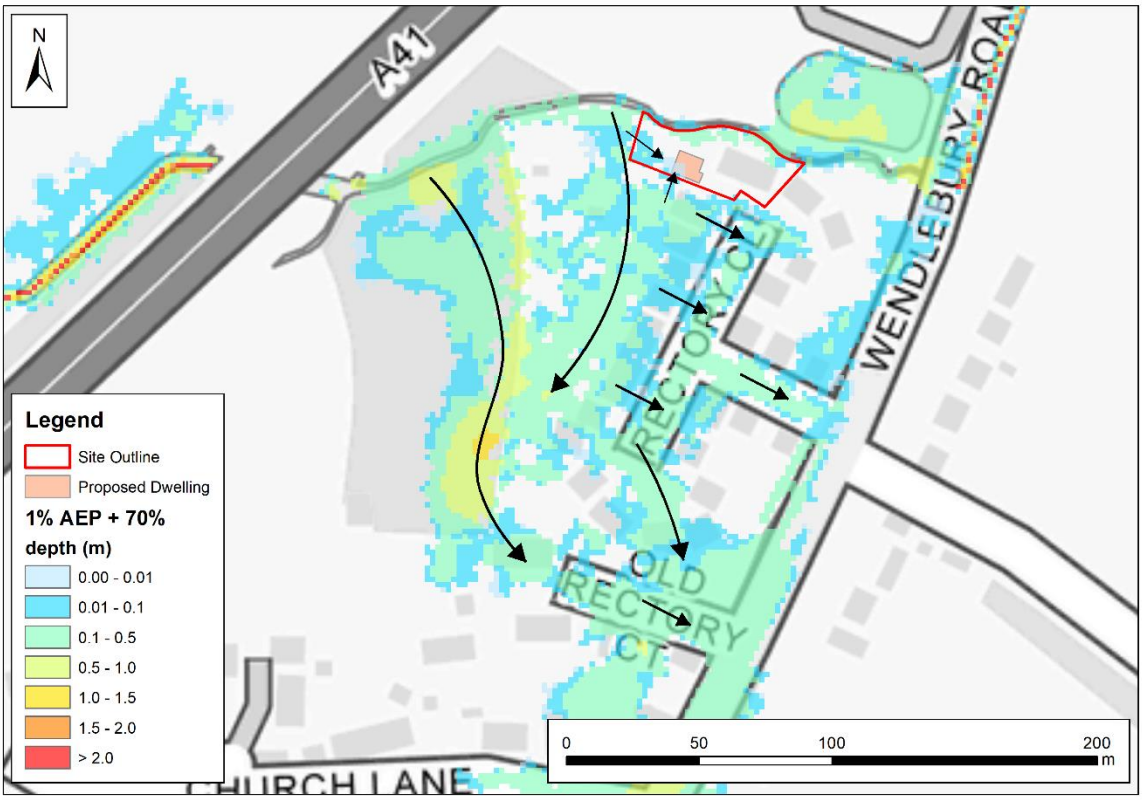


Figure 5-6: Flood mechanism of the Wendlebury Brook during the 1% AEP plus 70% climate change event



5.3.4 Conclusions of modelling results

Model results showed that during the 1% AEP event, no flooding is predicted to either the existing or proposed property. The Wendlebury Brook that flows along the northern site boundary remains mostly in bank (overtopping it's banks further upstream and consequently flooding Rectory Close).

The 1% AEP plus 35% and 70% model outputs show some shallow flooding predicted to occur within the garden and within the south west corner of the footprint of the proposed dwelling. However, these flood depths are predicted to be very shallow in depth, at less that 1cm within the proposed property.

6 Flood risk mitigation measures

In accordance with the NPPF and the associated PPG, it must be demonstrated that the proposed development will be safe for its lifetime taking account of the vulnerability of its users, without increasing the flood risk elsewhere and, where possible, will reduce the flood risk overall.

6.1 Finished floor levels

The updated 1% AEP +35% and +70% climate change events, flood depths within the proposed building footprint have been used to recommend minimum finished floor levels for the proposed development.

According to the Environment Agency's Standing Advice[7], the minimum finished floor level of the development is required to be 300mm above the general ground level or 600mm above the estimated flood level, whichever is higher.

The mean ground level of the proposed development is approximately 64.22mAOD. However, 1cm flood depth was predicted during the 1% AEP +35%. Therefore, the recommended finished floor level of the development is the mean ground level, plus flood depth, plus 600mm leaving the minimum finished floor level to be 64.83mAOD.

During the 1% AEP +70% event, the same flood depths are observed, therefore the recommended finished floor level of 64.83mAOD should offer resilience under this climate change scenario.

6.2 Access and egress

In the event of fluvial flooding, the following roads are inundated in the following return period:

- Rectory Close - (1% AEP)
- Wendlebury Road - (1% AEP)

In the event of surface water flooding, the following roads lose access in the following return period:

- Rectory Close - (3% AEP)
- Wendlebury Road - (3% AEP)

Following evaluation of access and egress to the site, the proposed development is at risk of becoming a dry island in the event of flood events from either fluvial or pluvial sources.

6.3 Flood alert and warnings

Where a development or its main route of access is located within a flood risk area, the NPPF recommends that flood warning plans are put in place for managing the flood risk to the development and, if necessary, support the evacuation of the site.

The EA's flood warning and alert services are free services that are frequently updated and accessible for 24 hours of the day. If a flood event is forecast, alerts and warnings are issued using a set of four easily recognisable codes as shown in Table 6-1. Generic advice and examples of actions to be taken on receipt of the alert of warning are shown in Table 6-1.

Table 6-1: The EA's flood alert and warning codes

Flood code	What it means	What to do
 Flood alert	Flooding is possible, be prepared	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.

7 https://www.gov.uk/guidance/flood-risk-assessment-standing-advice#vulnerable-developments-standing-advice

 Flood warning	Flooding is expected, immediate action is required	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.
 Severe flood warning	Severe flooding and danger to life	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.
Warning no longer in force	Warning has been removed in the last 24 hours	Be careful. Flood water may still be around for several days and could be contaminated If you've been flooded, ring your insurance company as soon as possible.

The time between when the alert or warning is issued to the onset of the property flooding (termed the lead time) can provide time for people to prepare for flooding and take action. The EA aims to provide between 2 and 12 hours lead time between a flood alert being issued and possible flooding occurring[8]. The EA also aims to issue alerts in waking hours and would rarely issue them before 6am and after 9pm[9].

Flood alerts cover larger areas than flood warnings and are issued more frequently when flooding is possible. The site is covered by the EA's flood alert area 'Langford and Wendlebury Brooks from Stratton Audley down to near Merton'. It is noted by the EA that site users should be prepared for flooding and to take action upon the receipt of a flood alert.

Flood warnings are only issued to specific areas when flooding is expected. Again, the EA note that site users should take immediate action following the receipt of a flood warning. The EA flood warning area of 'Wendlebury village on the Wendlebury Brook' is seen to cover the entirety of the site. The target lead time for fluvial Flood Warnings from the EA is 2 hours.

Residents of the new dwelling should be advised to sign up to both the EA's flood warning and alert services which cover the site.

6.4 Emergency planning

While the proposed development will help mitigate the risk of flooding to the site, flood risk cannot be removed completely. In accordance with the NPPF and the Cherwell and West Oxfordshire SFRA, the applicant must demonstrate that emergency access and egress procedures are in place to manage the residual risk of flooding associated an extreme flood event.

It is therefore recommended that a Personal Flood Plan is prepared and formalised for the site so safe access and egress can be achieved from the site following completion of the proposed development. The Plan should also provide a safe route that can be followed by emergency services in times of possible flooding.

A Personal Flood Plan template is available from GOV.UK website, which provides further official guidance of how to prepare for and protect yourself from a potential flood event:

- https://www.gov.uk/prepare-for-flooding/future-flooding

The Personal Flood Plan template is to be completed with the following information:

- General contact details (including important utility providers etc).
- Key locations of utility meters (including service cut-off points).
- Details of relatives, friends or neighbours that may be able to help during times of possible flooding.

9 Environment Agency, (February 2014), Flood Warning Data Integrity Guide

- Actions to be undertaken in the home, garden and outside the property if a flood is expected.
- Evacuation procedures to be followed if a flood is expected.

If a Plan already exists, it is recommended that the Plan is updated following completion of the proposed development and specifically includes the following:

- Off-site evacuation procedures and routes (including routes for emergency services),
- On-site containment procedures including on-site safe refuge areas;

It should be noted that any proposed flood plans may require careful consultation with the EA, the LPAs, emergency planners and emergency services so that residents are adequately prepared for the onset of any flooding and are able to respond effectively.

7 Summary and Conclusions

A Flood Risk Assessment is required to support a planning application for a new dwelling within the boundary of 8 Rectory Close, Wendlebury. A desk-based study was undertaken using the best available practices for the assessment of flood risk at the site, in order to address requirements in the National Planning Policy Framework and accompanying Planning Practice Guidance.

The site has been identified to be within fluvial Flood Zones 1, 2 and 3 and contains land where the severity of the fluvial flood risk varies from low to high (<0.1% to >1% annual chance of flooding).

The Environment Agency's Risk of Flooding from Surface Water flood maps have identified the site to be at medium risk from surface water flooding.

The site is considered to be at low risk of groundwater flooding, sewer flooding and flooding from potential reservoir breaches.

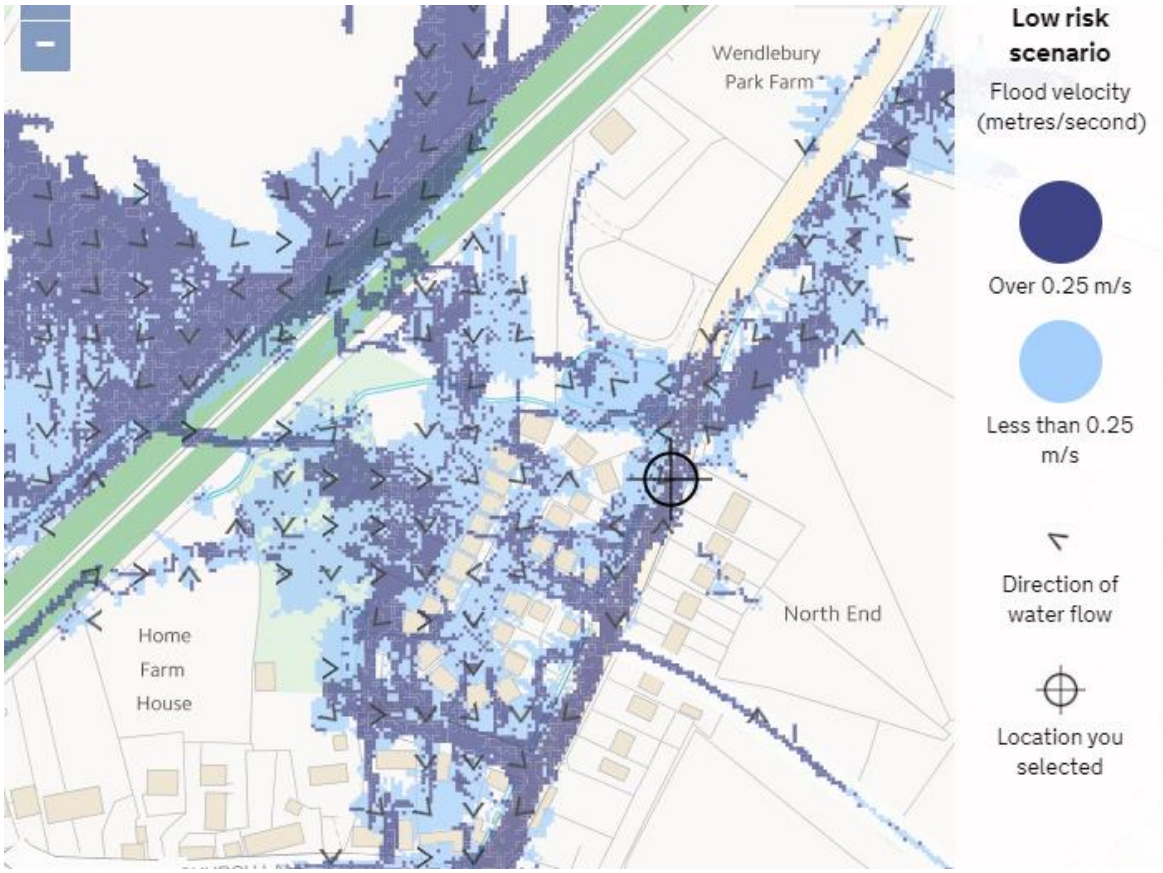
No records have been provided by the Environment Agency, Oxfordshire County Council or West Oxfordshire District Council to suggest the site has previously flooded from any sources.

Hydraulic analysis was undertaken using the existing Wendlebury Brook model to assess the flood risk to the proposed dwelling during the 1% AEP plus 35% and 70% climate change scenarios. This was completed by rerunning the existing Wendlebury Brook model with the updated EA climate change allowances. Model outputs demonstrated an increase in flood extent within the garden and the proposed dwelling. However, flood depths predicted at the proposed development were very low (less than 1cm). It is proposed that the finished floor level of the development should be 600mm above the flood level and therefore a minimum floor level of 64.82mAOD is recommended.

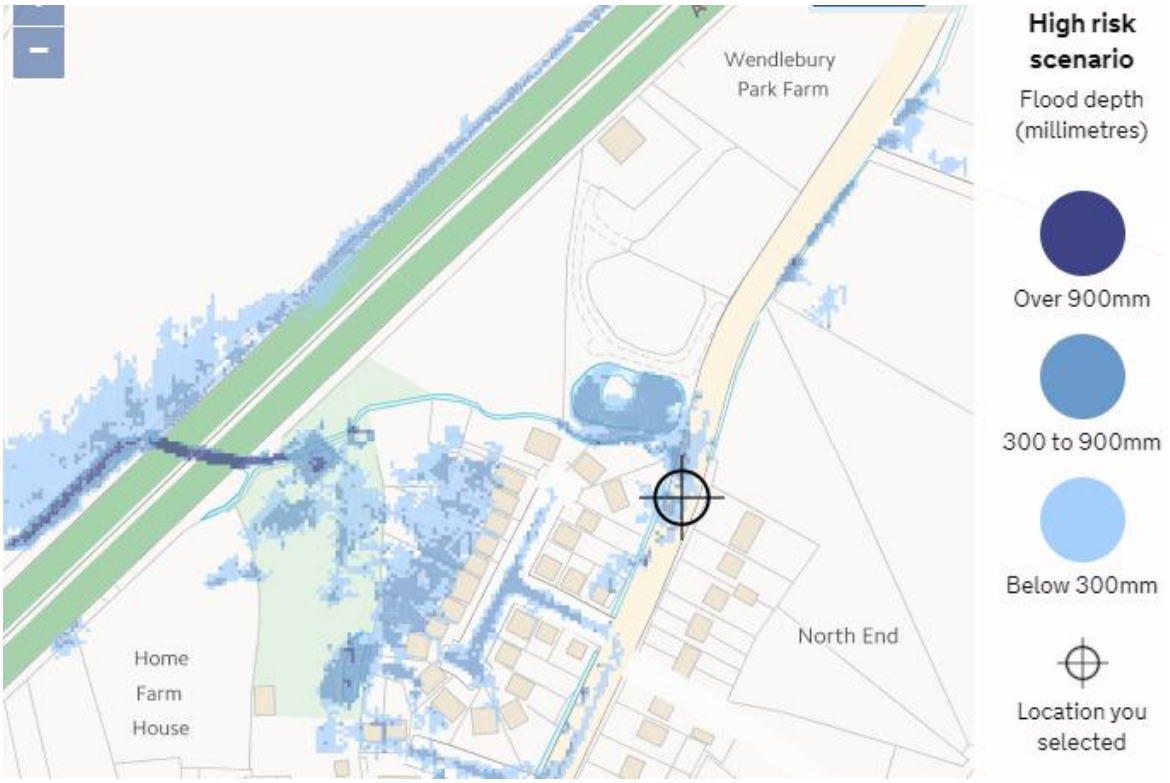
It should also be recommended that flood resilience measures are to be implemented during the construction of the property, such as flood resistant air bricks and flood proof doors so residual fluvial flood risk and surface water flood risk are addressed. The site could become a dry island in flood conditions. Therefore, it is recommended that a Personal Flood Plan is prepared and for the site.

Appendices

A Environment Agency Surface Water Flood Risk - Velocity


Wendlebury
Park Farm
North End
Home
Farm
House
Low risk scenario
Flood velocity (metres/second)
Over 0.25 m/s
Less than 0.25 m/s
Direction of water flow
Location you selected

B Environment Agency Surface Water Flood Risk - Depths




Wendlebury
Park Farm
North End
Home
Farm
House
Low risk scenario
Flood depth (millimetres)
Over 900mm
300 to 900mm
Below 300mm
Location you selected

C Climate Change Technical Note

TECHNICAL NOTE

JBA Project Code	2017s7110
Contract	FRA 8 Rectory Close Wendlebury
Client	Simon James
Date	January 2018
Project Manager	Jennifer Hill
Subject	Wendlebury Brook FRA Climate Change Modelling

1 Overview

This Technical Note details the updates performed on the existing Environment Agency hydraulic fluvial model of the Wendlebury Brook.

2 Climate change modelling

The Wendlebury Brook lies within the Thames River Basin District. The proposed development is a residential dwelling, and therefore is a more vulnerable development, with an anticipated lifetime of 100 years. The climate change allowances are therefore based upon the Higher Central and Upper end allowances for the 2080s (2070 to 2115) epoch. These are a 35% and 70% increase in flow inputs into the hydraulic model.

2.1 Wendlebury 2014

Table 2-1 – Summary of existing model used to inform climate change modelling

	Details
Existing model type	ISIS-TUFLOW (1D-2D)
Existing model version used	WB_33.DAT
Software version (existing)	ISIS version 6.6.0.81, TUFLOW version 2013-12-AA-iDP-w64
Software version (used for this study)	ISIS version 6.6.0.81, TUFLOW version 2013-12-AA-iDP-w64

Table 2-2 – Final model simulations, comments on necessary amendments

Event type	AEP + cc	Comments
Undefended	1% +35%	1% AEP IED and IEF files copied and updated for each climate change run.
Undefended	1% +70%	1% AEP IED and IEF files copied and updated for each climate change run.

Table 2-3 - Final model simulations and corresponding run files names

Event type	AEP + cc	1D run file name	2D control file name
Undefended	1% +35%	WBs_33_q100cc35_RC_SLext_SP.ief	WBs_33_q100cc35_RC_SLext_SP.tcf
Undefended	1% +70%	WBs_33_q100cc70_RC_SLext_SP.ief	WBs_33_q100cc70_RC_SLext_SP.tcf

Table 2-4 – Summary of supplied project deliverables

Deliverable	Supplied	Comment
Report	Yes	Technical note (this document) supplied in PDF
Model	Yes	
Flood extents (raw)	Yes	
Flood extents (cleaned)	No	
Water level grids	Yes	
Depth grids	Yes	
Velocity grids	Yes	
Hazard rating grids	Yes	
Node points flows levels	No	
Tabulated flows and levels (defended)	No	No defended scenarios
Tabulated flows and levels (undefended)	No	

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