Plot SGR 1, Bicester

Flood Risk Assessment

Section 1 of 2

On behalf of

SGR (Bicester 1) Limited

Project Ref: 41436/2002 | Rev: 02 | Date: August 2018

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1 Introduction

1.1.1 Peter Brett Associates LLP (PBA) has been commissioned by SGR (Bicester 1) Limited to prepare a Flood Risk Assessment (FRA) to support its outline planning application for the site known as Plot SGR 1, Bicester.

1.1.2 This Strategy has been prepared in accordance with relevant national, regional and local planning policy guidance as follows:

- National policy regarding flood risk as contained within National Planning Policy Framework (NPPF), dated 24th July 2018, and the accompanying National Planning Practice Guidance (NPPG), dated 24th July 2018,
- The Ministerial Statement HCWS161, dated 18th December 2014,
- Non-statutory Technical Standards for Sustainable Drainage Systems, March 2015, Defra,
- Flood Risk Assessments: Climate Change Allowances, 19th February 2016, Environment Agency (EA),
- Oxfordshire County Council Preliminary Flood Risk Assessment (PFRA), April 2011,
- Oxfordshire County Council Local Flood Risk Management Strategy, 2014,
- Cherwell District Council Level 1 Strategic Flood Risk Assessment (SFRA), 2009 updated May 2017,
- Cherwell District Council Level 2 Strategic Flood Risk Assessment (SFRA), May 2017,
- Cherwell District Council 'The Cherwell Local Plan 2011 – 2031 (Part 1)', adopted July 2015, and
- Cherwell District Council draft Supplementary Planning Document (SPD), October 2017.

1.1.3 This report summarises the risk from all forms of flooding that may affect the development.

2 Site Information

2.1 Site Location and Plan

2.1.1 The Plot SGR 1, Bicester site is approximately 5.03ha in size and lies to the north of Bicester town centre adjacent to Banbury Road (B4100). The site is formed from open pasture.

2.1.2 The site is bounded by Banbury Road to the northeast, the consented Bicester Eco-Town Exemplar site that is currently under construction to the northwest and southwest, and The Bure ordinary watercourse and Home Farm to the southeast. Refer to Figure 2.1 below.

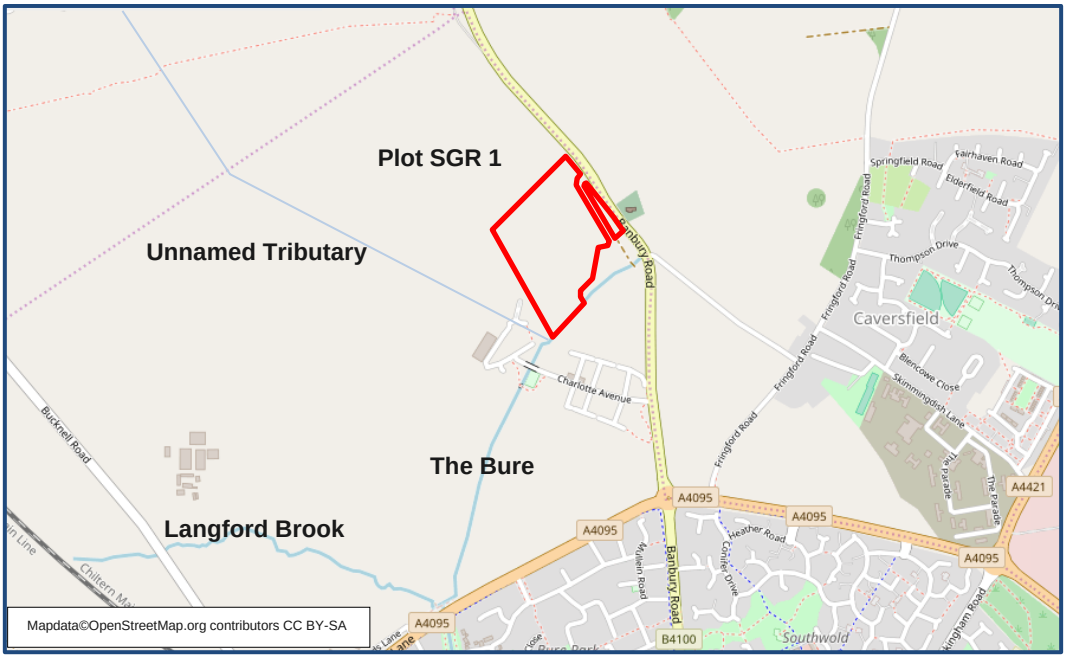

Figure 2.1: Site Location Plan

2.1.3 A copy of the topographical survey of the site undertaken by Amethyst Surveys Limited (Drawing Number 21166_OGL, dated 2014), is contained in **Appendix A**.

2.1.4 Two ordinary watercourses, The Bure and an Unnamed Tributary of The Bure, are located to the southeast and southwest of the site respectively. The Bure intersects the lower south-eastern edge of the site and is located within the site's red line boundary in this area.

2.2 Proposals

2.2.1 The proposed development will provide up to 75 residential dwellings with associated car parking, pedestrian and cycle routes, public open space and allotments/orchards. The proposed access road is via the Exemplar site to the west.

2.2.2 A copy of the proposed site, 'Illustrative Master Plan' (Drawing Number RCP001/016, dated March 2018, David Lock Associates) is contained in **Appendix B**.

3 Flood Risk Assessment

3.1 National Policy

3.1.1 The NPPF requires a site specific FRA to be carried out to support the planning application. The degree of detail that an FRA should include depends upon the scale and potential impact of the proposed development. The FRA should consider the risk to the development from all sources of flooding and the off-site impacts on the downstream flood risk to others. An assessment of climate change should also be included.

3.2 Strategic Flood Risk Assessment

3.2.1 Local Planning Authorities (LPAs) should prepare Strategic Flood Risk Assessments (SRFA) in consultation with the Environment Agency (EA). This is then used by the LPAs to inform sustainability appraisals and Local Development Documents (LDDs). The SFRA is initially used to refine information on areas that may flood, taking into account all sources of flooding and the impacts of climate change, in addition to the information depicted on the EA Flood Zone Mapping.

3.2.2 The LPA, Cherwell District Council (CDC), has prepared an SFRA which was originally released in 2009 and updated in May 2017. The Level 1 SFRA '*provides an overview of flood risk within the CDC boundary.*'

3.2.3 A Level 2 SFRA also prepared in May 2017 sets out '*to provide supplementary information to the Level 1 SFRA Update to inform CDC on specific flood risk issues and the suitability of 8 potential strategic development sites put forward by CDC*.' It should be noted that none of the 8 strategic sites are located in proximity to the Plot SGR 1 site.

3.2.4 This FRA has been compiled taking account of the information provided within the CDC Level 1 and 2 SFRA's.

3.3 Preliminary Flood Risk Assessment

3.3.1 Oxfordshire County Council (OCC) is defined as a Lead Local Flood Authority (LLFA) under the Flood and Water Management Act 2010. Under the Flood Risk Regulations LLFA's are required to produce a Preliminary Flood Risk Assessment (PFRA), providing a high level overview of flood risk from all sources within a local area, including consideration of surface water, groundwater, ordinary watercourses and canals.

3.3.2 The OCC PFRA was released in April 2011and information contained within the PFRA has been used to inform this FRA.

3.4 Cherwell Local Plan 2011 – 2031 (Part 1)

3.4.1 Local planning policy relevant to the site is currently contained within the Cherwell Local Plan (adopted July 2015), which forms part of the Local Plan and sets out the Council's overall planning strategy to the year 2031.

3.4.2 Policy ESD 6: 'Sustainable Flood Risk Management', addresses flood risk and states the following:

> *'Site specific flood risk assessments will be required to accompany development proposals in the following situations:*
>
> - *All development proposals located in flood zones 2 or 3*

- *Development proposals of 1 hectare or more located in flood zone 1*
- *Development sites located in an area known to have experienced flooding problems*
- *Development sites located within 9m of any watercourses.*

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

- *There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)*
- *Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.*

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

3.4.3 Policy ESD 7: 'Sustainable Drainage Systems (SuDS)', addresses the requirement for the use of SuDS and states the following:

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

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

In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed.

Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features.'

3.4.4 Policy ESD 8: 'Water Resources', is concerned with water quality, adequate resources and sustainable use and states the following:

'Water quality will be maintained and enhanced by avoiding adverse effects of development on the water environment. Development proposals which would adversely affect the water quality of surface or underground water bodies, including rivers, canals, lakes and reservoirs, as a result of directly attributable factors, will not be permitted.

Development will only be permitted where adequate water resources exist, or can be provided without detriment to existing uses. Where appropriate, phasing of development will be used to enable the relevant water infrastructure to be put in place in advance of development commencing.'

3.5 Fluvial Flood Zone

3.5.1 The initial phase of identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Maps, available on the EA's website.

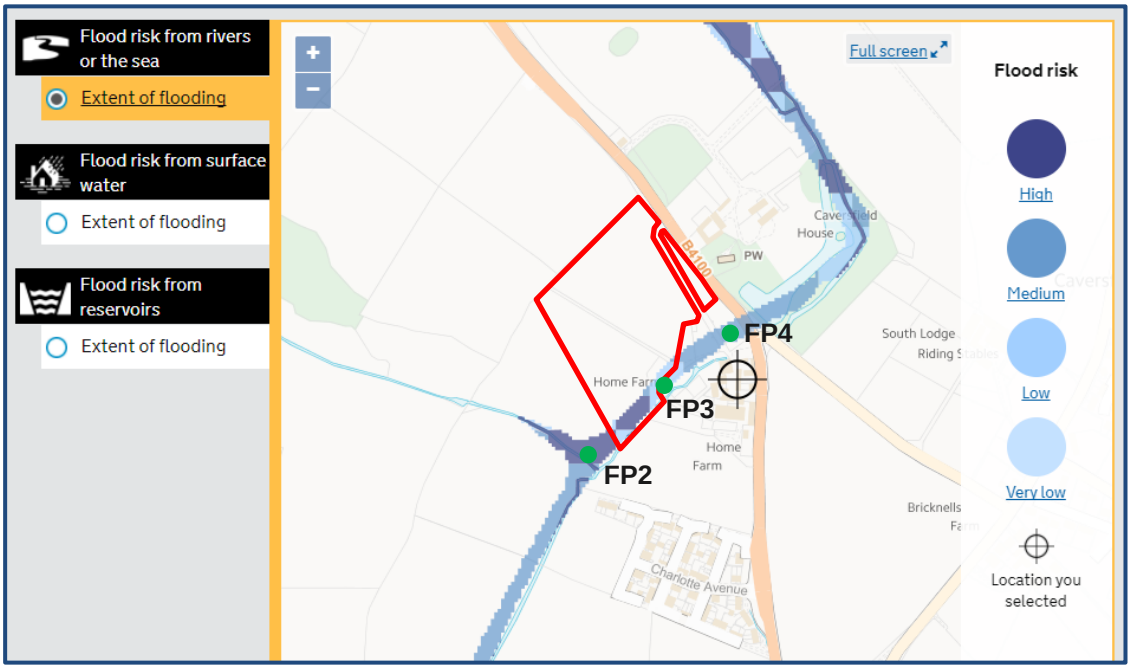

Figure 3.1: Extract of Flood Map from EA website

3.5.2 This mapping shows the majority of the site to lie in Flood Zone 1; land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). The adjacent local ordinary watercourses at the southeast boundary and southwest of the site are located within Flood Zones 2 and 3. No development has been proposed in these areas. However, areas of Flood Zones 2 and 3 do extend into the site boundary.

3.5.3 The CDC Level 1 SFRA confirms that the development lies within Flood Zone 1.

3.5.4 The EA have provided national generalised (JFLOW) flood level information for the watercourse which shows that the lowest residential dwelling proposed as part of the development is situated 2.92m above the modelled 1 in 1,000 year (0.1%) event on the watercourse.

EA Grid Cell Reference	Maximum Level (m AOD)			Proposed Development
	1% Annual Probability	1% Annual Probability + 20%	0.1% Annual Probability	
FP2	83.48m AOD	83.52m AOD	83.56m AOD	Lowest residential dwelling located at 87.50m AOD
FP3	84.27m AOD	84.33m AOD	84.39m AOD	
FP4	84.46m AOD	84.51m AOD	84.58m AOD	

Table 3.1: Comparison of JFLOW modelling to proposed residential development

3.5.5 A copy of the information provided by the EA is contained in **Appendix C**.

3.6 Vulnerability

3.6.1 The NPPF follows a sequential risk based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

3.6.2 NPPF Table 2, below, taken from the Planning Practice Guidance to the NPPF confirms the 'flood risk vulnerability classification' of a site depending on the proposed usage. This classification is subsequently applied to NPPF Table 3, below, to determine whether:

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

3.6.3 In this case the proposed development is for a residential development in Flood Zone 1. The only works proposed outside of the Flood Zone 1 extents are in relation to green infrastructure.

More Vulnerable	Hospitals Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. Buildings used for **dwelling houses**, student halls of residence, drinking establishments, nightclubs and hotels. Non-residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Table 3.2: NPPF Planning Practice Guidance Table 2: Flood Risk Vulnerability Classification

Flood Risk Vulnerability Classification	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓

Table 3.3: NPPF Planning Practice Guidance Table 3: Flood Risk Vulnerability and Flood Zone 'Compatibility'

3.6.4 Review of the NPPF tables, above, shows that development classed as '*more vulnerable'* is appropriate for Flood Zone 1.

3.7 Groundwater

3.7.1 The EA's Groundwater Source Protection Zone Maps, available on the EA's website, indicate the risk of contamination to groundwater sources such as wells, boreholes and springs used for public drinking water supply. The shape and size of a zone depends on the ground conditions, how the groundwater is abstracted, and other environmental factors.

3.7.2 The EA groundwater mapping, shown in Figure 3.2 below, confirms that the site lies outside all Groundwater Source Protection Zones. The site however lies over a Secondary A bedrock aquifer (refer to Figure 3.3) with a high groundwater vulnerability and soluble rock risk (refer to Figure 3.4). This means that the groundwater (aquifer) directly below the site is extracted and that the ground conditions above the aquifer have the potential to be permeable and at potential risk from solution features. This mapping therefore indicates that there is a potential for the movement of contaminants through the strata and subsequently pollution of the aquifer.

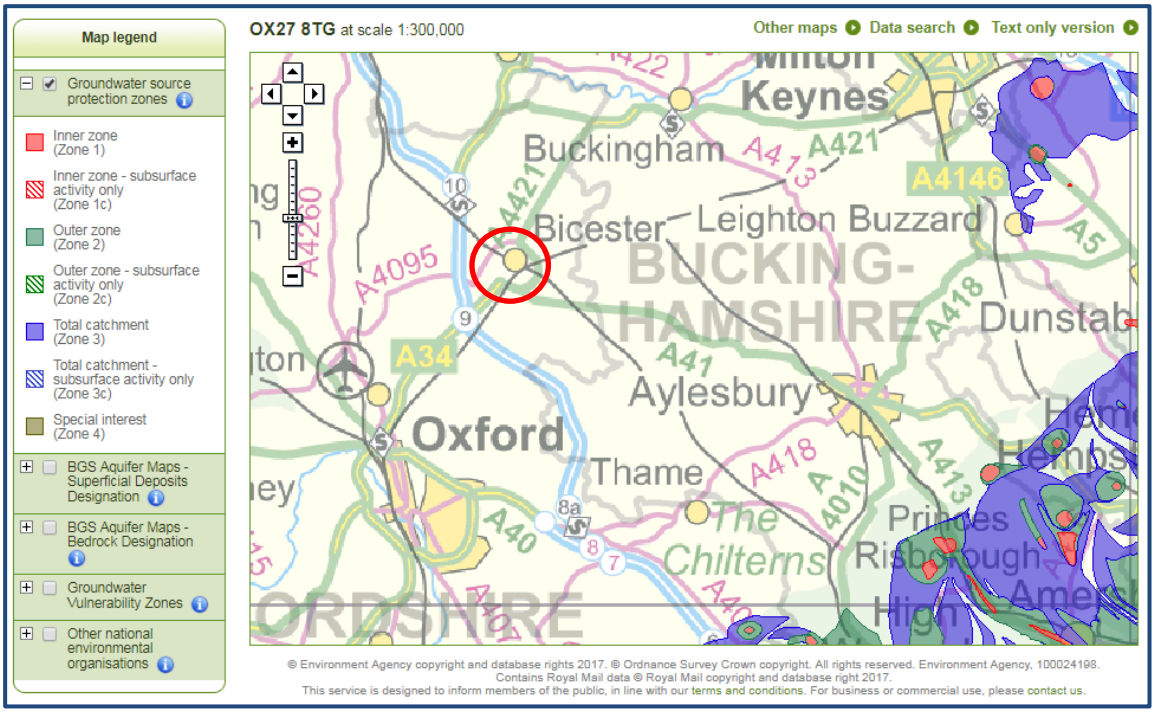

Figure 3.2: Extract from Source Protection Zone Map from EA website

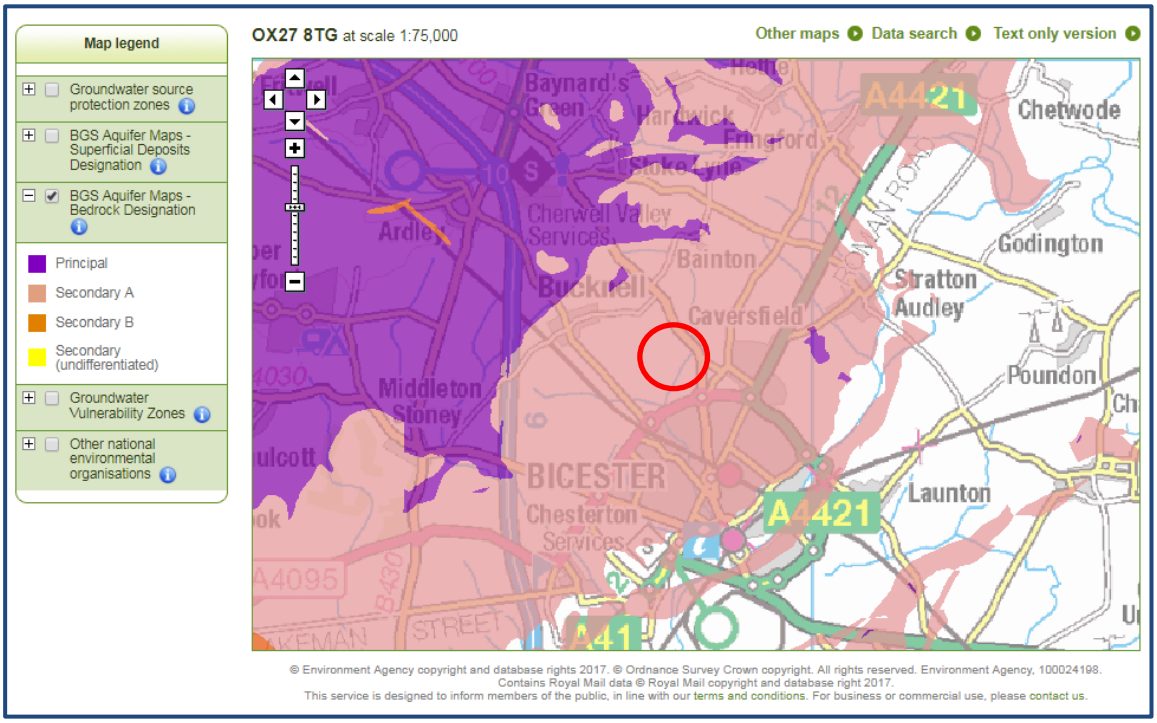

Figure 3.3: Extract from BGS Aquifer Map from EA website

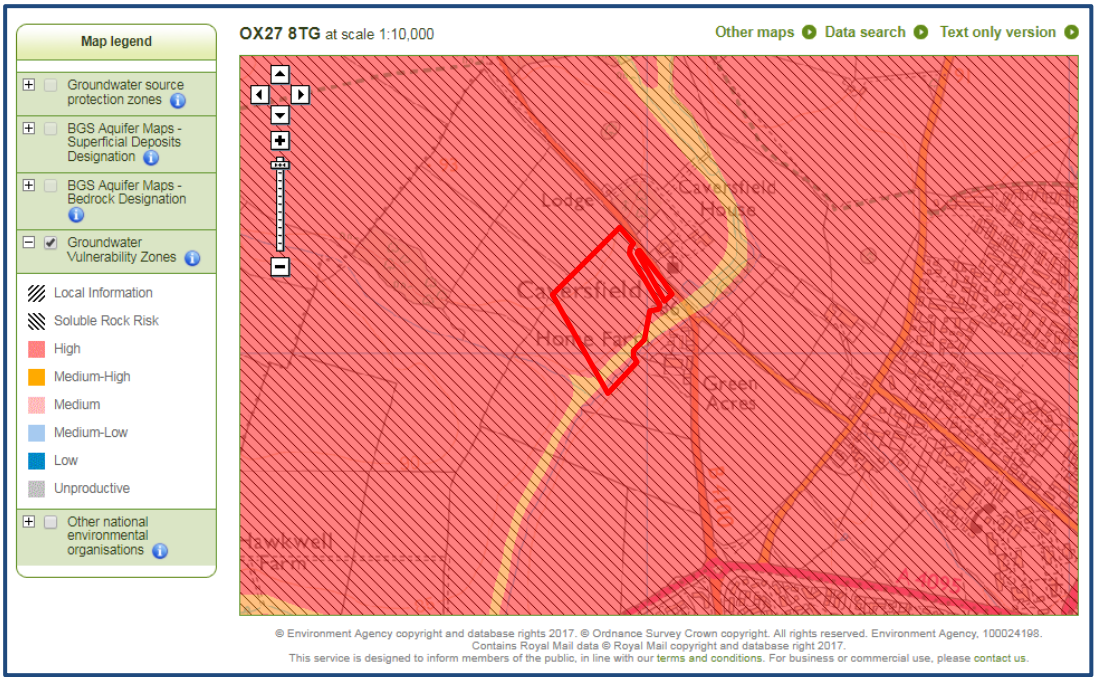

Figure 3.4: Extract from Groundwater Vulnerability Zone Map from EA website

3.7.3 The CDC Level 1 SFRA states that the site is currently at low risk of groundwater flooding.

3.8 Surface Water / Pluvial Flooding

3.8.1 The EA's Flood Map for Surface Water is generated by using a 'rolling ball' methodology of direct rainfall on an area and calculating where it flows. It is important to note that while this mapping takes into account rural and urban catchments it does not take into account infiltration or existing drainage networks.

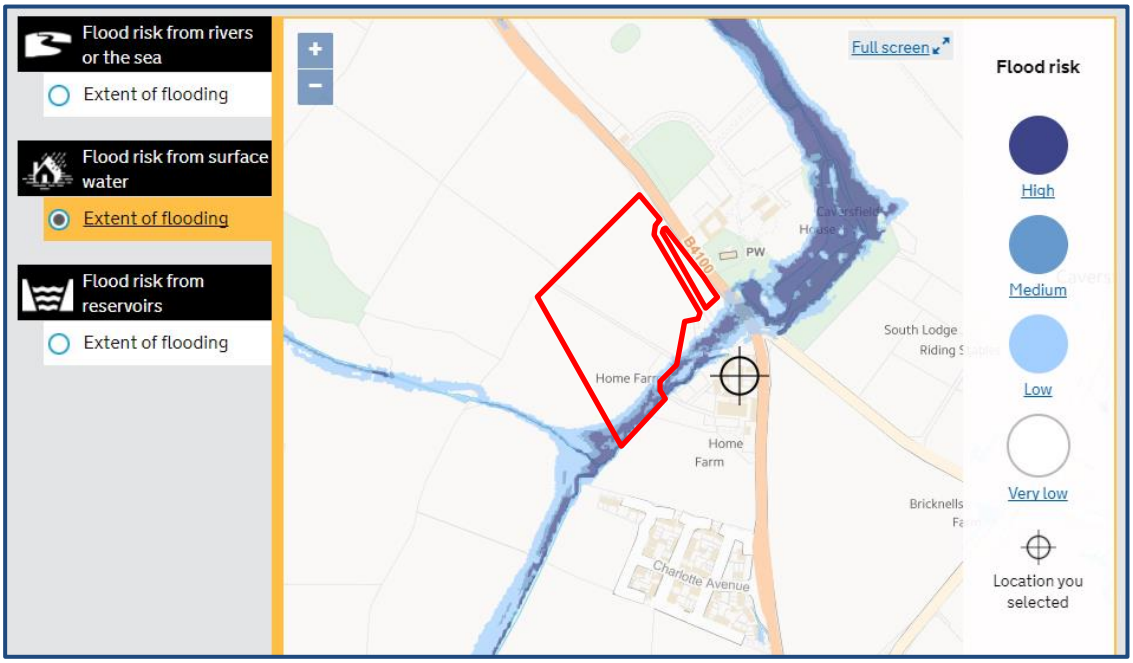

Figure 3.5: Extract from EA Flood Map for Surface Water

3.8.2 Review of this mapping shows that the majority of the site is not at risk of surface water flooding. However, surface water flooding could arise at the local ordinary watercourses to the southeast and southwest of the site. This is confirmed in the CDC Level 1 SFRA.

3.9 Other Potential Sources of Flooding

3.9.1 Historic flooding in terms of fluvial, surface water (pluvial) and existing sewers is covered in the CDC Level 1 SFRA with records dating back to 1852. More detailed records are available for incidents occurring post 2009. The closest reported incident of historic flooding to the site contained within the SFRA occurred approximately 5km to the northeast of the site in Fringford.

3.10 Climate Change

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

3.10.2 The EA's Flood Risk Assessments: Climate Change Allowances guidance which supports the NPPF provides contingency allowances for potential increases in sea level rise, peak river flow and rainfall intensity.

3.10.3 In accordance with this guidance, the potential for increased flood probability as the result of possible climate change has been taken into account in the consideration of mitigation measures over the lifetime of the development through a +30% allowance for increases in peak rainfall intensity (i.e. surface water drainage).

Applies across all of England	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2069	Total potential change anticipated for 2070 to 2115	Comment
Upper End	10%	20%	40%	30% allowance applied for 'more vulnerable' development in Flood Zone 1, not within a Critical Drainage Area with a 100 year life expectancy
Central	5%	10%	20%	

Table 3.4: Flood Risk Assessments: Climate Change Allowances Table 2 Peak Rainfall Intensity Allowance in Small and Urban Catchments (use 1961 to 1991 baseline)

3.10.4 As the EA have not carried out any detailed flood modelling in the area, refer to **Section 3.5**, the available EA flood mapping has been reviewed against the topographical survey to determine where the development lies in relation to Flood Zone 2. This comparison indicates that the southernmost part of the proposed residential development area is situated approximately 3.5m above the Flood Zone 2 extent.

3.11 Impact of the Development on Site Permeability

3.11.1 The proposed development will reduce the sites permeability, however the proposed surface water drainage strategy will capture and manage all surface water runoff generated by the development.

3.12 The Sequential Test and Exception Test

3.12.1 The NPPF follows a sequential risk based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. The SFRA provides the basis for applying the Sequential Test.

3.12.2 The NPPF states that *'the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding*.'

3.12.3 As the development lies within Flood Zone 1, and is therefore at the lowest risk of flooding, it is considered to have passed the Sequential Test.

3.12.4 Table 3 of the NPPF Planning Practice Guidance (a copy of which is contained in **Section 3.6**) confirms that an Exception Test does not need to be carried out for developments located within Flood Zone 1.

4 Surface Water Drainage

4.1 Existing Surface Water Regime

4.1.1 The site is currently undeveloped and there are no formal drainage networks on the site. The site falls from 89.66m AOD at the north to 83.16m AOD at the south and as such surface water runoff generally flows overland from north to south towards The Bure which is an ordinary watercourse adjacent to the site's southeast boundary.

4.1.2 A copy of the topographical survey of the site undertaken by Amethyst Surveys Limited (Drawing Number 21166_OGL, dated 2014), is contained in **Appendix A**.

4.1.3 Greenfield discharge calculations have been undertaken for the site in accordance with Rainfall Runoff Management for Developments (Report SC030219, October 2013, Defra/EA). In accordance with the Non-statutory Technical Standards for Sustainable Drainage Systems (March 2015, Defra) greenfield rates have been calculated for the 1 in 1 year and 1 in 100 year rainfall events. A copy of the calculations is contained in **Appendix D**. Table 4.1, provides a summary of the rates.

Return Period	Greenfield Discharge Rate
1 Year	1.20 l/s/ha
Q_{bar}	1.40 l/s/ha
100 Year	4.47 l/s/ha

Table 4.1: Greenfield Discharge Rates

4.2 Proposed Surface Water Strategy

Discharge Destination

4.2.1 In accordance with the discharge hierarchies of the Building Regulations H3 and the NPPF Planning Practice Guidance an assessment of the suitability of the site to utilise infiltration drainage techniques has been undertaken.

See the Planning Practice Guidance

This states:

"Generally the aim should be discharge surface runoff as high up the following hierarchy of drainage options as reasonably practicable:

1. *Into the ground (infiltration)*
2. *To a surface water body;*
3. *To a surface water sewer, highway drain or another drainage system;*
4. *To a combined sewer."*

4.2.2 No site-specific ground condition assessment has been undertaken. However, a review of British Geological Survey (BGS) mapping for the area indicates that site likely lies on sandy gravel, over limestone with clay bands, over clay. A BGS borehole located to the southeast of the site recorded a water strike at a depth of 1.80m.

4.2.3 Review of the borehole and trial pit data contained in the Geotechnical Interpretative Report (2505-UA001881, dated November 2010, Hyder Consulting (UK) Limited) and Factual Report (2504-UA001881, dated September 2010, Hyder Consulting (UK) Limited), for the NW Bicester Eco-Town Exemplar site which is located immediately to the north and west of the Plot SGR 1 site, shows that the ground conditions comprise the following:

Stratum	Stratum Description	Typical Depth Range (m bgl)
Topsoil	Topsoil	GL to 0.20m (max 0.30m)
Superficial/Head Deposits	Red brown, clayey sandy gravel with cobbles, or in places gravelly sandy Clay with cobbles	To 0.60m (max 0.80m)
Completely Weathered Limestone	Recovered as yellow-grey, sandy Gravel and in places yellow grey Clay	To 1.90m (max 2.90m)
Interbedded Limestone and Clays	Interbedded moderately strong to strong Limestone and stiff or hard Clay and mudstone	1.90m to >7.00m

Table 4.2: Geotechnical Interpretative Report Table 4.1 General Sequence of Strata across Site

4.2.4 According to these reports groundwater was found at a depth of 3.10m and 6.30m in BH1 and BH5 respectively. BRE 365 soakaway testing undertaken to a depth of 1.90m below ground level (bgl) within TP4 and TP6 indicated an infiltration rate of approximately $4x10^{-5}$ m/s within the sand and gravel.

4.2.5 The Exploratory Hole Locations plan taken from the Geotechnical Interpretative Report (2505-UA001881, dated November 2010, Hyder Consulting (UK) Limited) is included in **Appendix E**.

4.2.6 The limited information available regarding the ground conditions raises the following concerns:

- the potential solubility of the limestone,
- the presence of clay,
- and high groundwater.

4.2.7 Therefore, a conservative approach regarding the ability of the site to accept infiltration techniques has been taken to demonstrate that the proposed scheme is deliverable independent of whether or not infiltration is available on site.

4.2.8 It is recommended that a detailed assessment of the site's suitability to utilise infiltration techniques is undertaken as part of the geotechnical investigation at the detailed design stage, and that the proposed surface water drainage strategy is amended as appropriate.

4.2.9 There are currently two ordinary watercourses located close to the site. At this outline stage of design, it is proposed that surface water runoff generated by the development will be discharged via a controlled outfall into The Bure located along the site's south-eastern boundary.

Peak Flow Control – Defra Technical Standard S2

> **S2.** 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 should never exceed the peak greenfield runoff rate for the same event.

4.2.10 The site is undeveloped, therefore the design peak flow rates have been calculated in accordance with the greenfield rates stated in Table 4.1. However, due to the low peak flow rates calculated, in accordance with Rainfall Runoff Management for Developments (Report SC030219, October 2013, Defra/EA) and best practice, a minimum controlled discharge rate of 5 l/s has been applied to the design.

4.2.11 The proposed impermeable area has been calculated as 0.927ha based on the houses and roads depicted on the proposed site plan, 'Development Framework' (Drawing Numbers RCP001/016, dated March 2018, David Lock Associates). An allowance of 10% additional impermeable area has been included within the drainage calculations to account for potential future development of the site resulting in a total impermeable area of 1.020ha.

Return Period	Existing Greenfield Discharge Rate		Proposed Discharge Rate (l/s)
	l/s/ha	l/s (based on 1.020ha impermeable area)	
1 Year	1.20 l/s/ha	1.22 l/s	5.00 l/s
Q_{bar}	1.40 l/s/ha	1.43 l/s	-
100 Year	4.47 l/s/ha	4.56 l/s	-
100 Year + 30% CC	-	-	5.00 l/s

Table 4.3: Greenfield and Proposed Discharge Rates

4.2.12 A copy of the proposed surface water drainage layout (Drawing Number 41436/2002/001) and accompanying MicroDrainage calculations are contained in **Appendices F and H** respectively.

Volume Control – Defra Standard S6

> **S6.** Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with **S4** or **S5** above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

4.2.13 The impermeable area of the application site will be increased as a result of the development and therefore the volume of run-off in the 100 year 6 hour storm event will be increased above the pre-development greenfield level. The management of the additional volume through infiltration or re-use is not considered reasonably practicable for the development and therefore the rate of run-off will be restricted to a reduced rate, for all storm events, in order to prevent an adverse effect on flood risk.

4.2.14 Typically, the rate of run-off would be limited to the Q_{bar} rate for all storm events up to and including the 1 in 100 year event plus climate change allowance. However, due to the low flow rates arising from the application site area, the practical minimum of 5 l/s will be utilised. Refer to Table 4.3 above.

Flood Risk within the Development – Defra Technical Standards S6 to S9

> **S7.** The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.
>
> **S8.** The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

4.2.15 The proposed surface water drainage network has been designed not to flood in a 1 in 30 year or a 1 in 100 year rainfall event.

4.2.16 A copy of the proposed surface water drainage layout (Drawing Number 41436/2002/001) and accompanying MicroDrainage calculations are contained within **Appendices F and H** respectively.

> **S9**. The design of the site must ensure that so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

4.2.17 In the event of a rainfall event in excess of a 100 year + 30% climate change event surface water will flow overland south-westwards following the topography of the site towards the adjacent ordinary watercourse, The Bure, mimicking the natural drainage flow paths.

4.2.18 A copy of the overland flow route drawing (Drawing Number 41436/2002/002) is provided in **Appendix G**.

4.2.19 At the detailed design stage hard standing areas adjacent to buildings will be designed to route surface water away from the buildings.

SuDS (Sustainable Drainage Systems) Selection

4.2.20 The Ministerial Statement HCWS161, dated 18th December 2014 states that:

> *'…..the Government's expectation is that sustainable drainage systems will be provided in new developments **wherever this is appropriate**.'*

4.2.21 The NPPG paragraph 051 describes SuDS as follows:

> *'Sustainable drainage systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. **They provide opportunities to:***
>
> - *reduce the causes and impacts of flooding;*
> - *remove pollutants from urban run-off at source;*
> - *combine water management with green space with benefits for amenity, recreation and wildlife.'*

4.2.22 The current planning policy and guidance advises that SuDS in the form of open or near surface systems employing natural processes should be used where possible, **not that they must be**

used. They can also provide opportunities to combine water management with amenity and wildlife, but only where appropriate.

4.2.23 The preference and benefits of incorporating SuDS features within the development are reiterated in the CDC Supplementary Planning Document (SPD).

4.2.24 The proposed drainage strategy for the site utilises SuDS in the form of permeable paving in private parking bays and a detention basin. These features provide attenuation up to and including the 100 year + 30% climate change rainfall event below ground and provide water quality benefits through the biodegradation of hydrocarbons and the removal of suspended debris. A petrol interceptor will also be provided to further aid the removal of hydrocarbons.

4.2.25 As previously discussed, at this stage the site is not considered suitable for infiltration techniques therefore due to high potential for the mobilisation of pollutants to the Secondary A bedrock aquifer below the site (**Section 3.7**) all the proposed SuDS will be lined.

4.2.26 At the detailed design stage and following intrusive geotechnical testing, including soakage testing if appropriate, a review of the SuDS to be utilised on the site will be reviewed, and amended to take account of this new information.

4.2.27 These proposals follow the requirements of the Defra Non-Statutory Technical Standards for Sustainable Drainage Systems and the principles of the NPPG SuDS requirements by reducing flood risk and improving water quality.

4.2.28 A copy of the proposed surface water drainage layout and construction details (Drawing Numbers 41436/2002/001, 003 & 004) are contained within **Appendix F.**

Structural Integrity – Defra Technical Standards S10 & S11

> **S10.** Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.
>
> **S11.** The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

4.2.29 The components that make up any drainage network have different life expectances which can also be influenced by the effectiveness of their maintenance regime and upstream sediment capture/management.

4.2.30 The proposed drainage strategy comprises a piped network, inspection chambers/catchpits, gullies, permeable paving, detention basin and Hydrobrake flow control. As with any drainage system, this network requires regular inspection and maintenance to ensure that the individual components continue to operate as designed, both in terms of hydraulic capacity and potential pollutant removal. Further details regarding maintenance of the proposed system are contained in **Section 4.3**.

4.2.31 At the detailed design stage, individual components will be specified that ensure that the structural integrity of all the components is suitable for their intended use, location and anticipated loading conditions.

4.2.32 Construction details (Drawing Numbers 41436/2002/003 & 004) are contained within **Appendix F**.

4.3 Maintenance Strategy

Health, Safety and Welfare

4.3.1 All those responsible for maintenance should take appropriate health, safety and welfare precautions for all activities including lone working, if relevant, and risk assessments should always be undertaken. The site's infrastructure Health and Safety File should be consulted before carrying out any works either inside or outside of the development's boundary and information regarding the location of existing utilities passed on to operatives.

4.3.2 The requirements of the Health and Safety at Work Act 1974 and The Construction (Design and Management) Regulations 2015 should be adhered to and any residual risks identified in the Health and Safety File should be managed and information passed on to maintenance operatives through task specific risk assessments.

Operation and Maintenance

4.3.3 There are three types of maintenance activities associated with surface water drainage systems. The SuDS Manual, CIRIA C753, defines these as:

- Regular Maintenance – '*basic tasks undertaken on a frequent and predictable schedule, including inspections/monitoring, silt or oil removal if required more frequently than once a year, vegetation management, sweeping of surfaces and litter and debris removal.'*
- Occasional Maintenance – *'tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the regular tasks (eg sediment removal or filter replacement.'*
- Remedial Maintenance – *'intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design, construction and regular maintenance activities. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and so timings are difficult to predict.*'

4.3.4 Specific maintenance needs should be monitored and maintenance schedules adjusted to suit the location and condition of the drainage feature in question.

Operation and Maintenance Activity	SuDS Components		
	Piped Network / Inspection Chambers / Catchpits	Detention Basins	Permeable Pavements
Regular Maintenance			
Inspection	■	■	■
Litter and debris removal	■	■	■
Grass cutting		■	□
Weed and invasive plant control		□	□
Shoreline vegetation management		□	
Shrub management (including pruning)		□	□

Operation and Maintenance Activity	SuDS Components		
	Piped Network / Inspection Chambers / Catchpits	Detention Basins	Permeable Pavements
Aquatic vegetation management		□	
Occasional Maintenance			
Sediment management[1]	■	■	■
Vegetation replacement		□	
Vacuum sweeping and brushing			■
Remedial Maintenance			
Structure rehabilitation / repair	□	□	□
Infiltration surface reconditioning			□
■ Will be required □ May be required [1] Sediment should be collected and managed in pre-treatment systems, upstream of the main device			

Table 4.4: Extract **Table 32.1** Typical Key SuDS Components operation and Maintenance Activities, The SuDS Manual C753, CIRIA 2015

Piped Network / Inspection Chambers / Catchpits

4.3.5 Piped network components require regular inspection and maintenance to ensure that the individual components continue to operate as designed, both in terms of hydraulic capacity and potential pollutant removal. All drainage inspection chambers and catchpits will therefore be inspected and cleaned regularly.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Inspect and identify any features that are not operating correctly. If required take remedial action	Monthly for three months, then six monthly
	Debris removal from catchment surface / gratings (where may cause risks to performance)	Monthly (and after large storms)
	Remove sediment from trapped sumps, manholes and catchpits.	Annually or as required
Remedial Maintenance	Repair / rehabilitation of gratings, inlets and outlets	As required
Monitoring	Inspect / check all gratings, trapped sumps, manholes and catchpits to ensure that they are in good condition and operating as designed	Annually and after large storm events
Structure Rehabilitation / Repair	Regular Maintenance and Monitoring to identify if repair and / or replacement of features or pipework is required.	As required

Table 4.5: Operation and Maintenance for Piped Network / Inspection Chambers / Catchpits

Detention Basins

4.3.6 Detention basins are landscaped depressions that are normally dry except during and immediately following rainfall and storm events. When used as an online component, surface water runoff is directed through the basin and due to the restricted outlet the basin fills and provides storage attenuation.

4.3.7 If the detention basin is vegetated it can provide water quality benefits when designed to manage regular flows. This is due to the removal of sediment and buoyant materials. A significant reduction in levels of nutrients, heavy metals, toxic materials and oxygen-demanding materials may also be achieved.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – 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)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and foreby	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, foreby and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 4.6: Operation and Maintenance Requirements for Detention Basins

Permeable Pavements

4.3.8 Permeable pavements have a surface that is formed of a material that is itself impervious to water, however the materials are laid to provide void space between the materials. These voids allow surface water to pass between the materials and through to the sub-base below where is can be temporarily stored prior to infiltration into the ground or discharge into the wider drainage network.

4.3.9 Permeable pavements have been shown to reduce the concentrations of heavy metals, hydrocarbons, sediment and some nutrients. Treatment processes occurring within permeable pavements include:

- filtration of silt and the attached pollutants,
- biodegradation of organic pollutants, such as petrol and diesel,
- adsorption of pollutants, and the
- settlement and retention of solids.

4.3.10 Permeable pavements can provide amenity and visual benefits as there are a wide range of surface materials which can be selected to meet overall planning, architectural or landscape design.

4.3.11 The principal requirements related to permeable pavements involve surface cleaning at least three times a year. Additionally, litter and vegetation should be removed on a regular basis. Note that the use of grit and salt may adversely affect the treatment and drainage potential of permeable surfaces, and the use of weed killers can disrupt the biological breakdown of contaminants that would otherwise occur in the sub-base. An alternative de-icing agent such as wet gritting which does not contain the chlorides and contaminants found in road salt should be used.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface.	One a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as these areas are likely to collect the most sedimentation.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weeds or management using glyphosate applied directly to the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping, which through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required

Maintenance Schedule	Required Action	Frequency
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if surface infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection.	Monthly for three months after installation
	Inspect for evidence of poor operation and / or weed growth – if required take remedial action.	Three monthly, 48hr after large storm events in first 6 months
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers.	Annually

Table 4.7: Operation and Maintenance Requirements for Permeable Paving

5 Summary

5.1.1 The EA Flood Zone mapping shows the majority of the site to lie in Flood Zone 1; land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). While areas of Flood Zones 2 and 3 do extend into the site boundary JFLOW modelling shows that all the development area is located within Flood Zone 1. As such the Plot SGR 1, Bicester site has little or no risk of fluvial flooding and is therefore considered to have passed the Sequential Test.

5.1.2 The NPPF Tables 2 and 3, show that all development classes are appropriate for Flood Zone 1 and that an Exception Test is not required.

5.1.3 EA groundwater mapping confirms that the site lies outside of outside all Groundwater Source Protection Zones. The site however lies over a Secondary A bedrock aquifer with a high groundwater vulnerability and soft rock risk. The CDC SFRA's confirm that there are no records of any non-fluvial flood events on the site.

5.1.4 A review of the borehole and trial pit data contained in the Geotechnical Interpretative Report and Factual Report, for the neighbouring site indicates that the ground comprises of sand and gravel, over weathered limestone, over solid limestone. Due to the limited information available regarding the ground conditions, a conservative approach in relation to the ability of the site to accept infiltration techniques has been taken to demonstrate that the proposed scheme is deliverable independent of whether or not infiltration is available on site. It is recommended that a detailed assessment of the site's suitability to utilise infiltration techniques is undertaken as part of the geotechnical investigation at the detailed design stage, and that the proposed surface water drainage strategy is amended as appropriate.

5.1.5 The proposed surface water strategy utilises SuDS in the form of a detention basin and permeable paving to store runoff generated by the development up to and including 1 in 100 year + 30% allowance for climate change. It also mitigates for the increase in discharge volume resulting from the development by restricting the 1 in 100 year peak discharge rate from the proposed development to a best practice minimum controlled discharge rate of 5 l/s into local ordinary watercourse, The Bure, located to the southeast of the site.

5.1.6 Thus, the precautionary principle advocated by the NPPF to the uncertainties of flooding has been satisfactorily addressed and there are no flooding or drainage related constraints to development on the site.

Appendix A Topographical Survey, 21166_OGL, dated 2014, Amethyst Surveys Limited

N

Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	458095.456	224991.679	87.426
GH2	458092.628	224959.346	87.807
GH3	458042.857	224963.316	87.598
GH4	458060.035	224862.766	88.409
GH5	457977.610	224894.051	87.881
GH6	457969.017	225009.296	84.347
GH7	457904.017	225048.659	87.644
GH8	457924.935	225137.815	88.857
GH9	458033.072	225119.136	85.660
GH10	457979.861	225206.627	88.905

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings *Surveyed Buildings*

This survey has been orientated to the Ordnance Survey (O.S) National Grid (OSGB36) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN02 & OSGM02 transformation models.
The survey has been correlated to this point and a further one or more OSGB36 points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Overhead Cable
Concrete edge
Tarmac edge
Grass verge
Canopy/Overhang
Verge
1 — Station and Name
100.000 — Station Level
Tree / Bush / Sapling
Area of Undergrowth
Woodland
R: Ridge Level
E: Eaves Level
F: Flat Roof Level
Gate

Fence types:
IW Interwoven
IR Iron Railings
WM Wire Mesh
PR Post & Rail
PW Post & Wire
CL Chain Link
WP Wooden Panels
CP Concrete Panels
CI Corrugated Iron

IC	Inspection chamber	Boll	Bollard		
Pinv	Pipe invert	IB	Illuminated bollard		
Gy	Gully	Bin	Rubbish bin		
Bg	Back gully	Vp	Vent pipe		
Dp	Down pipe	Grl	Ground light		
Pipe	Pipe above ground	Lbox	Letter box		
MH	Manhole	Ldr	Ladder		
WL	Water level	Sty	Stile		
Fl	Flood light	IFL	Internal floor level		
Lp	Lamp post	THL	Threshold level		
Tp	Telegraph post	Sp	Sign post		
Ep	Electricity post	TH	Trialhole		
Tl	Traffic light	BH	Borehole		
Bus	Bus stop	ELC	Electric		
Sv	Stop valve	BT	British Telecom		
St	Stop tap	C'box	Control box		
Er	Earth rod	TT	Tactile		
Wm	Water meter	BP	Brick paved		
Gas	Gas valve	CPS	Concrete paving slabs		
Av	Air valve	CVR	Cover		
ICU	Undentified inspection	IC	Inspection chamber		
Wo	Wash out	RWall	Retaining wall		
Re	Rodding eye	UTL	Unable to lift		
BB	Bellsha beacon	TCL	Tree canopy level		
CTV	Cable tv	G:	Girth		
Mkr	Marker post	MG	Multi girth		
Gmkr	Gas marker post	Stmp	Tree Stump		
So	Soffit	CL:	Cover level		
		IL:	Invert level		

Rev	Date	Description	Drawn	Q. Ref.

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CLIENT
Altitude

PROJECT
Home Farm
Bicester
OX27 8TG

TITLE
Topographical Survey

SCALE	DATE
A1@ 1: 1000	10.12.14
DRAWN	QUALITY REF
J.S	T.P.D

Level datum	See OS Note
Grid orientation	See OS Note
Job number	10770

Drawing No.	Rev.
21166_OGL	0

Comments
This plan should only be used for its original purpose. Amethyst Surveys Ltd accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

Appendix B Illustrative Master Plan, RCP001/016, dated March 2018, David Lock Associates

Rev. A	Added Play Area	05.03.2018

Client:

SGR (Bicester 1) Limited

Caversfield, Bicester

Illustrative Master Plan

Scale@A3:	Drawn:	Designed:	Approved:
1:1,250	**MG**	**RM**	**SH**

0m — 50m

Drawing Number:	Revision:	Date:
RPC001-016	**A**	**27.02.18**

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Town Planning and Urban Design