now part of

Land West of Park Farm, Thornbury

Flood Risk Assessment

On behalf of **Barwood Development Securities Ltd & North West Thornbury Landowner Consortium**

Project Ref: 39209/4001 | Rev: G | Date: January 2020

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Document Control Sheet

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Revision	Date	Description	Prepared	Reviewed	Approved
A	11/06/2018	Draft	AB	-	-
B	03/09/2018	For planning	LD	PS	PS
C	14/09/2018	Minor amendments	LD	PS	PS
D	07/11/2018	Amendments to reflect revised masterplan	KT	LD	PS
E	09/11/2018	For client review	KT	LD	PS
F	16/12/2019	School added to proposals	LD	NT	NT
G	23/01/2020	Formatting edits	LD	NT	NT

Note to Reader

A1.1 This Flood Risk Assessment (FRA) has been produced in support of outline planning permission at Land West of Park Farm, Thornbury and updates and FRA that has previously been submitted to and commented on by both the Environment Agency (EA) and South Gloucestershire Council's Lead Local Flood Authority (LLFA). At the time, both indicated they had no objection to the development in the context of flood risk and surface water drainage.

A1.2 This FRA has been revised to cover the following additions:

- **Changes to the development proposals.**
- **Commentary regarding on site levels and surface water drainage proposals.**
- **Inclusion of additional information requested by the EA regarding mitigation against flood risk on site as a result of the predicted effects of climate change.**
- **Commentary regarding on site ditches.**
- **Incorporation of further details regarding updates to sewer design and construction guidance for systems proposed for adoption.**

A1.3 Amendments to the FRA are highlighted as bold and underlined for clarity, whilst the remaining text remains as previously submitted, as these aspects were deemed acceptable to the EA and LLFA.

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Appendices

1 Executive Summary

1.1. This Flood Risk Assessment (FRA) has been prepared by PBA now part of Stantec (PBA) to support a planning application by Barwood Development Securities Ltd and the North West Thornbury Landowner Consortium for proposed development at Land West of Park Farm, Thornbury, Gloucestershire. PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering.

1.2. The Flood Map for Planning shows that the majority of the site lies within Flood Zone 1 *'Low Probability'* within small areas falling within Flood Zone 3 *'High Probability'* and Flood Zone 2 *'Medium Probability'* (as defined in the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG) *'Flood Risk and Coastal Change'* Table 1). The areas shown to be at risk of flooding are associated with the Pickedmoor Brook which flows east to west in the southern part of the site.

1.3. The proposals are for all built development to be located within Flood Zone 1. This approach is in accordance with the sequential approach advocated by the NPPF. The PPG states that all forms of development are permitted in Flood Zone 1 and therefore there is no need to apply the Sequential or Exception Tests.

1.4. To robustly mitigate against the potential impact of climate change on both tidal and fluvial flood risk it is recommended that finished floor levels be set to 11.0mAOD or 600mm above the ground level at the edge of Flood Zone 2 adjacent to the development parcel, whichever is highest.

1.5. No other forms of flooding are considered to present a significant risk of flooding to the site. No records of flooding of the site have been provided by the EA or the Lead Local Flood Authority (LLFA). No reservoirs or canals have been identified that could breach and affect the site.

1.6. Access and egress to and from the site during the design (1 in 100 year plus climate change) flood event will not be precluded or impinged.

1.7. The Drainage Strategy has been developed using best practice Sustainable Drainage System (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the Non-Statutory Technical Standards for SuDS, the South Gloucestershire Council's Strategic Flood Risk Assessment and Developers and Designers Guide, *'The SuDS Manual'* (CIRIA C753) amongst other sources.

1.8. The proposed development will limit surface water discharge rates to match the existing present-day greenfield runoff rate for the QBAR event in accordance with the request of South Gloucestershire Council (SGC). This will provide a significant reduction in the rate of runoff during extreme rainfall events.

1.9. Open attenuation basins will attenuate surface water runoff for all events up to the 1 in 100 year storm event plus an additional 40% allowance for climate change. At detailed design stage it will be necessary to take account of the requirement to manage exceedance events when designing plot levels and road alignments.

1.10. In accordance with the fundamental objectives of the NPPF, this FRA demonstrates that:

i. The development is safe.

ii. The development does not increase flood risk.

iii. The development does not detrimentally affect third parties.

2 Introduction

2.1 Scope of Report

2.1.1 This Flood Risk Assessment (FRA) has been prepared by PBA, now part of Stantec (PBA) on behalf of our Client, Barwood Development Securities Ltd & North West Thornbury Landowner Consortium, to support an outline planning application for up to 595 dwellings, a new one form entry primary school, pre-school nursery, associated playing fields and a retail and community hub (with all matters reserved except for access) at Land West of Park Farm, Thornbury.

2.1.2 This report is based on available information for the site as detailed in **Section 3** and prepared in accordance with the planning policy requirements set out in **Section 4**. The scope of the FRA is consistent with the 'site specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG).

2.1.3 The local planning authority will make decisions with regards to any planning application within any floodplain or flood risk area. The EA is a designated statutory consultee for areas within Flood Zones and areas with critical drainage problems and plays a key role in providing advice on development and flood risk issues. The LLFA is a statutory consultee for major developments which have surface water or other local flooding impacts.

2.1.4 This FRA should be read in conjunction with other planning application supporting documents.

2.2 Caveats and Exclusions

2.2.1 This FRA has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533:2017), the standing advice provided by the EA or based on common practice.

2.2.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

2.2.3 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and South Gloucestershire Council in its role as Lead Local Flood Authority (LLFA).

2.2.4 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals.

2.2.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. PBA does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2.3 Flood Risk Assessment Credentials

2.3.1 PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

3 Proposed Development Site

3.1 Site Description

3.1.1 The proposed development site (hereafter referred to as *'the site'*) is located on the north-western edge of the existing development of Thornbury (approximate grid reference 363400, 191600). The site is approximately 35.97 hectares in area and comprises agricultural fields divided by hedgerows with some larger blocks of trees in the southern part of the site.

3.1.2 The eastern edge of the site is bounded by the Park Farm development which is in various stages of development. The northern edge of the site is bound by Oldbury Lane. The western and southern edges are surrounded by agricultural land. On the western boundary is a small parcel off ancient woodland known as Parkmill Covert.

3.1.3 A site location plan is included as Figure 1 in **Appendix A**.

3.2 Existing Topography

3.2.1 A topographic survey of the site was undertaken by Anthony Brooker Surveys in January 2018. The site is relatively flat and gently falls in a westerly direction. The maximum ground levels are 16.0mAOD in the central western part of the site and minimum ground levels are 8.8mAOD **in the west.**

3.2.2 A portion of the north-east of the site falls easterly towards Oldbury Lane to a level of 12.9mAOD.

3.2.3 A copy of the topographical survey information can be found in **Appendix A**.

3.3 Watercourses

3.3.1 A watercourse known as the Pickedmoor Brook runs from east to west through the southern part of the site. Approximately 300m upstream of the site is an unnamed watercourse that branches off the Pickedmoor Brook and rejoins it approximately 100m downstream of the site.

3.3.2 There are a number of minor field drains across the site which are recorded in the topographic survey.

3.4 Geology

3.4.1 As part of the *Combined Phase 1 and Phase 2 Ground Condition Assessment (PBA, 2018)* ground investigation works were carried out by PBA. The ground investigation works comprised five windowless sampler boreholes and five machine excavated trial pits. Boreholes were installed for post-fieldwork monitoring purposes. The report states that:

- "Tidal Flat Deposits were confirmed across most of the site comprising very clayey SAND to very sandy CLAY. Marginal Facies deposits were recorded as predominately GRAVEL of micritic limestone and dolomitic conglomerate. Mercia Mudstone ranged from firm to stiff green CLAY to reddish brown MUDSTONE.

- Groundwater was struck at depths of 0.45- 2.2m bgl and monitored at levels of 0.21 – 1.69m bgl during post-fieldwork monitoring."

3.5 Flood Defences

3.5.1 The site does not contain any formal or *'de facto'* flood defences. The EA Flood Map for Planning shows the shows the western area of the site as benefitting from flood defences. Although these defences are not defined it is presumed that they are the defences on the banks of the Severn Estuary along with associated infrastructure to prevent the ingress of tidal waters into the Oldbury Naite Rhine and watercourses that drain to them.

3.6 Development Proposals

3.6.1 The proposals comprise the following:

- **Up to 595 residential dwellings.**
- **A new one form entry primary school, pre-school nursery and associated playing fields.**
- **Land for a Neighbourhood Hub.**
- **Two vehicle access junctions from Oldbury Lane; and**
- **A sustainable travel corridor, including a bus, cycle and pedestrian links, south east through to the Park Farm development.**

3.6.2 A copy of the proposed development masterplan is contained at **Appendix A**.

4 Planning Policy

4.1 National Planning Policy and Legislation

National Planning Policy Framework and Planning Practice Guidance

4.1.1 The NPPF and the accompanying PPG set out the Government's policy on development and flood risk. The NPPF aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. In exceptional circumstances where new development is necessary in flood risk areas the policy also aims to ensure it is safe, without increasing flood risk elsewhere, and where possible, reducing flood risk overall.

4.1.2 The 2015 updates to the PPG refer to the updated non-statutory technical standards for sustainable drainage systems for guidance on surface water drainage design.

4.1.3 In February 2016, the PPG was updated to include revised guidance on the impact of climate change on flood risk. This included updating the guidance for peak river flow by river basin district, peak rainfall intensity, sea level rise and offshore wind speed and extreme wave height. For the individual river basin districts, the climate change allowance for peak river flows range from 10% to 70%, while peak rainfall intensity allowance ranges from 5% to 40%.

4.1.4 Updates to the NPPF in July 2018 require the implementation of SuDS for the management of surface water runoff in developments, unless demonstrated to be inappropriate.

The Water Framework Directive

4.1.5 The Water Framework Directive (WFD) (Commission of the European Communities, 2000) (ref 13.2) establishes a framework for a European-wide approach to action in the field of water policy. Its ultimate aim is to ensure all inland and near shore watercourses and water bodies (including groundwater) are of *'Good'* status or better, in terms of ecology and also chemical, biological and physical parameters, by the year 2027. Therefore, any activities or developments that could cause detriment to a nearby water resource or prevent the future ability of a water resource to reach its potential status, must be mitigated so as to reduce the potential for harm and allow the aims of the Directive to be realised.

4.1.6 The EA Catchment Data Explorer website has water quality data available for watercourses. This includes background data on the catchment, the existing standards of water quality and expected standards of water quality the watercourse is expected to achieve by set dates which are reviewed on a seven-year cycle. Also included are any national or local protected areas.

4.1.7 The Catchment Data Explorer website identifies the Project Site to lie within the Oldbury Naite Rhine catchment which forms part of the Severn catchment. The overall water body classification for the 2016 cycle is Poor with the objective of achieving Good by 2027. The ecological status for the 2016 cycle is also Poor with the objective to achieve Good by 2027, and the chemical status is Good with the aim to remain so.

The Flood and Water Management Act

4.1.8 The Flood and Water Management Act 2010 implements several key recommendations of Sir Michael Pitt's Review of the summer 2007 floods, protects water supplies to consumers and protects community groups from excessive charges for surface water drainage. It gives the EA a strategic overview role for flood risk and gives LLFAs responsibility for preparing and putting in place strategies for managing flood risk from ground water, surface water and ordinary watercourses in their areas. Under the Flood and Water Management Act the LLFA role is carried out by county councils and unitary authorities. SGC is the LLFA in this area.

4.2 Other National Guidance

- The *Non-statutory technical standards for sustainable drainage systems* (DEFRA, April 2015) should be used in conjunction with the NPPF and PPG. It provides planning guidance for the implementation of SuDS.

- *The SuDS Manual* (CIRIA 2015) outlines approaches to deal with surface water as close to the source as possible and reproduce natural drainage patterns to prevent an increase in the volume and peak discharge from development sites.

- *Designing for exceedance in urban drainage* (CIRIA, 2006) provides good practice guidance on the design and management of urban sewerage and drainage systems to reduce the impacts from drainage exceedance.

- *Sewers for Adoption 7th Edition* (WRc plc, 2012) provides guidance on the design, construction and maintenance of drains and sewers outside buildings which are to be adopted by a relevant public authority.

- ***Design and Construction Guidance, also referred to as Sewers for Adoption 8th Edition (SfA8).*** **On 25 October 2019, Ofwat approved the revised adoption documentation submitted by Water UK. The documentation includes the "Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England ("the Code")" which wholly replaces previous editions of Sewers for Adoption. For the first time, specific SuDS components are included as adoptable elements of a drainage system. The new sewerage adoption arrangements will come into effect on 1 April 2020 and will supersede the use of previous editions of Sewers for Adoption.**

- *Building Regulations Part H* (2015) covers drainage and waste disposal including foul water drainage, waste water treatment systems, rainwater drainage, building over sewers and separate systems of drainage.

- *BS EN 752:2008 – Drain and Sewer Systems Outside Buildings*, provides a framework for the design, construction, rehabilitation, maintenance and operation of drain and sewer systems outside buildings.

4.3 Local Planning Policy

South Gloucestershire Council Adopted Core Strategy (2013)

4.3.1 Objectives relating to flood risk and the site are as follows:

- **Policy CS1 – High quality design**

  Development will only be permitted where the highest possible standards of design and site planning are achieved.

Development proposals will be required to demonstrate that:

- *Take account of the South Gloucestershire Strategic Flood Risk Assessments and provide, where appropriate, measures to manage flood risk and prepare surface water management plans.*

- **Policy CS9 – Managing the environment and heritage**

  The natural and historic environment is finite and irreplaceable resource. In order to protect and manage South Gloucestershire's environment and its resources in a sustainable way, new development will be expected to:

  - *Be located away from areas of flood risk.*
  - *Reduce and manage the impact of flood risk through location, layout, design, choice of materials and the use of Sustainable Drainage Systems (SuDS).*
  - *Protect the quality and quantity of the water environment and its margins.*

- **Policy CS32 – Thornbury**

  Development plan documents and development proposals will take account of the vision and partnership priorities for Thornbury, and will:

  - *Demonstrate through the preparation of appropriate Flood Risk Assessments, surface water management plans and drainage strategies, how flood risk will be managed.*

South Gloucestershire Policies, Site and Places Plan (2017)

4.3.2 The Policies, Site and Places Plan for South Gloucestershire was adopted in November 2017. The policies relevant to this document reflect the Core Strategy objective. Policy PSP20 Flood Risk, Surface Water and Watercourse Management sets out the council's policies derived to meet the Core Strategy objective of *'Understanding and reducing susceptibility to flood risk'.* This policy is reproduced below.

1. Flood Risk and Surface Water Management

All development proposal(s) should follow the sequential approach to flood risk, for all potential flood risk sources.

Development proposal(s) will be expected to:

i) reduce surface water discharge from the site, wherever practicable and feasible on:

a) previously developed land, by reducing post development runoff rates for events up to and including the 1 in 100 year return period, with an allowance for climate change, to that of a greenfield condition. Where it can be demonstrated that this is not practical or feasible, a 30% betterment to the existing condition will be required;

b) greenfield sites, by restricting discharge to a watercourse or surface water sewer to the estimated mean Greenfield runoff rate (QBAR) by means of a controlled outflow. The drainage system should be designed so that flooding does not occur on any part of the development for the 3.33% (1 in 30 year) rainfall event other than in those areas/systems designated to store or convey water. Flooding within the development site should not occur in any part of a building or utility plant susceptible to water during a 1% (1 in 100 year) event, with an allowance for climate change; and;

ii) incorporate Sustainable Drainage Systems (SuDS) to reduce surface water runoff and minimise the flood risk, supported by an appropriate surface water drainage strategy; and

iii) ensure that surface water drainage proposals are designed to not increase off-site flood risk; and

iv) wherever practicable achieve the top tier of the following Surface Water Discharge Hierarchy, providing justification where lower tiers are considered appropriate:

1. infiltration.

2. surface water body (watercourse/ditch) (non-infiltration).

3. surface water sewer (non-infiltration).

4. combined sewer (non-infiltration).

2. Land Drainage and Water Quality

Development proposals will be acceptable where:

i) watercourses, ponds and lakes are retained, protected and enhanced as natural landforms, floodplains and wildlife habitats; and

ii) It is designed and located to protect the existing floodplain and enable suitable access for maintenance; and

iii) practicable the water environment is left in its natural state, and designed to avoid engineering activities which would cause harm to the water environment; and

iv) prevention and mitigation measures are sensitively designed to minimise the risk of pollution to the water environment.

3. Operation and Maintenance

Applicants must provide evidence of appropriate arrangements for future ownership, operation and maintenance of new and existing surface water drainage features, including SuDS, for the lifetime of the development proposal(s)."

South Gloucestershire Council Preliminary Flood Risk Assessment

4.3.3 The SGC Preliminary Flood Risk Assessment (PFRA) was produced in August 2011 is a high-level screening exercise to gather and assess information on past (historic) and future (potential) floods. It identifies areas of significant local flood risk within the PFRA study area (where there are locally significant harmful consequences). The Project Site is not specifically identified in the PFRA as an area at risk of flooding.

South Gloucestershire Council Strategic Flood Risk Assessment

4.3.4 SGC have produced Level 1 and Level 2 Flood Risk Assessments. Level 1 Report is primarily a desk-based study that allows a broad scale assessment of flood risk, which provides details of historic flooding incidents, areas at risk and areas which may become at risk from flooding in the future. It also identifies details of existing flood defences intended to reduce flood risk.

4.3.5 The Level 1 SFRA (2009) states that:

"The Lower Severn Internal Drainage Board (LSIDB) has suggested that without careful consideration of the potential impacts of surface water, urban extension of Thornbury is likely to have a detrimental impact upon flood risk downstream within the LSIDB area of responsibility. From discussions with the LSIDB, it is understood that the recipient watercourses of surface water from Thornbury experience flows at or near to capacity following rainfall. The LSIDB has suggested that whilst developers can limit the rate of surface water runoff, there is often no limit upon the duration of the controlled discharge and cumulative effect can result in an increase in flood risk.

Several watercourses flow through Thornbury, which all discharge into the rhine network near Oldbury on Severn.

There has been capacity issues associated with both the public surface water sewer network and a large culverted watercourse through residential development east of the town centre. It is understood that Wessex Water undertook the installation of a surface water relief sewer within the Knapp Road/Gillingstool area 2-3 years ago to alleviate internal flooding to a number of properties. The relief sewer diverts flow away from the aforementioned properties, but this scheme may have increased flood risk downstream due to surcharging of the connecting culverted watercourse.

The LSIDB have expressed the concern that increased development within Thornbury could detrimentally impact flows in the Pickedmoor Lane Rhine and the downstream rhine system.

Strategically placed surface water attenuation infrastructure, as part of any development proposals directly upstream of the known sewer capacity issues and culverted watercourse, could help to control and reduce the rural flow component to provided betterment."

4.3.6 The Level 2 (2011) SFRA states that:

"The main risk addressed in the Level 2 SFRA is the potential increased flows from proposed development will have on land downstream of Thornbury, particularly with respect to the impact on the network of rhines.

The network of rhines is a complex system of drains of ditches serving to convey flows away from agricultural land in the Lower Severn Internal Drainage Board. The rhine network area is at risk from tidal flooding from the Severn Estuary and is prone to tide-locking."

4.3.7 With regards to the Pickedmoor Brook it further states:

"Two models have been prepared to classify the present level of flood risk. One is a developer model to support proposed development at Park Farm, the other was produced as part of this study to establish Flood Zones for the remaining length of watercourse."

4.3.8 The models referred to are the JFlow+ model and the model developed by Hyder to inform and support the planning application for the Park Farm development to the east of the site. The report further states:

"South Gloucestershire Council commissioned some additional modelling of the Pickedmoor Brook using JBA's JFLOW+ modelling software. Pickedmoor Brook had no previous modelled Flood Zones/outlines for its length. These outlines have been used to supplement areas outside the outlines from the Park Farm, Thornbury model. It should be noted that when viewing the outlines from JFlow+ that culverts and bridges have not been taken into account. For the development site at Thornbury, outlines were generated using the Park Farm 1D- 2D linked ISIS model. No defences were identified for the Pickedmoor Brook; therefore, a defended model outline was not produced."

South Gloucestershire Council Local Flood Risk Management Strategy

4.3.9 The SGC Local Flood Risk Management Strategy (2015) sets out a series of objectives to ensure the successful delivery of the strategy across the authority. These are:

- *"**Objective 1:** Prioritise and implement improvements to local flood infrastructure to reduce the likelihood of flooding causing harm to the communities, businesses and environment of South Gloucestershire.*
- ***Objective 2:** Increase public awareness of the level of flood risk affecting communities and businesses and how they can better protect themselves and their property.*
- ***Objective 3:** Actively work with other Lead Local Flood Authorities and Risk Management Authorities to co-ordinate management and reduce flood risk across South Gloucestershire.*
- ***Objective 4:** Contribute to wider social, economic, environmental and cultural benefits by encouraging sustainable multi-benefit solutions and maximising use of resources.*
- ***Objective 5:** Improve our understanding of drainage assets, flood risk and how climate change will influence future flood risk.*
- ***Objective 6:** Ensure future development considers all known flood risks and climate change projections for South Gloucestershire."*

West of England Sustainable Drainage Developer Guide Section 1

4.3.10 The West of England Sustainable Drainage Developer Guide Section was published in March 2015 and was produced through the partnership of Bath & North East Somerset, Bristol City, North Somerset and South Gloucestershire Councils. The guide is also supported by the EA, LSIDB, Somerset County Council, North Somerset Internal Drainage Board and Wessex Water.

4.3.11 The guide is intended to be used by developers, planners, designers and consultants seeking guidance on the requirements for the design and approval of SuDS in the sub-region of the West of England and Somerset.

4.3.12 The Section 1 guide provides an overview for the sub-regional approach with an introduction to SuDS, an explanation of the application processes and technical assistance signposting to design guidance and practical help with applications. Section 2 sets out the character of each authority, the authority-specific technical and procedural requirements and key contacts for the authority. It is indicated that the Section 2 guide for South Gloucestershire is as yet unpublished.

4.3.13 Each Authority has reviewed the appropriateness of the Non-Statutory Technical Standards for SuDS in conjunction with the NPPF and relevant PPG against their individual Local Plans/Core Strategies. The guide highlights any local variations from the non-statutory technical standards. South Gloucestershire's variations are as follows:

- Peak flow control – For Greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must not exceed QBAR.

5 Assessment of Flood Risk

5.1 Data Collection

5.1.1 A review of publicly available data has formed the basis of the assessment of flood risk at the site. The EA, SGC, LSIDB and Wessex Water have also been consulted directly. The assessment also draws on information from other technical analysis carried out for the site.

5.1.2 Data received from direct consultations can be found in **Appendix B**.

5.2 Fluvial and Tidal Flooding

5.2.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the Flood Map for Planning hosted on the GOV.UK website[1]. This website presents the Flood Zones, which reflect the probability of flooding from rivers and/or the sea. They are also used as the basis for determining which development types are appropriate within a given location and whether or not the Sequential Test or Exception Test need to be applied.

5.2.2 Flood Zone definitions are set out in Table 1 of the online PPG (Paragraph: 065 Reference ID: 7-065-20140306) as below:

- *"**Zone 1 – Low Probability:** Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3).*
- ***Zone 2 – Medium Probability:** Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map).*
- ***Zone 3a - High Probability:** Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding (Land shown in dark blue on the Flood Map).*
- ***Zone 3b – The Functional Floodplain:** This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map).*

  Note: The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Reference should therefore also be made to the Strategic Flood Risk Assessment[2] when considering location and potential future flood risks to developments and land uses."

5.2.3 The Flood Zones are predominantly based on hydraulic modelling work, but Flood Zone 2 can extend to include recorded flood outlines. Where detailed modelling has not been carried out, the Flood Zones are based on the *'National Generalised Flood Model'*. This model does not explicitly represent channel geometry or structures such as culverts, bridges and weirs and hence may not provide an accurate estimation of the probability of flooding.

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

[2] https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-section

5.2.4 The site is shown by the EA's Flood Map for Planning to lie predominantly in Flood Zone 1. Some of the site falls within Flood Zones 2 and 3 associated with the low-lying land adjacent to the Pickedmoor Brook. The Flood Zones extend between 100m and 150m from the Pickedmoor Brook. The Flood Zones have been derived from assessments of both fluvial and tidal flooding.

Fluvial Flood Risk

5.2.5 The SFRA (refer to Section 4.3) states that the Flood Zones are derived from a developer model which was prepared to support proposed development at Park Farm and from JFlow+ modelling carried out as part of the SFRA. The SFRA figures for the Pickedmoor Brook are reproduced in **Appendix B**. These outlines are significantly smaller than the Flood Zones as presented on the Flood Map for Planning.

5.2.6 Within the site boundary the outputs of the Park Farm modelling agree closely with the Flood Map for Planning but do show a marginal reduction in flood extents on the site. The EA have not provided flood levels for the site but did advise that the Flood Zones should be used for the purpose of this FRA.

5.2.7 It is not clear what information has been used to define the Flood Zones as it does not agree with the Park Farm developer model or the JFlow+ model commission as part of the SFRA. The EA consultation response (reproduced in **Appendix B**) advises that they do not hold any 1D model levels which suggests that the fluvial component of the Flood Zone definition is based on the National Generalised Model (JFlow). As previously noted, this methodology does not explicitly represent the channel capacity which generally leads to an overestimation of flooding.

5.2.8 No information equivalent to the Flood Zones has been provided to account for the effects on climate change on fluvial flood risk. As the site falls with the Severn Basin, the projected increased in fluvial flood flows for the period 2070 to 2115 are:

- Central allowance (50th percentile) – 25%.
- Higher central allowance (70th percentile) – 35%.
- Upper end (90th percentile) - 70%.

5.2.9 Guidance on the GOV.UK website states

"In flood zone 1 use the central allowance for essential infrastructure, highly vulnerable, more vulnerable and less vulnerable developments. For water compatible developments use none of the allowances."

5.2.10 As the development falls within Flood Zone 1, the allowance that should be applied is 25%. The SFRA shows that the modelled 1 in 100 year plus 20% climate change extents for the Pickedmoor Brook to be similar to the 1 in 1,000 year outlines. The 1 in 100 year plus 25% climate change event would only be marginally larger than the 20% event and hence it is unlikely that they would extend significantly beyond those in the SFRA.

5.2.11 The Flood Zones within the site boundary are very wide (in the order of 200m) and the channel catchment is relatively small (approximately 10km^2 at the downstream extent of the site). The SFRA shows predicted flood depths during the 1 in 100 year plus 20% climate change event for the Park Farm site (reproduced in **Appendix B**) which extends to cover some of the application site. Within the floodplain simulated flood depths are for the most part less than 100mm and significant areas are less than 10mm. Although this plan doesn't extend to cover all of the application site, the channel geometry and floodplain between the two sites do not change significantly so it is reasonable to assume that flood depths within the floodplain on the application site would be comparable.

5.2.12 The EA have stated that hydraulic modelling of the Pickedmoor Brook should be run to further assess the impacts of climate change. However. further correspondence with the EA indicated that they could not provide a copy of the Park Farm developer model (due to not holding the intellectual property rights). Therefore, PBA have been unable to undertake this assessment.

5.2.13 As the floodplain is very wide and flood depths are very shallow, any incremental increase in level represents a significant increase in flow. To robustly mitigate against the potential future flooding, it is recommended that finished floor levels be set to be at least 600mm above the ground level at the edge of Flood Zone 2.

5.2.14 Areas where finished floor levels will need to be set to be at least 600mm above the ground level at the edge of Flood Zone 2 are indicated within Appendix A.

Tidal Flood Risk

5.2.15 Although the predominant source of flood risk is fluvial flooding, there is also a risk of tidal flooding at the western edge of the site. The EA, in their 2012 Wessex Coastal Model, have provided the following levels for flooding from tidal events.

Event	Maximum Level (mAOD)
Defended - 1 in 200 year event	0.00
Undefended - 1 in 200 year event	9.44
Undefended - 1 in 1,000 year event	9.86

Table 5:1 Tidal Flood Levels provided by the Environment Agency

5.2.16 Guidance on the projected increase in sea level (both as a result of climate change and slow land movement) is provided on the GOV.UK website. The sea level rise allowances are presented in **Table 5:2** below.

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115
East/East Midlands/London/South East	4 mm/yr	8.5 mm/yr	12 mm/yr	15 mm/yr
South West	3.5 mm/yr	8 mm/yr	11.5 mm/yr	14.5 mm/yr
North West/North East	2.5 mm/yr	7 mm/yr	10 mm/yr	13 mm/yr

Table 5:2 Tidal Flood Levels provided by the Environment Agency

5.2.17 Assuming that sea-level rise continues beyond 2115 at rate of 14.5mm/yr, sea level rise between 2012 and 2118 is projected to be 1.113m. On this basis, the 1 in 200 year plus climate change tidal flood level would be 10.532mAOD in 2118. To mitigate against this risk, it is recommended that finished floor levels are set at a minimum of 11.0mAOD.

5.2.18 Areas where finished floor levels will need to be raised more than 150mm above surrounding ground levels (the typical allowance made for damp proof membranes) in order to achieve a minimum of 11.0mAOD are indicated within Appendix A.

5.2.19 The flood level data and the Flood Map for Planning provided by the EA is included in **Appendix B**.

5.3 Surface Water Flooding

5.3.1 The Flood Risk Maps for Surface Water hosted on the flood warning information service website[1], show areas which could be potentially susceptible to surface water flooding in extreme rainfall events.

5.3.2 The mapping has been derived by broadscale modelling using ground levels defined on a 2m square grid with building footprints raised by 0.3m, roads lowered by 0.125m and variable roughness values used to account for different land uses. Rainfall events of various likelihoods and durations where then simulated to determine likely flood depths and velocities for different risk categories.

- **High** - each year, the area has a chance of flooding of greater than 1 in 30 (3.3%).
- **Medium** - each year, the area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
- **Low** - each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%).
- **Very low** - each year, the area has a chance of flooding of less than 1 in 1000 (0.1%).

5.3.3 It should be noted that the model does not explicitly include any below ground drainage infrastructure. Nonetheless, the maps provide an indication of how water would be expected to flow and pond once the capacity of any drainage systems have been exceeded.

5.3.4 The mapping indicates that the majority of the site is at 'Very Low' risk of flooding. The majority of the areas defined as being within Flood Zone 2 and Flood Zone 3 are shown to be at risk of 'Low' risk of surface water flooding, with some isolated areas being defined as being at risk of surface water flooding.

5.3.5 Outside the floodplain of the Pickedmoor Brook, there are areas at or beyond the site boundary to the north shown as being at risk of surface water flooding. Some isolated low spots (generally field ditches or existing ponds) are shown as being at 'High' risk. Further information on flood risk at Oldbury-on-Severn downstream of the site is discussed in more detail in **Section 5.7**.

[1] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

5.3.6 Some sections of Oldbury Lane and Butt Lane are shown as being a 'Medium' risk of flooding but predicted depths are below 300mm. These areas are assumed to be the parts of the ground model which have been lowered by 125mm to define the road flow paths (see paragraph 5.3.2). In reality, these roads are slightly higher than the surrounding land and generally served by drainage ditches on one or both sides (which are not fully represented in the modelling work) so flooding that would hinder access is considered to be extremely unlikely. There is no record of surface water flooding in these areas.

5.3.7 The Flood Risk Map for Surface Water is included in **Appendix B**. Further information on the Flood Risk Maps for Surface Water can be found in *Risk of flooding from surface water - Understanding and using the map*[1] document hosted on the GOV.UK website[2].

5.4 Groundwater Flooding

5.4.1 As discussed in **Section 3.4** ground investigation works have been carried out on site which recorded groundwater levels as being close to the ground surface.

5.4.2 Ground conditions on-site comprise superficial Tidal flat Deposit (non-productive) in the south over Mercia Mudstone Group Mudstone (Secondary B Aquifer) across the south and Marginal Facies (Principal Aquifer) across the north. There is potential for water production from Marginal Facies but the conditions during monitoring are representative of near-worst-case conditions and so any such production is anticipated to limited. Furthermore, the topography is not conducive to groundwater accumulating on the site to any significant depth. Should groundwater emerge on site, any water would be expected to flow across the site towards the Pickedmoor Brook. This risk would be mitigated by the design principles used to mitigate against surface water flooding.

5.5 Sewer Flooding

5.5.1 There is no record of sewer flooding. A foul water sewer main bisects the site in a north-westerly direction.

5.5.2 Wessex Water has advised that there are currently some issues within the wider network causing surcharging in some locations within Thornbury village but there is no reference to flooding. Wessex Water are currently undertaking network improvements to resolve these issues.

5.6 Flooding from Artificial Sources

5.6.1 Artificial sources of flooding include reservoirs, canals, lakes and ponds. No such features have been identified that could present a flood risk to the site.

5.7 Historic Flooding

5.7.1 The EA have provided plans showing the outline of historic flooding in the vicinity of the site. None of these are recorded to have flooded the site itself. Three historic food maps provided by the EA area and the accompanying text is included in **Appendix B**.

5.7.2 Two of the recorded flood events are downstream of the site at Oldbury on Severn. The event in July 1968 is recorded as 'Lower Severn'. It is presumed from the outline that it was caused by fluvial flooding driven by the same intense rainfall event that caused flooding of large areas of Bristol on July 10th. The event on the 1st December 1981 was a tidally driven event.

[2] https://www.gov.uk/government/publications/flood-risk-maps-for-surface-water-how-to-use-the-map

Oldbury-on-Severn 2016 Flooding

5.7.3 The EA data does not include any information about the flooding event that occurred on 9th March 2016. There are two separate reports produced discussing this event: one by Oldbury-on-Severn Parish Council[3] and one by SGC[4].

5.7.4 The reports assert that the flooding was caused by high river flows at Oldbury-on-Severn coinciding with high tidal levels (which restricted discharge) and failure of some flood defence infrastructure (notably flap valves at outfall locations). The high river flows were caused by 27mm of rain falling within 6 hours on heavily saturated ground.

5.7.5 The SGC report suggests that approximately 500,000m^3 of water would have reached Oldbury-on-Severn during this event and that the peak flow would have been 10.9m^3/s. No records of flooding on the site or within Thornbury itself during this event have been identified.

5.7.6 The report also makes recommendations regarding tasks the should be undertaken as part of flood risk management activities at Oldbury-on-Severn. The majority of these recommended tasks involved further site investigation of fluvial flood risk and drainage infrastructure.

5.7.7 In 2017, SGC successfully applied for £3.53 million of government funding *"to make major improvements to drainage systems at nine sites in South Gloucestershire".* One of these sites is referred to as *"Church Road & Chapel Road & Camp Road"* in Oldbury-on-Severn and another is *"Oldbury Lane"* in Thornbury.

5.7.8 A document[5] was produced by SGC on 25th July 2018 providing outline information regarding the proposed works at *"Church Road & Chapel Road & Camp Road"* in Oldbury-on-Severn. These proposed works are aligned with those recommended in the May 2017 Flood Report. The document indicates that it is intended for these works to commence in early 2019.

5.7.9 An SFRA2 was also commissioned by SGC in 2017 to provide further detailed evidence of existing flood risk in Oldbury-on-Severn. Currently, there is not a version of the Level 2 SFRA publicly available for review. However, SGC's website states that Oldbury-on-Severn is at risk but defended from tidal, therefore the highest flood risk affecting the area is fluvial flooding associated with the Oldbury Naite Rhine and Pickedmoor Brook. Chapel Lane and Pickedmoor Lane are identified as being at risk.

5.8 Development Vulnerability

5.8.1 Within the Flood Risk and Coastal Change section of PPG, Table 2 defines the *'Flood risk vulnerability classification'* of various proposed site uses. This classification is subsequently applied to PPG Table 3 to determine if:

- The proposed development is suitable for the flood zone in which it is located.
- The Sequential Test is required as part of the planning application.
- The Exception Test is required for the proposed development.

[3] Flooding in Oldbury on Severn 9th March 2016 Report prepared by Oldbury on Severn Parish Council

[4] Oldbury-on-Severn Flood Report May 2017

[5] Flood Resilience Project – Oldbury-on-Severn

5.8.2 Flood risk vulnerability classifications are provided in Table 2 of the PPG website (Paragraph 066) of PPG ID: 7. The mix of uses proposed as part of the proposed development can be classified generally as follows:

- **More vulnerable:** Residential and educational uses.
- **Less vulnerable:** Retail space.
- **Water-compatible development:** Amenity open space.

5.8.3 All built development will be located within Flood Zone 1 in accordance with the development compatibility, as indicated in Table 3 of the online PPG (Paragraph: 067 Reference ID: 7-067-20140306).

5.9 The Sequential and Exception Test

5.9.1 The NPPF requires local planning authorities to apply the Sequential Test to steer new development towards areas of lowest flood risk. As all built development will be located within Flood Zone 1, the Sequential and Exception Tests are not required.

5.10 Access and Egress

5.10.1 The Planning Practice Guidance (PPG) website sets out the requirements for developments in terms of safe access and egress. Paragraph 039 (Reference ID: 7-039-20140306) states:

'Where access and egress are important to the overall safety of the development, this should be discussed with the local planning authority and Environment Agency at the earliest stage, as this can affect the overall design of the development. Access considerations should include the voluntary and free movement of people during a 'design flood', as well as the potential for evacuation before a more extreme flood."

5.10.2 Flood risks to Oldbury Lane are negligible and are not likely to significantly impact on access or egress.

5.11 Residual Risks

5.11.1 No significant residual risks of flooding have been identified. Should the structures on the Pickedmoor Brook become blocked, the impact would be a localised increase in levels. However, the distance between the Pickedmoor Brook and proposed areas of development indicate that these localised water level increases will not have a significant impact for future occupants.

6 Managing Surface Water

6.1 Overview

6.1.1 In April 2015, the LLFA became a statutory consultee for major developments which have surface water or other local flooding impacts. As the LLFA, SGC is responsible for the approval of surface water drainage systems for new major development. Major development consists of any of the following:

a. the provision of dwelling houses where residential development of 10 or more units; or

b. where the development is to be carried out on a site having an area of 0.5 hectares or more and the number of units is not known; or

c. the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or

d. development carried out on a site having an area of 1 hectare or more.

On this basis, the proposals for the site are classified as major development.

6.1.2 The detailed surface water drainage design will be developed at the detailed design stage with consideration of key design parameters. For the purposes of the FRA an outline strategy has been developed to demonstrate that it is feasible for the site proposals to meet requirements for sustainable drainage.

6.2 Design Requirements

6.2.1 A key requirement for the proposed development is to ensure that flood risk downstream is not increased. The potential increase is associated with additional runoff generated by the introduction of roofs and hard-paved surfaces as part of the development. These surfaces replace natural ground where water can percolate into soil pores and to a greater or lesser extent infiltrate into the underlying rock. Additionally, natural ground is more uneven, promoting localised ponding while vegetation intercepts rainfall by collecting water. Lastly, natural ground is generally more resistant to flow reducing the velocity of overland flow and the time that it takes to leave the site.

6.2.2 The replacement of natural surfaces has two principal effects on the land's response to rainfall:

- An increase in the rate of runoff.
- An increase in the volume of runoff.

Both of these impacts have the potential to increase the flood risk downstream. The rate of runoff is normally of principal concern as it can impact on the peak flow rate in the receiving watercourse or drainage network. Increasing the volume of runoff can also increase flood risk in particular situations.

6.2.3 The SFRA sets out policies for managing development runoff and also for assessing the impact of the planned drainage strategy on flood risk downstream.

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

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

a. an adequate soakaway or some other adequate infiltration system; or

b. a watercourse; or where that is not practicable;

c. a sewer.

Infiltration

6.2.6 Based on the Building Regulations Part H hierarchy, the preferred method for disposal of surface water from the new development is via infiltration drainage.

6.2.7 The ground investigation encountered water levels close to the ground surface and concluded that infiltration will not be an appropriate strategy for managing surface water arising on site. The surface water drainage strategy has been developed assuming no contribution from infiltration.

Discharge to Watercourse

6.2.8 Where infiltration is not possible, the next preference in the Building Regulations Part H hierarchy is to discharge to a watercourse.

6.2.9 It is proposed that the surface water drainage network discharges to an existing on-site drain that flows out of the western site boundary and discharges to the Pickedmoor Brook.

6.3 Surface Water Drainage Strategy

6.3.1 Based on the preferred method of surface water discharge, an indicative surface water drainage strategy has been developed. The surface water drainage strategy has been developed to a level suitable for an outline planning application, using best practice SuDS techniques and consultation with the EA and the LLFA. Guidance on suitable techniques and methods has been obtained from the EA, the SFRA and The SuDS Manual (CIRIA C753) amongst other sources.

6.3.2 The overall philosophy of SuDS is to replicate, as closely as possible, the natural drainage process of a site prior to development to mitigate the adverse effects of urban storm water run-off on the environment. SuDS provide the ability to control surface water flows but also improve water quality, ecology and amenity within the development.

6.3.3 The surface water drainage strategy has been designed for the 1 in 100 year rainfall event plus a 40% allowance for climate change to reflect current climate change guidance (published February 2016).

6.3.4 An estimate of the coverage of impermeable surface has been made assuming that 65% of the residential blocks and 90% of the retail and community hub are impermeable. In accordance with the South Gloucestershire *Designers and Developers Guide* a 6% allowance for urban creep has been included on the basis that the housing density will be a minimum of 38 units per hectare.

6.3.5 **As stated in Section 3.2, a north-eastern portion of the site falls towards Oldbury Lane rather than towards the Pickedmoor Brook in the west. However, ground levels in this portion of the site fall to 12.9mAOD whilst approximately the highest elevation a drainage route would need to take is 14.1mAOD before the existing ground begins to fall towards the Pickedmoor Brook. This level difference is not viewed as prohibiting the proposed drainage route to be constructed as per best practice and adoptable standards. Further assessment of this drainage route will be required during subsequent reserved matters applications whereby an assessment of proposed ground levels will be available.**

6.3.6 At the detailed design stage, opportunities should be sought to convey water to storage features using above ground features such as swales or integrating the existing field drainage network into the system. Opportunities for providing on plot drainage features should also be pursued.

6.3.7 A plan of the proposed indicative surface water drainage strategy can be found in **Appendix C**.

6.4 Surface Water Drainage Parameters

Development Discharge Rates

6.4.1 As the site is currently greenfield, local planning policy dictates that post-development runoff rates should be limited to match the existing QBAR greenfield runoff rate for all return periods up to the 100-year (1% AEP) event.

6.4.2 The existing runoff rates for the site were calculated using the Flood Estimation Handbook (FEH) Statistical Method using XML data exported from the FEH web service and are shown in **Table 6:1** below.

Return Period	Existing Site		Post-Development	
	Greenfield Runoff per Hectare (l/s/ha)	Greenfield Runoff for 12.2ha (l/s)	Discharge Rate per Hectare (l/s/ha)	Discharge Rate for 12.2ha (l/s)
QBAR	2.9	35.3	2.9	35.3
1 in 30-year	5.7	68.9	2.9	35.3
1 in 100-year	7.0	85.4	2.9	35.3
1 in 100-year plus 40% climate change	9.8	119.6	2.9	35.3

Table 6:1 Existing Greenfield Runoff Rates and Proposed Discharge Rates (for 12.2ha)

6.4.3 In summary, the surface water drainage strategy has been developed based on the following key design criteria:

- Peak runoff rates limited to 2.9 l/s/ha (QBAR).
- On-site attenuation designed for 1 in 100-year (1% AEP) storm event plus a 40% increase in rainfall intensity allowance for climate change over the lifetime of development.
- No surface water flooding in the 1 in 30-year (33.3% AEP) storm event.

6.4.4 Within the development site area of 35.97ha, it has been assessed that 12.2ha will be converted to impermeable surfacing and will be positively drained. Drainage from this area will be restricted to a maximum discharge rate of 2.9 l/s.

6.4.5 Calculations for the development discharge rates can be found in **Appendix C**.

Attenuation Volumes

6.4.6 Increasing impermeable areas (roads, houses etc) combined with reducing runoff rates and taking into account climate change over the lifetime of the development, introduces the need to attenuate the additional surface water runoff. In addition, while attenuation storage manages the additional rate of runoff caused by paving over natural surfaces, a provision of *'long-term'* storage is also required (calculated separately to the attenuation volume) to cater for the additional runoff volume generated by the new development.

6.4.7 There are normally two accepted options for dealing with this volume where infiltration is not an option. They are as follows:

i. The additional volume is stored and discharged at rates limited to 2 litres per second per hectare (l/s/ha) after the storm event subsides. This volume is known as the Long Term Storage volume (LTS).

ii. All runoff from the development is limited to the mean annual peak flow rate (QBAR) for all return periods up to the design event.

6.4.8 As it is the local policy to restrict all runoff to QBAR it is not necessary to provide long-term storage. The QBAR rate is only slightly higher at 2.9l/s/ha than the rate at which long-term storage is discharged.

6.4.9 Using MicroDrainage and limiting the peak discharge rate to 2.9 l/s/ha, it has been calculated that the attenuation volume required on site is 900.1m^3 per impermeable hectare of development. Based on the assessed impermeable area across the development of 12.2ha it is assessed that the total storage requirement for the site will be 10,999m^3.

6.4.10 Attenuation storage has been calculated within MicroDrainage utilising *'Hydro-brake'* vortex control devices. Hydro-brake is a trademark product manufactured exclusively by Hydro International. Due to the differing characteristics of outfall controls, should detailed design specify a different manufacturer or type of outfall then calculations will have to be reviewed.

6.4.11 MicroDrainage calculations and the long-term storage calculation can be found in **Appendix C**.

Indicative Attenuation Design

6.4.12 Runoff generated by the development will be attenuated within open attenuation basins.

6.4.13 **For the purpose of demonstrating the feasibility of the proposed development, open attenuation basins have been modelled in 3D.** The basins modelled as part of this outline application have a maximum storage depth of 0.9m for a 1 in 100 year rainfall event plus the required 40% allowance for climate change. An additional 0.2m freeboard has been added (making the total depth 1.1m). The basins will have a maximum of 1 in 4 side slopes based on the existing topography of the site.

6.4.14 The basins are located at the lowest part of the site based on the existing topography to minimise the risk of any overland flow bypassing them. In order to manage potential exceedance events, it may be necessary to carry out some minor reprofiling works or drainage features to ensure these cannot be bypassed on the southern and western boundaries. The internal street layout within individual plots will need to be appropriately designed to prevent exceedance flows affecting vulnerable receptors or bypassing the storage features. This will need to account for the road design (including vertical alignment) and proposed plot levels.

6.4.15 The design of attenuation basins will be refined at the detailed design stage. It is recommended that the attenuation basins have varying side slopes to allow the features to be multi-functional and integrate with the proposed landscape and ecology requirements for the site. **Therefore, reference should be made to the relevant landscape design plans and documents.**

6.4.16 A plan of the proposed indicative surface water drainage strategy, along with the MicroDrainage outputs can be found in **Appendix C**.

6.5 Downstream Flood Risk

6.5.1 The discharge rate post-development will be less than the greenfield rate representing a betterment in peak flow rates and a commensurate reduction to flood risk downstream.

6.5.2 Using the long-term storage calculation set out in the SuDS manual it has been calculated that the development will result in an additional 262.7m^3 of direct runoff per impermeable hectare during a six-hour storm. This calculation ignores that during the greenfield condition some of this volume would reach the river through displacement of soil moisture.

6.5.3 The MicroDrainage model for conceptual storage of runoff from one hectare of impermeable land demonstrates that 48 hours after a 6 hour rainfall event, the attenuation feature would still contain 271.4m^3 of water. For events of longer duration, the volume remaining after 48 hours is greater still. Therefore, over a 48 hour period there will be no increase in volume for storm events lasting 6 hours or longer. By this time, any flooding at Oldbury on Severn would have significantly receded during the several low tides occurring since the peak of the event allowing discharge for the drainage network.

6.5.4 The long-term storage calculation can be found in **Appendix C**.

6.5.5 The proposed discharge rate in this FRA complies with local policy, by controlling discharge rates from the site post-development to match the existing greenfield QBAR rate. The QBAR rate represent a return period of approximately 1 in 2.3 years. This means that there will be a reduction in off-site discharge rates following the development of the site when compared with the existing greenfield situation for storm events in excess of this return period. This will therefore aid in reducing flood risk from fluvial sources in downstream Oldbury-on-Severn.

6.5.6 In **Section 5.7** it was noted that flood risk management actions for Oldbury-on-Severn had been identified and that government funding acquired will provide flood risk benefits to Oldbury-on-Severn. In complying with local planning policy, the proposed development at this site would provide further betterment.

6.5.7 **A number of ditches on site have been indicated by the LLFA as either conveying off site flows or critical for the highway drainage of Oldbury Lane. Most of these ditches are situated near to the site's boundaries and are indicated within the development proposals as remaining as green space post-development. Therefore, these ditches will not be modified as part of the development and downstream flood risk will not be impacted.**

6.5.8 **One ditch does lie within the site's boundary. Whilst most of this ditch is also shown to be within proposed green space, the eastern reach of the ditch is indicated to lie within an area of proposed residential development. Given the critical function of this ditch, it is proposed that this ditch form a boundary between proposed residential plots and will therefore be unmodified and unaffected by the development.**

6.5.9 **Details of the development's interaction with critical ditches will need to be finalised as part of subsequent reserved matters applications and detailed design on site.**

6.5.10 **Based on information available, other ditches on site are land drains serving discrete sub-catchments within the site's boundary. These ditches will be infilled as part of the development proposals (unless indicated as proposed green space). As the sub-catchment served by each of these ditches will form part of the development proposals, post-development these areas will be served by the proposed surface water drainage network. As such, these sub-catchments will be managed in accordance with the principles set out in Section 6.4 and will not impact downstream flood risk.**

6.5.11 **A plan indicating which on site ditches are critical and will be maintained alongside those on site which will be infilled is included in Appendix A.**

6.6 Sustainable Drainage Techniques

6.6.1 As a greenfield site and particularly in view of the need to protect water quality downstream, the drainage strategy has aimed to use SuDS where possible. SuDS techniques that could be incorporated into the drainage strategy for this include:

- Bio-retention areas include vegetation and planting media which act to filter and treat runoff from developed areas.
- Filter strips are vegetated/grassed strips of land designed to accept runoff from upstream development.
- Swales and ditches convey runoff at a rate that allows infiltration (where possible) and settlement of suspended particles.
- Permeable paving allows pedestrian and vehicular traffic as normal, whilst allowing rainwater to infiltrate through the surface and into the underlying layers.
- Water butts can be used to assist in rainwater recycling where appropriate. Water butts also provide a degree of water treatment in the form of settlement of sediments.
- Rain gardens are small planted depressions which collect runoff close to source and provide natural attenuation and filtration before discharging to the drainage network. Rain gardens can be used to provide storage for *'normal'* rainfall events, reducing the reliance on the strategic attenuation.
- Tree pits can be designed to form part of the treatment train and be integrated into attenuation, swales and bio-retention areas.
- Rainwater recycling could be incorporated into the development by diverting outflows from attenuation into allotments or local commercial interests where appropriate.

6.6.2 The above techniques have not been included within drainage calculations due to the risk of property owners removing elements (permeable paved driveways). However, their use within the drainage network would provide *'source control'* of rainwater, both providing treatment at source and slowing the flow of water across the site, further mitigating flood risk downstream.

6.7 Operational and Maintenance

6.7.1 To ensure the ongoing performance of the SuDS scheme, the proposed drainage will require regular maintenance over its lifetime. Typically, the maintenance of a SuDS network involves removing litter/debris in the system and general landscaping/grass cutting.

6.7.2 Final designs of the attenuation areas, outfalls, inlets and strategic drainage network must be designed with a regard for future maintenance. All areas should be easily accessible and safe for operatives without compromising the overall attenuation and landscape requirements.

6.7.3 Following the adoption of the Design and Construction Guidance, approved by Ofwat in October 2019, the majority of SuDS features are now legally viewed as sewers and therefore can be adopted by water companies. Therefore, potential options for a SuDS adopting maintenance party include: an independent management company, Wessex Water or SGC. These options will be explored as part of the detailed design phase.

6.7.4 Recommended attenuation basin operation and maintenance requirements are shown in **Table 6:2** below. **However, it should be noted that following the detailed landscape design of the proposed SuDS features, these requirements may vary.**

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Litter and debris removal	Monthly
	Grass cutting – for spillways and access routes	Monthly (during growing season), or as required
	Grass cutting – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional maintenance	Re-seed areas of poor vegetation growth	Annually or as required
	Prune and trim trees and remove cuttings	2 years, or as required
	Remove sediment from forebay, when 50% full and from micropools if volume reduced by >25%	3–10 years (or as required)
Remedial actions	Repair of erosion or other damage by re-seeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Re-level uneven surfaces and reinstate design levels	As required
Monitoring	Inspect inlets, outlets and overflows for blockages and clear if required	Monthly/after large storms
	Inspect banksides, structures, pipework etc. for evidence of physical damage	Monthly/after large storms
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Half yearly
	Check penstocks and other mechanical devices	Half yearly

Table 6:2 Recommended Attenuation Basin Maintenance Schedule

6.8 Residual Risk

6.8.1 Two residual risks have been identified, namely:

- potential blockage of drainage infrastructure; and
- the occurrence of (rare) storm events which exceed the design conditions.

6.8.2 The risk associated with a potential blockage on site is considered to be small. Routine inspection and maintenance procedures will minimise the risk of the accumulation of detritus and debris as well as ensuring that the drainage systems continue to operate efficiently.

6.8.3 In the event of a rare storm (beyond the design standard i.e. 1 in 100 year storm event plus 40% additional allowance for climate change), the capacity of the drainage network could be temporarily exceeded and drainage inlets could be bypassed creating overland flow. All buildings should be provided with internal threshold levels raised above surrounding ground levels and designated flow paths created around the buildings to the lower lying levels. Localised grading may be required to achieve level access criteria. Exceedance flows would then naturally be directed around the buildings to lower ground.

6.8.4 An overland flow assessment should be carried out at detailed design stage once all construction information is available so that any hotspots can be identified and designed out.

7 Conclusion

7.1 Planning Application

7.1.1 This FRA has been prepared to support a planning application by Barwood Development Securities Ltd and the North West Thornbury Landowner Consortium for proposed development at Land West of Park Farm, Thornbury, Gloucestershire.

7.2 Flood Risk

7.2.1 Flood Map for Planning provided by the EA demonstrates that the site lies predominantly within Flood Zone 1. All built development is proposed with Flood Zone 1 therefore, it is not necessary to apply the Sequential or Exception Test. There are areas of the site within Flood Zones 2 and 3 which are associated with fluvial and tidal flood risks from the Pickedmoor Brook. These areas have been set aside for public open space uses.

7.2.2 To robustly mitigate against the potential impact of climate change it is recommended that finished floor levels be set to 11.0mAOD or 600mm above the ground level at the edge of Flood Zone 2 adjacent to the development parcel, whichever is highest.

7.2.3 There are no other significant sources of flood risk to the site.

7.2.4 Access/egress via Oldbury Lane will not be hindered by flooding.

7.3 Surface Water Drainage

7.3.1 Infiltration is not feasible on the site due to elevated groundwater levels. Consequently, it is proposed that surface water is discharged to an on-site field drain which itself discharges to the Pickedmoor Brook.

7.3.2 In accordance with local policy, discharge will be limited to the greenfield QBAR runoff rate, which has been calculated to be 2.9 l/s/ha for the 1 in 100 year storm event. Using a hydro-brake to restrict discharge from a 0.9m deep basin, MicroDrainage calculates that 900.1m^3/ha of attenuation will be required.

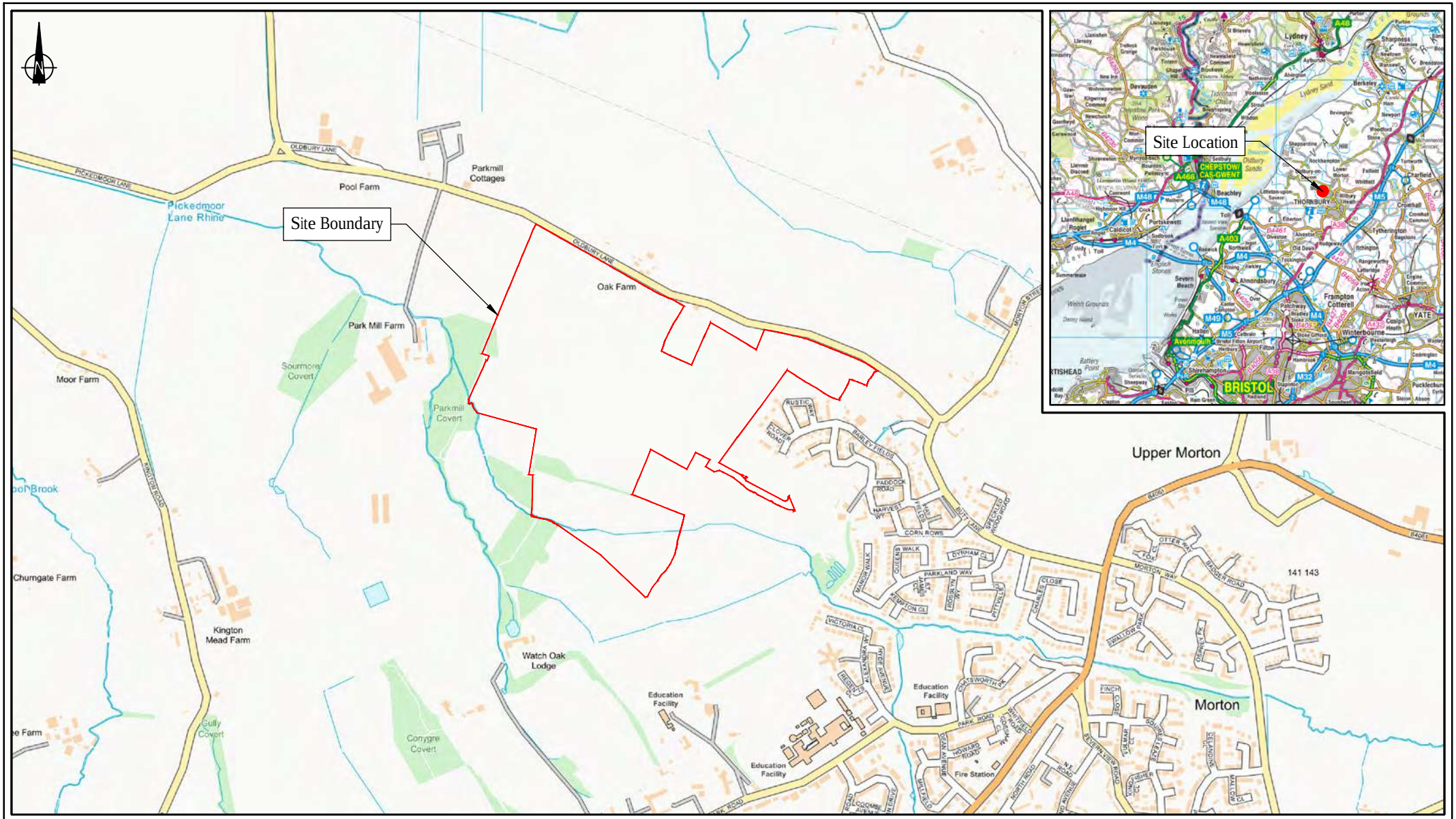
7.3.3 This will provide a reduction in runoff rates when compared with calculated greenfield rates. Furthermore, for rainfall events over 6 hours in duration there will be no increase in runoff volume for 48 hours from the start of the rainfall event.

7.4 Summary

7.4.1 The proposal complies with the NPPF and local planning policy with respect to flood risk and is an appropriate development at this location.

Appendix A Figures

1. Figure 1 Site Location Plan
2. Figure 2 Topographical Survey
3. Development Masterplan
4. Figure 3 Finished Floor Levels
5. Figure 4 On Site Ditches



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TAUNTON
Tel: 01823 218 940

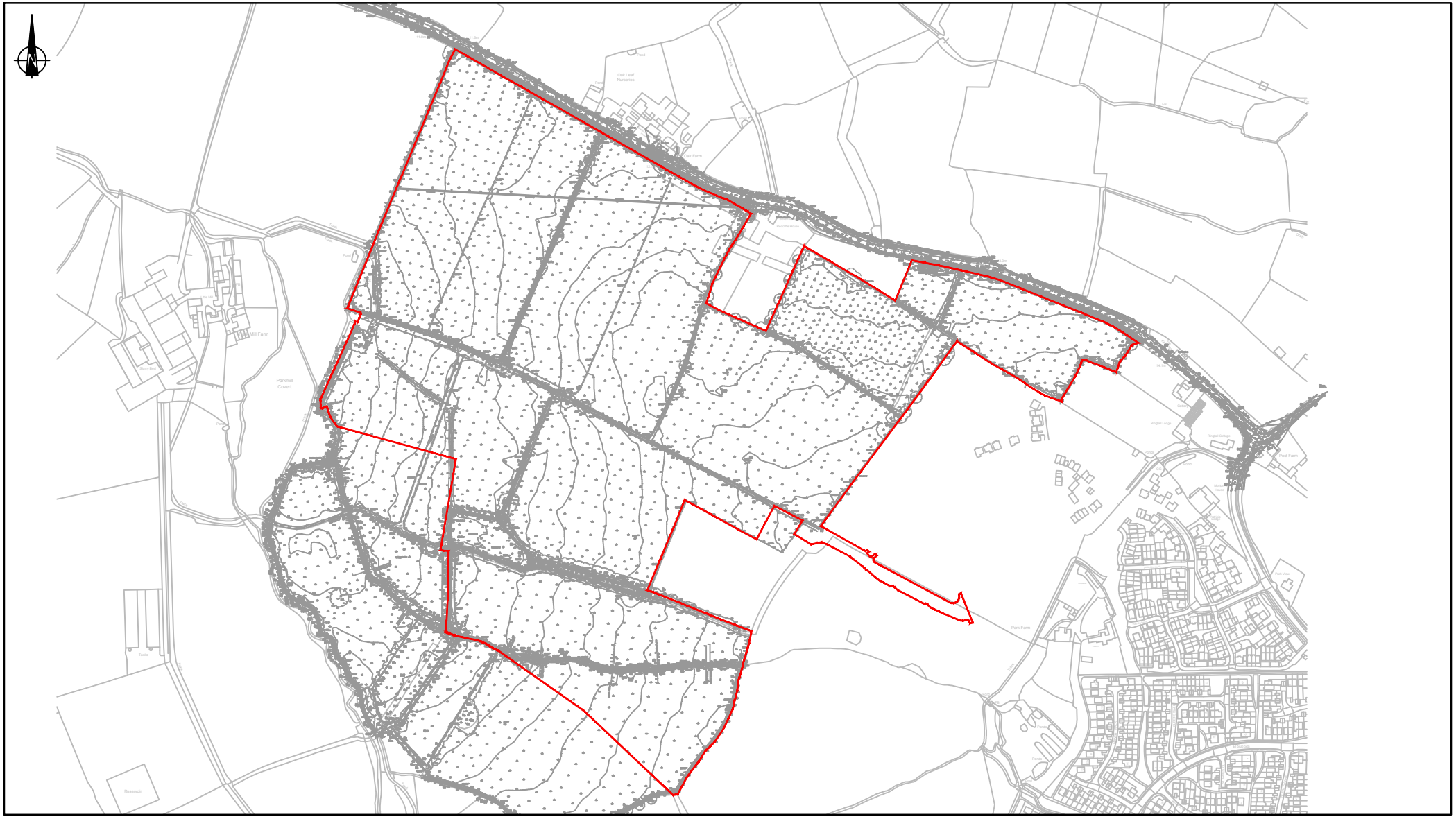
Client
Barwood Development Securities

Land to the West of Park Farm
Thornbury

Site Location Plan

Date	11.12.2019
A4 Scale	NTS
Drawn by	LD
Checked by	-

Figure Number
Figure 1



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Client

Barwood Development Securities

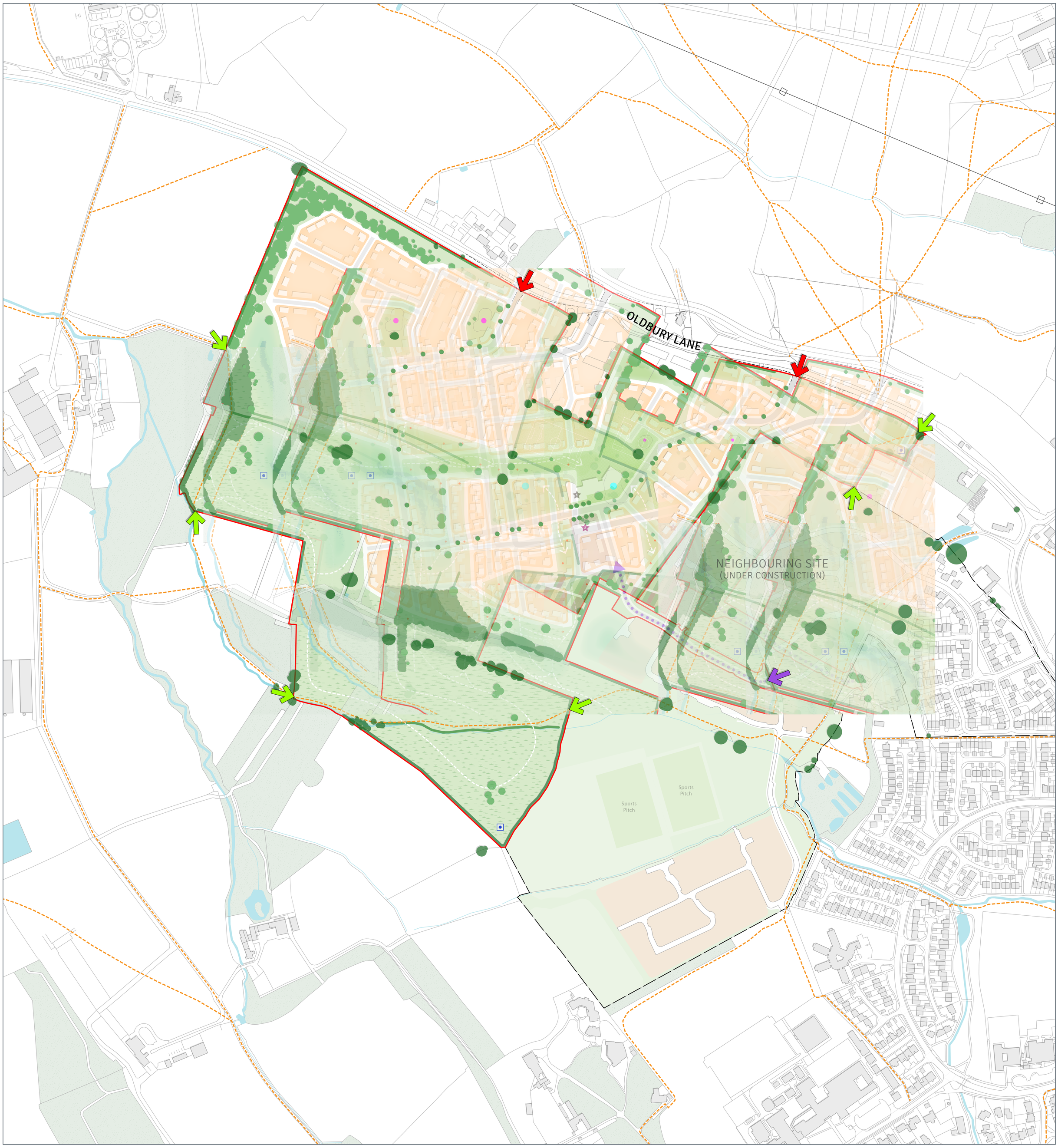
Land to the West of Park Farm
Thornbury

Topographical Survey

Date	11.12.2019
A4 Scale	NTS
Drawn by	LD
Checked by	-

Figure Number

Figure 2



- Site Boundary
- Residential
- Mixed-Use
- Public Open Space
- 1FE School
- Drainage
- Natrual / Semi-Natural Open Space
- Primary Vehicle Access Point
- Retained Pedestrian Access (PROW)
- Pedestrian, Cycle and Bus Access Point (Sustainable Transport Link)
- Sustainable Transport Connection
- Existing Trees
- Proposed Trees
- Hedgerows
- Destination Park
- Neighbourhood Greens
- Opportunities for Natural Play
- PROW
- Allotments
- Potential Wildlife Pond Location
- School Building
- Indicative Location of Retail / Community Hub

The scaling of this drawing cannot be assured

Rev A (23.08.18) - Update to site boundary (GR)
Rev B (06.09.18) - Plan amended to reflect updated tree survey (GR)
Rev C (16.09.18) - Sustainable Transport Connection added (GR)
Rev D (30.10.18) - Layout adjusted (GR)
Rev E (01.11.18) - Proposed hedgerow adjusted (GR)
Rev F (07.11.18) - Proposed hedgerow adjusted (GR)
Rev G (08.11.18) - Illustrative tree planting updated (GR)
Rev H (21.10.19) - School added, layout revised (GR)
Rev I (22.11.19) - Indicative built form updated (GR)
Rev J (25.11.19) - Hedge added along site boundary (GR)
Rev K (05.12.19) - Additional wildlife pond (AT)

N 0 50 100 200m

PROJECT
NW Thornbury

DRAWING TITLE
Illustrative Masterplan

DATE	SCALE	DRAWN BY	CHECK BY
15.08.18	1:2500@A1 1:5000@A3	GR	AJT

PROJECT NO	DRAWING NO	REVISION
27982	9410	K

J:\27000 - 27999\27900 - 27999\27982 - NW Thornbury\A4 - Dwgs & Registers\Master Planning\PDFs

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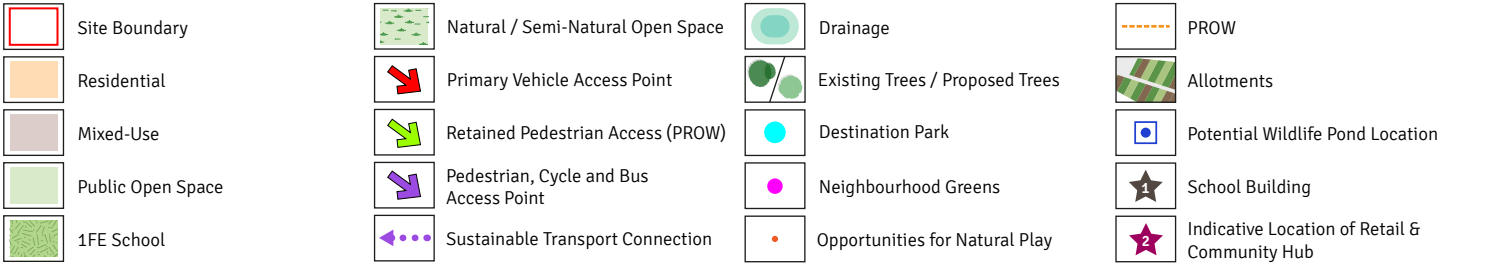
Site Boundary
Residential
Mixed-Use
Public Open Space
1FE School
Natural / Semi-Natural Open Space
Primary Vehicle Access Point
Retained Pedestrian Access (PROW)
Pedestrian, Cycle and Bus Access Point
Sustainable Transport Connection
Drainage
Existing Trees / Proposed Trees
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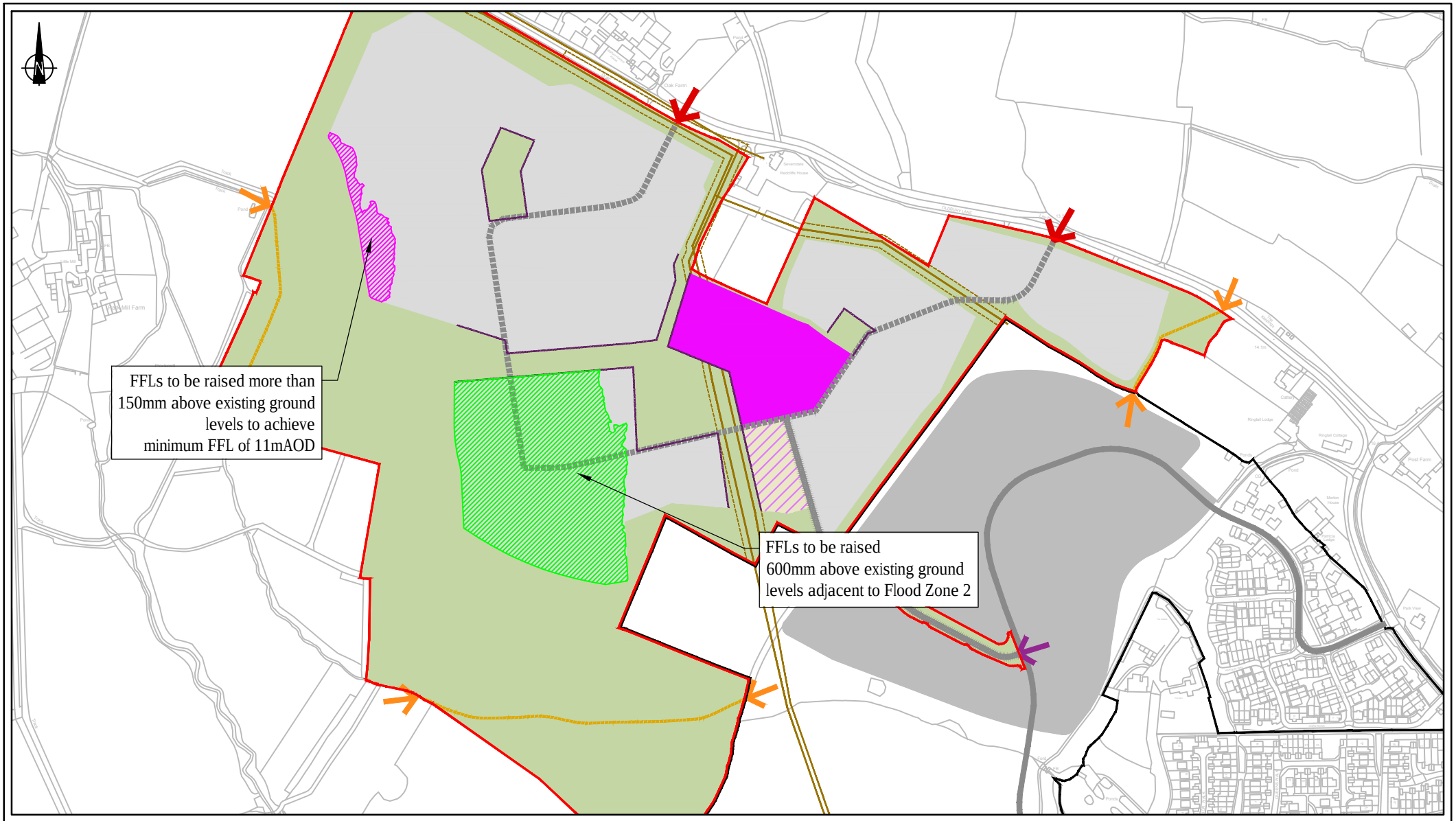
PROW
Allotments
Potential Wildlife Pond Location
1
School Building
2
Indicative Location of Retail & Community Hub



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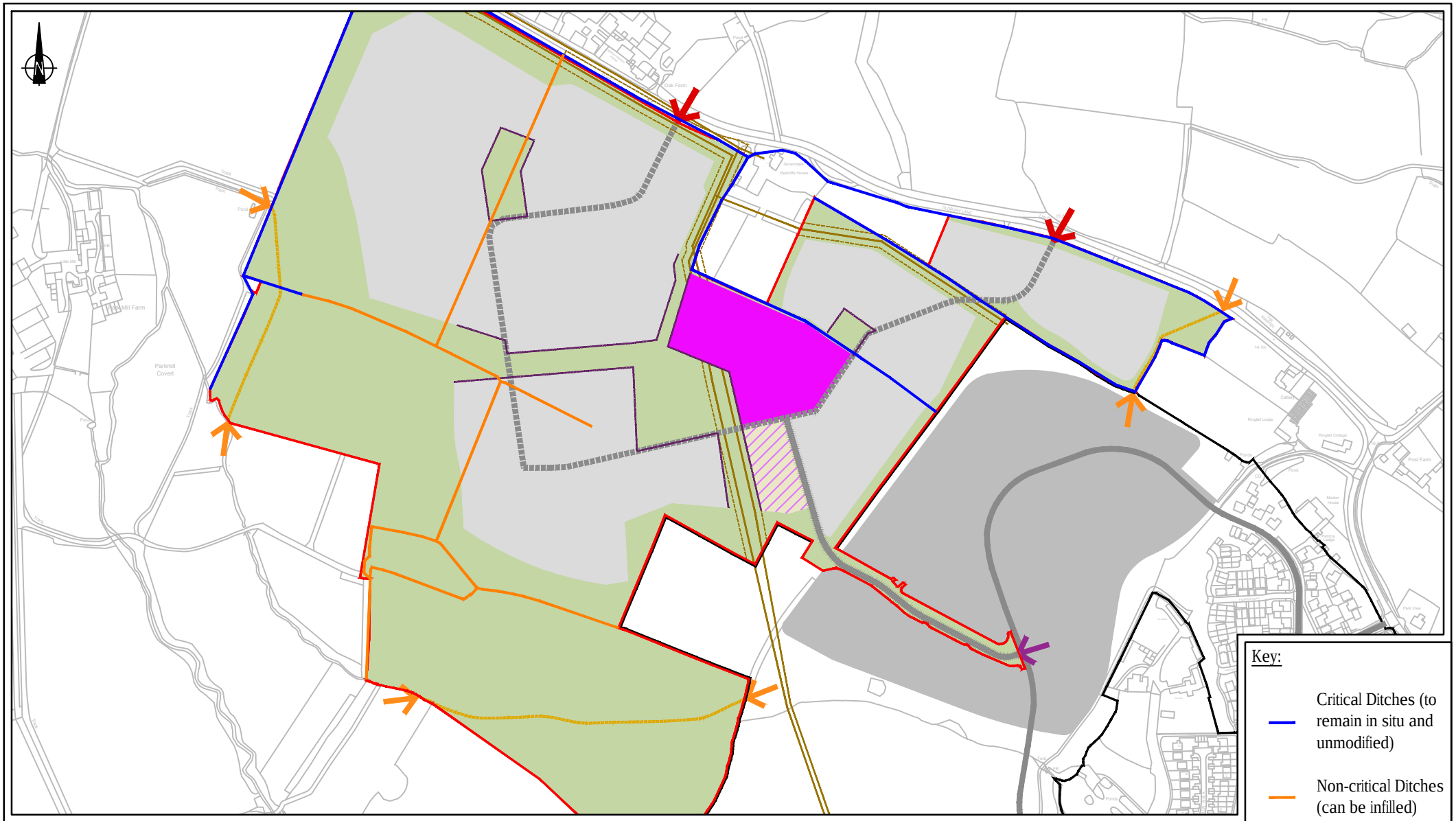
Land to the West of Park Farm
Thornbury

Climate Change Mitigation

Date	11.12.2019
A4 Scale	NTS
Drawn by	LD
Checked by	-

Figure Number
Figure 3



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Land to the West of Park Farm
Thornbury

On Site Ditches

Date	16.12.2019
A4 Scale	NTS
Drawn by	LD
Checked by	-

Figure Number
Figure 4

File Location: \\pba.int\tnt\projects\39209 west of park farm, thornbury\4001_hydro task_ta-hyd\cad\dwgs\figure 4_on site ditches.dwg

Appendix B 3rd Party Data

1. EA Letter Product 4
2. Flood Map for Planning
3. Risk of Flooding Surface Water
4. Historic Flooding Text
5. Historic Flood Map 1
6. Historic Flood Map 2
7. Historic Flood Map 3
8. SFRA Modelling – Flood Zone Maps – Pickedmoor Brook
9. SFRA Modelling – Flood Zone Maps including climate change – Pickedmoor Brook
10. SFRA Modelling – Flood Zone Maps including climate change – Pickedmoor Brook
11. SFRA Modelling – 1 in 100 year plus climate change depths / Housing Opportunity (Thornbury)
12. Critical On Site Ditches

creating a better place

Environment Agency

[redacted]

Our ref: 67533-WX
Your ref:
Date: 6 December 2017

Dear Ms Vesse,

Thank you for your enquiry which was received on 21 November 2017. We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Abstract

Name	Product 4
Description	Detailed Flood Risk Assessment Map for **Land West of Park Farm, Thornbury**
Licence	Open Government Licence
Information Warnings	*The mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply.*
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. Contains Ordnance Survey data © Crown copyright 2017 Ordnance Survey 100024198.

Flood Map for Planning

A Flood Map for Planning (Rivers and the Sea) is attached for spatial planning purposes. This map contains Flood Zones that show the areas of natural floodplain that would flood if there were no raised flood defences. Please be aware this information is also available for download on the following link.

Flooding history

Our historic records indicate the area flooded in **1968, 1981, 2000, 2012 and 2013,** Please see the attached Historic Map for the approximate outline of the events. We also attached a sheet providing further information regarding these flood events, such as dates, source and cause of flooding.

Please note: we cannot guarantee that it is an exhaustive list of all past flood events in this location. The extent of the flooded area was mapped and validated from the best available on-the-ground evidence collated by the authorities at the time of the event. All reasonable care has been taken to ensure the historical flood event outline is as accurate as possible, but the Environment Agency will update the outline if new evidence emerges.

Customer & Engagement, Wessex
Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS
Phone: 03708 506 506
Email: wessexenquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Open Data
The following Environment Agency published datasets are now available on the weblink below as part of the Government's 'Open Data' project and are available for you to download free of charge. Environment Agency published datasets; https://data.gov.uk/data/search?publisher=environment-agency&unpublished=false

You will need to search and select the name of the following datasets to take you directly to the weblink to enable you to download the data:

- Flood Map for Planning (Rivers and the Sea) – Flood Zones 2 and 3
- Flood Map for Planning (Rives and Sea) – Areas Benefiting from Defences
- Flood Map for Planning (Rivers and Sea) Spatial Flood Defences
- Flood Map for Planning (Rivers and Sea) Flood Storage Areas
- Risk of Flooding (Rivers and Sea)
- Recorded Flood Outlines
- Historic Flood Map
- Risk of Flooding from Surface Water Extent for:
  - → 3 percent annual chance
  - → 1 percent annual chance
  - → 0.1 percent annual chance

If you have requested this information to help inform a development proposal, then you should also note the detail in the attached advisory text on the use of Environment Agency Information and Further Guidance for FRAs**.**

Strategic Flood Risk Assessment (SFRA)
When preparing your FRA to support the planning application, you should also refer to South Gloucestershire Council's Level 1 SFRA available to download via the following link: http://www.southglos.gov.uk/environment-and-planning/planning/local-development-framework/flood-risk/

Planning
If you have questions regarding the planning nature of your enquiry, or require advice on floor levels, please contact our Sustainable Places team on NWX.SP@environment-agency.gov.uk.

Please be aware that we now charge for planning advice when consulted on pre-application enquiries. This new approach provides advice to developers in two ways. Firstly there is the provision of 'free' advice available to everyone where we give a preliminary opinion on a proposed development. This sets out the environmental constraints together with any issues this raises for us. Should you wish us to review in detail any of these issues then we can do this through a chargeable scheme aimed at recovering our costs.

Flood Levels
Fluvial flood levels and depths
We do not hold any 1D (fluvial) modelling for the vicinity of your site.

Coastal/tidal flood levels and depths
The tables below show the maximum modelled tidal flood levels and depths for defended (actual situation) and undefended (natural floodplain) scenarios taken from our 2012 Wessex North Coast Model.

For the undefended scenarios the 0.5% (1 in 200 year return period) and 0.1% (1 in 1000 year return period) annual exceedance probability (AEP) is given. Only the 0.5% (1 in 200 year) AEP is available for the defended scenario.

Defended

AEP	Maximum depth (in metres)	Maximum level (mAOD)
0.5%	0.00	0.00

Undefended

AEP	Maximum depth (in metres)	Maximum level (mAoD)
0.5%	0.60	9.44
0.1%	1.01	9.86

NB 0.00 (m or mAOD) indicates the data does not reach the site

Levels and depths have been extracted based upon the site boundary plan provided.

There is no climate change data available from our 2012 Wessex North Coast Model.

Please be aware that we have provided you with 20% climate change flood flow model results. This climate change allowance has been applied to the current day 1%AEP (1 in 100 year) flood flow estimates used in our model.

If you intend undertaking a FRA for a planning application using climate change flood level information supplied in this letter, you should consider whether it is appropriate in light of a range of potential allowances for fluvial flood flow now advised in curent planning guidance on 'Flood risk assessments: climate change allowances'. The relevant guidance is available at the following website address: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Environmental Permit for Flood Risk Activities

In addition to any other permission(s) that you may have already obtained e.g. planning permission, you may need an environmental permit for flood risk activities (formerly known as Flood Defence Consent prior to 06 April 2016) if you want to do work:

- in, under, over or near a main river (including where the river is in a culvert)
- on or near a flood defence on a main river
- in the flood plain of a main river
- on or near a sea defence

For further information and to check whether a permit is required please visit: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.

For any further advice, please contact your local Environment Agency Office, at bridgwater.frap@environment-agency.gov.uk.

Further Information

We advise that you also contact the Flood Risk Management Team, by email LeadLocalFloodAuthority@southglos.gov.uk or by telephone, 01454 868000, at South Gloucestershire Council, Council Offices, Badminton Road, Yate, Bristol, BS37 5AF as they may be able to provide further advice with respect to localised flooding and drainage issues.

Customer & Engagement, Wessex
Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS
Phone: 03708 506 506
Email: wessexenquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Further details about the Environment Agency information supplied can be found on our website:
https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for FRAs:
https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

We hope you find this information helpful and it is provided subject to the Open Government Licence, which we strongly recommend you read.

Yours sincerely

Enc:
Use of Environment Agency Information for Flood Risk Assessments (below)
67533-WX Historic Map
67533-WX Historic Data
67533-WX Flood Map for Planning
67533-WX Node Location Map
67533-WX Node Data
67533-WX Defence Map
67533-WX Defence Data

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Use of Environment Agency Information for Flood Risk Assessments (FRAs)

Important
Use of Environment Agency data: you should note that

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but the use of Environment Agency information does not constitute such an assessment on its own.

2. As part of your data request, we have provided all of the modelled data we hold for your location. Please note that some of our modelled information may have been produced for purposes other than for flood zone generation. This may mean that some of the modelled data you have been provided with has a lower confidence level, and has not been used in producing our flood map, nor definitively reflects the predicted flood water level at the property/development site scale. To check the suitability of the use of this information in your FRA please contact your local Partnership & Strategic Overview (PSO) team.

3. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or surface water runoff. The information produced by the Local Planning Authority and the Lead Local Flood Authority (LLFA) may assist in assessing other sources of flood risk.

4. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection.

5. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your Local Planning Authority.

Pre-Planning Advice from the Environment Agency
If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:

Pre-application Preliminary Opinion:
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Pre-application Charged Service:
https://www.gov.uk/government/publications/planning-advice-environment-agency-standard-terms-and-conditions

Depending on the enquiry we may also provide advice on other issues related to our responsibilities, including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

Flood Risk Assessment (FRA) Guidance
You should refer to the Planning Practice Guidance of the National Planning Policy Framework (NPPF) and the Environment Agency's Flood Risk Standing Advice for information about Flood Risk Assessment (FRA) for new development in the different Flood Zones. These documents can be accessed via:

National Planning Policy Framework Planning Practice Guidance:
http://planningguidance.planningportal.gov.uk/

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Phone: 03708 506 506
Email: wessexenquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

VAT No: **662 4901 34**

Environment Agency advice on FRAs:
https://www.gov.uk/flood-risk-assessment-for-planning-applications#when-to-follow-standing-advice

https://www.gov.uk/government/publications/planning-applications-assessing-flood-risk

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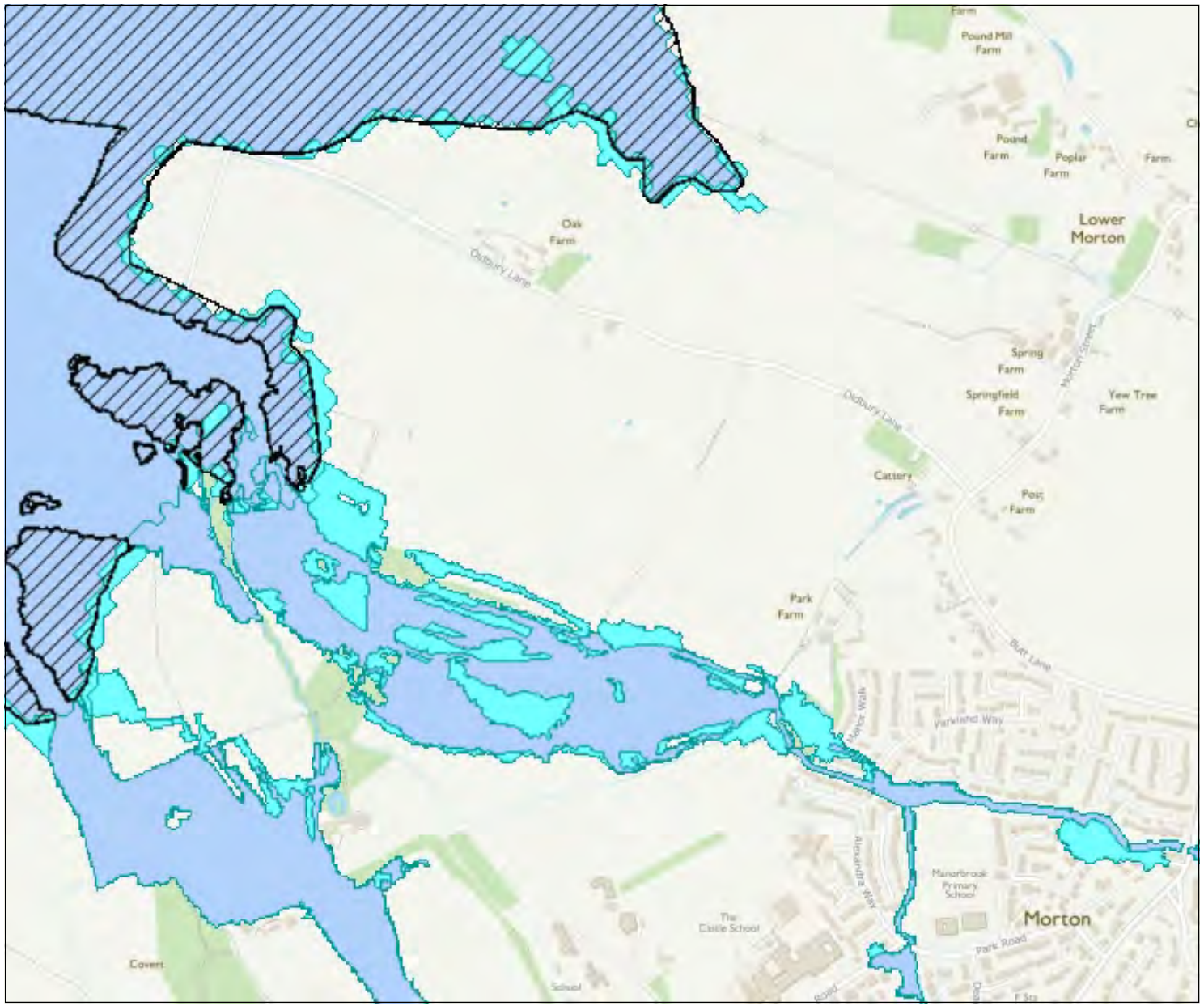
www.environment-agency.gov.uk

Flood map for planning - ST 63392 91620 06/12/2017 Ref: 67533-WX



Environment Agency

Scale 1: 10,000

N W E S

Flood Map for Planning (Rivers & Sea)

- Defences
- Flood Storage Areas
- Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occuring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Risk of flooding - surface water - ST 63392 91620 06/12/2017 Ref: 67533-WX

Environment Agency

Scale 1:10,000

N W E S

Likelihood of flooding from Surface Water

- High (>= 3.3%)
- Medium (3.3% - 1%)
- Low (1% - 0.1%)
- Very Low

Likelihood of flooding from Surface Water

High:	Greater than or equal to 3.3% (1 in 30) chance in any given year
Medium:	Less than 3.3% (1 in 30) but greater than or equal to 1% (1 in 100) chance in any given year
Low:	Less than 1% (1 in 100) but greater than or equal to 0.1% (1 in 1,000) chance in any given year
Very Low:	Less than 0.1% (1 in 1,000) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on our website.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). E-mail: enquires@environment-agency.gov.uk

Start Date	End Date	Name	Comments	Source of Flooding	Cause of Flooding
01/07/1968	01/07/1968	July 1968 (Lower Severn)	aerial photography	main river	channel capacity exceeded (no raised defences)
01/12/1981	13/12/1981	Tidal Severn	Local Authority	main river	unknown
29/10/2000	12/11/2000	November 2000 (Lower Severn)	aerial photography	main river	channel capacity exceeded (no raised defences)
25/11/2012	25/11/2012	Oldbury on Severn_Nov 2012	visual	ordinary watercourse	channel capacity exceeded (no raised defences)
23/12/2013	23/12/2013	Oldbury-on-Severn_Winter 2013 to 2014	Local Authority	ordinary watercourse	channel capacity exceeded (no raised defences)