Submitted to
Vale of White Horse
District Council

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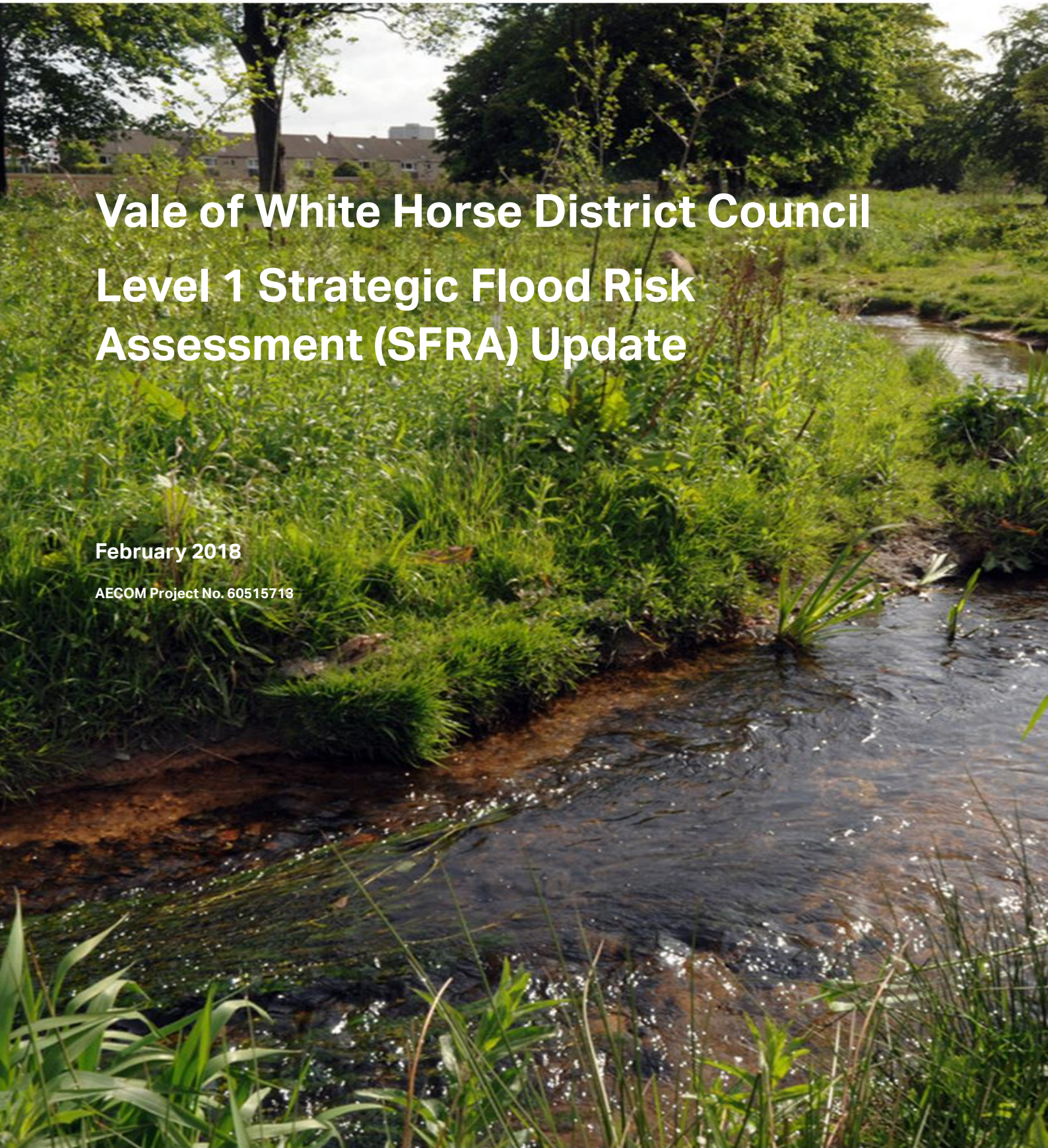

Vale of White Horse District Council

Level 1 Strategic Flood Risk Assessment (SFRA) Update

February 2018

AECOM Project No. 60515718

Quality Information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	28/08/2017	Draft Report for Client and Stakeholder Review		Sarah Kelly	Regional Director
2	08/09/2017	Incorporation of Client Comments		Sarah Kelly	Regional Director
3	22/02/2018	Incorporation of Environment Agency Comments and finalisation		Jon Robinson	Director

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List of Acronyms

ABD	Areas Benefiting from Defences
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System
AOD	Above Ordnance Datum
BGS	British Geological Survey
CC	County Council
CFMP	Catchment Flood Management Plan
DC	District Council
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Flood and Rural Affairs
DRN	Detailed River Network
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
FDGiA	Flood Defence Grant-in-Aid
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FWMA	Flood and Water Management Act 2010
GIS	Geographic Information System
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LoWS	Local Wildlife Sites
LPA	Local Planning Authority
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
OCC	Oxfordshire County Council
PDL	Previously Developed Land
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Policy Guidance
PPS25	Planning Policy Statement 25
RoFSW	Risk of Flooding from Surface Water
RBD	River Basin District
RMAs	Risk Management Authorities
SFRA	Strategic Flood Risk Assessment

SSSIs	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TWS	Thames Water Services
UKCP09	United Kingdom Climate Projections
VOWH	Vale of White Horse
WCS	Water Cycle Study
WFD	Water Framework Directive
WwTW	Wastewater Treatment Works

Glossary of Terms

Glossary	Definition
Annual exceedance probability (AEP)	Chance of occurrence in any one year, expressed as a percentage. For example, a 1% annual probability event has a 1 in 100 chance of occurring in any given year.
Areas Benefitting from Defences (ABD)	Hatched areas on the Environment Agency Flood Map for Planning (Rivers and Sea) behind flood defences, which, if the flood defences were not present, would flood, in the event of a river flood with a 1 % (1 in 100) chance of happening each year, or a flood from the sea with a 0.5 % (1 in 200) chance of happening each year.
Asset Information Management System (AIMS)	Environment Agency management system of assets associated with main rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Catchment Flood Management Plan (CFMP)	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances, including flooding.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the NPPF and Planning Practice Guidance (PPG).
Culvert	A channel or pipe that carries water below the level of the ground.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are ‘at risk’ of sewer flooding more frequently than once in 20 years.
Exception Test	A method set out in the NPPF to 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 two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

Glossary	Definition
Flood and Water Management Act (FWMA)	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 Floods; the aim of which is to clarify the legislative framework for managing local flood risk (flooding from surface water, groundwater and ordinary watercourses) in England.
Flood Defence	Infrastructure used to protect an area against flooding such as floodwalls and embankments.
Resilience measures	Measures designed to reduce the impact of water that enters property and businesses and to promote fast drying and easy cleaning; for example raising electrical appliances, installing tiled flooring.
Resistance measures	Measures to prevent flood water entering a building or damaging its fabric, for example the use of flood guards. This has the same meaning as flood proofing.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Regulations	Transposition of the EU Floods Directive (2007) into UK law. The Flood Risk Regulations (2009) address flood risk by prescribing a common framework for its measurement and management.
Flood Zone	Areas defined by the probability of river and sea flooding, ignoring the presence of defences. Flood Zones are shown on the Environment Agency's Flood Map for Planning (Rivers and Sea), available on the Environment Agency's web site.
Fluvial	Relating to the actions, processes and behavior of a watercourse (river or stream).
Freeboard	The height of a flood defence crest, level (or building level) above a particular design flood level.
Functional Floodplain	Land where water has to flow or be stored in times of flood. It is defined by LPAs within SFRAs. Functional floodplain (also referred to as Flood Zone 3b) is not separately distinguished from Zone 3a on the Environment Agency Flood Map for Planning.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the County Council for the area. In this case, OCC.

Glossary	Definition
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'main river map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers. However overall responsibility for maintenance lies with the riparian owner.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
National Planning Policy Framework (NPPF)	The National Planning Policy Framework was published on 27 March 2012. It is a framework which sets out the Government's planning policies for England and how these are expected to be applied.
Ordinary watercourse	A watercourse that does not form part of a main river. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act 1991.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	An approach to future site planning whereby new development is directed towards areas with the lowest probability of flooding before consideration of higher risk areas. The Sequential Test helps ensure that development can be safely and sustainably delivered and developers do not waste their time promoting proposals which are inappropriate on flood risk grounds.
Sewer Flooding	Flooding caused by a blockage or overflowing of a sewer or urban drainage system.
Surface Water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.

Glossary	Definition
Surface Water Management Plan (SWMP)	A plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels.

1. Introduction and Background

1.1 Terms of Reference

AECOM has been commissioned by Vale of White Horse (VOWH) District Council (DC) to review and update the Level 1 Strategic Flood Risk Assessment (SFRA) for its administrative area. This Report supersedes the joint 2013 VOWH and South Oxfordshire District Council (SODC) SFRA for the VOWH District.

1.2 Project Background

The National Planning Policy Framework[1] (NPPF) and associated Planning Practice Guidance for Flood Risk and Coastal Change (PPG)[2] emphasise the active role Local Planning Authorities (LPAs) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by a SFRA and LPAs should use the findings to inform strategic land use planning.

In July 2013, JBA Consulting prepared a SFRA for VOWH and SODC based on Planning Policy Guidance 25 (PPG25) and Planning Policy Statement 25 (PPS25) published by Central Government in 2006.

Since the preparation of these reports there have been a number of further changes in legislation and guidance relating to planning and flood risk. The introduction of the Localism Act in 2011 was intended to create a planning system oriented around consideration of local planning issues. Planning Policy Statements (PPS), covering all aspects of national planning policy have since been replaced by the NPPF. The accompanying technical guidance document relating to flood risk, originally derived from the PPS documents has also been recently replaced by the Planning Practice Guidance 2016 (PPG). Furthermore, the wider planning system has been subject to considerable change since 2008 with the withdrawal of the previous regional planning framework and the revocation of Regional Spatial Strategies in 2010.

The Flood and Water Management Act (FWMA) attained royal assent in 2010, with the intention of enabling the provision of more effective flood management following the flooding of July 2007. As such OCC is designated a Lead Local Flood Authority (LLFA) and has significant duties and powers in relation to flooding from local sources across VOWH, specifically surface water, groundwater and ordinary watercourses. The Environment Agency retains responsibility for leading and coordinating the management of flood risk associated with main rivers and the sea.

As well as legislative and planning policy changes, a number of new and revised datasets have been made available since the release of the previous Level 1 SFRA. The purpose of the Level 1 SFRA Update is to collate and analyse the most up to date readily available flood risk information for all sources of flooding, to provide an overview of flood risk issues across the study area. This will be used by VOWH to inform the preparation of Local Plans, including the application of the Sequential Test to future site allocations. It is also intended that the revised Level 1 SFRA deliverables will assist prudent decision-making on flood risk issues by Development Management Officers on a day-to-day basis.

1.3 Approach to Flood Risk Management

The NPPF sets stringent tests to protect people and property from flooding which all LPAs are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed. The main steps to be followed can be summarised as Assess, Avoid and Manage and Mitigate flood risk.

[1] Department for Communities and Local Government. 2012. *National Planning Policy Framework*. Available at:

https://www.gov.uk/government/publications/national-planning-policy-framework--2

[2] Department for Communities and Local Government. 2016. *Planning Practice Guidance: Flood Risk and Coastal Change.* Available at: https://www.gov.uk/government/collections/planning-practice-guidance

These steps are set out below, and are designed to ensure that if there are better sites in terms of flood risk, or a proposed development cannot be made safe, it should not be permitted.

Table 1-1 Approach to Flood Risk Management set out by the NPPF

Assess Flood Risk	LPAs should undertake a SFRA to fully understand the flood risk in the area to inform Local Plan preparation. For sites in areas at risk of flooding, or with an area of 1 hectare or greater, developers must undertake a site-specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development).
Avoid Flood Risk	VOWH DC should apply the sequential approach to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk. In plan-making this involves applying the Sequential Test, and where necessary the Exception Test to Local Plans, as described in Section 5. In decision-taking this involves applying the Sequential Test and if necessary the Exception Test for specific development proposals.
Manage and Mitigate	Where alternative sites in areas at lower risk of flooding are not available, it may be necessary to locate appropriate development in Flood Zone 2 (medium risk of flooding) and Flood Zone 3 (high risk of flooding). In these cases, VOWH DC and developers must ensure that development is appropriately flood resilient and resistant, safe for its users for the lifetime of the development, and will not increase flood risk overall. VOWH DC, and developers should seek flood risk management opportunities (e.g. safeguarding land), and to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems).

A flow chart to provide guidance on the use of the SFRA when taking flood risk into account during the planning process and preparation of the Local Plan is outlined in Figure 1-1.

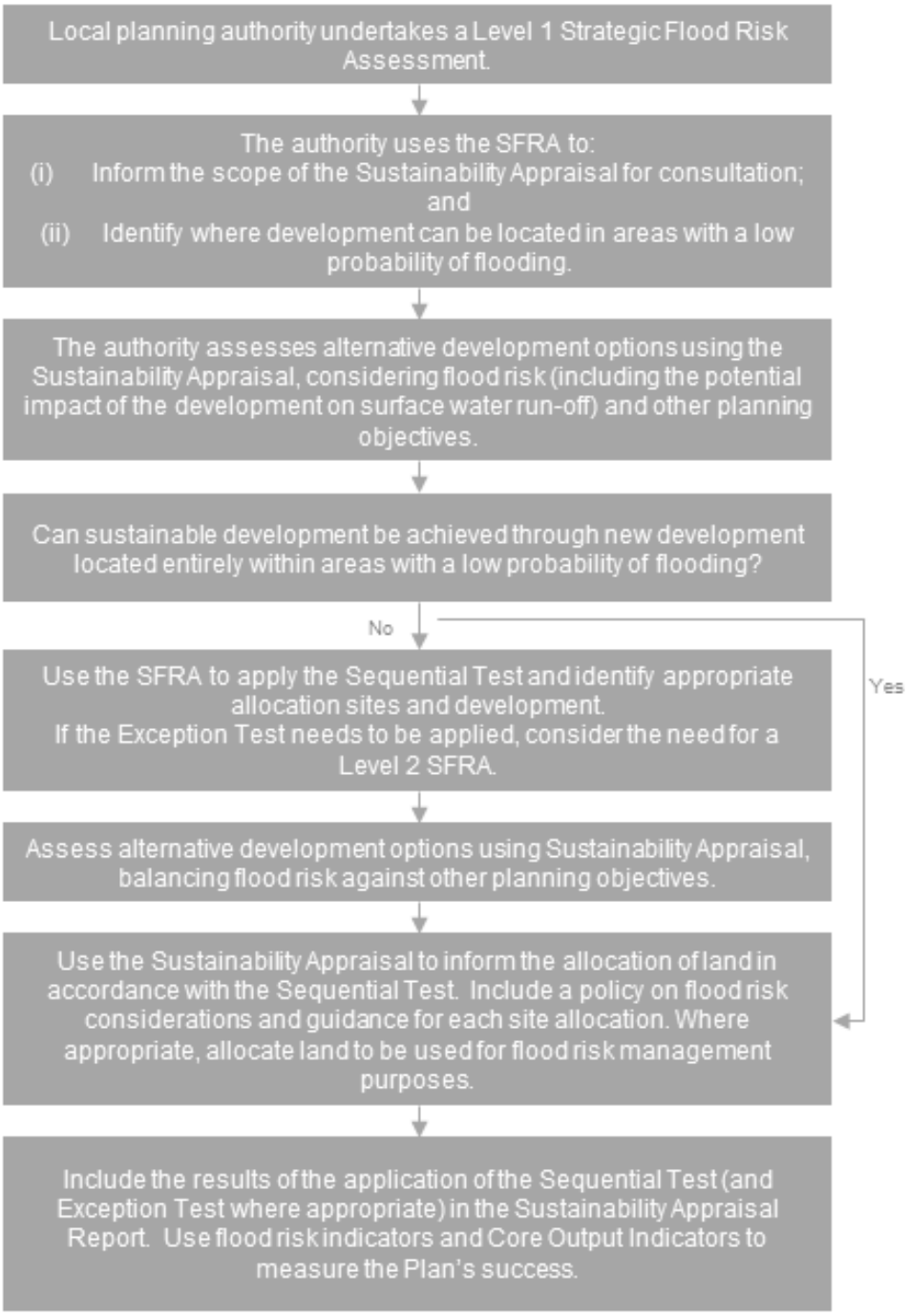


Figure 1-1 Taking flood risk into account in the preparation of a Local Plan

(Source PPG https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/574832/flood1_005.pdf)

1.4 Partner Organisations

There are several organisations involved in development and flood risk management across the study area. These are identified below.

VOWH District Council is the Local Planning Authority (LPA) for part of the study area, responsible for long term strategic planning of future development through the preparation of Local Plans, as well as for determining planning applications within the District. In accordance with the FWMA and subsequent communication from Central Government, since 6th April 2015, VOWH has been required to ensure that SuDS are implemented for all major developments where appropriate, and that through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

Oxfordshire County Council is designated the Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA), and has a duty to lead and coordinate the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses.

Environment Agency has a strategic overview role for flood risk management associated with main rivers and is a statutory consultee for any development, other than minor development, proposed within Flood Zone 2 or 3 associated with these watercourses, or works in the bed, within 8m of the bank of a main river or within 8m of a flood defence structure or culvert on a main river. The Environment Agency is continually improving and updating their flood map for main rivers and has permissive powers to carry out flood defence works, maintenance and operational activities for these main rivers. However, overall responsibility for maintenance lies with the riparian owner.

Thames Water has a duty as a statutory body to provide clean and waste water services to the study area and is responsible for the management, maintenance and operation of flood control structures. Water Companies are defined as a Risk Management Authority within the FWMA and are responsible for flood risk management functions in accordance with the Water Resources Act 1991 and the Land Drainage Act 1991. TW is responsible for surface water drainage from development via adopted sewers and for maintaining trunk sewers into which much of the highway drainage in the study area connects.

Highways England and Oxfordshire County Council have responsibilities (under the Highways Act 1980) for the effectual drainage of surface water from adopted roads along red routes insofar as ensuring that drains, including kerbs, road gullies , ditches and the pipe network which connect to the sewers (often TW), are maintained. In relation to the SFRA, Highways England was consulted to provide details of any known historic and recent flood risks along the highways in the District. Highways England have responded and provided locations of flooding incidents in the VOWH.

1.5 Level 1 SFRA Approach

The Level 1 SFRA is a desk-based study, using readily available existing information and datasets to enable the application of the Sequential Test and to identify where the Exception Test may be required. The main tasks in preparing the Level 1 SFRA are described below.

The remainder of Section 1 provides a description of the study area and identification of partner organisations involved in assessing and managing flood risk in VOWH. Section 2 provides a review of the legislative and planning policy context of managing flood risk in the District.

1.5.1 Gathering data and analysing it for suitability

Under Section 10 of NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from tidal sources, rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources.

In order to provide this assessment of all sources of flooding in the study area, an extensive set of datasets was requested from a number of organisations, including VOWH, OCC (as the LLFA and Highways Authority), the Environment Agency, Thames Water and Highways England.

1.5.2 Producing strategic flood risk maps, GIS deliverables and a technical report

A series of GIS maps have been produced using the data gathered during the study. The mapping deliverables are summarised in Table 1-2 and should be referred to when reading Section 3 ‘Assessing Flood Risk’ which provides an overview of flood risk across the study area.

Table 1-2 Strategic Flood Risk Maps

Figure No.	Figures Title and Content
Figure 1	Topography and VOWH District Boundary
Figure 2	Bedrock Geology
Figure 3	Superficial Geology
Figure 4	Environment Agency Historic Flood Outlines (District Wide)
Figure 4.1	Environment Agency Historic Flood Outlines (Sheet 1)
Figure 4.2	Environment Agency Historic Flood Outlines (Sheet 2)
Figure 4.3	Environment Agency Historic Flood Outlines (Sheet 3)
Figure 4.4	Environment Agency Historic Flood Outlines (Sheet 4)
Figure 5	Flood Map (Flood Risk from Rivers) and Development Locations (District Wide) Flood Zones, Watercourses, Flood Management Assets, Recorded Flood Incidents, Development Locations (as identified in the VOWH DC Preferred Options Consultation).
Figure 5.1	Flood Map (Flood Risk from Rivers) and Development Locations (Sheet 1)
Figure 5.2	Flood Zoe Map (Flood Risk from Rivers) and Development Locations (Sheet 2)
Figure 5.3	Flood Map (Flood Risk from Rivers) and Development Locations (Sheet 3)
Figure 5.4	Flood Map (Flood Risk from Rivers) and Development Locations (Sheet 4)
Figure 6	Flood Warning Areas and Emergency Refuge Centres (District Wide)
Figure 6.1	Flood Warning Areas and Emergency Refuge Centres (Sheet 1)
Figure 6.2	Flood Warning Areas and Emergency Refuge Centres (Sheet 2)
Figure 6.3	Flood Warning Areas and Emergency Refuge Centres (Sheet 3)
Figure 6.4	Flood Warning Areas and Emergency Refuge Centres (Sheet 4)
Figure 7	Risk of Flooding from Surface Water (District Wide) (RoFSW, Watercourses, VOWH DC and Highways England flood incidents)
Figure 7.1	Risk of Flooding from Surface Water (Sheet 1)
Figure 7.2	Risk of Flooding from Surface Water (Sheet 2)
Figure 7.3	Risk of Flooding from Surface Water (Sheet 3)

Figure No.	Figures Title and Content
Figure 7.4	Risk of Flooding from Surface Water (Sheet 4)
Figure 8	Groundwater Flooding (District Wide) (Areas Susceptible to Groundwater Flooding (AStGWF), recorded groundwater flood incidents)
Figure 9.1	External Sewer Flooding (Thames Water Records of External Sewer Flooding)
Figure 9.2	Internal Sewer Flooding (Thames Water Records of Internal Sewer Flooding)
Figure 10	Flooding from Reservoirs (Watercourses, extent of reservoir flooding)

1.5.3 Providing suitable guidance

Based on Section 3 ‘Assessing Flood Risk’, and the supporting mapping deliverables, the Level 1 SFRA Report provides specific guidance for VOWH.

Section 5 provides guidance on ‘Avoiding Flood Risk’ through the appropriate application of the Sequential Test by VOWH when allocating future development sites as part of the plan-making process, as well as by developers promoting development on windfall sites.

Sections 6 provides guidance for measures to ‘Manage and Mitigate Flood Risk’ on future development sites and to assist the preparation of site-specific FRAs.

Section 8 outlines a number of flood risk management objectives and policy recommendations for consideration by VOWH throughout the development of their strategic planning documents.

2. Legislative and Planning Policy Context

2.1 Introduction

There is an established body of policy and guidance documents which are of particular importance when considering development and flood risk. These are identified in Table 2-1 along with links for where these documents can be found for further detail.

Table 2-1 Flood Risk Policy and Guidance Documents

National Policy Documents		
National Planning Policy Framework (para. 99-104)	The NPPF2 was published by the UK's DCLG in March 2012, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG) for use in England.	https://www.gov.uk/government/publications/national-planning-policy-framework--2
Flood and Water Management Act (2010)	Provides for a more comprehensive management of flood risk.	http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf
Flood Risk Regulations (2009)	The Flood Risk Regulations transpose the EU Floods Directive into law in England. It aims to provide a consistent approach to flood risk across Europe.	http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf
Regional Flood Risk Policy		
OCC Local Flood Risk Management Strategy (LFRMS)	As LLFA, OCC has created the LFRMS to understand and manage flood risk within the county.	https://www.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/environmentandplanning/flooding/OxfordshireFloodRiskManagementStrategy.pdf
Thames Catchment Flood Management Plan	Role of the CFMP is to establish flood risk management policies which will deliver sustainable flood risk management for the long term (an Environment Agency Document).	https://www.gov.uk/government/collections/catchment-flood-management-plans
OCC Preliminary Flood Risk Assessment (PFRA)	In accordance with the Flood Risk Regulations 2009, OCC provided a PFRA to provide a high level overview of flood risk from local sources for provision to the Environment Agency, ultimately reporting to Europe.	https://www.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/environmentandplanning/flooding/pfra/PFRApreliminaryreport.pdf
Oxford Area Flood Information	Describes the management structures and actions of local responders in response to a flooding event in Oxfordshire	Available on the internet

Guidance Documents		
Planning Policy Guidance – Flood Risk and Coastal Change	Describes the planning approach to development within areas at risk of flooding from all sources	http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
Environment Agency Standing Advice	Guidance on information to be included within robust site specific FRAs	https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
Local Documents and Strategies		
VOWH Local Plan 2031 Part 1	The VOWH DC Core strategy sets out the Districts plans for development within the District over the next 15 year including policy guidance on flood risk. VOWH DC set out various aims in their Local Plan 2013 Part 1[3] that act to improve the flood resilience of the district. For full policy wording refer to the VOWH DC Local Plan Part 1. Policies include: **Core Policy 37** ○ Ensure that new developments are sustainable and resilient to climate change by taking into account landform, layout, building orientation, massing and landscaping to minimise energy consumption and mitigate water run-off and flood risks. **Core Policy 40** ○ Using materials to prevent penetration of heat, including use of cool building materials, green roofs and walls and using flood resilient materials ○ Incorporating flood resilient measures such as raising floor levels, electrical fittings and rain-proofing and overhangs to prevent infiltration of heavy rain around doors and windows. **Core Policy 42:** ○ Directing new development to areas with the lowest probability of flooding ○ Ensuring that all new development addresses the effective management of all sources of flood risk	http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/new-local-plan-2031-part-1-strategic-sites

[3] http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/new-local-plan-2031-part-1-strategic-sites

	○ Ensuring that development does not increase the risk of flooding elsewhere, and ○ Ensuring wider environmental benefits of development in relation to flood risk.	
VOWH Local Plan 2031 Part 2	Sets of policies, and locations for housing for the Vale's proportion of Oxford's housing need up to 2031, which cannot be met within the City Boundaries	http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/local-plan-2031-part-2 The VOWH draft Local Plan Part 2 is currently under consultation and subsequent review, and will be issued in due course.
VOWH Sustainability Appraisal	Supporting document to the VOWH Local Plan 2031: Part 2. Provides a mechanism to consider and communicate the likely effects of the plan and present alternatives.	http://www.whitehorsedc.gov.uk/sites/default/files/Draft%20Sustainability%20Appraisal%20-%20LPP2_0.pdf
VOWH Surface Water Management Plan	A SWMP can include an assessment of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.	There currently are no Surface Water Management Plans for the Vale of White Horse
VOWH Water Cycle Study	A WCS considers the impact that new developments may have on the current water cycle in the allocated area, including impacts on water demand and water treatment.	The Water Cycle Study (WCS) for the VOWH is currently being updated. There may be implications on the capacity of the sewers from the potential developments.

3. Assessing Flood Risk

3.1 Introduction

This section provides a strategic assessment of flood risk across the VOWH DC study area from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the figures in Appendix A and B.

3.2 Study Area

3.2.1 Location

The topography and location of VOWH District is shown in Appendix A Figure 1, together with the location of the principal watercourses and reservoirs. VOWH District forms part of the County of Oxfordshire, and is surrounded by the Districts of West Oxfordshire to the North, South Oxfordshire to the east, and Cherwell and Oxford City Council to the Northeast. VOWH is surrounded by the counties of Wiltshire and Gloucestershire in the west and Berkshire in the south.

3.2.2 Hydrogeology

Hydrogeology is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers). It is important to understand the hydrogeology as it affects the rate of surface runoff and indicates where there is risk of groundwater flooding. Substantial areas of impermeable surface rock are likely to induce rapid runoff, leading to surface water flooding in downstream locations. Furthermore, the presence of aquifers is likely to promote the risk of groundwater flooding and therefore should be located accordingly.

There are many different types of bedrock throughout the VOWH, however it is only summarised here. The bedrock in the VOWH lies in strips that run generally from the north east of the district to the south west.

The bedrock in the area is broadly separated into three sections, the oolitic limestone in the hills of the Cotswolds to the north west of VOWH. The next section is a band to the south east of that which is made of bands of clays, mudstone, siltstone and sandstone. This area holds the main rivers in the VOWH, the Thames and Ock. Then the third section is a band of chalk to the south east of the VOWH which forms the hills of the North Wessex Downs.

The main types of superficial deposits in the VOWH are Alluvium, Northmoor Sand and Gravel Member, Northmoor Sand and Gravel Member Lower Facet and Northmoor Sand and Gravel Member Upper Facet, Head, and Clay-with-flints formation.

There are also other types of superficial in the district in small and localised sections. These superficial deposits are:

- Alluvium 1, Hanborough Gravel Member, Northern Drift Formation, Peat, River Terrace Deposits, Sand and Gravel, Summertown-Radley Member, Lower and Upper Facet, Summertown-Radley Sand and Gravel Member, Till, Tufa, Westland Green Gravel, Wolvercote Sand and Gravel Member.

3.3 Summary of Flood Sources

Table 3-1 summarizes the range of potential flood sources and pathways in the study area. Where relevant, each source is discussed in further detail below. Maps of the historic flood events in the VOWH are included in **Appendix A Figure 4.0 – 4.4**.

Table 3-1 Potential flood sources and pathways

Flood Type	Source	Pathway	Consider further
Fluvial	River Thames, Seacourt Stream or Wytham Stream, Abbey Stream, River Stert, Larkhill Stream, Sandford Brook, Childrey Brook, Nor Brook, Mill Brook, Ginge Brook, Moor Ditch, East Hendred Brook, Cow Common Brook, Portobello Ditch, Pill Ditch, River Ock, Letcombe Brook, Humber Ditch, Land Brook, Stutfield Brook, Wadley Stream, Pennyhooks Brook, Tuckmill Brook.	Floodplain ponding / conveyance / breach and overtopping	Yes
Surface Water	Greenfield and urban runoff	Flow paths merging from surrounding fields and built up areas	Yes
Arterial Drainage Network	Sewer network	Surcharged sewers or burst water mains (failure of infrastructure)	Yes
Tidal	VOWH DC has no coastline, therefore there is no tidal flood risk	No coastline	No
Groundwater	Perched within alluvial deposits	Rising water level	Yes
Artificial Sources	Reservoir (a list of the reservoirs in the area is included in section 3.8)	Flow paths should a reservoir fail	Yes
	Wilts and Berks Canal	Conveyance, breach and overtopping	

3.4 Flooding from Rivers

3.4.1 Sources

The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e. main river or ordinary watercourse). There are a number of designated main rivers in the study area, the locations of which are shown in **Appendix A Figure 5**. Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Flood and Rural Affairs (Defra). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance however, lies with the riparian owner.

The study area falls within the Thames catchment which is described in the Thames Catchment Flood Management Plan. The CFMP covers an area of around 2,600km2 and includes the catchment of a number of major rivers: including the River Thames, River Cole, River Ock, Letcombe Brook and Hinksey Stream. The VOWH has many small watercourses, a list of Environment Agency designated main rivers is included below attributing them to Rivers if they are tributaries. There are additional watercourses that are not named or listed here. A description of each significant watercourse in VOWH District is outlined below:

- **River Thames** borders about half of the VOWH District. Although it barely enters the district, the river catchment does spread into the district. The Thames also known in some locations as River Isis starts in the Cotswolds, travels 210 miles including through the centre of London and out to join the North Sea.
- **River Cole** marks the border between the VOWH and Wiltshire. It is a tributary to the River Thames.
- **River Ock** is a tributary to the River Thames. Its catchment is in the VOWH and joins the River Thames near Abingdon. The river appears in a small village called Little Coxwell within the VOWH District.
- **Letcombe Brook** which originates in Letcombe Basset at the base of the Berkshire Downs, and flows for 7.5 miles until it joins Childrey Brook. Childrey Brook is a tributary to the River Ock. Letcombe Brook is one of the 210 remaining chalk streams in the world, 160 of which are in the United Kingdom.
- **Stutfield Brook** is a tributary of River Ock in the west side of VOWH. It starts on the east side of Uffington.
- **Betterton Brook** becomes **Lockinge Brook**, which becomes **West Hendred Brook**, **Ginge Brook** flows into West hundred Brook. West Hendred Brook becomes **East Hendred Brook**, which then becomes **Mill Brook**. This group of water courses is a tributary to the River Thames.
- **Abandoned Wilts and Berks Canal**, the canal which linked Kennet and Avon Canal at Semington, near Melksham and Trowbridge to the River Thames in Abingdon. The canal was abandoned in 1914, restorative works are continuing to try and re-water the canal. 8 miles of the canal has so far been restored and re-watered.

There are lots of small watercourses in the VOWH. The following are tributaries/offshoots to/from the River Thames:

- **Hinksey Stream** which starts as Seacourt Stream (also known as Wytham Stream) which is a bifurcation from the River Thames, it later joins the Thames again south of Oxford.
- **Moor Ditch** Tributary to the river Thames.

The following are tributaries to the River Ock (not previously mentioned):

- **Nor Brook** is a short tributary to River Ock, It runs roughly alongside Childrey Brook for perhaps 2km in total.
- **Sandford Brook** starts near Wooton, fed from the Cothill Fens.
- **Land Brook** originates near West Challow, and flows north towards the River Ock.

Other:

- **Cow Common Brook** which flows along f the abandoned Wilts and Berks Canal.
- **Humber Ditch** is a tributary to Letcombe Brook.
- **Tuckmill Brook** is a tributary to the River Cole.
- Abbey Stream, River Stert, Portobello Ditch, Larkhill Stream, Pill Ditch, Wadley Stream and Pennyhooks Brook are also watercourses in the area.

As previously discussed, the headwaters of the large rivers will originate in clay, mudstone, siltstone and sandstone catchments in the north and in chalk catchments in the south. Clay deposits generally encourage rapid runoff, due to their impermeable characteristics, which results in a quicker response to rainfall. A quick catchment response can often lead to large volumes of water reaching the river simultaneously, which may result in a flood event. But due to the permeable nature of chalk deposits, these catchments have a slower response to rainfall events. Nevertheless, all watercourses in the District will exert a level of flood risk on the surrounding area regardless of the immediate geology.

3.4.2 Receptors

The Environment Agency's flood maps provide an understanding of the current risk of flooding in the VOWH District. The Flood Map for Planning shows the simulated extent of fluvial flooding during the estimated lower than 0.1% AEP (1 in 1000 year), between 0.1% AEP and 1% AEP (1 in 100 year), and greater than 1% AEP (1 in 100 year). The mapping highlights that flooding is generally confined to strips of land adjacent to the floodplain, affecting the neighbouring settlements. However, there are areas that experience more widespread flooding with extensive floodplains, as seen along the River Thames to the north of the District and the River Ock that runs horizontally through the centre of the District.

Flooding generally becomes more widespread with increasing distance downstream as larger volumes of water in the system result in wider floodplains. A number of towns and villages are at risk from fluvial flooding within the District, including: Shrivenham, Upper Inglesham, Buscot, Hinton Waldrist, Toll, Abindgdon-on-Thames, Drayton, Sutton Courtney, Marcham, Garford and Charney Basset. On the smaller scale many individual dwellings, and industrial premises for example are also at fluvial flood risk.

3.4.3 Structures

Throughout the river network there are hydraulic structures such as weirs, mills, bridges and culverts. These may elevate water level and hence exacerbate flood risk in the associated areas. Structures can promote debris dam formation which may reduce the capacity of the watercourse. Moreover, the existence of structures is likely to reduce watercourse capacity themselves.

The Environment Agency fluvial modelling study 'Additional Stour Modelling for Key Structures' (2009) highlighted that mills and the associated structure have the largest impact on water levels. Keeping mill gates closed at key structures increased the upstream flood water level and decreased the downstream when compared to baseline flows. By adding automated sluice gates to open and close at set stage levels to allow flood flows to pass during high discharge and to retain water levels during low discharge, the river's water levels can be maintained. Different automation control settings can be used to increase or decrease the backwater effect from the mill gates and the amount of flow in the upstream bypass channel. Importantly, even if more flow can be carried by an upstream bypass channel, the flood water level in the main channel may be close to bank top. The automation of sluice gates requires careful consideration of the control settings, and a detailed examination of the local topography and stage level settings should be made[4].

[4] JBA Consulting (2009) Additional Stour Modelling for Key Structures

Implementing new operation techniques of the mills can have an impact on the flood water levels along the channel, which inevitably alters the connection between the channel and floodplain, changing the pattern of flood risk. Therefore it is fundamental that mill owners are made aware of their responsibility and potential liability for flood risk management. A set of operating procedures should be made available to provide guidance for mill owners.

3.4.4 Historic Records of River Flooding

The Environment Agency has provided an extract from the 'Recorded Flood Outlines' dataset for the study area. This dataset details historic fluvial flood events in the District. This is shown in **Appendix A, Figures 4.0 – 4.4**.

There have been several more recent flood events in the VOWH District; these were made available by VOWH District Council. These have been mapped on the appropriate maps in Appendix A.

3.4.5 NPPF Flood Zones

The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers by categorising areas within the fluvial floodplain into zones of low, medium and high probability, as defined in Table 3-2.

Table 3-2 Fluvial Flood Zones (extracted from the NPPG, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1,000 AEP (0.1% AEP) of river flooding. Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2	Land having between a 1 in 100 and 1 in 1,000 AEP of river flooding (between 1% and 0.1% AEP of flooding each year).	Medium
Flood Zone 3a	Land having a 1 in 100 or greater AEP of river flooding (greater than 1% AEP of flooding each year).	High
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The identification of the functional floodplain takes into account local circumstances but for the purposes of this SFRA, land modelled to flood during a 1 in 20 AEP (5% AEP) event or greater in any year has been mapped, in agreement with the Environment Agency.	Functional Floodplain

The '***Flood Map for Planning (Rivers and Sea)***' is available on the Environment Agency website[5] and is the main reference for planning purposes as it contains Flood Zones 1, 2 and 3a which are referred to in the NPPF and presented in Table 3-2. The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain.

The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling and is routinely updated and revised using the results from the Environment Agency's modelling programme, entailing topographic surveys and hydrological and/or hydraulic modelling as well as previous flood events.

In the VOWH District, the following models have been developed as part of the Environment Agency modelling programme and used to inform the Flood Map for Planning:

- Letcombe Brook (2009)
- Moor Ditch, Didcot to Thames Confluence (2007)
- River Ock, Frillford to A34 (2007)
- Thames MRL to St Johns (2014)
- Thames, Sandford to Whitchurch (2000)
- River Ock (A34 to Thames confluence), 2009

It is noted that this list is not exhaustive, and further studies may have been used to inform the development of the Flood Map for Planning.

At the time of SFRA preparation (2017), the Environment Agency is currently undertaking updated modelling of the River Ock and Ginge Brook as part of their ongoing modelling programme.

It should be noted that the scope of these modelling studies typically covers flooding associated with main rivers, and therefore ordinary watercourses that form tributaries to the main rivers may not always be included in the model. Modelling of ordinary watercourses, and some main rivers, available on the 'Flood Map for Planning (Rivers and Sea)' may be the result of the national generalised modelling carried out by the Environment Agency and may need to be refined when determining the probability of flooding for an individual site and preparing a site-specific FRA. Further detail regarding the scope of site specific FRAs is provided in Section 7.

A separate map is available on the Environment Agency website which is referred to as '***Risk of Flooding from Rivers and Sea***'[6]. This map takes into account the presence of flood defences and so describes the actual risk of flooding, rather than the residual risk if there were no defences present. While flood defences reduce the level of risk they don't completely remove it as they can be overtopped or fail in extreme weather conditions, or if they are in poor condition. As a result the maps may show areas behind defences which still have some risk of flooding – a residual risk. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Functional Floodplain Flood Zone 3b

The Functional Floodplain is defined in the NPPF as 'land where water has to flow or be stored in times of flood'. The Functional Floodplain (also referred to as Flood Zone 3b), is not separately distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea). Rather the SFRA is the place where LPAs should identify areas of Functional Floodplain in discussion with the Environment Agency.

[5] Environment Agency Flood Map for Planning (Rivers and Sea) https://flood-map-for-planning.service.gov.uk/

[6] Environment Agency 'Risk of Flooding from Rivers and Sea' https://flood-warning-information.service.gov.uk/long-term-flood-risk

The PPG states that the identification of Functional Floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5% AEP) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% AEP) flood, should provide a starting point for consideration. The guidance goes on to say that 'areas which would naturally flood with an annual probability of 1 in 20 or greater, but are prevented from doing so by existing infrastructure or solid buildings will not normally be defined as functional floodplain'.

Flood outlines for the 1 in 20 (5% AEP) event are available for the watercourses identified in Section 3 and these outlines have been used to map Functional Floodplain across the VOWH District, as shown in **Appendix A Figures 5.0 – 5.4**.

Climate Change

A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. Climate change may increase peak rainfall intensity and river flow, which could result in more frequent and severe flood events. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the frequency and severity of flooding will change measurably within our lifetime.

In February 2016 the Environment Agency published revised guidance on climate change allowances in an update to the document 'Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities'[7]. This version of the document reflects an assessment completed by the Environment Agency between 2013 and 2015 using United Kingdom Climate Projections 2009 (UKCP09) data, to produce more representative climate change allowances for river basin districts across England. The allowances for the Thames river basin district are of relevance to VOWH and are set out in Table 3-3.

Table 3-3 Peak river flow allowances for Thames river basin district (use 1961 to 1990 baseline)

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Thames	Upper end (90th)	25%	35%	70%
	Higher central (70th)	15%	25%	35%
	Central (50th)	10%	15%	25%

In order to determine which range of allowance should be assessed for a proposed development or plan, the flood zone and vulnerability classification should be considered, as set out below.

In Flood Zone 2

- essential infrastructure – use the higher central and upper end to assess a range of allowances
- highly vulnerable – use the higher central and upper end to assess a range of allowances
- more vulnerable – use the central and higher central to assess a range of allowances
- less vulnerable – use the central allowance

[7] Environment Agency, February 2016, Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516116/LIT_5707.pdf

- water compatible – use none of the allowances

In Flood Zone 3a

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – use the higher central and upper end to assess a range of allowances
- less vulnerable – use the central and higher central to assess a range of allowances
- water compatible – use the central allowance

In Flood Zone 3b

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – development should not be permitted
- less vulnerable – development should not be permitted
- water compatible – use the central allowance

The lifetime of the development should be considered when determining which future climate change allowance time period should be used. The lifetime of a proposed development should be judged based on the characteristics of the development. In the case of residential developments, a minimum lifetime of 100 years should be taken when selecting climate change allowance percentages. For other types of development, the applicant should assess how long they anticipate the development to be in place for, and justify the lifetime of the development. Otherwise, a 75 year lifetime should be used.

For the purposes of strategic planning, applicants are required to use the '2070 to 2115' allowances. The new climate change allowances state that for More Vulnerable development in Flood Zone 3a, the higher central and upper end allowances should be used to assess a range of allowances. This correlates to the 35% and 70%.

No revised hydraulic modelling has been completed since the preparation of the previous SFRA in 2013. In the absence of model outputs for the updated climate change allowances, this Level 1 SFRA has adopted a conservative approach to assessing climate change for the purpose of the Sequential Test by using the existing Flood Zone 2 extent (1 in 1000 annual probability of river flooding) as a proxy for the Flood Zone 3a plus climate change. This represents the 'higher central' allowance. The existing 1 in 1000 year plus 20% scenario can been used to provide an indication of the 'upper end' allowance, and as a sensitivity scenario. This approach has been agreed by VOWH DC and the Environment Agency for the Level 1 SFRA, however all subsequent site specific FRAs will be required to determine the appropriate climate change impact allowances in more detail, potentially with the need for additional hydraulic modelling, in agreement with the Environment Agency and LPA. In September 2016, the Environment Agency produced area specific guidance on how to apply the updated climate change allowances in site specific flood risk assessments[8].

Developers should note that the Environment Agency guidance should be used as a guide only and the agreed approach should be based on expert local knowledge of flood risk conditions, local sensitivities and other influences. **It is recommended that developers contact the Environment Agency at the pre-planning application stage to confirm the assessment approach, on a case by case basis.**

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

3.4.6 Flood Risk Management Measures

Flood risk management measures can consist of bunds, walls and other structures that manage flow in times of flooding and therefore reduce the risk of water from entering property. They generally fall into one of two categories; 'formal' or 'informal'.

A 'formal' flood risk management asset has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the Flood and Water Management Act, the Environment Agency has discretionary powers to construct and maintain defences to reduce flood risk.

An 'informal' flood risk management asset has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

A study of informal flood risk management assets has not been made as part of this assessment. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study area it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal flood defences should be identified as part of site specific FRAs and the residual risk of their failure assessed.

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). This dataset contains details of flood defence assets associated with main rivers and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA or site specific FRA where the need arises).

Assets in the study area, as detailed in the Environment Agency AIMS, are presented in **Appendix A, Figure 5.1 – 5.4.**

Existing assets extend along the majority of the River Thames and some of its tributaries, and along the River Ock and some of its tributaries. There are not currently any formal flood defences in the district, with the exception of the newly completed flood wall at St Helens Mill in Abingdon, which has been developed to manage flood risk associated with the River Ock.

As of 6th April 2016, the Water Resources Act 1991 and associated land drainage byelaws have been amended and flood defence consents will now fall under the Environmental Permitting (England and Wales) Regulations 2016. Any works within 8m of a main river or within the floodplain may be subject to the Environmental Permitting Regulations (EPR). This includes the construction of any buildings, culverts, bridges, footways and outfalls, both permanent and temporary works. Further details and guidance are available on the GOV.UK website[9].

In addition, as of 6th April 2012 responsibility for the consenting of works by third parties on Ordinary watercourses under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) has transferred from the Environment Agency to the LLFA. OCC is now responsible for the consenting of works to ordinary watercourses and has powers to enforce un-consented and non-compliant works. This includes any works (including temporary) that will affect the cross sectional area of the channel (such as in channel structures or diversion of watercourses).

[9] https://www.gov.uk/guidance/flood-risk-activities-environmental-permits

3.4.6.1 Completed and ongoing flood alleviation schemes

Table 3-4 below lists all the flood alleviation schemes and flood defence works that have been completed within the VOWH since 2005. The information has been made available by VOWH[10]. The data is not known to be available in mapped form.

Table 3-4 Completed Flood Alleviation Schemes

Date	Location	Details
2013/14	Cumnor Road, Boars Hill	Flood alleviation scheme to reduce risk of surface water flooding to nine properties – completed
2013/14	Kennington Rd Kennington 2	Construction of flood bund as part of Thames water's multi agency project – completed
2013/14	Abingdon – Farm Road	Flood alleviation scheme to construct bypass pipe to existing piped water course – completed
2013/14	Abingdon – St Helens Mill	Construction of a low flood wall to reduce flood risk from the River Ock – completed Summer 2017.
2012/13	Appleton - Oakesmere	Installation of new road culvert – completed
2011/12	East Hanney	Property level protection to two properties - complete
2011/12	Kennington Road Kennington 3	Installation of new trash screen - complete
2011/12	Appleton – Netherton Rd	Joint scheme with OCC for new surface water culvert - complete
2011/12	South Hinksey	Construction of new surface water culvert - complete
2011/12	Wooton – Arthur Evans Close	Repair/replacement to existing piped watercourse
2010/11	Cumnor Rd Boars Hill	Property level protection to two properties
2010/11	Cumnor Rd Boars Hill	Replacement trash screens – complete
2010/11	Longcot Village	FDGiA flood alleviation scheme along Longcot Road - complete
2010/11	Sunningwell	Construction of flood retention basin - complete
2010/11	Appleton – The Millway	Replacement culvert under the Millway - complete
2010/11	Abingdon – Sandford Brook	Riverbank stabilisation in Ladygrove Meadow - complete
2010/11	Abingdon - Abingdon Bridge	Riverbank stabilisation and new moorings - complete

[10] http://www.whitehorsedc.gov.uk/services-and-advice/environment-and-neighbourhood-issues/severe-weather/flooding/flood-alleviation-s

Date	Location	Details
2010/11	Abingdon – Mill Stream	River bank stabilisation to repair breach in bank
2010/11	Appleton – Oakesmere	FDGiA funding to undertake flood alleviation study - complete
2009/10	Steventon – Hanney Road	Clearance of ditches
2009/10	Wantage – Mill Street	Joint scheme with OCC/riparian owners for clearance of silt in Letcombe Brook - complete
2007/08	Abingdon – Appleford Drive	Trash screen replacement and watercourse clearance - complete
2006/07	Kennington Rd Kennington 1	Construction new headwall with flap valve and watercourse clearance - complete
2006/07	Sunningwell	Construction of new surface water pipe across cricket ground - complete
2006/07	Great Coxwell	Joint scheme with OCC for culvert cleaning/replacement and watercourses clearance - complete
2004/05	Wantage – Mill Street	Replacement trash screens - complete

Several flood alleviation schemes are currently ongoing and being led by the Environment Agency in consultation with several local councils. The following information has been provided by the Environment Agency regarding these schemes.

Oxford Flood Alleviation Scheme

Since the 2014 floods the Environment Agency has been working with partners, including Oxfordshire County Council, Oxford City Council, Vale of White Horse District Council, Thames Water and the Oxford Flood Alliance, to develop a scheme to reduce flood risk to residents and businesses in Oxford.

Investigations have been carried out into the flood risk and possible options for alleviating it. The results show that by lowering parts of the floodplain to the west of Oxford, widening and deepening some of the rivers and streams that run through it, and constructing some physical defences, the capacity of the floodplain can be increased and flood risk to over 1000 properties can be reduced.

The scheme runs from north of Botley Road down to Munday's Bridge and will require various approvals including planning permission. Providing the scheme is fully approved and funded the earliest work will start is in 2018 and construction is expected to take 3 to 4 years.

Abingdon Flood Alleviation Scheme

The Environment Agency is working with the Vale of White Horse District Council to develop a potential flood risk management scheme to reduce flood risk in Abingdon from the River Ock. Several projects have been investigated to reduce flood risk including a flood storage area, permanent flood defences, modifying weirs and natural flood management such as land-use change.

3.4.7 Flood Warning Areas

The Environment Agency provides a free Flood Warning Service[11] for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency has provided a GIS layer of Flood Warning Areas in the study area which are presented in **Appendix A Figures 6.0 – 6.4**.

3.5 Flooding from Surface Water

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding. The NPPG states that a SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information.

In line with the previous SFRA, for practical purposes, flooding from drains and ditches has been considered in the same category as surface water flooding. Where ordinary watercourses are culverted, trash screens and culverts have the potential to become blocked by items such as plant debris and rubbish. Blockages can restrict the natural flow of water, increasing the chance of water flowing out of bank and causing local flooding due to the reduced conveyance potential of the associated watercourse.

Overall, the flooding from surface waters is considered to be at a smaller risk in relation to inundation and the consequences from flooding. The pathways of surface water will be defined by the local topography. Natural or unnatural features may influence the route that floodwater will take. In urban areas roads form a common pathway for surface water, helping dictate the area that will be affected by flooding. This is further exemplified where there are steep gradients. Within site specific scale the risk from this flood source should be identified in a Flood Risk Assessment.

The hydrological response of a particular catchment throughout the country varies, with the geological conditions being a key factor in the determination of hydrological response. The upper and middle parts of the VOWH catchment is characterised by clay, whilst the lower is chalk. The two opposing geological conditions will result in significant difference in the catchment hydrological response to rainfall. Catchments characterised by clay deposits will permit little infiltration and result in large quantities of overland flow. However, Chalk will promote infiltration, potentially reduce runoff and help sustain river water levels via a significant base flow input.

The Flood Map for Surface Water (FMfSW) (**Appendix A Figures 7.0 – 7.4**) identifies flood risk areas as predominantly following topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. If the FMfSW indicate a risk to a site allocation or settlement this has been discussed in further detail in Section 4. It should be noted that because of its broad-scale nature, wherever possible, these mapped outlines should be used in conjunction with other sources of local flooding information to confirm the presence of a surface water risk.

3.5.1 Historic Records

Records of flooding from surface water, drains, ditches and ordinary watercourses have been provided from VOWH and Highways England. Records of surface water flooding which are georeferenced are presented in **Appendix A Figures 7.0 – 7.4**.

The Highways Agency data shows 63 incidents of flooding all along the A34. Many of the surface water incidents recorded by VOWHDC are concentrated on the eastern side of the VOWH, however there are some spread out over the district. These events all occur in the bands of bedrock made of clays, mudstone, siltstone and sandstone and limestone, none of these occur in the areas of chalk bedrock, where the ground is more permeable.

[11] Environment Agency Flood Warning Service https://www.gov.uk/sign-up-for-flood-warnings

OCC Records

The PFRA for OCC (2013) includes a list of recorded historic surface water flood incidents across Oxfordshire County. Only one entry includes locations within the VOWH, this was a significant flood event affecting approximately 2682 properties across Oxford County. This event was caused by all the different types of flooding discussed in this report.

3.5.2 Risk of Flooding from Surface Water

The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual probability events: 1 in 30 year (3.33% annual probability), 1 in 100 year (1% annual probability) and 1 in 1,000 year (0.1% annual probability). The latest version of the mapping is referred to as the 'Risk of Flooding from Surface Water' (RoFSW) and the extents have been made available for the Level 1 SFRA as GIS layers. This dataset is also available on the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'.

The RoFSW provides all relevant stakeholders, such as the Environment Agency, LPAs and the public access to information on surface water flood risk which is consistent across England and Wales. The modelling helps the Environment Agency take a strategic overview of flooding, and assists LLFAs in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the study area which may have a surface water flood risk.

The modelling represents a significant improvement on previous mapping, namely the FMfSW (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid,
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers,
- Use of a range of storm scenarios, and
- Incorporation of appropriate local mapping, knowledge and flood incident records.

However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas,
- It does not show the susceptibility of individual properties to surface water flooding,
- The mapping has significant limitations for use in flat catchments,
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses,
- In a number of areas, modelling has not been validated due to a lack of surface water flood records, and
- As with all models, the RoFSW is affected by a lack of, or inaccuracies, in available data.

The RoFSW for the study area is presented in **Appendix A Figures 7.0 – 7.4** in combination with historical surface water flooding data.

The RoFSW shows that surface water flooding largely follows the fluvial pathways, yet is much more extensive, often originating upstream of the tributaries. There are also multiple localised surface water flood areas dispersed across the District, this is often where ditches or drains have become blocked. Surface water also accumulates along impermeable surfaces; this is particularly noticeable over the road network.

Climate Change

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change

3.6 Flooding from Groundwater

Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

3.6.1 Areas Susceptible to Groundwater Flooding

As part of the SFRA, an assessment of the risk of groundwater flooding needs to be considered; however, a quantified assessment of risk from groundwater flooding is difficult to undertake, especially on a strategic scale. This is due to lack of groundwater level records, the variability in geological conditions and the lack of predictive tools (such as modelling) that can be used to make assessments of groundwater flow and risk of groundwater flooding following rainfall events.

The Environment Agency Areas Susceptible to Groundwater Flooding (AStGWF) dataset is a strategic scale map showing groundwater flood areas on a 1km square grid. The Environment Agency has provided information with the data and guidance for using it, which is summarised below.

The AStGWF dataset has been prepared primarily as part of the PFRA process, to allow LLFAs across England and Wales such as OCC to obtain a broad feel for the wider areas which might be at risk from groundwater flooding.

The data has used the top two susceptibility bands of the BGS 1:50,000 Groundwater Flood Susceptibility Map and therefore covers consolidated aquifers and superficial deposits. It does not take account of the chance of flooding from groundwater rebound. It shows the proportion of each 1m square where geological and hydrogeological conditions show that groundwater might emerge. The susceptible areas are represented by one of four area categories showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwater flooding occurring.

The dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The datasets has a number of limitations, as follows:

- The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding, but may be of use to LLFAs in identifying, where, for example, further studies may be useful;
- The AStGWF should not be used as the sole evidence for any specific flood risk management, land use planning or other decision at any scale. The data may however help to identify areas for assessment at a local scale where finer resolution datasets exist.

The AStGWF dataset has been mapped in **Appendix A Figure 8**. It highlights that the majority of the District has a susceptibility to surface water flooding of <25%. The area has intermittent areas where the risk is greater 25-50%. Where the River Thames borders the northern and eastern boundary and where River Ock flows through the Vale (between Abingdon/ Sutton Courtenay and West Hanney/Grove) as well as some other more isolated areas, there is much greater risk, which areas susceptible to groundwater flooding at 50-75% and >75%. Some areas in the map have no data provided this is more significant in the south of the VOWH, this corresponds to an area of high ground (Wessex Downs) and this area is known to be chalk therefore the high permeability in the area will mean reduced risk of ground water flooding.

3.7 Flooding from Sewers

The sewer system is made up of foul, surface water and combined systems. After a heavy rainfall event the surface water system could reach full capacity resulting in surcharge from manholes and drains (referred to external flooding). Where the surface water and foul systems are combined there is also a risk of full capacity leading to surcharging. However, with the combined sewer system this could result in surcharging within buildings from toilets and drains (referred to as internal flooding.). Basement conversions are particularly prone to sewer flooding, where they lie low relative to the depth of the public sewer.

During heavy rainfall, flooding from the sewer system may occur if:

(1) The rainfall event exceeds the capacity of the sewer system/drainage system:

New sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While Thames Water Services (TWS), as the sewerage undertaker for the study area, recognise the impact that more extreme rainfall events may have, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event. However, many of the sewer systems in England date back to Victorian times, where the capacity could be significantly less than the 1:30 year. This could result in sewer flooding occurring much more frequently in these older systems.

(2) The system becomes blocked by debris or sediment:

Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

(3) The system surcharges due to high water levels in receiving watercourses:

Within the study area there is potential for surface water outlets to become submerged due to high river levels. When this happens, water is unable to discharge. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

This flood occurrence is likely to become a more common occurrence in the future due to climate change and an increase in the number and intensity of convective storms. It is now a widely accepted phenomenon that one of the main effects of climate change in the south east of England will be higher intensity rainfall events and more frequent winter storms, all of which will increase the risk of flooding from all sources.

3.7.1 Historic Records of Sewer Flooding

Thames Water provided the location of previous sewer flood records, as shown in **Appendix A Figure 9.1 and 9.2**. Sewer flood incidents are arranged in to post code areas and coloured depending on the number of incidents recorded in that area.

Comparisons with the recorded sewer flood incidents and proposed development sites can help identify the risk local sewers may have on particular sites. In addition to the flood risk posed to the site, areas with higher instances of flooding from sewers may suggest reduced capacity within the receiving sewer network. As part of any development, contact should be made with the sewer provider (in this instance TW) to confirm discharge locations, volumes and capacities and all efforts to reduce runoff entering the sewer network should be made.

It should be noted that while particular locations may be at a greater risk, all sewers represent a degree of flood risk. Therefore regardless of sewer flood history an assessment for flood risk from this source should be made part of a site specific FRA.

3.8 Reservoirs, Canals and Other Artificial Sources

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPF encourages LPAs to identify reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

The reservoirs present in the VOWH District are listed in Table 3-5. There are no records of reservoir flooding in VOWH.

Table 3-5 Reservoirs in VOWH (Environment Agency Reservoir mapping)[12]

Reservoir	Location	Reservoir Owner/Undertakers
Butterbush Reservoir	Wantage	Unconfirmed
Ridgeway Reservoir	Wantage	Unconfirmed
Farmoor Reservoir	Farmoor	Thames Water
Buscot Reservoir - Abandoned	Buscot Park, Faringdon	National Trust, Estate Office, Coleshill, Swindon, Wiltshire. SN6 7PT
Buscot Park Lake	Buscot Park, Faringdon	National Trust, Estate Office, Coleshill, Swindon, Wiltshire. SN6 7PT
Faringdon House Estate Lake	Faringdon	Faringdon House Estate
Otmoor Phase 1	Oddington, Islip,· Oxford	RSPB
Otmoor Phase 2	Oddington, Islip,· Oxford	RSPB
Radley Ash Lake G	Radley near Abingdon	RWE npower plc.
Radley Ash Lake H and I	Radley near Abingdon	RWE npower plc.
Rycote Park Lake	Situated on the Rycote Estate Rycote park	Taylor
Thame Park Lake	Thame	Thame Park Estate
West Cherwell Flood Storage Area	Cherwell	Thames Water

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs (> 25,000m^3) must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a managed risk. VOWH DC is responsible for working with members of the OCC Emergency Planning Unit and other District Councils to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

[12] Environment Agency (2015) Risk of Flooding from Reservoirs

3.8.1 Risk of Flooding from Reservoirs Mapping

The Environment Agency dataset 'Risk of Flooding from Reservoirs' available online identifies areas that could be flooded if a large reservoir (> 25,000m^3) were to fail and release the water it holds. The map of flood risk due to Reservoirs is included in **Appendix A Figure 10**. The mapping shows:

- the risk to the majority of the VOWH in regards to reservoir flooding is very low. The main areas of concern would be around Farmoor Reservoir and the areas around the borders of the district which lie close to or along the River Thames or one of its tributaries.

In relation to the potential development areas, none of the locations are within the extents of the reservoir flooding as shown on this map, although this information may be subject to update in the future.

3.8.2 Canals

There is one canal in the VOWH, this runs from the Kennet and Avon Canal near Melksham to the River Thames near Abingdon. The canal was abandoned in 1914, however restoration works are being undertaken to restore it to use. To date only 8 miles of the canal has been re-watered.

Although the canal is generally not used as a water course, naturally it still collects surface water; therefore the risk of flooding can increase if outlets from the canal become blocked over time. An example of this is that two properties experienced increased flood risk at West Challow in 2013 when an outlet pipe from the canal was blocked.

4. Review of Potential Development Sites

4.1 Introduction

The VOWH DC are currently progressing their Local Plan 2031: Part 2 (LPP2) with submission to the Secretary of State timetabled for February 2018. The LPP2 will:

- allocate small (non-strategic) development areas; and,
- allocate development areas to address unmet housing need for Oxford to be allocated throughout the study area.

The VOWH DC LPP1 and LPP2 sets the strategic policies and identifies strategic sites for housing, employment and supporting infrastructure required in the district up to 2031. Each of LPP1 and LPP2 sites have corresponding site development templates (Appendix A of Local Plan 2031 Part 1 and Part 2) which sets out general requirements that all development needs to adhere to.

A technical note covering the VOWH DC LPP2 initial site options and allocations, following the format used in the 2013 SFRA and the 2014 addendum, using updated data sets for all sources of flood risk was issued in October 2016.

This Level 1 SFRA report provides an assessment of the development areas that were chosen in the Preferred Options Consultation following the issue of the Initial Site Options and Allocations Technical Note.

The assessments have been carried out in the same format as that used in the technical note, the 2013 SFRA and the 2014 addendum, for each of the 7 development areas chosen in the Preferred Options Consultation using the same data that has been illustrated in **Appendix A**.

The 7 shortlisted sites to be allocated by the LPP2 are shown in Table 4-1.

Table 4-1 Final list of sites to be allocated in the VOWH Local Plan

Site Number	Location of Site	Area (ha)
1	Harwell Campus	34.5
2	North West of Grove	28.4
3	Dalton Barracks (Shippon)	288.7
4	East of Kingston Bagpuize with Southmoor	34.7
5	South East of Marcham	5.0
6	North of East Hanney	3.4
7	North East of East Hanney	2.4

The location and extent of the 7 development area locations is shown in **Appendix A Figure 5, 5.1 and 5.2**.

Five of these locations were considered in the previously prepared Stage 2 SFRA report, and have been updated as appropriate, while new assessments have been carried out for the additional four sites.

These summaries are included below.

In this assessment the following information has been assessed:

- Fluvial flood risk summary, Flood Map, (Figure 5 in Appendix A)
- Flood defence information (Figure 5 in Appendix A)
- Surface water flood risk (Figure 7 in Appendix A)
- Ground water flood risk (Figure 8 in Appendix A)
- Internal and External Sewer Flood Risk (Figure 9.1 and 9.2 in Appendix A)
- Reservoir flood risk (Figure 10 in Appendix A)
- Impact of climate change.

4.2 VOWH - Development Area Assessments

4.2.1 Harwell Campus

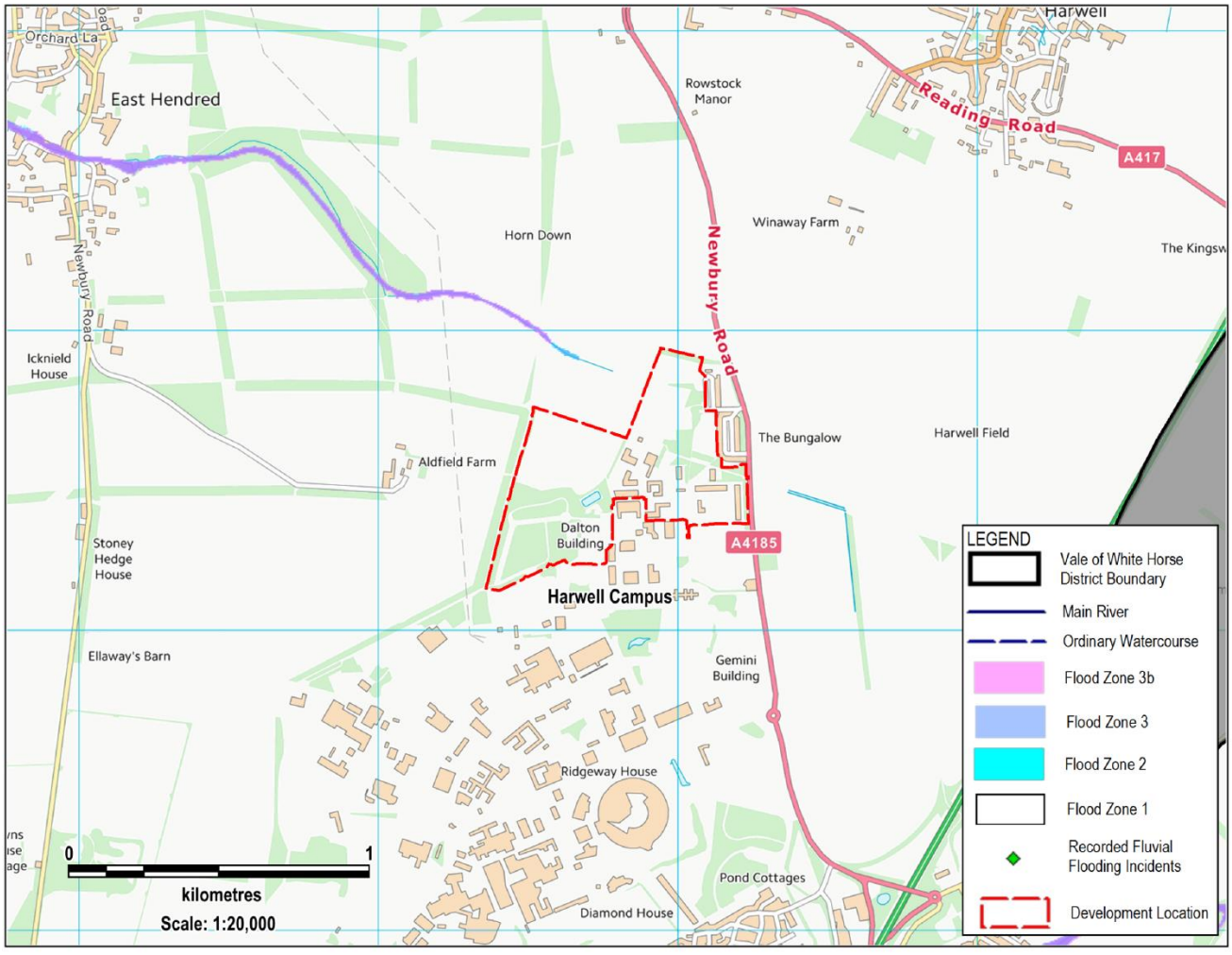
Harwell Campus			
Area: 34.35 ha	**Brownfield/Greenfield:** Both	**Proposed use:** Residential	**Flood risk vulnerability classification:** Less vulnerable
Summary of flood risk to site			

Fluvial

There is an unnamed watercourse to the north west of the site. This flows west and forms a tributary of the Ginge Brook. There are no formal flood defences. The site lies within Flood Zone 1.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.

Flood Map



Harwell Campus

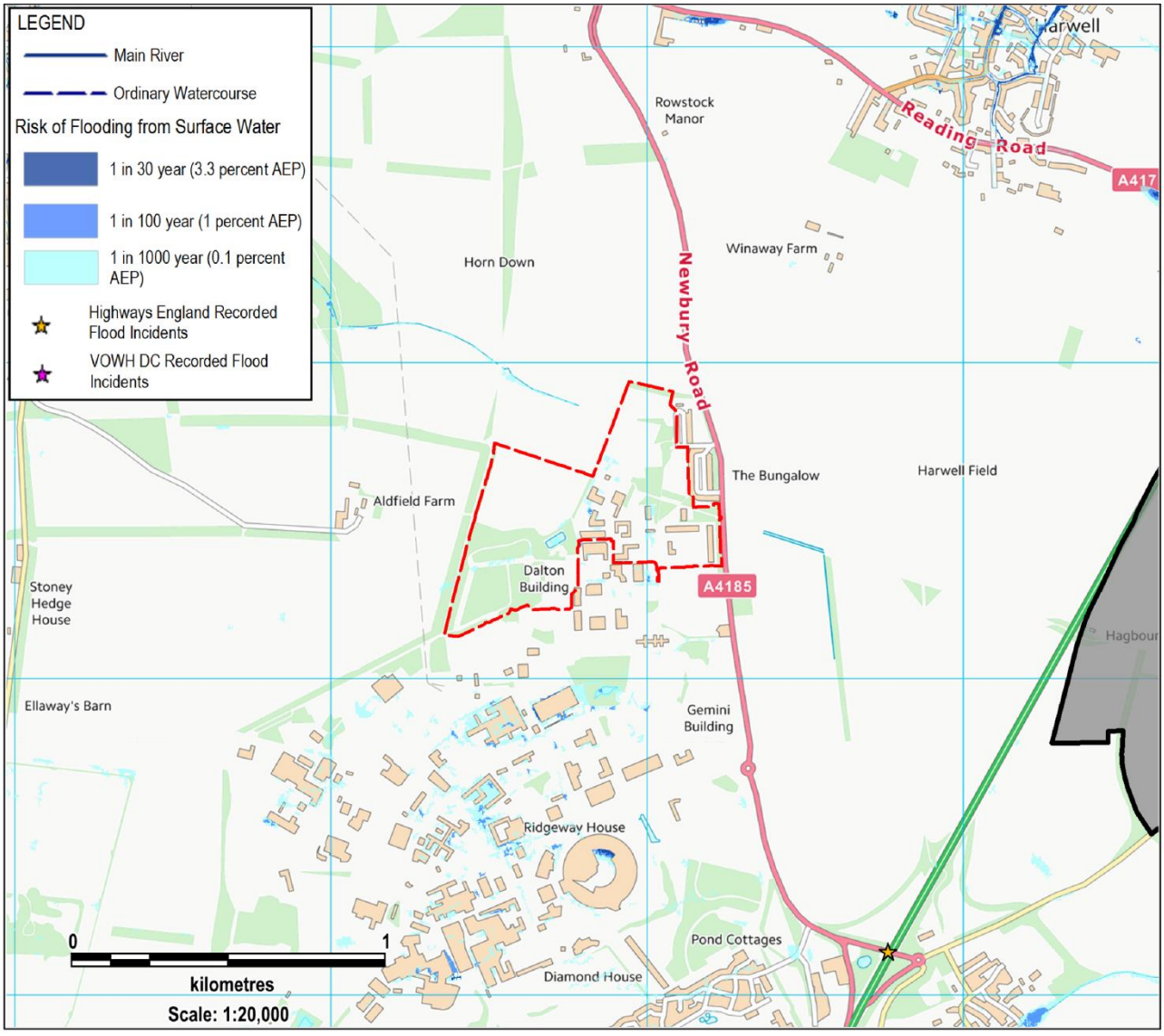
Surface Water

The RoFSW shows there is a low risk (0.1% -1% Annual Exceedance Probability (AEP) of surface water ponding in the centre of the site. There are no known historical records of surface water flooding in the vicinity of the site. Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



Groundwater

The AStGWF map suggests the area is predominantly in the very low category (<25%) of areas susceptible to groundwater flooding. There are no known historical records of groundwater flooding in the vicinity of the site.

Harwell Campus
This site is in a strip of West Melbury Marly Chalk Formation, which is made up of Chalk and Limestone. Chalk has a natural high level of permeability; this increases the ability of water to infiltrate into the ground.
Sewer There have been 6 reported external sewer incidents in OX110. No known internal sewer flooding problems.
Available survey/detailed modelling No detailed models available.
Implications for development • The site is >1ha, therefore a FRA and drainage strategy is required. • The site is in Flood Zone 1. Further clarification of the 1 in 100 year + climate change allowance flood outline will be required at the planning application stage to re-confirm the potential impact of climate change on fluvial flood risk at this site. • A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings. • Site level topography should be used to re-confirm surface water flow paths both pre and post development • Pre-application engagement with the LLFA regarding suitable drainage, taking into account the local ground conditions is recommended. High level assessment identifies chalk geology which may provide opportunities for infiltration SuDS. This should be investigated further with on-site surveys. • Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary.

4.2.2 North West of Grove

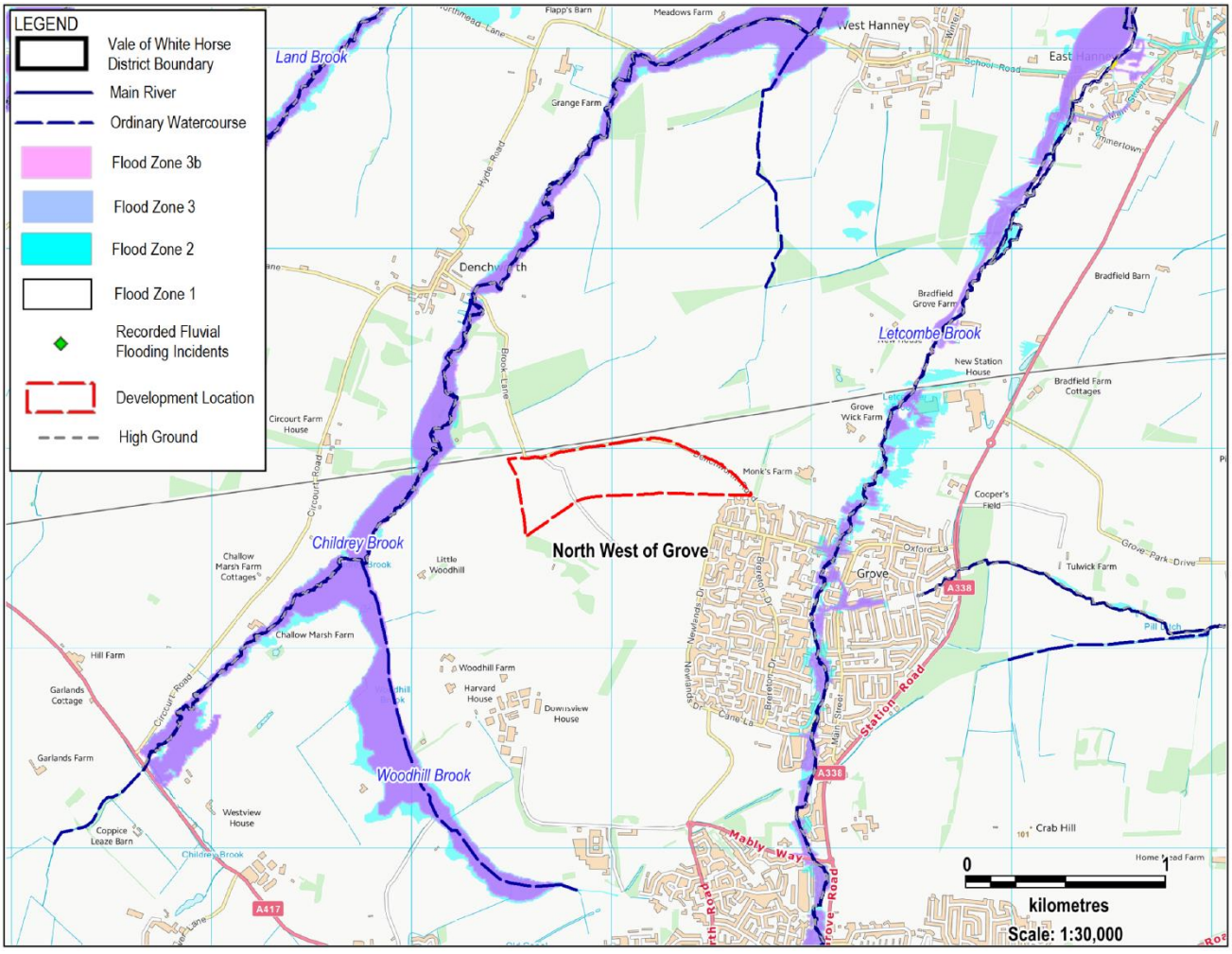
North West of Grove			
Area: 28.27 ha	**Brownfield/Greenfield**: Greenfield	**Proposed use:** Residential	**Flood risk vulnerability classification**: More vulnerable
Summary of flood risk to site			

Fluvial

The site lies within Flood Zone 1. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.

Flood Map



North West of Grove

Surface Water

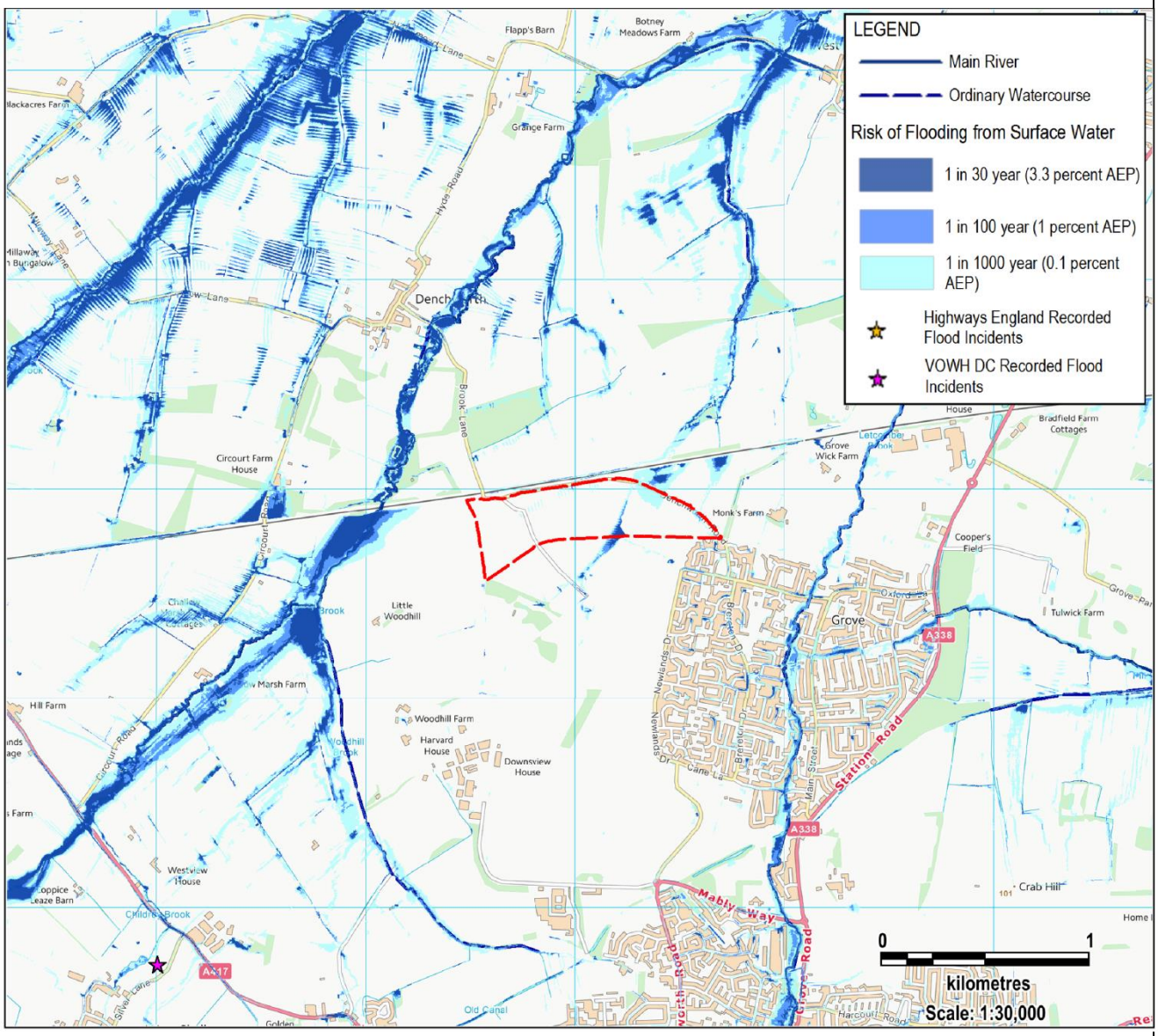
The RoFSW shows a potential flow path flowing from the south to the north of the site. Parts of the site are at high risk (>3.3% AEP) of surface water flooding. There are no known historical records of surface water flooding on the site.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



North West of Grove

Groundwater

The AStGWF map suggests the area is predominantly within the medium to high (50%-<75%) risk category of groundwater flooding. There are no known historical records of groundwater flooding on the site.

Gault Formation is made up of a stiff clay. Clay is naturally impermeable, therefore in this area it is difficult for water to infiltrate into the ground, increasing the risk of ponding and flooding.

Sewer

There have been six reported external sewer incidents in OX120. No known internal sewer flooding problems have been recorded.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- The site is in Flood Zone 1. Further clarification of the 1 in 100 year + climate change allowance flood outline will be required at the planning application stage to re-confirm the potential impact of climate change on fluvial flood risk at this site.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- A site specific FRA should include a detailed assessment of flood risks from all sources. Existing strategic surface water modelling identifies a potential impediment to surface water flow created by the rail embankment to the north of the site. This data should be refined where possible as part of a site level FRA.
- Site level topography should be used to re-confirm surface water flow paths both pre and post development
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology identifies the presence of clay which may make infiltration of surface water less viable. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.

Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary.

4.2.3 Dalton Barracks (Shippon)

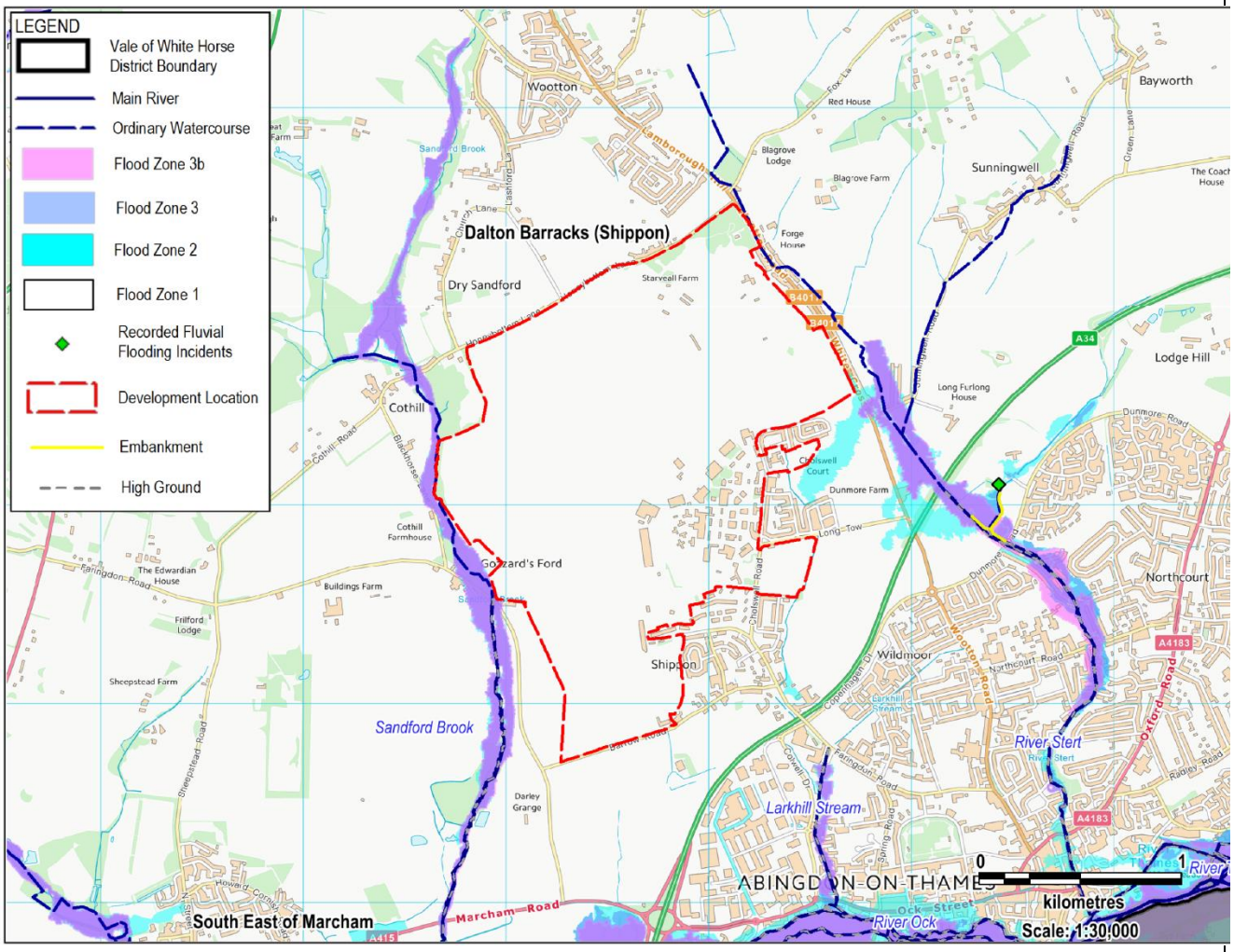
Dalton Barracks (Shippon)			
Area: 312.5ha	**Brownfield/Greenfield:** Brownfield/Greenfield	**Proposed use:** Residential	**Flood risk vulnerability classification:** More vulnerable
Summary of flood risk to site			

Fluvial

A small area to the west of the site touches Flood Zone 3. On the east of the site, a small section of the area touches Flood Zone 2. There are no watercourses on the site however Gozzard's Ford is located along the western edge of the site and an unnamed watercourse is located on the east edge of the site. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.The site will still touch Flood Zone 2 and 3 in some places, however they do not spread onto the site.

Flood Map



Dalton Barracks (Shippon)

Surface Water

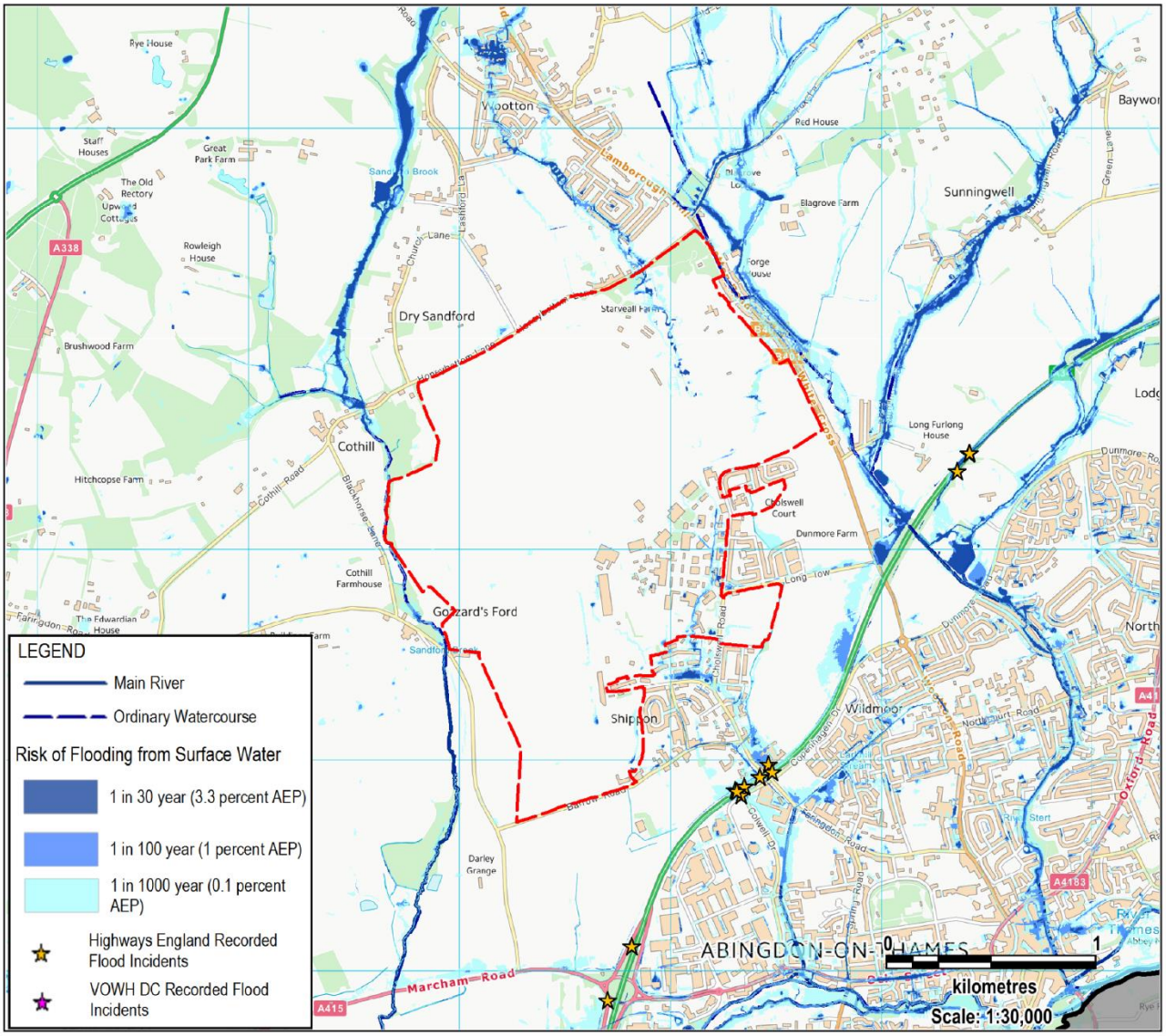
The RoFSW shows that the majority of the site to be at very low risk (<0.1% AEP) of surface water flood risk. Areas of medium (1% - 3.3% AEP) and high risk (>3.3% AEP) surface water flood risk can be seen in the north of the site and in the area to the south, around Shippon. There are a number of areas of ponding that are located around the site. There are no known historical records of surface water flooding in this area.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



Dalton Barracks (Shippon)

Groundwater

The AStGWF map suggests the area is predominantly within the low to medium (25%-<50%) risk category. The other areas of the site are within the very low (>25%) to the very high risk category (<75%). There are no known historical records of groundwater flooding on the site.

Stanford Formation made up of limestone, mudstone and marl. This is in an area designated to be a Secondary A aquifer therefore it can be supposed that this area has limited permeability, increasing risk of flooding due to its weak ability allow water to infiltrate to the ground.

Sewer

There have been 14 reported external sewer incidents and 1 reported internal sewer flooding incident in OX136.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- The site is in Flood Zone 1. However, there are two watercourses bounding the site to the east and west. Clarification of the 1 in 100 year + climate change flood outline will be required at the planning application stage to re-confirm the potential impact of climate change on fluvial flood risk at this site.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- A site specific FRA should include a detailed assessment of flood risks from all sources. Existing strategic surface water modelling identifies three potential surface water flow paths crossing the site. This data should be refined where possible as part of a site level FRA.
- Site level topography should be used to re-confirm surface water flow paths both pre and post development
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology suggests limited permeability. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.
- Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary.
- This is a large site and every effort should be made to apply a sequential approach to development layout and provide space for water.

4.2.4 East of Kingston Bagpuize with Southmoor

East of Kingston Bagpuize with Southmoor			
Area: 34.63 ha	**Brownfield/Greenfield:** Greenfield	**Proposed use:** Residential	**Flood risk vulnerability classification:** Low vulnerability

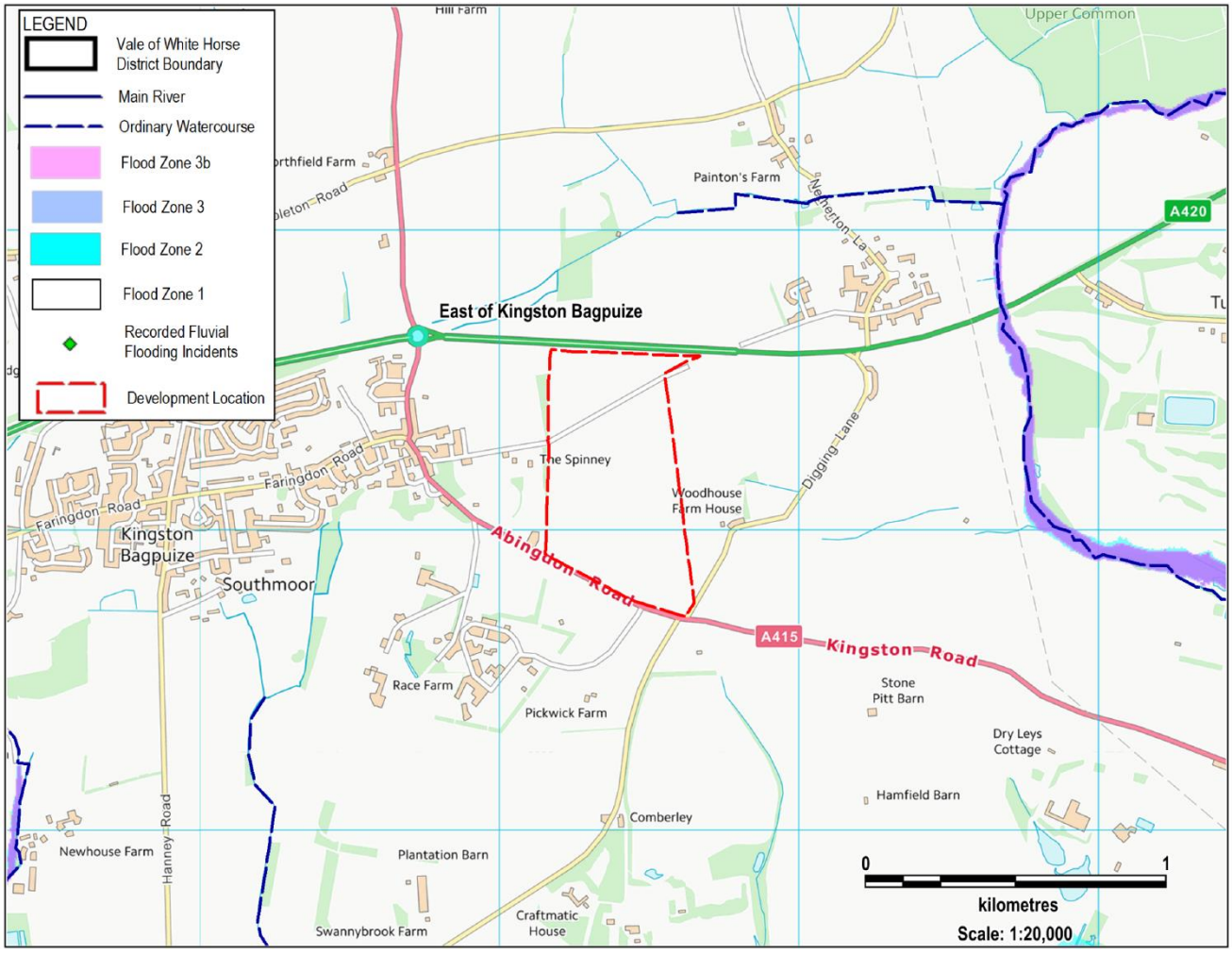
Summary of flood risk to site

Fluvial

The site lies within Flood Zone 1 and there are no watercourses located on the site or close to the site boundary. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.

Flood Map



East of Kingston Bagpuize with Southmoor

Surface Water

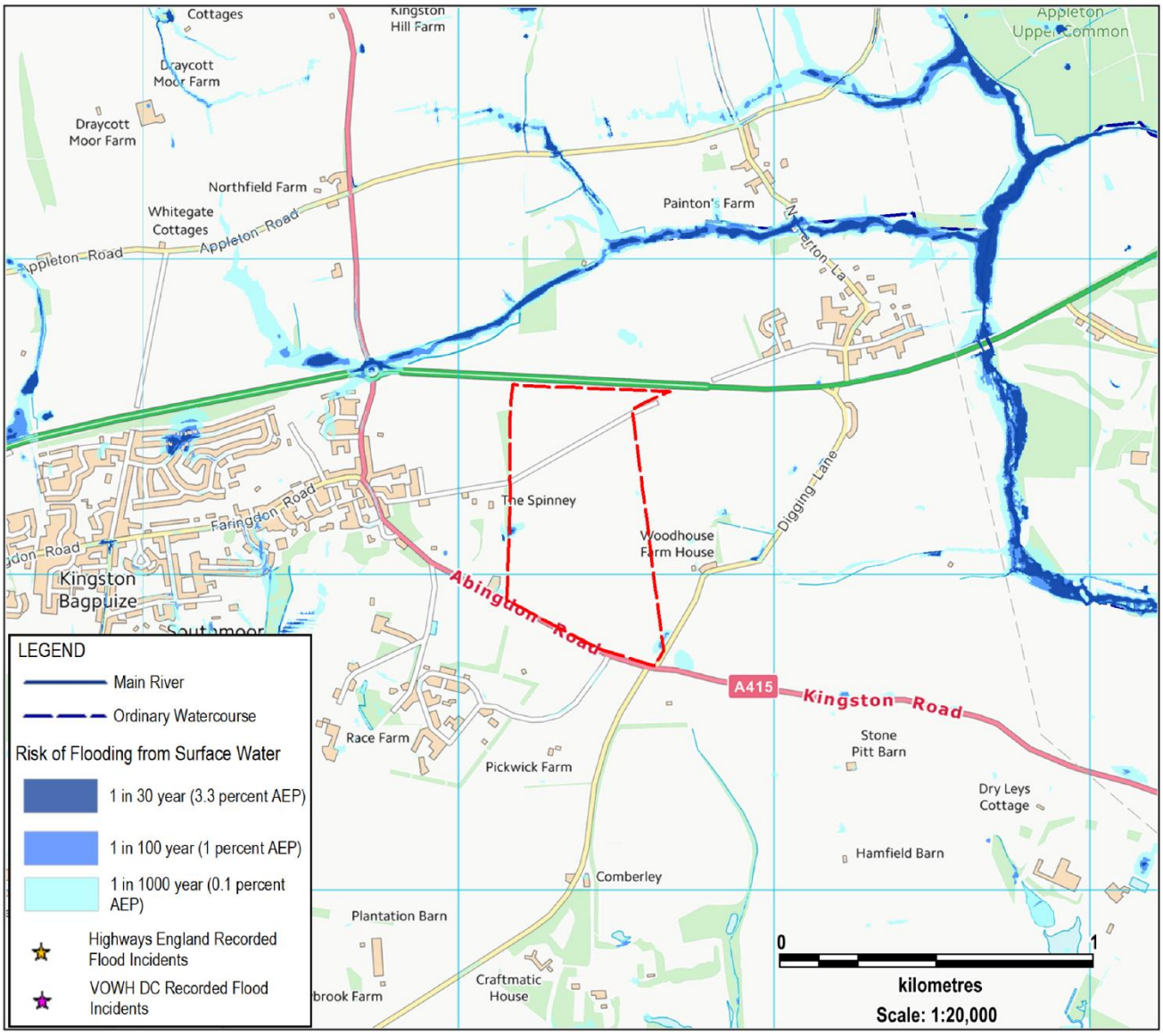
The RoFSW shows that the majority of the site to be at very low risk (<0.1% AEP) of surface water flood risk, with two very small areas of medium (1% - 3.3% AEP) and high risk (>3.3% AEP) surface water flood risk located on the eastern and western boundaries of the site. There are no known historical records of surface water flooding on the site.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



East of Kingston Bagpuize with Southmoor

Groundwater

The AStGWF map suggests the area is predominantly in the very low category (<25%) of areas susceptible to groundwater flooding. There are no known historical records of groundwater flooding on the site.

Kingston Formation – made up of limestone, sandstone and mudstone. This is in an area designated to be a Secondary A aquifer therefore it can be supposed that this area has limited permeability, increasing risk of flooding due to its weak ability allow water to infiltrate to the ground.

Sewer

There have been 3 reported external sewer incidents and 1 reported internal sewer flooding incident in OX135.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- It is unlikely that the site will be affected by the impact of climate change on fluvial flood risk. However, a site level assessment should be competed at the planning application stage.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- Site level topography should be used to re-confirm surface water flow paths both pre and post development
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology suggests limited permeability. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.
- Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system and any upgrades are carried out where necessary.

4.2.5 South East of Marcham

South East of Marcham			
Area:	**Brownfield/Greenfield:**	**Proposed use:**	**Flood risk vulnerability classification:**
4.950ha	Greenfield	Residential	Less vulnerable

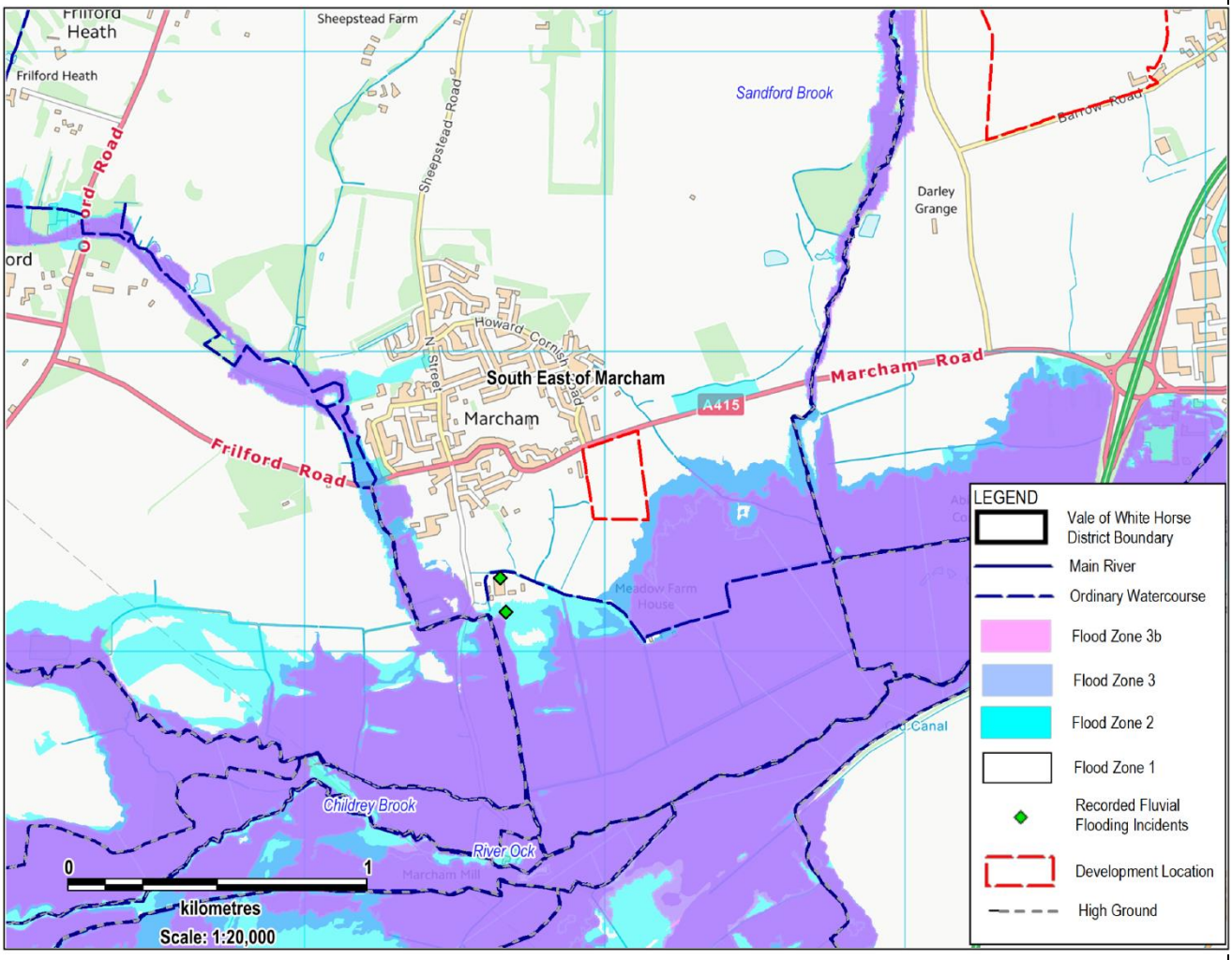
Summary of flood risk to site

Fluvial

The site lies within Flood Zone 1 and there are no watercourses located on the site although an unnamed watercourse linked to River Ock flows near the site on the south west side. The south east boundary touches Flood Zone 3. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.

Flood Map



South East of Marcham

Surface Water

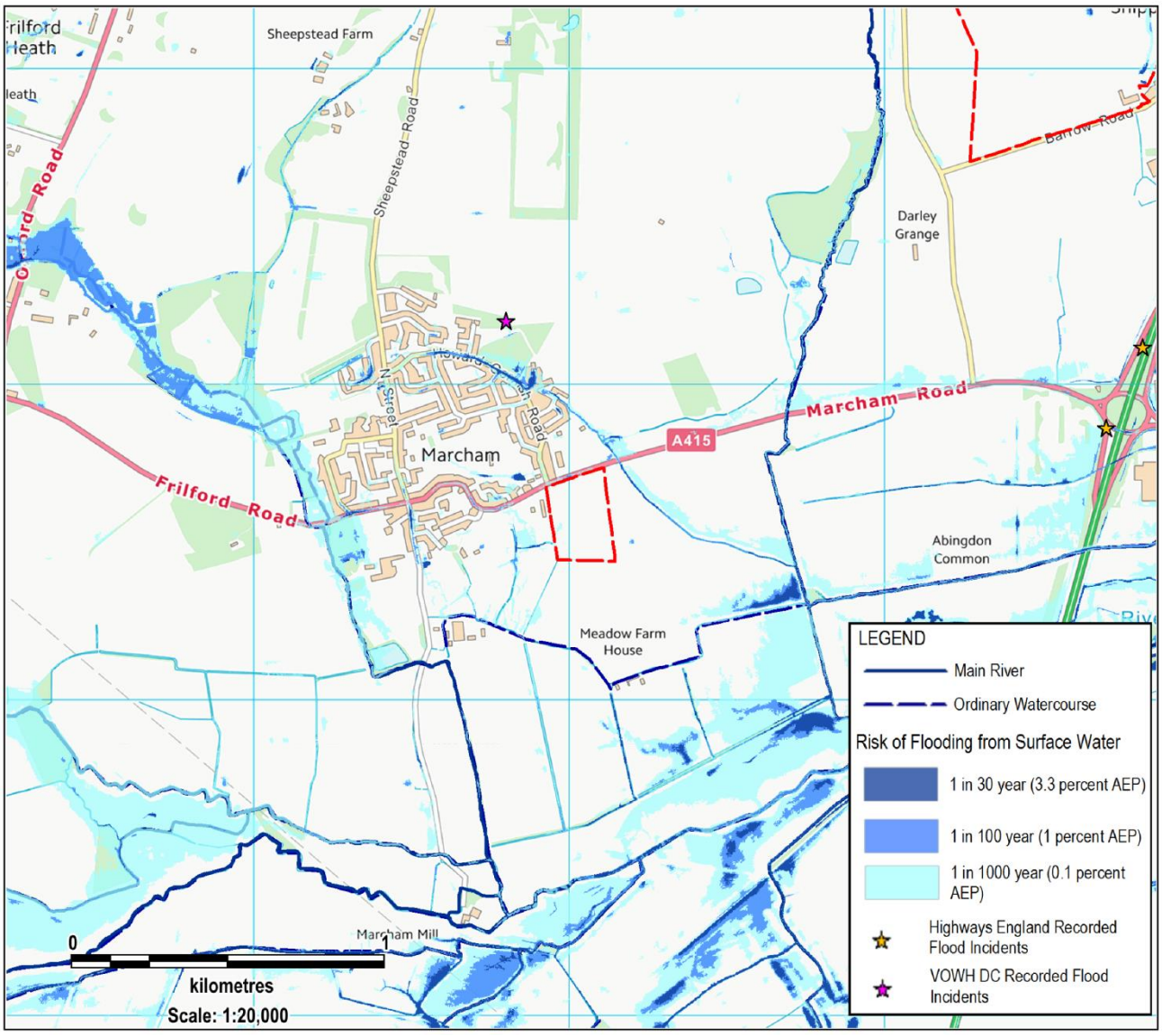
The RoFSW shows that the majority of the site to be at very low risk (<0.1% AEP) of surface water flood risk, with one small area of low risk (0.1% - 1% AEP) within the site and a number of low risk (0.1% - 1% AEP) areas for surface water flooding along the north, west, and southern boundaries. There are no historical records of surface water flooding on the site.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



South East of Marcham

Groundwater

The AStGWF map suggests that the site is mostly within the high risk (>75%) from groundwater flooding area. There are no known historical records of groundwater flooding on the site.

Stanford Formation made up of limestone, mudstone and marl. Kingston Formation – made up of limestone, sandstone and mudstone. The site is in an area designated to be a Secondary A aquifer therefore it can be supposed that this area has limited permeability, increasing risk of flooding due to its weak ability allow water to infiltrate to the ground.

Sewer

There have been 14 reported external sewer incidents and 1 reported internal sewer flooding incident in OX136.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- The site is in Flood Zone 1. However, hydraulic modelling places it on the boundary of Flood Zone 2. Contact should be made with the Environment Agency at the earliest opportunity to confirm the source of modelled data at this location. Additional assessment will be required to confirm the 1 in 100 year + cc outline associated with the main river to the south of the site. In addition, there appear to be two ordinary watercourses in the vicinity of the site, located to the north east and south west. Neither appears to have Flood Zones associated with them. Again, this should to be confirmed with the Environment Agency and LLFA and further assessment may be required to confirm the fluvial risk posed by these sources.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- A site specific FRA should include a detailed assessment of flood risks from all sources. Existing strategic surface water modelling identifies potential surface water flow paths to the west of the development and along the access road to the north. If site access is to be provided in this location, surface water flow routes should be considered to ensure that flood risk to adjacent property is not increased, and where possible reduced.
- Site level topography should be used to re-confirm surface water flow paths both pre and post development
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology suggests limited permeability. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.
- Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary.

4.2.6 North East of Hanney

North of East Hanney			
Area: 3.433ha	**Brownfield/Greenfield:** Greenfield	**Proposed use:** Residential	**Flood risk vulnerability classification:** More vulnerable

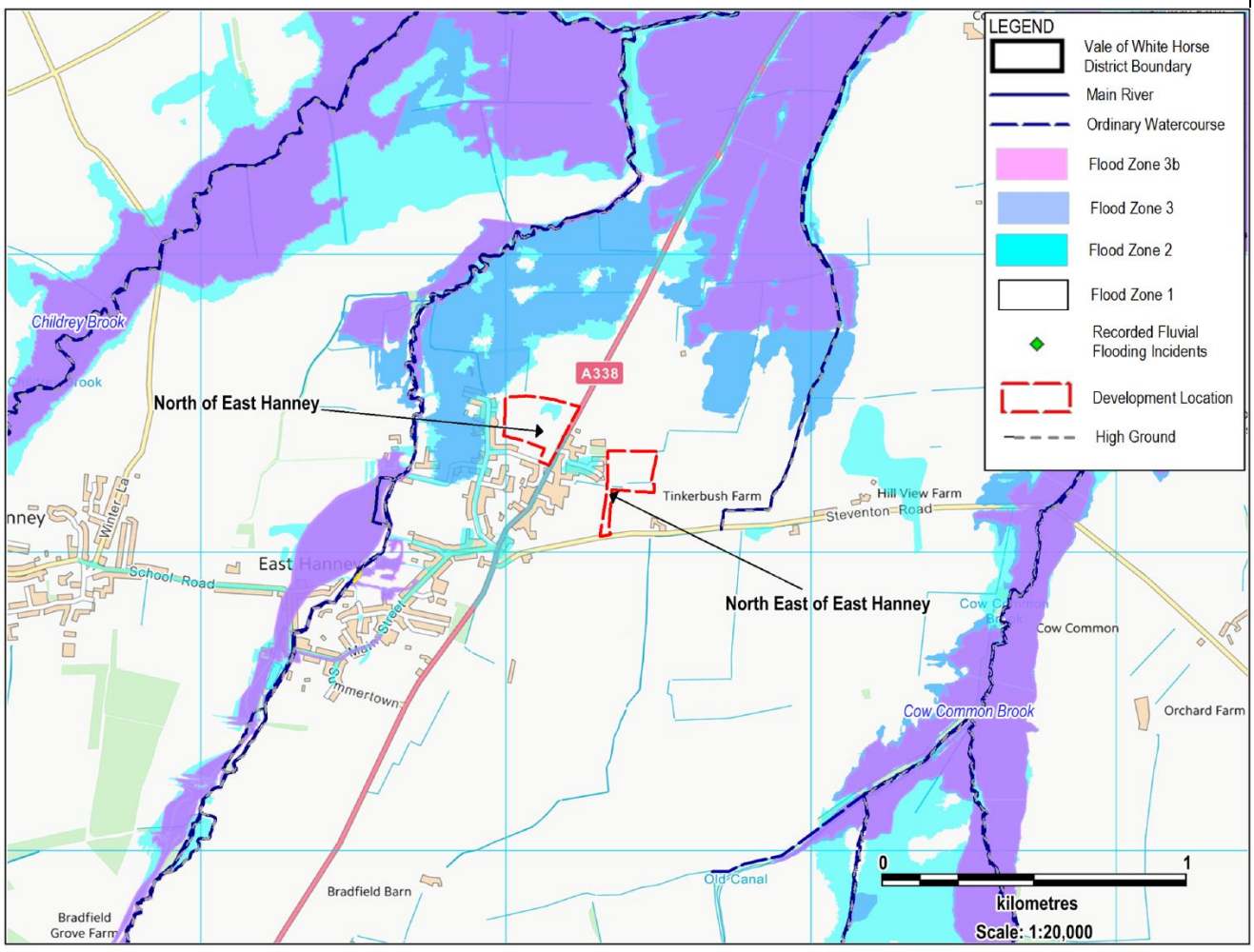
Summary of flood risk to site

Fluvial

The site lies mostly within Flood Zone 1, there is a section within the site that is Flood Zone 2 and the south eastern boundary touches Flood Zone 2 also. There are no watercourses located on the site, although an unnamed watercourse flows along the eastern site boundary and another flows north of the site. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the a section of the site does fall within the 1 in 100 year + cc flood outline and therefore will be within Flood Zone 2.

Flood Map



North of East Hanney

Surface Water

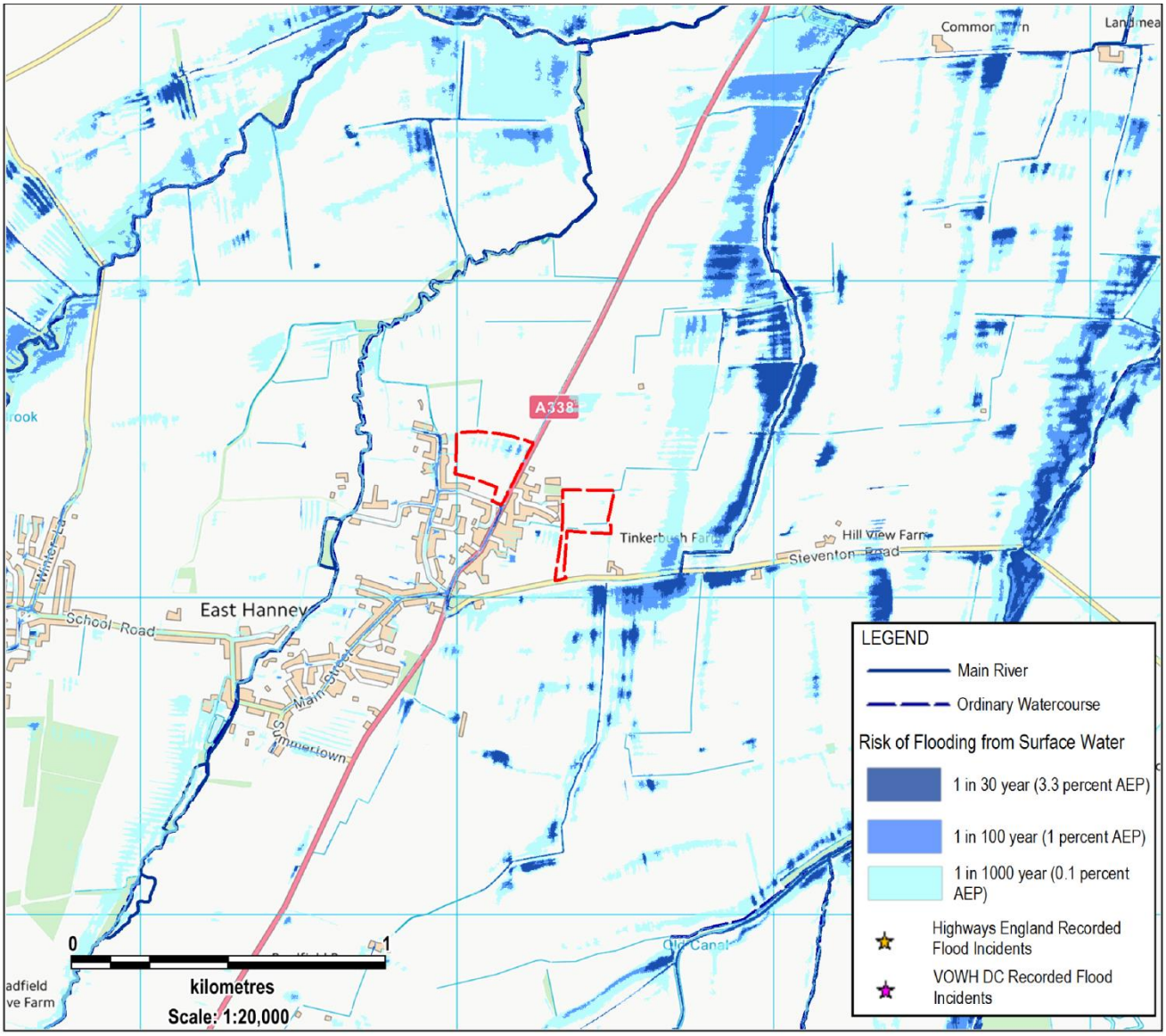
The RoFSW shows a lot of the site to be at very low risk (<0.1% AEP) of surface water flood risk. A significant part of the northern part of the site is at medium risk (<3.3% AEP) of surface water flooding along with areas along the eastern border of the site. There are no historical records of surface water flooding on the site.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



North of East Hanney

Groundwater

The AStGWF map suggests that the site is mostly within the high risk (>75%) from groundwater flooding area. There are no known historical records of groundwater flooding on the site.

Ampthill Clay Formation and Kimmeridge Clay are made up of mudstones. The site is in an area designated to be a Secondary A aquifer therefore it can be supposed that this area has limited permeability, increasing risk of flooding due to its weak ability allow water to infiltrate to the ground.

Sewer

There have been 3 reported external sewer incidents in OX120. There are no known internal sewer flooding issues.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- The majority of the site is in Flood Zone 1, with an isolated section of Flood Zone 2. Contact should be made with the Environment Agency to confirm flood outlines at this location as the isolated Flood Zone 2 seems doubtful. The 1 in 100 year + cc flood outline should be refined as part of a site level FRA, with the approach agreed with the Environment Agency. There appear to be two further drainage channels located to the north and south east of the site. The significance of these in terms of fluvial flood risk should be confirmed.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- A site specific FRA should include a detailed assessment of flood risks from all sources. Existing strategic surface water modelling identifies potential surface water ponding across the northern half of the site. This risk may require further investigation and should be confirmed at the planning application stage.
- Site level topography should be used to re-confirm surface water flow paths both pre and post development
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology suggests limited permeability. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.
- Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary

4.2.7 North East of East Hanney

North East of East Hanney			
Area:	**Brownfield/Greenfield:**	**Proposed use:**	**Flood risk vulnerability classification:**
2.379	Greenfield	Residential	More vulnerable

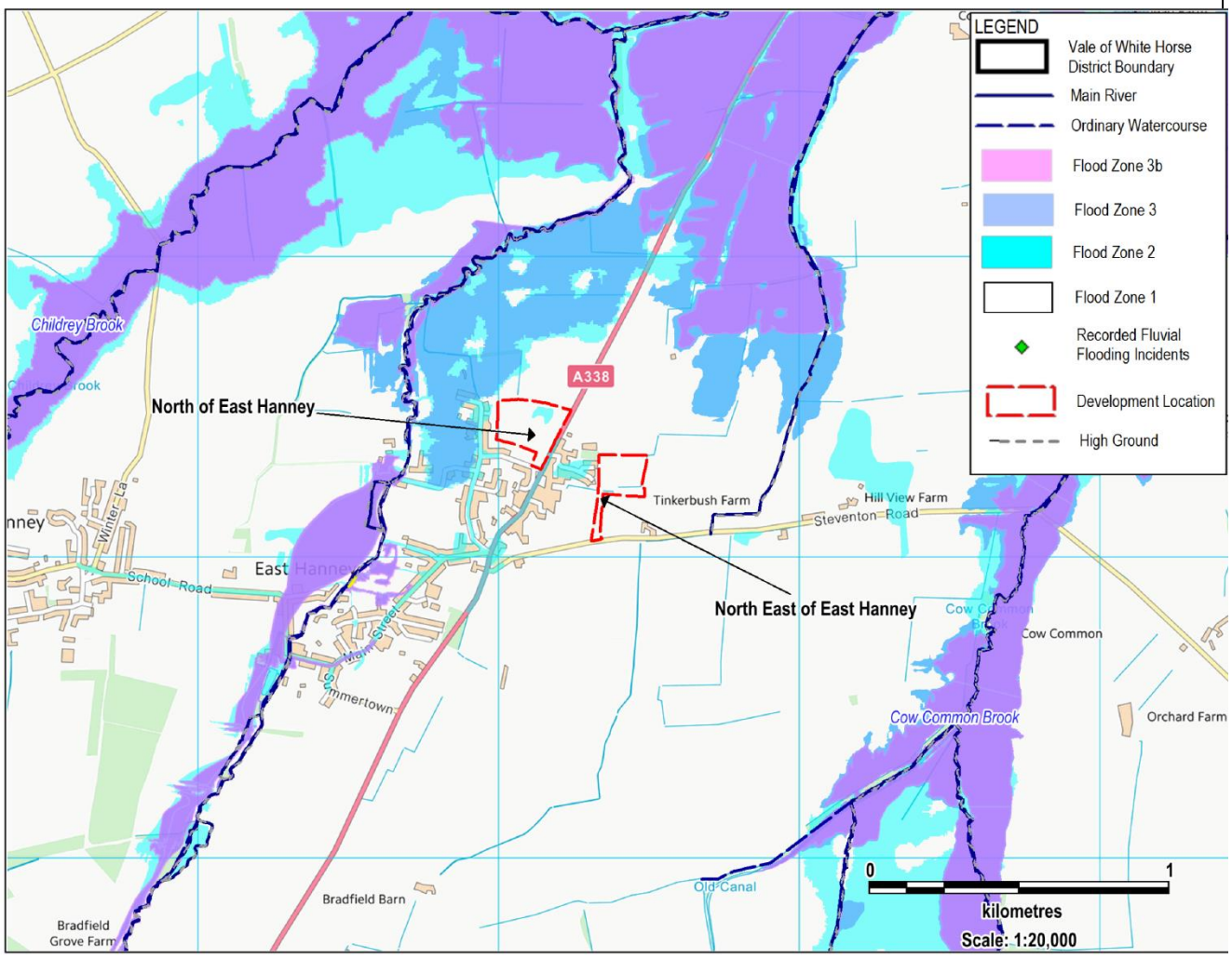
Summary of flood risk to site

Fluvial

The site lies within Flood Zone 1. An unnamed water course flows through the site. There are no formal flood defences.

No updated Climate change information has been provided for the Vale of White Horse, therefore in the absence of this data, the approach has been taken that the 0.1% AEP (FZ2) will represent the 1% AEP + climate change flood outline. Using this approach the site does not fall within the 1 in 100 year + cc flood outline and remains within Flood Zone 1.

Flood Map



North East of East Hanney

Surface Water

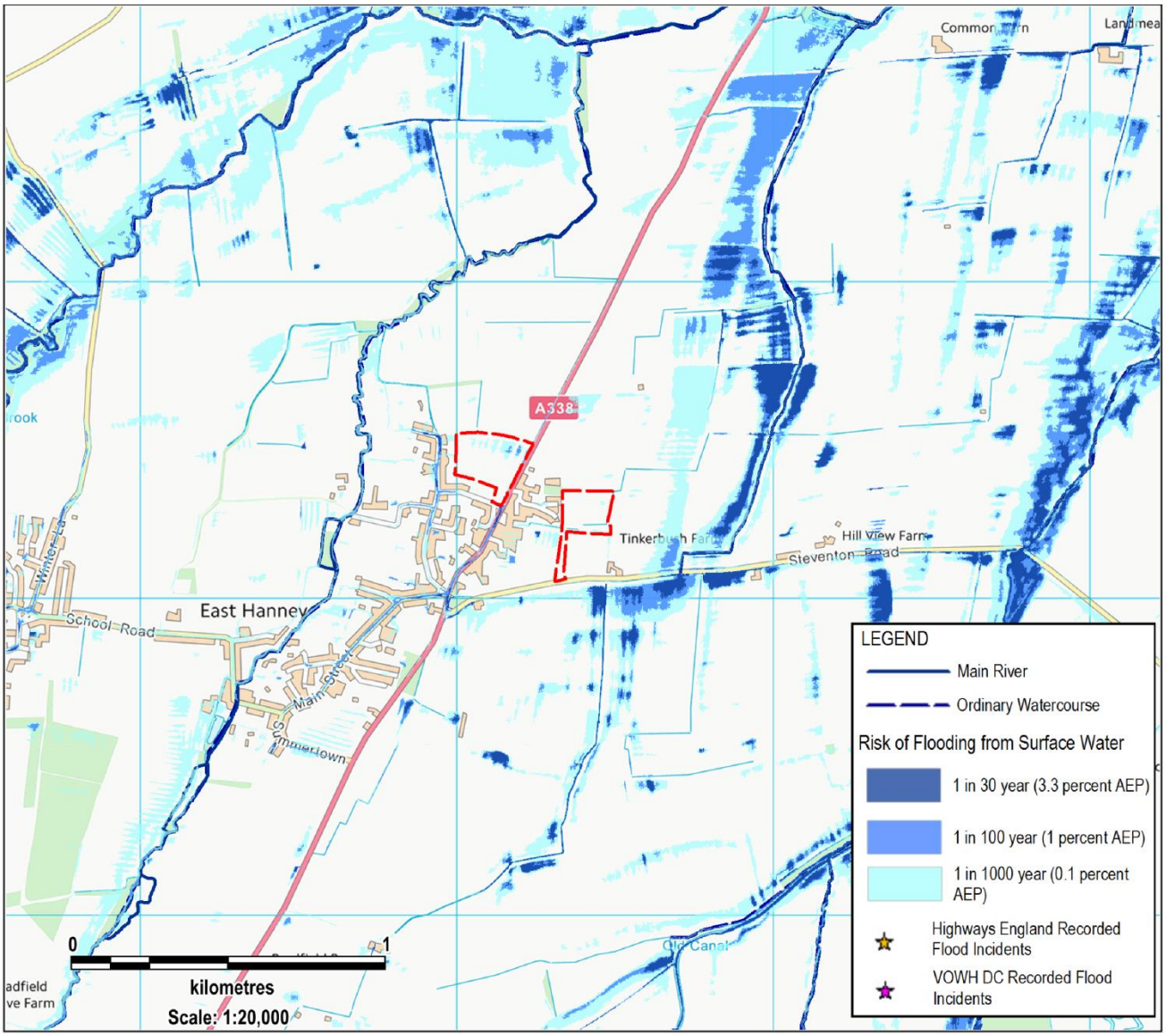
The RoFSW shows that the majority of the site to be at very low risk (<0.1% AEP) of surface water flood risk, with four small areas with low risk (0.1% - 1% AEP) of surface water flooding located on the northern half of the site. There are no historical records of surface water flooding on the site.

Increased rainfall intensity due to climate change may exacerbate surface water flood risk in the future. Further modelling would be required to determine the extent of this impact in the vicinity of the site.

Currently there are no Surface Water Management Plans for the Vale of White Horse, therefore there are no known Critical Drainage Areas in the district.

For a complete view of the RoFSW in the district refer to Figure 7, 7.1, 7.2, 7.3 and 7.4.

Risk of Flooding from Surface Water



North East of East Hanney

Groundwater

The AStGWF map suggests that the site is mostly within the high risk (>75%) from groundwater flooding area. There are no known historical records of groundwater flooding on the site.

Ampthill Clay Formation and Kimmeridge Clay are made up of mudstones. The site is in an area designated to be a Secondary A aquifer therefore it can be supposed that this area has limited permeability, increasing risk of flooding due to its weak ability allow water to infiltrate to the ground.

Sewer

There have been 3 reported external sewer incidents in OX120. There are no known internal sewer flooding issues.

Available survey/detailed modelling

No detailed models available.

Implications for development

- The site is >1ha, therefore a FRA and drainage strategy is required.
- The site is located within Flood Zone 1, however there is an un-modelled ordinary watercourse flowing through the site. Contact should be made with the Environment Agency and LLFA at the earliest opportunity to confirm a suitable approach to confirming the 1 in 25 year, 1 in 100 year, 1 in 100 year + cc and 1 in 1000 year flood levels associated with this watercourse, and the potential impact that this may have on the development layout.
- A drainage strategy should be submitted at an early stage. This should adhere to Local Plan Core Policy 42 Flood Risk which seeks to ensure that development provides appropriate measures for the management of surface water as an essential element of reducing future flood risk both to the site and its surroundings.
- A site specific FRA should include a detailed assessment of flood risks from all sources. Existing strategic surface water modelling does not identify any surface water flow routes. However, site level topography should be used to re-confirm surface water flow paths both pre and post development.
- Pre-application engagement with the LLFA regarding suitable drainage taking into account local ground conditions should be prepared. High level geology suggests limited permeability. Site investigations will be required to confirm infiltration rates to inform the site drainage strategy.

Thames Water should be consulted at an early stage to ensure that there will be sufficient capacity in the wastewater system if required and any upgrades are carried out where necessary.

5. Avoiding Flood Risk – Applying the Sequential Test

5.1 Sequential Approach

This Section guides the application of the Sequential Test and Exception Test in the plan-making and planning application processes. Not all development will be required to undergo these tests, as described below, but may still be required to undertake a site specific FRA, guidance about which is included in Section 7.

The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test, where required, will ensure that new developments in areas of particular flood risk will only occur where flood risk is clearly outweighed by other sustainability drivers and where development can be made safe from flooding and not increase the risk of flooding elsewhere.

The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments (except Water Compatible) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

5.2 Applying the Sequential Test – Plan-Making

As the LPA and in line with Core Policy 42 of LPP1, VOWH DC must demonstrate that throughout the site allocation process a range of possible sites have been considered in conjunction with the flood risk and vulnerability information from the SFRA, and that the Sequential Test, and where necessary the Exception Test, has been applied.

The Sequential Test requires an understanding of the Flood Zones in the study area and the vulnerability classification of the proposed developments. Flood Zone definitions are provided in Table 3-2 and mapped in the figures in Appendix A (and the Environment Agency's Flood Map for Planning (Rivers and Sea)). Flood risk vulnerability classifications, as defined in the NPPG are presented in Table 5-2.

The flow diagram presented in Figure 5-1 illustrates how the Sequential Test process should be applied to identify the suitability of a site for allocation, in relation to the flood risk classification.

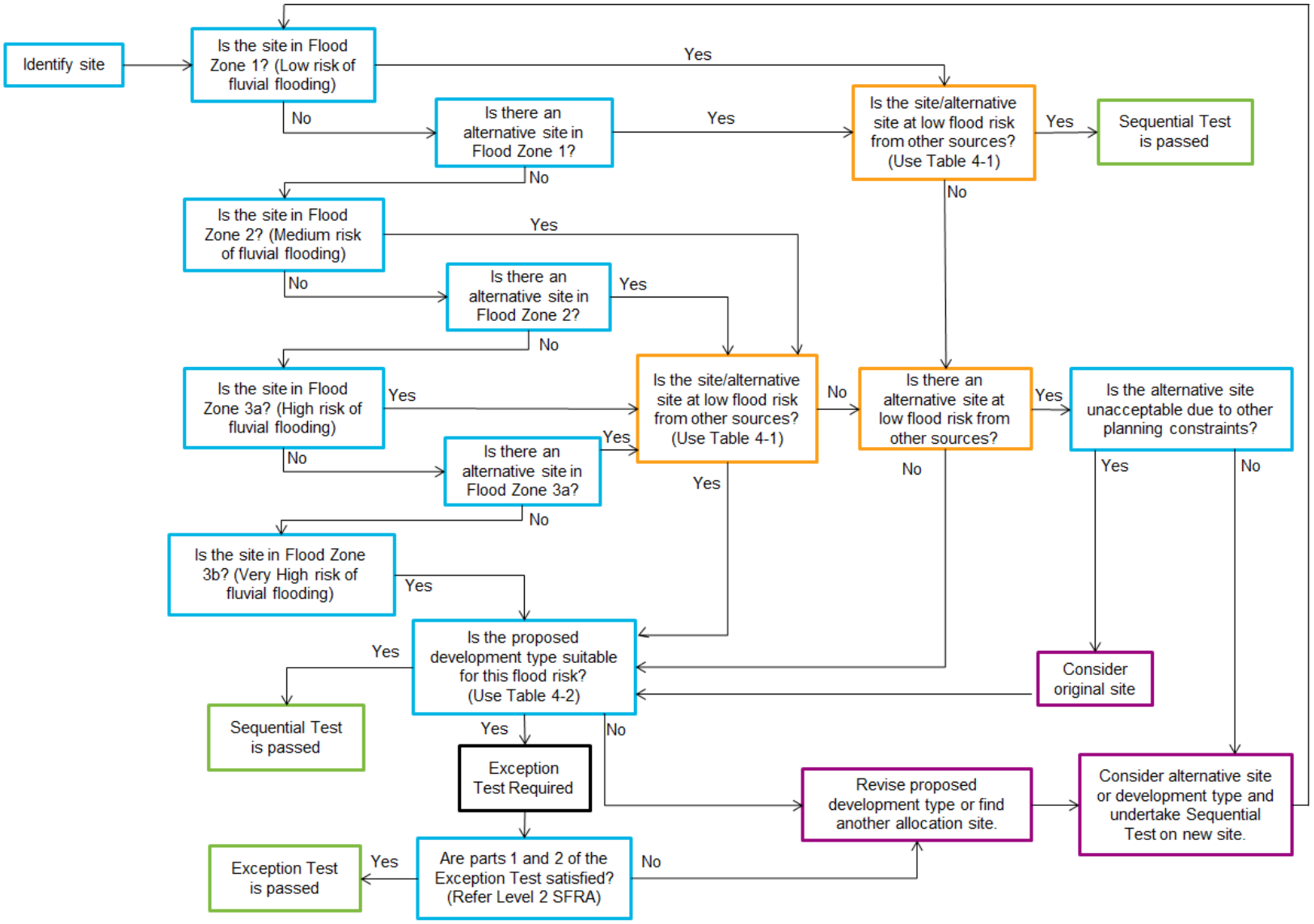


Figure 5-1 Application of Sequential Test for Plan-Making

Table 5-1 Flood Risk Vulnerability Classification (PPG, 2014)

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. • 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 facilities 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 caravans 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 which do not need to remain operational during times of flood. • Sewage 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 working. • 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.

The NPPF acknowledges that some areas will (also) be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including: flooding from land or surface water runoff; groundwater; sewers; and artificial sources.

If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

The recommended steps in undertaking the Sequential Test are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability. Table 5-2 indicates the compatibility of different development types with the Flood Zones.

Table 5-2 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3a	Exception Test Required	✓	×	Exception Test Required	✓
	3b	Exception Test Required	✓	×	×	×

✓ - Development is appropriate × - Development should not be permitted

5.2.1 Recommended stages for LPA application of the Sequential Test in Plan-Making

The information required to address many of these steps is provided in the accompanying maps presented in **Appendix A**.

1. Assign potential developments with a vulnerability classification (Table 5-1). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.
2. The location and identification of potential development should be recorded.
3. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these span more than one flood zone, all zones should be noted, preferably using percentages.
4. The risk of flooding from other sources should also be identified, based on readily available datasets and local information.
5. Identify existing flood defences serving the potential development sites. However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used.
6. The design life of the development should be considered with respect to climate change:
    a. 100 years – up to 2116 for residential developments; and
    b. Design life for commercial / industrial developments will be variable, however a 75 year design life may be assumed for such development, unless demonstrated otherwise.

7. Highly Vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1 and at low risk of flooding from other sources. If these cannot be located in areas of low flood risk, because the identified sites are unsuitable or there are insufficient sites in areas of low risk, sites in Flood Zone 2 can then be considered. Highly Vulnerable developments in Flood Zone 2 will require application of the Exception Test. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. Within each flood zone Highly Vulnerable development should be directed, where possible, to the areas at lowest risk from all sources of flooding. It should be noted that Highly Vulnerable development is not appropriate in Flood Zones 3a and 3b.

8. Once all Highly Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test. As with Highly Vulnerable development, within each flood zone More Vulnerable development should be directed to areas at lowest risk from all sources of flooding. It should be noted that More Vulnerable development is not appropriate in Flood Zone 3b.

9. Once all More Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located in any remaining unallocated sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then Flood Zone 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.

10. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.

11. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.

12. Where the development type is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than fluvial), the site and flood sources should be investigated further regardless of any requirement for the Exception Test. It is noted that for any development at risk of flooding, a site specific FRA will be required.

5.2.2 Windfall Sites

Windfall sites are those which have not been specifically identified as available in the Local Plan process. They comprise previously-developed sites that have unexpectedly become available. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends and expected future trends. It is recommended that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

5.3 Applying the Sequential – Individual Planning Applications

It is necessary to undertake a sequential test for a planning application if both of the following apply:

- If development is proposed in Flood Zone 2 or 3,
- If the Sequential Test has not already been carried out for the site for the same development type at the Local Plan level

The Environment Agency publication 'Demonstrating the Flood Risk Sequential Test for Planning Applications'[13] sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the District area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area identified for regeneration in Local Plan policies).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning, the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 5-2, apply the Exception Test.
- Apply the Sequential approach to locating development within the site (as described in Section 5.2).

Ultimately, after applying the Sequential Test, VOWH DC (taking advice from the Environment Agency) needs to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere. This needs to be demonstrated within a FRA and is necessary regardless of whether the Exception Test is required.

5.3.1 Sequential Test Exemptions

It should be noted that the Sequential Test does not need to be applied in the following circumstances:

- Individual developments proposed on sites which have been allocated in development plans through the Sequential Test.
    - Minor development, which is defined in the NPPF as:
    - minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2;
- alterations: development that does not increase the size of buildings e.g. alterations to external appearance;
- Householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats;
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site;
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of climate change);

[13] Environment Agency, April 2012, 'Demonstrating the flood risk Sequential Test for Planning Applications', Version 3.1

5.4 Exception Test

The purpose of the Exception Test is to ensure that where it may be necessary to locate development in areas at risk of flooding, new development is only permitted in Flood Zone 2 and Flood Zone 3 where the flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The NPPF states that for the Exception Test to be passed:

- Part 1 - "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and
- Part 2 - 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."

Both elements of the test will have to be passed for development to be allocated or permitted.

Satisfying the Exception Test involves consideration of the reasons behind the selection of the site for development (from the VOWH DC Local Plan sustainability appraisal)[14],[15] as well as consideration in planning and design, such that the site will remain safe and operational in the event of flooding. This may involve demonstrating that:

- A sequential approach is taken to development site layout, such that within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- Buildings are designed to be appropriately flood resilient and resistant, with essential services remaining functional in the event of flooding, and quick recovery following a flood;
- there is a safe means of access and egress during a flood event;
- Emergency evacuation procedures are developed, to be utilised following receipt of a flood warning;
- Priority is given to the use of sustainable drainage systems

[14] http://www.whitehorsedc.gov.uk/sites/default/files/VOWH_Local%20Plan%202031_Modifications_SA%20Report%20Addendum_NTS_FINAL.pdf

[15] http://www.whitehorsedc.gov.uk/sites/default/files/Draft%20Sustainability%20Appraisal%20-%20LPP2_0.pdf

6. Managing and Mitigating Flood Risk through Spatial Planning and Development Control

6.1 Overview

The NPPF appreciates that it may not always be possible to avoid locating development in areas at risk of flooding. This Section provides guidance and recommendations on a range of measures that could be considered in order to manage and mitigate flood risk. These measures should be considered when preparing a site-specific FRA as described in Section 7 and could be considered in the formulation of council policy.

As noted in Section 3, it is essential that the development control process influencing the design of future development within the District carefully mitigates the potential impact that climate change may have upon the risk of flooding. As a result mitigation measures should be designed with an allowance for climate change over the lifetime of the proposed development as follows:

- 100 years (up to 2115) for residential developments; and
- 75 years (up to 2090) for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.

6.2 Development Layout and Sequential Approach

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding.

Core Policy 42 of LPP1 relates to Flood Risk management and the implementation of the sequential approach.

6.3 Riverside Development

The Environment Agency is likely to seek an 8 metre wide undeveloped buffer strip alongside main fluvial rivers for maintenance purposes, and would also ask developers to explore opportunities for riverside restoration as part of any development.

As of 6th April 2016, the Water Resources Act 1991 and associated land drainage byelaws have been amended and flood defence consents will now fall under the Environmental Permitting (England and Wales) Regulations 2016. Any works within 8m of a main river or within the floodplain may be subject to the Environmental Permitting Regulations (EPR). Further details and guidance are available on the GOV.UK website[16]. The Environment Agency can be consulted regarding permission to do work on or near a river, flood or sea defence by contacting enquiries@environment-agency.gov.uk.

[16] https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.

As of 6th April 2012, responsibility for the consenting of works by third parties on Ordinary watercourses under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) has transferred from the Environment Agency to the LLFA, OCC. OCC is now responsible for the consenting of works to ordinary watercourses and has powers to enforce un-consented and non-compliant works. This includes any works (including temporary) that will affect the cross sectional area of the channel (such as in channel structures or diversion of watercourses). It is advised that OCC is consulate early of proposed alterations. Enquiries and applications for ordinary watercourse consent should be made through the following website page *https://www.oxfordshire.gov.uk/cms/content/contact-drainage-team or sent to Drainage Team, County Hall, New Road, Oxford, OX1 1ND.*

An application form for Ordinary Watercourse Consent can be found on the Oxfordshire CC website: https://www.oxfordshire.gov.uk/cms/content/how-apply-consent-change-ordinary-watercourse.

To further support this, Development Policy 29 of the VOWH LPP2 seeks a 10m buffer from development along all watercourses, not just main rivers. It further acknowledges that development within 8m of a main river requires an environmental permit from the Environment Agency. In addition, any development that could impact the flow within an ordinary watercourse will require consent from OCC (as LLFA).

6.4 Floodplain Compensation Storage

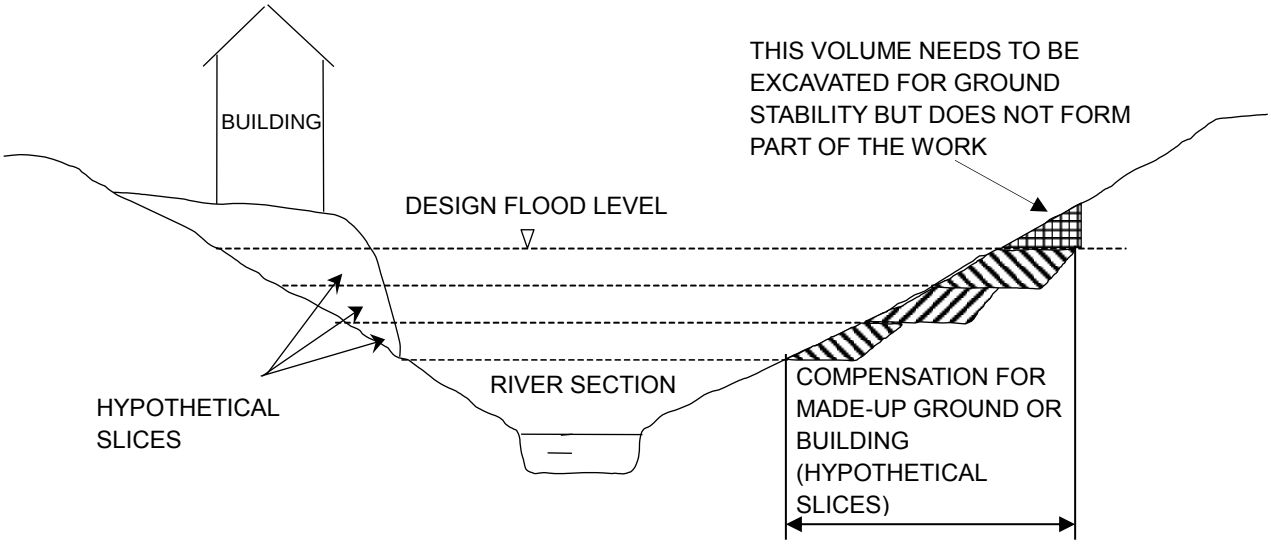
Recommendation 1: All new development within Flood Zone 3 must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.

Where proposed development results in a change in building footprint, the developer must ensure that it does not impact upon the ability of the floodplain to store water, and should seek opportunities to provide betterment with respect to floodplain storage. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

As depicted in Figure 6-1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it needs to be in the immediate vicinity, in the applicant's ownership and hydraulically connected to the site. Floodplain compensation must be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change. When designing a scheme, flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C62417.

[17] CIRIA January 2004, CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry

Figure 6-1 Example of Floodplain Compensation Storage (Environment Agency 2009)



The requirement for no loss of floodplain storage means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain. It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, or indirect compensation, by lowering land already within the floodplain, however, this would be subject to detailed investigations and agreement with the Environment Agency to demonstrate (using an appropriate flood model where necessary) that the proposals would improve and not worsen the existing flooding situation or could be used in combination with other measures to limit the impact on floodplain storage.

6.5 Finished Floor Levels

Recommendation 2: All More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set finished floor levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.

Where developing in Flood Zone 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable land uses, is to ensure internal floor levels are raised above the design flood level[18].

With reference to British Standards[19] for the 1 in 100 year return period event (1% AEP) including a suitable allowance for climate change, flood levels associated with surface water drainage and flood risk should be not less than 300mm below the finished ground floor level and the level of any opening into any basement of the proposed buildings on site.

In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the Environment Agency and/or VOWH DC should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood resistance measures are implemented up to an agreed level.

[18] The design flood level is generally taken as; fluvial flooding likely to occur with a 1% annual probability (1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year). Both should include a suitable allowance for climate change.

[19] BSI Standards Publication Code of Practice for surface water management for development sites, BSI 2013

There are also circumstances where flood resilience measures should be considered first. These are described further below. For both Less and More Vulnerable developments where internal access to higher floors is required, the associated plans showing the access routes and floor levels should be included within any site-specific FRA.

6.6 Safe Access and Egress

Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1) using public rights of way without the intervention of emergency services or others. This is of particular importance when contemplating development on sites located on dry islands (refer to Section 6.8).

'Safe' access should remain dry for More Vulnerable and Highly Vulnerable development uses, and should preferably by dry for other uses such as Less Vulnerable land use classifications. Dry escape for residential dwellings should be considered in relation to the 1 in 100 year flood event conditions, including an appropriate allowance for climate change.

Guidance prepared by the Environment Agency[20] uses a calculation of flood hazard to determine safety in relation to flood risk. Flood hazard is calculated using the flood depth and flow velocity at a particular point in the floodplain along with a suitable debris factor to account for the hazard posed by any material entrained by the floodwater. The derivation of flood hazard is based on the methodology in Flood Risks to People FD2320, the use of which for the purpose of planning and development control is clarified in the abovementioned publication. When considering the acceptability of a proposed access route it needs to be demonstrated that the depths and velocities of flood water will be acceptable to the danger categories of this calculator.

Figure 6-2 Hazard to People Rating (Table 13.1 FD2320/TR2)

Flood Hazard	Hazard Rating	Description
Low	Less than 0.75	Very low hazard – Caution
Moderate	0.75 to 1.25	Dangerous for some – includes children, the elderly and the infirm
Significant	1.25 to 2.0	Dangerous for most – includes the general public
Extreme	More than 2.0	Dangerous for all – includes the emergency services

[20] Environment Agency (2008) Supplementary note on Flood hazard ratings and thresholds for development planning and control purpose. Clarification of Table 13.1 FD2320/TR2 and Figure 3.2 FD2321/TR1. http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2321_7400_PR_pdf.sflb.ashx

Recommendation 3: For developments located in areas at risk of fluvial flooding, safe access / egress must be provided for new development as follows in order of preference:

- Safe dry route for people and vehicles.
- Safe dry route for people.
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.

In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.

6.7 Safe Refuge

In exceptional circumstances, dry access above the 1% AEP (1 in 100 year) fluvial flood level including climate change may not be achievable. In these circumstances VOWH DC should be consulted to ensure that the safety of the site occupants can be satisfactorily managed. This will be informed by the type of development, the number of occupants and their vulnerability and the flood hazard along the proposed egress route. For example, this may entail the designation of a safe place of refuge on an upper floor of a building, from which the occupants can be rescued by emergency services. It should be noted that sole reliance on a safe place of refuge is a last resort, and all other possible means to evacuate the site should be considered first. Provision of a safe place of refuge will not guarantee that an application will be granted.

6.8 Dry Islands

In some instances across the District, there are isolated areas of Flood Zone 1 where land rises above the flood level used to define Flood Zone 3a. These areas require special consideration as they can present hazards in terms of access and egress in a flood event. Environment Agency guidance is that dry islands, areas of land totally surrounded by Flood Zone 3a should, for spatial planning purposes, be considered as Flood Zone 3a. Dry islands within Flood Zone 2 should be treated as Flood Zone 1.

Therefore, any More or Highly Vulnerable development planned in a Flood Zone 3a dry island area must undergo the Exception Test and have a detailed FRA prepared, with due consideration of safe access and egress. It may be appropriate to consider the size of the dry island, and the duration for which access to the site may be compromised. Where a dry island forms between the floodplains of two watercourses, it may be appropriate to consider the joint probability of both watercourses being in flood at the same time. More or Highly Vulnerable development, particularly involving the creation of new residential units, will require dry access and egress up to the 1 in 100 AEP flood event including an allowance for climate change over the lifetime of the development.

6.9 Car Parks

Where car parks are specified as areas for the temporary storage of surface water and fluvial floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

6.10 Flood Routing

Recommendation 4: All new development in Flood Zones 2 and 3 should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water, such as:

- Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps).
- Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede.
- Create under-croft car parks or consider reducing ground floor footprint and creating an open area under the building to allow flood water storage.
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

In order to demonstrate that 'flood risk is not increased elsewhere', development in the floodplain will need to prove that flood routing is not adversely affected by the development, for example giving rise to backwater affects or diverting floodwaters onto other properties.

Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

6.11 Flood Warning and Evacuation Plans

Evacuation is where flood alerts and warnings provided by the Environment Agency enable timely actions by residents or occupants to allow evacuation to take place unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses and other premises. Rescue by the emergency services is likely to be required where flooding has occurred and prior evacuation has not been possible.

Recommendation 5: For all developments (excluding minor developments and change of use) proposed in Flood Zone 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.

The Environment Agency has a tool on their website to create a Personal Flood Plan. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

Flood Warning and Evacuation Plans should include:

How flood warning is to be provided, such as:

- availability of existing flood warning systems (See **Appendix A Figure 6.0 – 6.4**);
- where available, rate of onset of flooding and available flood warning time; and
- how flood warning is given.

What will be done to protect the development and contents, such as:

- How easily damaged items (including parked cars) or valuable items (important documents) will be relocated;
- How services can be switched off (gas, electricity, water supplies);
- The use of flood protection products (e.g. flood boards, airbrick covers);
- The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc.; and
- The time taken to respond to a flood warning.

Ensuring safe occupancy and access to and from the development, such as:

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;
- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

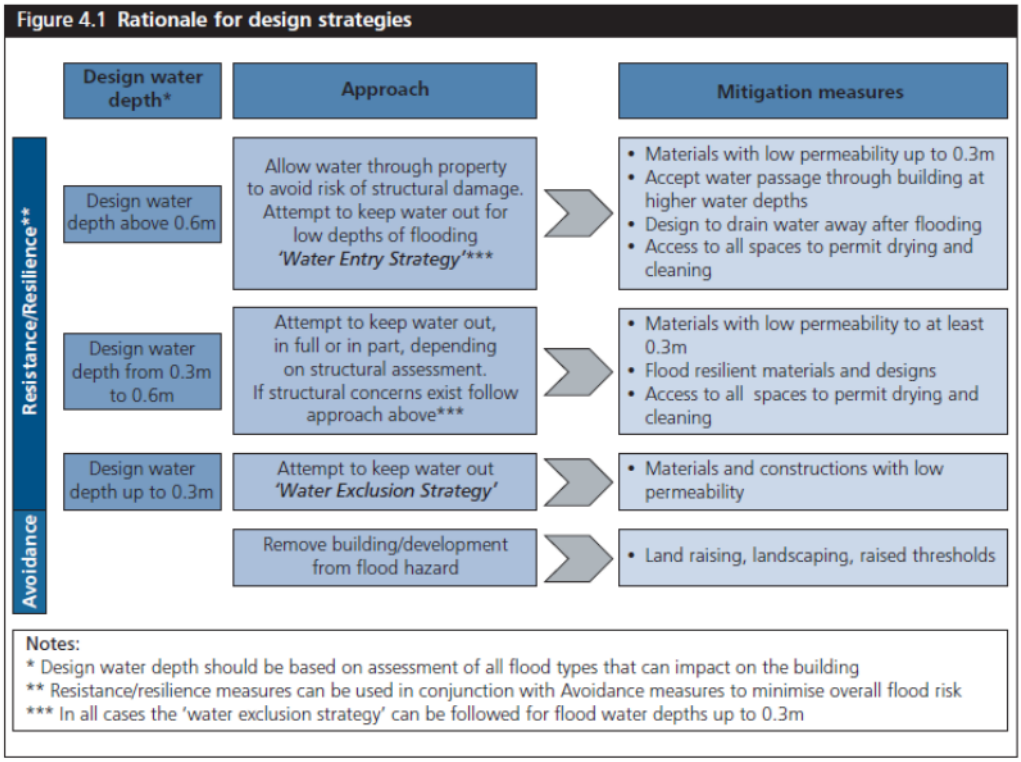
There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. VOWH DC is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff.

6.12 Flood Resistance 'Water Exclusion Strategy'

There are a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. The Department for Communities and Local Government (CLG) have published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[21], the aim of which is to provide guidance to developers and designers on how to improve the resistance and resilience of new properties to flooding through the use of suitable materials and construction details. Figure 6-2 provides a summary of the Water Exclusion Strategy (flood resistance measures) and Water Entry Strategy (flood resilience measures) which can be adopted depending on the depth of floodwater that could be experienced.

[21] CLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction

Figure 6-3 Flood Resistant/Resilient Design Strategies, Improving Flood Performance, CLG 2007



Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m, although these measures should be adopted where depths are between 0.3m and 0.6m and there are no structural concerns.

Recommendation 6: In areas at risk of flooding of low depths (<0.3m), the following flood resistance measures could be considered:

- Using materials and construction with low permeability.
- Land raising.
- Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties).
- Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance.
- Flood gates with waterproof seals.

Property flood protection devices are available on the market, designed specifically to resist the passage of floodwater (Figure 6-4 and 6-5). These include removable flood barriers and gates designed to fit openings, vent covers and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as well as surface water and sewer flooding. The efficacy of such devices relies on their being deployed before a flood event occurs. It should also be borne in mind that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

Figure 6-4 Examples of flood barriers, air bricks and on-return valves

Figure 6-5 Example of flood gates

6.13 Flood Resilience 'Water Entry Strategy'

For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, but to implement careful design in order to minimise damage and allow rapid re-occupancy. This is referred to as the Water Entry Strategy. These measures are appropriate for uses where temporary disruption is acceptable and suitable flood warning is received.

Materials should be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

Recommendation 7: In areas at risk of frequent or prolonged flooding, the following flood resilience measures could be implemented:

- Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances and utility metres.
- Coat walls with internal cement based renders; apply tanking on the inside of all internal walls.
- Ground supported floors with concrete slabs coated with impermeable membrane.
- Tank basements, cellars or ground floors with water resistant membranes.
- Use plastic water resistant internal doors.

Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[22].

6.14 Structures

Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground and designed in such a way as to prevent entrainment of debris which in turn could increase flood risk and/or breakaway posing a danger to life during high flows.

[22] CLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction. http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf?bcsi_scan_E956BCBE8ADBC89F=0&bcsi_scan_filename=flood_performance.pdf

7. Guidance for preparing site-specific FRAs

7.1 What is a Flood Risk Assessment?

A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 100 of the NPPF and PPG. An FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow VOWH DC to satisfy itself that the requirements have been met.

7.2 When is a Flood Risk Assessment required?

The NPPF states that a site-specific FRA is required in the following circumstances:

- Proposals for new development (including minor development* and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.
- Sites under 1 ha, classified as major development will require the submission of a surface water drainage strategy.

*According to the PPG, minor development means:

- minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2.
- alterations: development that does not increase the size of buildings e.g. alterations to external appearance. Householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats

7.3 How detailed should a FRA be?

The PPG states that site-specific FRAs should be proportionate to the degree of flood risk, the scale and nature of the development, its vulnerability classification (Table 5-1) and the status of the site in relation to the Sequential and Exception Tests. Site-specific FRAs should also make optimum use of readily available information, for example the mapping presented within this SFRA and available on the Environment Agency website, although in some cases additional modelling or detailed calculations will need to be undertaken.

For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, VOWH DC would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater VOWH DC may require a more detailed assessment, for example, the preparation of site-specific hydraulic modelling to determine the flood risk to and from the site pre and post-development, and the effectiveness of any management and mitigation measures incorporated within the design.

Table 7-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C62423 and identifies typical sources of information that can be used.

Table 7-1 Levels of Site-Specific Flood Risk Assessment

Description
Level 1 Screening study to identify whether there is any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information. The screening study will ascertain whether a FRA Level 2 or 3 is required. Typical sources of information include: • Strategic Flood Risk Assessment (SFRA) • Flood Map for Planning (Rivers and Sea) • Environment Agency Standing Advice • NPPF Tables 1, 2 and 3
Level 2 Scoping study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include: • An appraisal of the availability and adequacy of existing information; • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. • The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development. Typical sources of information include those listed above, plus: • Local policy statements or guidance. • Catchment Flood Management Plan. • OCC PFRA and LFRMS. • Data request from the Environment Agency to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity. • Consultation with Environment Agency/OCC/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding. • Historic maps. • Interviews with local people and community groups. • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition.

[23] CIRIA (2004) Development and flood risk – guidance for the construction industry C624.

Description
• Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.
Level 3 Detailed study to be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and • Quantitative demonstration of the effectiveness of any proposed mitigations measures. Typical sources of information include those listed above, plus: • Detailed topographical survey. • Detailed hydrographic survey. • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development. • Monitoring to assist with model calibration/verification. • Continued consultation with the LPA, Environment Agency and other flood risk consultees.

The scope of each site-specific FRA will vary considerably. Sufficient information must be included to enable the Council and where appropriate, consultees, to determine that the proposal will be safe for its lifetime, not increase flood risk elsewhere and where possible, reduce flood risk overall. Failure to provide sufficient information will result in applications being refused.

7.3.1 Environment Agency Data Requests

The Environment Agency offers a series of 'products' for obtaining flood risk information suitable for informing the preparation of site-specific FRAs as described on their website https://www.gov.uk/planning-applications-assessing-flood-risk.

- Products 1 – 4 relate to mapped deliverables including flood level and flood depth information and the presence of flood defences local to the proposed development site;
- Product 5 contains the reports for hydraulic modelling of the main rivers;
- Product 6 contains the model output data so the applicant can interrogate the data to inform the FRA.
- Product 7 comprises the hydraulic model itself.

Products 1 – 6 can be used to inform a Level 2 FRA. In some cases, it may be appropriate to obtain Product 7 and to use as the basis for developing a site-specific model for a proposed development as part of a Level 3 FRA. This can be requested via their National Customer Contact Centre via enquiries@environment-agency.gov.uk.

7.3.2 Modelling of Ordinary Watercourses

It should be noted that the scope of modelling studies undertaken by the Environment Agency typically cover flooding associated with main rivers, and therefore Ordinary Watercourses that form tributaries to the main rivers may not always be included in the model. Where a proposed development site is in close proximity to an Ordinary Watercourse and either no modelling exists, or the available modelling is considered to provide very conservative estimates of flood extents (due to the use of national generalised JFLOW modelling), applicants may need to prepare a simple hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. This should be carried out in line with industry standards and in agreement with the Environment Agency and OCC (as the LLFA).

7.4 What needs to be addressed in a Flood Risk Assessment?

The PPG states that the objectives of a site-specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

7.5 Flood Risk Assessment Checklist

Appendix B provides a checklist for site-specific FRAs including the likely information that will need to be provided along with references to sources of relevant information. The exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk.

7.6 Pre-application Advice

At all stages, VOWH DC, and where necessary the Environment Agency, Oxfordshire CC and/or the Statutory Water Undertaker may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

The Environment Agency, Oxfordshire CC and VOWH DC each offer pre-application advice services which should be used to discuss particular requirements for specific applications.

- **VOWH DC** offer pre-application advice. A fee is charged to cover the cost of providing the service Enquiries can be submitted by completing the Preliminary Enquiries Form available online at http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/application-advice/pre-application-advice
- **Environment Agency** offers one free 'preliminary opinion' for development proposals. This will highlight the types of issues that the application should address. A request for a preliminary opinion can be made using the form at: https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion. Further detailed advice, including a review of an FRA, is offered as part of a charged for cost recovery service. Information on this is available at: https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals.

8. Flood Risk Management Policy

8.1 Draft LPP2 Policy

As stipulated within Section 2, several key policies relating to Flood Risk exist within adopted VOWH DC Local Plan 2031 Part 1 including Core Policy 37, Core Policy 40 and Core Policy 42. As a part of the Draft VOWH DC Local Plan Part 2, one policy applicable to Flood Risk should be considered, as detailed below.

Draft Development Policy 29: Watercourses

Development of land that contains or is adjacent to a watercourse will only be permitted where it would not have a detrimental impact on the function or setting
of the watercourse or its biodiversity, or the detrimental impact can be appropriately mitigated.

Plans for development adjacent to or encompassing a watercourse should include a minimum 10 m buffer zone along both sides of the watercourse to create a corridor of land and water favourable to the enhancement of biodiversity.

Proposals which involve culverting a watercourse are unlikely to be considered acceptable.

Development which is located within 20 m of a watercourse will require a construction management plan to be agreed with the Council before commencement of work to ensure that the watercourse will be satisfactorily protected from damage, disturbance or pollution.

The adopted and draft policies applicable to Flood Risk for VOWH DC 2031 LPP1 and LPP2 have been developed in consultation with the Environment Agency.

9. Next Steps

9.1.1 Sequential Test

Using the strategic flood risk information presented within this Level 1 SFRA, VOWH DC should undertake the Sequential Test for their potential development sites to document the process whereby future development is steered towards areas of lowest flood risk.

9.1.2 Future Updates to the SFRA

This SFRA has been updated building heavily upon existing knowledge and newly available datasets with respect to flood risk within the district, made available by the Environment Agency. In the future, new modelling studies or new information may influence future development management decisions within the district. Therefore it is important that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives, flood risk datasets and an improving understanding of flood risk within the district.

9.1.3 Useful documents and links

District Council planning policy documents (including Local Plan 2031 Part 1)

Vale of White Horse Planning website

http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy

Vale of White Horse Neighbourhood plans

http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/neighbourhood-plans

Lead Local Flood Authority flood risk management documents

Oxfordshire County Council Local Flood Risk Management Strategy

https://www.oxfordshire.gov.uk/cms/content/oxfordshire-local-flood-risk-management-strategy

Legislation and government guidance

Localism Act (2011) Section 100: Duty to cooperate in relation to planning of sustainable development

http://www.legislation.gov.uk/ukpga/2011/20/section/110/enacted

Flood and Water Management Act (2010)

https://www.legislation.gov.uk/ukpga/2010/29/contents

National Planning Policy Framework, Department of Communities and Local Government (2012)

https://www.gov.uk/government/publications/national-planning-policy-framework--2

https://www.gov.uk/government/collections/planning-practice-guidance

Defra (March 2010) Surface Water Management Plan Technical Guidance

https://www.gov.uk/government/publications/surface-water-management-plan-technical-guidance

Department of Communities and Local Government (2007) Improving the Flood Performance of New Buildings: Flood Resilient Construction

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

Environment Agency resources and guidance

Environment Agency website, Flood risk information (risk of flooding from sea, rivers, reservoirs)

https://flood-warning-information.service.gov.uk/long-term-flood-risk

Environment Agency Flood Map for Planning

https://flood-map-for-planning.service.gov.uk

Flood risk assessment for planning applications

https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

Flood risk assessment: the sequential test for applicants

https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants

Environment Agency (2006) Building a Better Environment: A guide for developers

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289894/LIT_2745_c8ed3d.pdf

Thames River Basin District Management Plan

https://www.gov.uk/government/collections/river-basin-management-plans-2015#thames-river-basin-district-rbmp:-2015

Other resources and guidance

Association of British Insurers and National Flood Forum (April 2012) Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England

CIRIA (2004) Development and Flood Risk: Guidance for the Construction Industry. Report C624

CIRIA (2007) The SuDS Manual (C697) (can be purchased at www.ciria.org)

CIRIA (2010) Culvert Design and Operation Guide. CIRIA report C689 (available free by registering at www.ciria.org)

Defra (2004) Strategy for Flood and Coastal Erosion Management: Groundwater Flooding Scoping Study (LDS23)

Defra/Environment Agency (2005) Preliminary rainfall runoff management for developments.

R&D Technical Report W5-074/A/TR/1 http://eprints.hrwallingford.co.uk/184/

Defra/Environment Agency (2006) Flood Risks to People Phase 2. R&D Technical Report FD2321/TR2

http://vlb-esstaging.bl.uk/handle/123456789/2818

National SuDS Working Group (2004) Interim Code of Practice for Sustainable Drainage

Systems http://www.susdrain.org/files/resources/other-guidance/nswg_icop_for_suds_0704.pdf

Susdrain website http://www.susdrain.org/

UK Climate Change Impacts Programme, Identifying adaptation options

http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID_Adapt_options.pdf

Appendix A Figures

Appendix B Flood Risk Assessment (FRA) Checklist

What to Include in the FRA		Source(s) of Information
1. Site Description		
Site address	-	-
Site description	-	-
Location plan	Including geographical features, street names, catchment areas, watercourses and other bodies of water	SFRA Appendix A
Site plan	Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel	OS Mapping Site Survey
Topography	Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum). Plans showing existing and proposed levels.	Site Survey
Geology	General description of geology local to the site.	BGS geological data Ground Investigation Report
Watercourses	Identify main rivers and Ordinary Watercourses local to the site.	SFRA Appendix A, Figure 4.0 – 4.4
Status	Is the development in accordance with the Council's Spatial Strategy?	VOWH Council website
2. Assessing Flood Risk		
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 5-2 regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.		
Flooding from Rivers	Provide a plan of the site and Flood Zones. Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine flood levels on the site for the 1% annual probability (1 in 100 chance each year) flood event	SFRA Appendix A Environment Agency Flood Map for Planning (Rivers and Sea). New hydraulic model.

What to Include in the FRA		Source(s) of Information
	including an allowance for climate change. Determine flood hazard on the site (in terms of flood depth and velocity). Undertake new hydraulic modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	
Flooding from Land	Identify any historic flooding that has affected the site. Review the local topography and conduce a site walkover to determine low points at risk of surface water flooding. Review the Risk of Flooding from Surface Water mapping. Where necessary, undertake modelling to assess surface water flood risk.	SFRA Area Assessments. Topographic survey. Site walkover. Risk of Flooding from Surface Water mapping (Environment Agency website). New modelling study.
Flooding from Groundwater	Desk based assessment based on high level BGS mapping in the SFRA. Ground survey investigations. Identify any historic flooding that has affected the site.	SFRA Appendix A Ground Investigation Report
Flooding from Sewers	Identify any historic flooding that has affected the site.	Refer SFRA Section 3.7, Appendix A Figure 9.1 and 9.2. Where appropriate an asset location survey can be provided by Anglian Water Services.
Reservoirs, canals and other artificial sources	Identify any historic flooding that has affected the site. Review the Risk of Flooding from Reservoirs mapping.	Risk of Flooding from Reservoirs mapping (Environment Agency website). Refer SFRA Section 3.8 and Appendix A Figure 10
3. Proposed Development		
Current use	Identify the current use of the site.	-
Proposed use	Will the proposals increase the number of occupants / site users on the site such that it may affect the degree	-

What to Include in the FRA		Source(s) of Information
	of flood risk to these people?	
Vulnerability Classification	Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?	SFRA Table 5-1 SFRA Table 5-2
4. Avoiding Flood Risk		
Sequential Test	Determine whether the Sequential Test is required. Consult VOWH DC to determine if the site has been included in the Sequential Test. If required, present the relevant information to VOWH DC to enable their determination of the Sequential Test for the site on an individual basis.	SFRA Section 5.
Exception Test	Determine whether the Exception Test is necessary. Where the Exception Test is necessary, present details of: Part 1) how the proposed development contributes to the achievement of wider sustainability objectives as set out in the VOWH DC Sustainability Appraisal Report. (Details of how part 2) can be satisfied are addressed in the following part 5 'Managing and Mitigating Flood Risk'.)	SFRA Section 5
5. Managing and Mitigating Flood Risk		
Section 6 of the SFRA presents measures to manage and mitigate flood risk and when they should be implemented. Where appropriate, the following should be demonstrated within the FRA to address the following questions: How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime? How will you ensure that the proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? Are there any opportunities offered by the development to reduce flood risk elsewhere? What flood-related risks will remain after you have implemented the measures to protect the site from flooding (i.e. residual risk) and how and by whom will these be managed over the lifetime of the development (e.g. flood warning and evacuation procedures)?		
Development Layout and Sequential	Plan showing how sensitive land uses have been placed in areas within the site that are at least risk of flooding.	SFRA Section 6.2

What to Include in the FRA		Source(s) of Information
Approach		
Riverside Development Buffer Zone	Provide plans showing how a buffer zone of relevant width will be retained adjacent to any main river or Ordinary Watercourse in accordance with requirements of the Environment Agency or OCC.	SFRA Section 6.3
Floodplain Compensation Storage	Provide calculations or results of a hydraulic modelling study to demonstrate that the proposed development provides compensatory flood storage and either will not increase flood risk to neighboring areas or will result in an overall improvement. This should be located and designed to achieve level for level and volume for volume compensation, should be provided on land that is in hydrological continuity with the site within the applicant's ownership and subject to appropriate maintenance regimes for its lifetime. Include cross sectional drawings clearly showing existing and proposed site levels.	SFRA Section 6.4
Finished Floor Levels	Plans showing finished floor levels in the proposed development in relation to Ordnance Datum taking account of indicated flood depths.	SFRA Section 6.5
Safe Access / Egress	Provide a figure showing proposed safe route of escape away from the site and/or details of safe refuge. Include details of signage that will be included on site. Where necessary this will involve mapping of flood hazard associated with river flooding. This may be available from Environment Agency modelling, or may need to be prepared as part of hydraulic modelling specific for the proposed development site.	SFRA Section 6.6
Flood Routing	Provide evidence that proposed development will not impact flood flows to the extent that the risk to surrounding areas is increased. Where necessary this may require modelling.	SFRA Section 6.9
Flood Warning and Evacuation Plan	Where appropriate reference the Flood Warning and Evacuation Plan or Personal Flood Plan that has been prepared for the proposed development (or will be prepared by site owners).	SFRA Section 6.10
Flood Resistance	Details of flood resistance measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 6.11

What to Include in the FRA		Source(s) of Information
Flood Resilience	Details of flood resilience measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 6.12

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