Forge Engineering Design Solutions

FLOOD RISK ASSESSMENT
GREATER THAN 1HA IN FLOOD ZONE 1

Proposed Recreation Ground,
Land Off Milton Road,
Adderbury, Banbury

Adderbury Parish Council
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List of Abbreviations:

CDC	Cherwell District Council
WODC	West Oxfordshire District Council
NPPF	National Planning Policy Framework
FRA	Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
LPA	Local Planning Authority
PPS25	Planning Policy Statement 25 'Development and Flood Risk' for England and Wales
PPG FRCC	Planning Practice Guidance Flood Risk and Coastal Change
SuDS	Sustainable Drainage Systems
IOH	Institute of Hydrology
SWMS	Surface Water Management Strategy
CIRIA	Construction Industry Research and Information Association
URBAN	Urbanisation factor
CIND	Catchment Index
CWI	Catchment Wetness Index
SAAR	Standard Average Annual Rainfall
NC	Rainfall Continentality Factor
QBAR	A Flood Studies Report denoting the Mean Annual Flood flow rate

1. Introduction

Forge Engineering Design Solutions Ltd was commissioned by Adderbury Parish Council, to carry out a Flood Risk Assessment (FRA) to support a planning application to Cherwell District Council (CDC) for the development of a recreational ground, building, amenities and parking in compliance with the National Planning Policy Framework1[1] (NPPF).

1.1. National Planning Policy Framework

When determining planning applications, paragraph 103 of the NPPF requires that local planning authorities should ensure flood risk is not increased elsewhere, and only consider development appropriate in areas at risk of flooding when informed by a site-specific FRA which is compliant with the technical guidance to the NPPF, "Planning Practice Guidance Flood Risk and Coastal Change[2]" (PPG FRCC), following the Sequential Test, and if required the Exception Test. More specifically, the site-specific FRA should seek to demonstrate that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

1.2. District Council's Strategic Flood Risk Assessment

Cherwell District Council and West Oxfordshire District Council commissioned Scott Wilson (Limited) to produce a joint Level 1 Strategic Flood Risk Assessment (SFRA) in April 2009. In April 2016, Cherwell District Council commissioned AECOM to produce an update to the Level 1 SFRA (2009) for it's administrative area, which was published in May 2017.

The level 1 SFRA (2017) update was produced as a tool to select appropriate sustainable development sites away from areas vulnerable to flood risk in accordance to changes in policy and guidance such as those laid down in the NPPF and associated Planning Practice Guidance on Flood Risk and Coastal Change.

The update was produced to provide appropriate supporting evidence to the Cherwell Local Plan and will be used to inform decisions on future development, and for guidance on the preparation of sustainable policies for the long-term management of flood risk. The SFRA (2017) includes revised datasets made available since the original SFRA Level 1 was published.

[1] Department for Communities and Local Government (2012) National Planning Policy Framework
[2] Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change

However, the SFRA (2017) update advises that the information only provides an overview of flood risk within CDC and reiterates further investigation via an appropriate site-specific Flood Risk Assessment should be carried out where necessary. The aim of the SFRA is met through the following outputs:

- consideration of changes to policy
- guidance on the required content of and preparation of site specific FRAs to address flood risks and residual flood
- guidance on the application of Sustainable Drainage Systems (SuDS) in the District

In April 2016, AECOM was also commissioned by CDC to produce a Level 2 SFRA to compliment the Level 1 SFRA (2017) update. The Level 2 SFRA states that it provides additional information to inform on specific flood risk issues and the suitability of 8 potential strategic development sites put forward by CDC.

The proposed development was designed to comply with the above planning and flood risk mitigation requirements.

1.3. Environment Agency Standing Advice

The site covers an area greater than 1ha and consists of Outdoor sports and recreation and essential facilities such as changing rooms and parking. In accordance with the NPPFTG, the proposed development is classified as a Water Compatible Development, greater than 1ha located in Flood Zone 1.

This FRA has been carried out in accordance with the EA's Standing Advice for a Water Compatible Development, greater than 1ha located in Flood Zones 1. The Standing Advice states that FRAs must include the management of surface water run-off, including the feasibility of the use of infiltrating SuDS.

Therefore, this FRA and associated conclusions are focussed on preventing any increase in surface water run-off and where practical reducing the rate of run-off from the site through the utilization of sustainable drainage principles.
The FRA should address the following issues:

- Surface water run-off should not increase flood risk to the development or third parties. This should be done by using a SuDS to attenuate to at least pre-development runoff rates and volumes or where possible achieving betterment in the surface water run-off regime.
- An allowance for climate change needs to be incorporated, which means adding an extra amount to peak rainfall.
- The residual risk of flooding needs to be addressed should any drainage features fail or if they are subjected to an extreme flood event. Overland flow routes should not put people and property at unacceptable risk. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

2. Development Site Information:

In this section, site-specific information is presented in regard to the site location, main rivers, watercourses and flood zones. Data pertaining to both existing and proposed developments is shown, allowing a comparison of permeable and impermeable areas. Lastly, information is presented on ground levels through a topographical survey, descriptions of existing site drainage and site-specific geology, hydrogeology and permeability.

2.1. Site Location, Main Rivers, Watercourses and Flood Zones

The site is located on land to the north of Milton Road, which is situated west of Adderbury. The site is set to the west of the A4260, and to the east of the A361. The proposed development site covers an area of approximately 36,259m^2 (3.6259 ha). The site can be located by Grid Coordinates 446282mE, 235085mN. See site location maps in Appendix 1.

To the east of the site is a residential development site, and to the west is the horticultural company Ball Colegrave, and garden centre Florensis Flower Seeks UK Ltd. To the north of the site is undeveloped land. To the south is Milton Road and adjacent to Milton Road further south is undeveloped farmland.

The nearest Main River is the Sor Brook that is approximately 660m to the east of the site. The Environment Agency's (EA) Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. See EA's Indicative Flood Zone Maps in Appendix 1.

2.2. Existing Development

The existing site was undeveloped Greenfield with an impermeable area of approximately 0m^2 (0.00ha) and a permeable area of 36259m^2 (3.6295ha). Accordingly, 0.0% of the existing site was impermeable, while 100.0% is permeable. See Existing Site Plan in Appendix 2.

2.3. Proposed Development

The proposed development includes a recreational ground comprising of two 100m x 60m pitches, a 25m x 40m Multiuse Games Area (MUGA), construction of one amenity building, and parking. See Proposed Site Plan in Appendix 2.

The proposed site would have an impermeable area of approximately 1054.0m^2 (0.1054ha) and a permeable area of 35,205.0m^2 (3.5205ha). Accordingly, approximately 3% of the proposed site would be impermeable, while 97% would be permeable. See Proposed Site Plan in Appendix 2.

Table 1: Permeable and Impermeable areas for existing and proposed developments

	Existing Development	Proposed Development
Impermeable Area (m^2, ha)	0.0; 0.0	1054.0; 0.1054
Fraction of total site (%)	0.0%	3.0%
Permeable Area (m^2, ha)	36,259.0; 3.6259	35,205.0; 3.5205
Fraction of total site Area (%)	100.0%	97.0%

2.4. Topographical Survey

Ground levels at the site, Above Ordnance Datum (AOD), are shown on the topographical survey included in Appendix 3.

The site slopes gently downwards from the south-west to the north-east of the site with levels ranging from 102.690m AOD in the south-west of the site down to 97.114m AOD in the north-east of the site. The average site level is approximately 99.902m AOD.

2.5. Existing Site Drainage

As well as infiltrating into the ground at its source, surface water falling onto the site flows across the site, in a general south-west to north-east direction at the Greenfield run-off rate, via overland flow. See the Topographical survey in Appendix 3.

A feasibility study report was completed by sports turf consultancy STRI on 4th October 2017. STRI states that there is a drainage ditch to the north east of the site but advises that the ditch is overgrown with vegetation. STRI note that the drainage ditch connects to a surface water drainage network where it extends to the cemetery located north-east of the site.

There is a rising main to the south of the site running from west to east along Milton road, and going around the west of the site. See Thames Water Asset Location Plans in Appendix 4

There is a 150mm diameter gravity foul sewer to the east of the site in Milton Road, and a 150mm diameter gravity foul sewer to the south east of the site in St Mary's Road

See the Topographical survey in Appendix 3 and the Thames Water Asset Location Plans included in Appendix 4.

2.6. Geology, Hydrogeology and Permeability

The British Geological Survey[3] (BGS) published geological maps indicate that there is superficial geology of Alluvium comprising of clay, silt and sand at the site. The site is underlain by a bedrock geology of the Lias Group Formation, which consists of mudstone, siltstone, limestone and sandstone. See BGS Maps in Appendix 1.

This type of geology can typically have a moderate to good permeability within the region of $1x10^{-4}$m/s and $1x10^{-5}$m/s.

The SFRA (2017) notes the geology of the area to the south-east of Banbury to be mainly mudstone.

STRI (2017) completed a soil particle size analysis and confirmed the soil type to be Clay loam, however they have noted that the result is only relevant to the soil samples submitted for testing.

The published Aquifer Designation Maps identify that the site is underlain by a bedrock Secondary Aquifer A. The site is not underlain with a superficial Aquifer.

The SFRA (2017) shows the aquifer to be a Minor Aquifer – Intermediate, which correlates with the published Aquifer maps.

The Aquifer designation maps correlate with the BGS published geology data. Aquifer Designation Maps are included in Appendix 1.

A BRE 365 Infiltration Test was conducted. The test indicated a good infiltration rate, which would be suitable for all types of infiltrating SuDS techniques.

Three tests were carried out in the test pit that gave results of:

- $1.85x10^{-4}$m/s
- $1.67x10^{-4}$m/s
- $1.58x10^{-4}$m/s

The lowest permeability rate of $1.58x10^{-4}$m/s, which equates to 0.5688m/hr, was used for the Conceptual SuDS surface water management strategy design to prove feasibility of the utilization of infiltrating SuDS techniques.

See BRE 365 Test Results in Appendix 5.

[3] The British Geological Survey. Accessed at http://www.bgs.ac.uk/

3. Surface Water Management Strategy

3.1. The SuDS Manual and Sustainable Systems

The implementation of a surface water management strategy for new developments can ensure that there is no increase of flood risk as a result of the proposed development by avoiding the creation of, reducing and delaying the discharge of rainfall run-off to watercourses and public sewers using SuDS techniques.

The SuDS Management Train as set out in the SuDS Manual[4] (CIRIA C753), which provides best practice guidance on the planning, design, construction and maintenance of SuDS, should be utilized in the SuDS design to mimic natural catchment processes as closely as possible. It uses SuDS drainage techniques in series to incrementally reduce pollution, flow rates and volumes.

3.1.1. Hierarchical Approach to Design of Sustainable Systems

The hierarchy of techniques that should be considered in developing the management train are as follows:

1. **Prevention** – the use of good site design and site housekeeping measures to prevent run-off and pollution (e.g. sweeping to remove surface dust and detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. **Source control** – control of run-off at or very near its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).
3. **Site control** – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).
4. **Regional control** – management of run-off from a site or several sites, typically in a balancing pond or wetland.

Wherever possible, storm water should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas (end of pipe solutions).

The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at source should always be considered before site or regional controls.

The use of the SuDS management train and infiltration techniques also allows for the management of potential pollution to controlled waters, through sedimentation and infiltration.

[4] CIRIA 753 The SuDS Manual 2015

SuDS ensure that surface water run-off cannot discharge directly into controlled waters such as groundwater and watercourses, and consequently reduces the risk of pollution.

3.1.2. Types of SuDS Infiltration Techniques

The proposed site's existing surface water run-off rate can be maintained or reduced through the utilisation of SuDS. SuDS aim to mimic the natural drainage processes whilst also removing pollutants from urban run-off at the source before entering a watercourse. There are a wide range of SuDS infiltration techniques. These include, but are not limited to;

- Soakaways (Recharge groundwater/aquifer)
- Filter strips adjacent to roads (Re-charge groundwater/aquifer)
- Swales around the site and adjacent to roads (Re-charge groundwater/aquifer and biodiversity)
- Pervious paving of road and car parks (Re-charge groundwater/aquifer)

There are other forms of SuDS that do not use infiltration. These SuDS provide attenuation and controlled release of surface water, which can assist in the reduction of the post-development surface water run-off. Examples of these are;

- Rainwater harvesting tanks and rainwater harvesting butts (water conservation)
- Above ground attenuation ponds and detention basins (amenity and biodiversity areas)
- Below ground geo-cellular attenuation tanks
- Green Roof (attenuation)

3.1.3. Other Uses and Benefits of SuDS

SuDS, can be used to mitigate flooding or pollution. They also provide environmental benefits. Some of the environmental benefits are listed below:

- The hydraulic benefits, including peak flow rate reductions, storm run-off volume reductions, and enhancements to river base flow and aquifer recharge.
- The pollutant loading reductions achieved by the system, and associated benefits to in-stream ecology, human health, and human value perceptions.
- The amenity and recreational benefit enjoyed by those who live close to the SUDS scheme.
- The additional value of properties adjacent or within view of the SUDS scheme.
- The ecological value of the SUDS schemes themselves.

In conclusion, one or more of the above SuDS techniques should be utilized in the surface water management strategy to minimise the surface water run-off from the site and the impacts of the development on the surrounding area.

3.2. Climate Change

Climate change is expected to increase the risk of fluvial flooding due to increased river flows, and surface water run-off is expected to increase due to increased rainfall intensities (Environment Agency, 2016).

Developments should not increase flood risk at the site or the surrounding area and, where possible, they should aim to reduce existing flood risk by incorporating SuDS to reduce the surface water run-off rate of the site.

Paragraph 100 of the NPPF requires Climate Change to be considered with regards to flood risk and recommends the national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights that should be applied to new developments – these are shown in Table 2.

Table 2 Climate change allowances related to peak river flows, pluvial intensity, offshore wind speeds and extreme wave height. Source: Environment Agency[5], 2016.

Parameter	2015 to 2039	2040 to 2069	2070 to 2115
Peak Rainfall intensity – Upper End	10%	20%	40%
Peak Rainfall intensity - Central	5%	10%	20%
Thames Peak River Flow – Upper End	25%	35%	70%
Thames Peak River Flow – Higher Central	15%	25%	35%
Thames Peak River Flow – Central	10%	15%	25%
Offshore wind speed	5%		10%
Extreme wave height	5%		10%

The surface water management strategy should ensure that the new surface water drainage system at the site is capable of attenuating the 1 in 100-year storm event including a 40% allowance for climate change, while limiting the surface water discharge rate from the site to the site's existing run-off rate or where possible the Greenfield run-off rate or less.

[5] Adapting to Climate Change: advice for Flood and Coastal Erosion Risk Management 2016 Environment Agency

3.3. Development Contributing Areas – Existing and Proposed

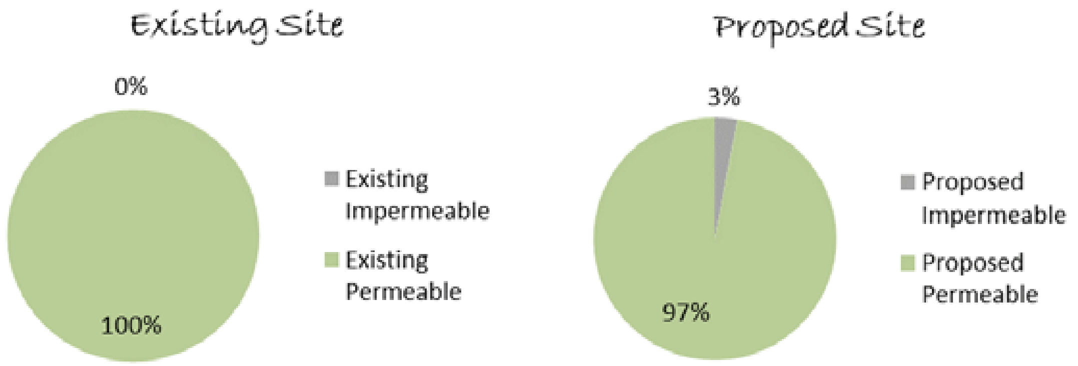
The existing site has an impermeable area of approximately 0.0m² (0.00ha) and a permeable area of 36259m² (3.6259ha). Accordingly, 0.0% of the existing site is impermeable, while 100.0% is permeable. See Existing Site Plan in Appendix 2.

The proposed development includes a recreational ground comprising of two 100m x 60m pitches, a 25m x 40m Multiuse Games Area, construction of one building, amenities and parking.

The proposed site has an impermeable area of approximately 1054m² (0.1054ha) and a permeable area of 35,205m² (3.5205ha). Accordingly, 3% of the proposed site is impermeable, while 97% is permeable. See Proposed Site Plan in Appendix 2.

Table 3: Permeable and Impermeable areas for existing and proposed developments

	Impermeable Area (m²; ha)	% of Total Site Area	Permeable Area (m²; ha)	% of Total Site Area
Existing Development	0; 0.00	0.0%	36259.0; 3.6259	100.0%
Proposed Development	1070.0; 0.1070	3.0%	35189.0; 3.5189	97.0%



Therefore, without mitigating SuDS, there could be an increase in the impermeable areas at the site, rising from 0.0% to 3.0% of the total site area. As such, this could potentially lead to an increase in the resultant surface water run-off from the site. Consequently, without mitigating SuDS, there could be an increase in flood risk to the site and the surrounding areas.

Therefore, the development proposals would incorporate SuDS to mitigate the potential impacts of any increase in impermeable area and Climate Change, as well as aiming to provide betterment where possible.

3.4. Surface Water Run-Off Calculations

3.4.1. Greenfield Run-off Rates

Greenfield run-off rates are calculated to determine the theoretical peak flow rates of discharge from the Greenfield site to surrounding areas and receiving watercourses in the vicinity, for 1, 30, 100 and 100 year plus a climate change allowance year return periods.

The calculation of peak rates of run-off from Greenfield areas is related to catchment characteristics which include size, soil index, annual rainfall and regional growth curves. Surface water volumes are calculated using a 6 hour storm duration.

As stated in the SuDS Manual, the existing site's estimated Greenfield run-off rate – denoted herein as QBarGreenfield - was calculated using the Institute of Hydrology's (IH) Report No. 124 methodology for sites with an area between 0 ha and 50 ha:

$$QBar_{Greenfield} = 0.00108\ AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17} \qquad \text{(IHR 124 equation 7.1)}$$

where,

0.00108 is a conversion factor for the units used,
AREA is the site catchment area in km^2,
SAAR is the Standard Average Annual Rainfall in mm, and
SOIL is the soil index classification.

The run-off rate is calculated for a 50 ha ($0.50km^2$) catchment using the site's catchment details, and then interpolated using the site's total area to calculate the site's Greenfield run-off rate.

Using a SAAR of 654mm and SOIL of 0.150 (class 1 type soil with moderate to low permeability), the estimated existing site's Greenfield surface water run-off rate is:

$$QBar_{Greenfield} = 0.00108 \times 0.50^{0.89} \times 654^{1.17} \times 0.150^{2.17}$$
$$= 0.0187\ \text{cumecs/50 ha}$$

Multiplying the latter by 1000 yields:

$$QBar_{Greenfield} = 18.7\ \text{l/s/50 ha}$$

Dividing by 50 leads to:

$$QBar_{Greenfield} = 0.374\ \text{l/s/ha}$$

Thus, a site area of 3.6259 ha gives a site $QBar_{Greenfield} = 1.356$ l/s

For the site's catchment area of 3.6259ha and specified storm events, the site's estimated Greenfield run-off peak flow rates and volumes (without mitigating SuDS) for the 1, 30, 100 and 100 year with climate change allowance return periods are shown in Table 4.

Table 4: Shown are the site's estimated Greenfield peak run-off rates and volumes for the 1, 30, 100 and 100 year with climate change allowance return periods.

Storm Event 1 in n year	Growth Curve Factor	Estimated Site's Run-off Rate Peak Flows (l/s)	Estimated Site's Run-off Peak Volume (m^3)
$QBAR_{Greenfield}$	-	1.356	29.29
1 in 1 year	0.85	1.153	24.90
1 in 30 year	2.40	3.255	70.30
1 in 100 year	3.19	4.326	93.44
1 in 100 year + 40% CC	4.47	6.056	130.80

3.4.2. Brownfield Run-off Rates

3.4.2.1. Run-off Rates for Proposed Development

The IH 124 method requires that Brownfield run-off rates are calculated using the Greenfield Run-off rates and an adjustment for urbanisation, to allow for the Brownfield impermeable areas, which is demonstrated below for the proposed development site;

The ratio of $QBar_{Brownfield}$ to $QBar_{Greenfield}$, denoted herein as R, is defined as:

$$R = (1+URBAN)^{2NC} [1+URBAN((21/CIND)-0.3)]$$

where,
URBAN is the fraction of the catchment that is impermeable,
NC is the Rainfall continentality factor which is a function of SAAR,
CIND is the catchment index = 102.4 SOIL+0.28(CWI-125),
CWI is the Catchment Wetness Index which is a function of SAAR from FSR Report.

For the proposed site, these variable parameters are calculated as:

$$URBAN = 0.03$$
$$NC = 0.92-(0.00024 \times 654) = 0.76$$
$$CWI = 92.1$$
$$CIND = (102.4 \times 0.150) + 0.28(92.1 - 125) = 6.15$$

leads to a ratio

$$R_{Proposed} = QBar_{Brownfield\ Proposed} / QBar_{Greenfield}$$
$$= (1+0.03)^{1.52}[1+0.03((21/6.15)-0.3)]$$
$$= 1.14$$

For the site's catchment area of 3.6259 ha, $QBAR_{Proposed}$ of 1.548 l/s (1.14 x 1.356) and specified storm events, the proposed site's estimated Brownfield peak run-off rates and volumes for the 1, 30, 100 and 100 year with climate change allowance return periods are shown in Table 5.

Table 5: Shown are the proposed site's estimated brownfield peak run-off rates and volumes for the 1, 30, 100 and 100 year with climate change allowance return periods.

Storm Event 1 in n year	Growth Curve Factor	Proposed Site's Run-off Rate Peak Flows (l/s)	Proposed Site's Run-off Peak Volume (m^3)
QBrown Existing	-	1.545	33.37
1 in 1 year	0.85	1.313	28.37
1 in 30 year	2.40	3.708	80.10
1 in 100 year	3.19	4.929	106.46
1 in 100 year +CC	4.47	6.900	149.04

3.4.2.2. Summary

In light of data presented in Tables 4 and 5, it can be see that the post development site's surface water run-off rates and volume could increase by approximately 14%.

Therefore, the development proposals must incorporate SuDS to mitigate any potential increase in surface water run-off due to increases in impermeable areas and climate change. Where possible betterment should be provided beyond the existing site's run-off rates and volumes.

4. Proposed Surface Water Management Strategy

The proposed conceptual surface water management strategy (SWMS) aims to not increase, and where practicable reduce the rate of run-off from the site as a result of the proposed development, in accordance with sustainable drainage principles and the published SFRA.

4.1. Preventative SuDS

Firstly, in accordance with the SuDS Management Train, it is proposed to mitigate any increase in surface water run-off by implementing conceptual preventative SuDS techniques, as per the hierarchy approach described in section 3.1.1.

Accordingly, it is proposed to include permeable hardstanding areas (e.g. pervious paving, porous asphalt, gravel paths) and maximise soft permeable landscaped areas (i.e. grass, planting etc) in order to minimise any increase in post development impermeable areas and their surface water run-off.

4.2. Source Control:

In addition to preventative SuDS, it is also proposed to implement “Source Control” infiltration techniques such as soakaways (crates, chambers) and pervious paving/asphalt to manage surface water run-off from roofs and roads at their source.

The Flood and Water Management Act 2010, Sewers for Adoption and The SuDS Manual require that, as a minimum, the SuDS should be designed to manage and attenuate the 1 in 30-year storm event so that there is no flooding of the site.

However, new developments should also mitigate Climate Change, so SuDS should be designed for exceedence and, be designed to manage and attenuate the 100-year storm event including an allowance for Climate Change.

4.2.1. Conceptual SuDS Design

Hardstandings are proposed to be constructed of either gravel or porous paving/asphalt, wherever possible and to suit the budget of the development, to enable impermeable areas and resultant surface water run-off to be kept to a minimum.

Roof water from the building is proposed to be discharged to a designated soakaway that would be located 5m from the structure. Surface water from the access road is proposed to be discharged to a designated soakaway in a landscaped area.

4.2.1.1. Amenity Building SuDS Design

The proposed new amenity building's total roof area is approximately 900m^2, which equates to a total contributing area of 0.0900ha.

Using MicroDrainage, an impermeable contributing area of 0.0900ha, the 6 hr 100 year storm event plus 40% Climate Change and a permeability rate of 1.58x10^{-4}m/s (0.570m/hr), the new building's soakaway would need to have a net storage capacity of approximately 29.6m^3.

Therefore, provide a soakaway with dimensions of 10.000m x 4.000 x 0.800m deep, which has a net storage capacity of 30.4m^3. See MicroDrainage calculations in Appendix 5 and proposed site plan in Appendix 2.

4.2.1.2. Access Road SuDS Design

The proposed new access road impermeable area is approximately 154m^2, which equates to a total contributing area of 0.0154ha.

Using MicroDrainage, an impermeable contributing area of 0.0154ha, the 6 hr 100 year storm event plus a 40% Climate Change and a permeability rate of 1.58x10^{-4}m/s (0.570m/hr), the new access soakaways would need to have a net storage capacity of approximately 4.2m^3.

Therefore, provide a soakaway with dimensions of 6.500m x 1.000 x 0.800m deep, which has a net storage capacity of 4.94m^3. See MicroDrainage calculations in Appendix 5.

4.2.1.3. Pitch Land Drainage

The proposed new pitches and MUGA would have a total area of 13,000m^2 and have perforated pipe land drainage below ground to maintain a usable pitch surface throughout the year. After surface water run-off, evaporation, infiltration and plant uptake losses the contributing area is perceived to be approximately 4500m^2, which equates to a total contributing area of 0.450ha. This assumes that just over 30% of rainfall will enter the land drainage, which would require attenuation and infiltration to prevent it leaving the site.

Using MicroDrainage, an impermeable contributing area of 0.450ha, the 6 hr 100 year storm event plus a 40% Climate Change and a permeability rate of 1.58x10^{-4}m/s (0.570m/hr), the new pitches and MUGA would need to have a net storage capacity of approximately 114.8m^3.

Therefore, provide an infiltration strip/basin with dimensions of 150.0m x 1.500m based width and 3.900m top width x 0.300m deep, which has storage capacity of 121.5m^3. See MicroDrainage calculations in Appendix 5. The infiltration strip should be located along the lowest boundary of the site, which is the northern boundary. See proposed site plan in Appendix 2.

4.2.2. Reduction in Post Development Site's Run-off

The above SuDS are sized to mitigate the 100 year storm plus a 40% allowance for climate change with a zero piped outflow, which is designing for exceedence.

All impermeable areas such as the access roads and roofs are proposed to discharge to infiltrating SuDS with a zero piped discharge.

Consequently, with the proposed mitigating SuDS 3% of the site (0.1054ha of impermeable roof and road areas) would not have a Greenfield or brownfield run-off rate as they would discharge to zero outflow SuDS.

Therefore, the site's post development run-off rate could be reduced by 0.041 l/s to approximately 1.315 l/s through the utilization of mitigating SuDS, which is less than the site's calculated Greenfield run-off rate of 1.356 l/s.

As only 97% of the post development site would discharge surface water at the Greenfield run-off, reducing the run-off rate to below the existing site's Greenfield run-off rate, and mitigating Climate Change would provide betterment as less water would be discharged to the existing drainage ditches and Main Rivers.

Therefore, the proposed SuDS could provide a reduction in flood risk at and around the site. See Proposed Site Plan in Appendix 2. The proposed SuDS surface water management strategy ensures that:

- there would be no increase in run-off as a result of the proposed development,
- there would be no increased flood risk as a result of the proposed development,
- there would be a decrease in the site's overall run-off rate and volume,
- the site's run-off rate would be reduced to less than the Greenfield run-off rate,
- betterment can be provided with regards to flood risk.

A combination of the SuDS infiltration techniques could be used with other techniques at the detailed design stage as long as there would be no increase in the site's post development surface water run-off rate and the SuDS mitigated Climate Change.

5. Assessment of Flood Risk from All Potential Sources

The Flooding of a site can occur from several sources, including, watercourses such as Main Rivers, Ordinary Watercourses and streams, tidal seas and estuaries, groundwater, sewers, surface water run-off and failure of water infrastructure. The risk of flooding to the site from each source has been assessed in turn.

5.1. Main Rivers

The nearest Main River is the Sor Brook tributary of the River Cherwell that is approximately 660m to the east of the site.

The SFRA (2009) notes that the most significant flood event recorded within the Cherwell District occurred in April 1998 when flood levels reached what were then considered to have a return period of greater than 1 in 100 years.

However, the SFRA advised that other events approaching a similar magnitude have occurred several times in the 25 years prior to publishing in 2009 and may indicate that severe flooding may be becoming more frequent.

The Banbury located gauging station confirms the 1998 flood levels to be the highest recorded since the station installation in 1966. Flooding was also recorded along the Cherwell corridor on July 2007, and January 2008.

However, The SFRA (2009) Appendix B, does not show the site to be within an area at risk of fluvial flooding. The SFRA (2009) does however consider the site to be within an area suitable for development.

The SFRA (2017) Appendix B, Part 2, Figure B4 shows that there have been no recorded flooding incidents from any source within the vicinity of the site.

The EA's Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. See EA's Indicative Flood Zone Maps included in Appendix 1. The SFRA (2017) Appendix B, Part 3 correlates with this data.

The Sequential Test looks at the Flood Risk Vulnerability and Flood Zone Compatibility of a development.

Table 3 of the PPG FRCC, identifies the development types that are appropriate in each flood zone, subject to the requirements of the EA National Standing Advice and the Application of the Sequential Test.

PPG FRCC Table 3:

Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception Test	✓	✓
Flood Zone 3a	Exception Test	✓	✗	Exception Test	✓
Flood Zone 3b Functional FZ	Exception Test	✓	✗	✗	✗

Key:
✓ Development is appropriate
✗ Development should not be permitted

Outdoor recreation and sports developments are classified as Water Compatible development, in accordance with Table 2: Flood Risk Classification of TGNPPF, which are suitable for Floods Zone 1.

Therefore, based on Table 3 of the PPG FRCC, the development classification and land use, the development proposals are appropriate for the flood zone at the site.

Based on available flooding records and the distance between the site and the main river it is unlikely that the site is at risk of flooding from Main Rivers.

Therefore, the site is perceived to have a Low risk of fluvial flooding from Main Rivers.

5.2. Ordinary Watercourses and Streams

There is a surface water ditch to the north of the site, however this has been observed to be overgrown with vegetation. There are no ordinary watercourses or streams within the site boundary. There are no records of watercourses and streams affecting the site.

The SFRA does not have any records of flooding at the site from ordinary watercourses or streams. Therefore, the site is perceived to have a low risk of flooding from ordinary watercourses and streams.

5.3. Coastal or Estuarine

The site is not located near the coastline or an estuary. Consequently, the site is at Low risk of tidal flooding.

5.4. Groundwater

Groundwater flooding is caused by the emergence of groundwater at the ground surface away from perennial river channels or the rising of groundwater into man-made ground, under conditions where the 'normal' ranges of groundwater level and groundwater flow are exceeded. The impact of groundwater flooding can occur before water levels reach the ground surface where there is inundation of building basements and buried services or other assets below ground level. Groundwater levels that rise above ground have the potential to reach low-lying areas protected from fluvial flooding.

The SFRA (2017) shows the site to be in an area where geological or hydrological conditions indicate a 25% - 50% risk of groundwater flooding occurring. However, the SFRA (2017) reports no instances of groundwater flooding within the site.

The SFRA (2017) Appendix B, figure B9 shows the site to underlain by a minor aquifer – Intermediate.

There are no known records, including anecdotal records, of the site being flooded due to groundwater. Therefore, the site is perceived to have a low risk of groundwater flooding.

5.5. Sewers and highway drains

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The SFRA (2009) advises that much of sewer network within the district dates back to Victorian times and therefore of an unknown capacity and condition. Therefore, it likely that parts of the sewer system within the district may become overloaded during large, high intensity rainfall events and result in sewer flooding.

The SFRA (2017) Appendix B, Part 5, Figure B10 shows the site to be within an area that has 5-10 reported incidents of sewer flooding. The figure illustrates Historical sewer flooding events in Cherwell as reported by Thames Water in their DG5 Sewer Flooding Register by postcode. However, the SFRA states that the map does not illustrate areas at risk of future flooding, and that maintenance work may have been completed since flooding incidents have occurred.

There are no known records of the site, being flooded due to surcharging of sewers. This indicates that the risk of sewer flooding at the site is low.

All new drainage on site should be constructed to comply with the current Building Regulations Approved Document H and Sewers for Adoption, to ensure that sewer surcharging is mitigated.

5.6. Surface water and Overland Flow

Flooding of land from surface water run-off is usually caused by intense rainfall that may only last a few hours, and usually occurs in lower lying areas often where the drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage or drainage blockage by debris and sewer flooding.

The SFRA (2017) indicates that there have been 973 reported pluvial flood incidents. However, there is no indication of what the sources of the flooding is. It is advised that there may be unreported incidents that have therefore gone unregistered, hence the results should be interpreted with caution.

The SFRA (2017) mentions several settlements that are at risk of surface water flooding due to being in large urban areas, or along watercourses. The site is not within any of these areas.

The SFRA (2017) indicates no historical cases of any flood event within the site. Appendix B, part 4, Figure B7-D of the SFRA does not show the site to be at risk from surface water flooding.

The site is perceived to have a low risk of surface water flooding.

The development proposals are required to ensure that there would be no increase in surface water volumes or peak flow rates, which could result in increased flood risk. The development proposals include the implementation of the SuDS philosophy to ensure there would be no increase in flood risk to the site and the surrounding areas.

5.7. Water Infrastructure Failure

Flooding may result from the failure of engineering installations such as flood defence, land drainage pumps, sluice gates and floodgates. Hard defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement or the failure of ground anchors. Such deterioration is often difficult to detect, so that failure, when it occurs is often sudden and unexpected. Failure is more likely when the structure is under maximum stress, such as extreme fluvial events when pressures on the structure are at its most extreme.

There are no reservoirs, or major water infrastructure within close proximity to site. Therefore, the risk of flooding from water infrastructure failure impacting upon the site is perceived to be Low.

6. Main River Bylaw Distance

In accordance with the Land Drainage Act 1976, The Water Resources Act 1991 and the Environment Act 1995 a Flood Defence Consent must be separately obtained from the EA for any work in, over, under or within the Bylaw distance of a Main River.

This is to ensure that the work activities do not cause or make existing flood risk worse, interfere with the EA's work, and do not adversely affect the local environment, fisheries or wildlife.

The nearest Main River is Sor Brook that is 660m to the east of the site. Therefore, the proposed development works would not require a Flood Defence Consent to be granted by the EA.

7. Conclusions and Recommendations

Paragraph 103 of the National Planning Policy Framework (NPPF) requires that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (FRA), compliant with the technical guidance to the NPPF (PPG FRCC), following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

The site is located on land to the north of Milton Road, which is situated west of Adderbury. The site is set to the west of the A4260, and to the east of the A361. The proposed development site covers an area of approximately 63259m^2 (3.6259 ha). The site can be located by Grid Coordinates 446282mE, 235085mN.

To the east of the site was a residential development site, and to the west is the horticultural company Ball Colegrave, and garden centre Florensis Flower Seeks UK Ltd. To the north of the site is undeveloped land. To the south is Milton Road and adjacent to Milton Road further south is undeveloped farmland.

The proposed development includes a recreational ground comprising of two 100m x 60m pitches, a 25m x 40m Multiuse Games Area, construction of one amenity building and parking.

The nearest Main River is Sor Brook that is approximately 660m to the east of the site.

The EA's Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers.

Therefore, in accordance with the NPPF and based on Table 3 of the PPG FRCC the development's classification and land use, the development proposals would be appropriate for the flood zone at the site.

The site was at a low risk of flooding from main rivers, sewers, infrastructure failure and ordinary watercourses and streams.

The site was identified as having a low risk of surface water flooding.

The site was identified as having a medium risk of ground water flooding.

The existing site has an impermeable area of approximately 0.0m² (0.00ha) and a permeable area of 36259m² (3.6259ha). Accordingly, 0.0% of the existing site is impermeable, while 100.0% is permeable.

The proposed site would have an impermeable area of approximately 1054.0m² (0.1054ha) and a permeable area of 35,205.0m² (3.5205ha). Accordingly, approximately 3% of the proposed site would be impermeable, while 97% would be permeable.

Therefore, without mitigating SuDS, there could be an increase in the impermeable areas at the site, rising from 0.0% to 3.0% of total site area. As such, the development proposals would incorporate SuDS to mitigate the potential impacts of any increase in impermeable area and Climate Change, providing betterment where possible.

The SWMS has demonstrated that by utilising SuDS it is feasible to mitigate surface water run-off as a result of the proposed development.

Consequently, with the proposed mitigating SuDS 3% of the site (0.1054ha of impermeable roof and road areas) would not have a Greenfield or brownfield run-off rate as they would discharge to zero outflow SuDS. Therefore, the site's post development run-off rate could be reduced by 0.041 l/s to approximately 1.315 l/s through the utilization of mitigating SuDS, which is less than the site's calculated Greenfield run-off rate of 1.356 l/s.

As only 97% of the post development site would discharge surface water at the Greenfield run-off rate this would reduce the total site's run-off rate to below the existing site's Greenfield run-off rate, while also mitigating Climate Change. This would provide betterment as less water would be discharged to the existing surface water drainage ditches and Main Rivers.

Consequently, the proposed SuDS, which would be based on "Prevention" and "Source Control", would provide a reduction in flood risk at and surrounding areas.

This site-specific FRA has identified that the development proposals, which incorporate a feasible SuDS surface water management strategy, ensures that:

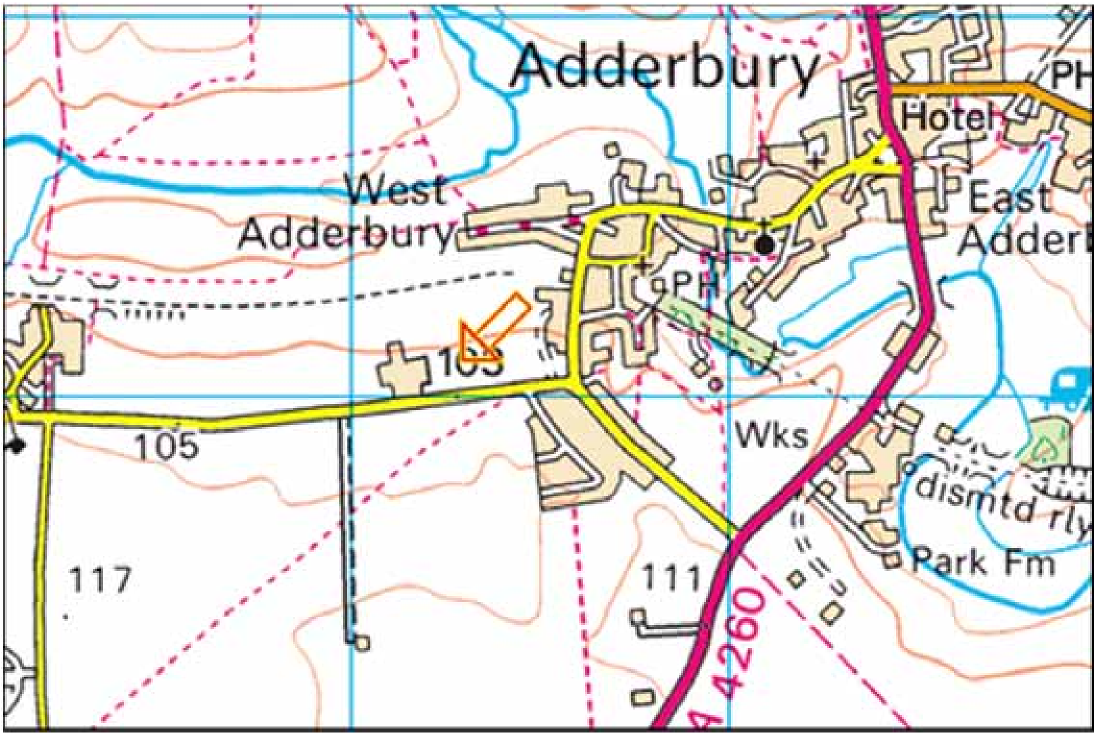
- there would be no increase in run-off as a result of the proposed development,
- there would be no increased flood risk as a result of the proposed development,
- there would be a decrease in the overall site's run-off rates and volumes,
- the site's run-off rate would be reduced to less than the Greenfield run-off rate,
- betterment could be provided with regards to reduction in flood risk,
- the development proposals would comply with the EA's requirements,
- the development proposals comply with the NPPF and the PPG FRCC.

Based on the findings of this site specific FRA, the proposed SuDS SWMS is feasible and consequently the development proposals are considered acceptable.

APPENDIX 1

Site Location

Proposed Recreation Ground Land Off Milton Road, Adderbury, Banbury Grid Reference Location 446282mE, 235085mN



Environment Agency Indicative Main River Flood Zone Maps

Key:

Flood Zone 3 – Medium to High Risk

Flood Zone 2 – Low to Medium Risk

Flood Zone 1 – None to Low

Flood Defence Protected Area

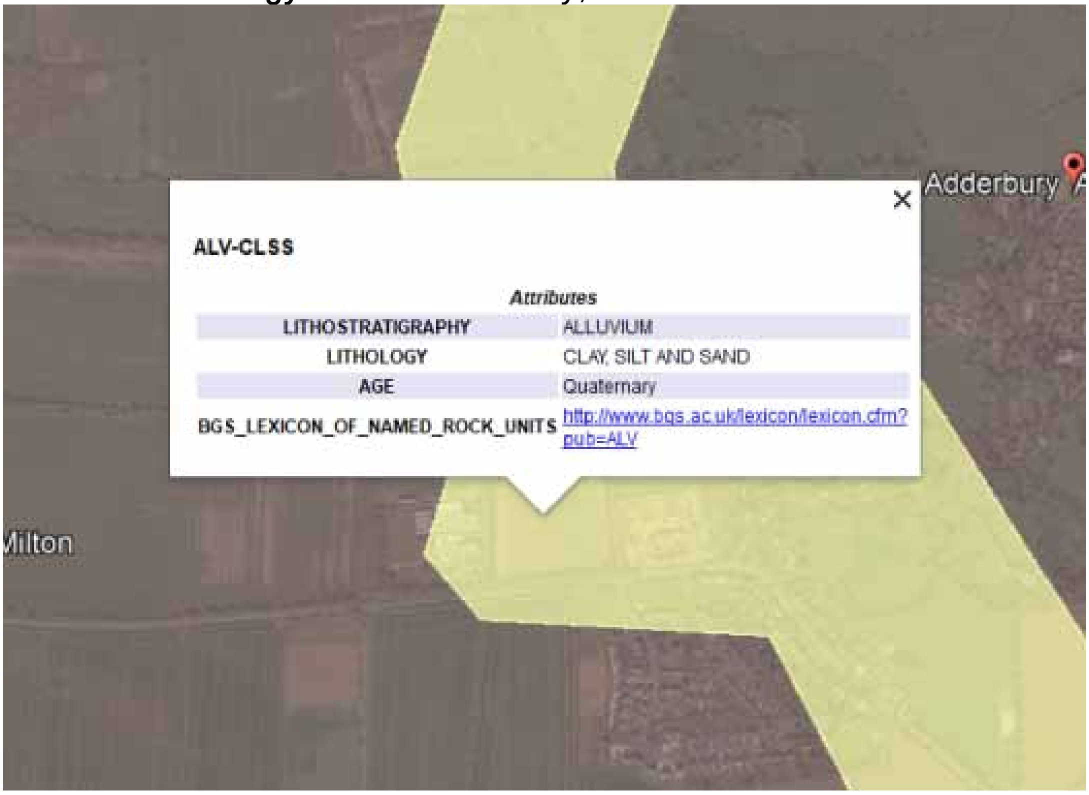
Flood Defence

Main River

Approximate Site Location

British Geological Survey Published Geological Maps

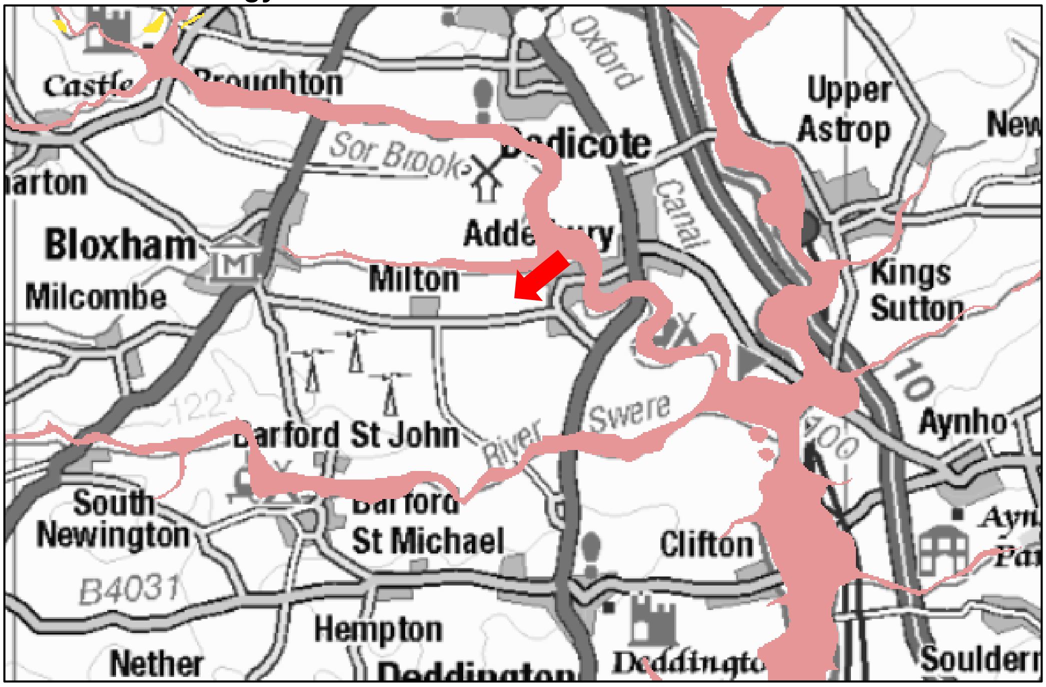
Superficial Drift Geology – Alluvium - Clay, Silt and Sand



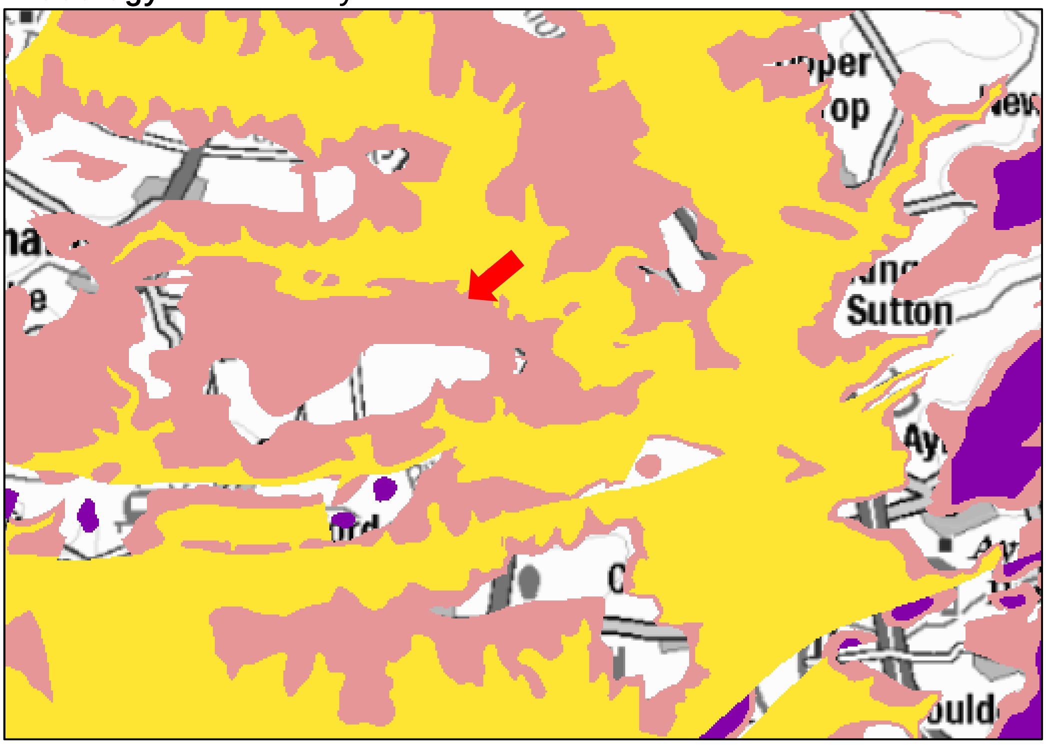
Bedrock Geology – Lias Group Mudstone, Siltstone, Limestone and Sandstone

Published Aquifer Maps

Superficial Drift Geology –None

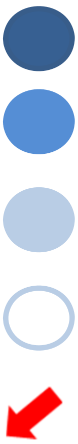


Bedrock Geology – Secondary A



EA Indicative Surface Water Flood Map

Key



High

Medium

Low

Very Low

Site Location

APPENDIX 2

APPENDIX 3

APPENDIX 4

APPENDIX 5