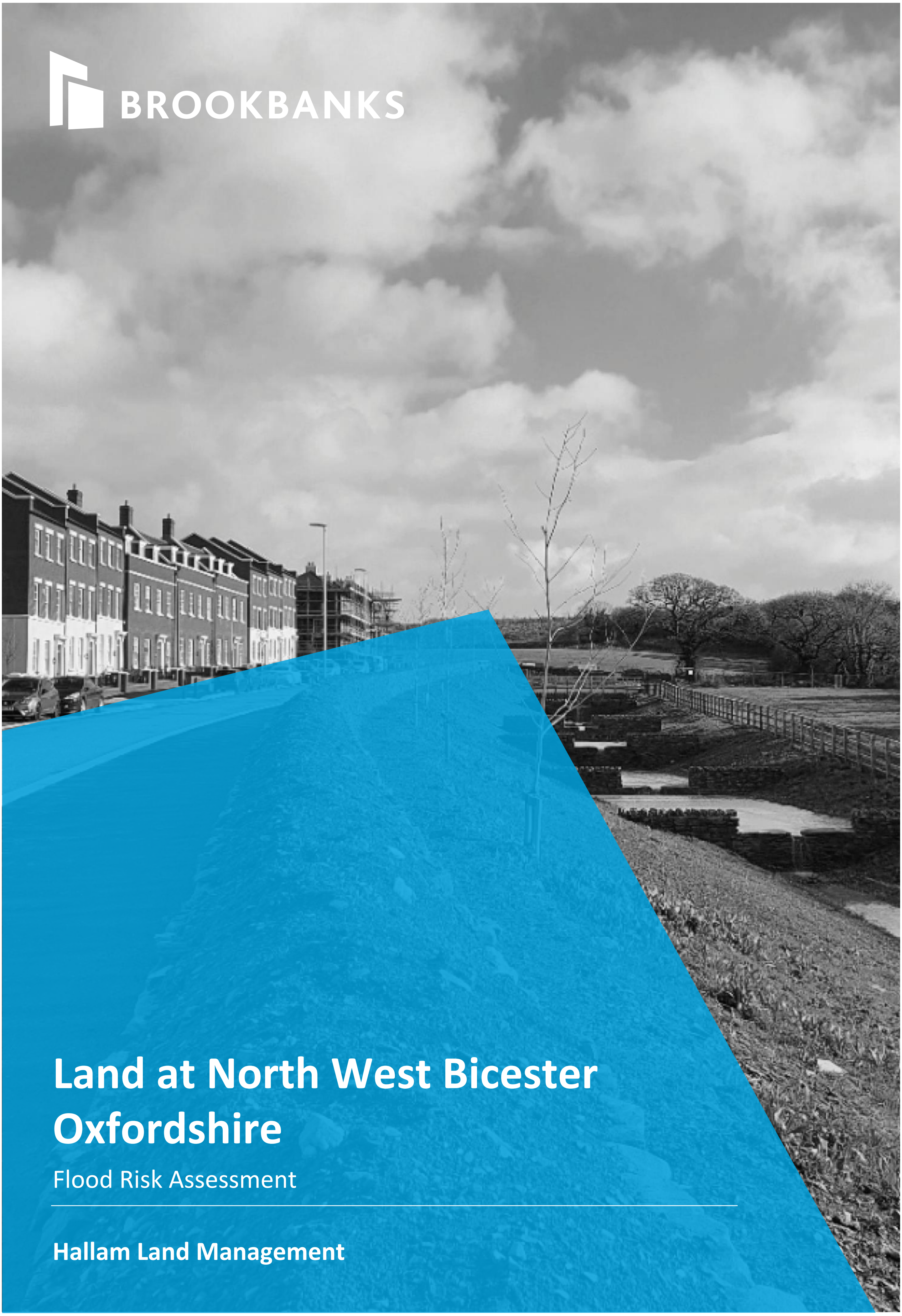

BROOKBANKS

Land at North West Bicester Oxfordshire

Flood Risk Assessment

Hallam Land Management

Document Control Sheet

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1 Introduction

1.1 Brookbanks is appointed by Hallam Land Management Ltd to complete a Flood Risk Assessment for a proposed residential and employment development at Land at North West Bicester.

1.2 The objective of the study is to demonstrate the development proposals are acceptable from a flooding risk and drainage viewpoint.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Surface water drainage
- Foul water drainage

1.4 Plans showing the existing and proposed development are contained within the appendices.

Planning Application

1.5 This Flood Risk Assessment has been produced in order to provide information for an outline planning application.

1.6 Everything designed within this report is to illustrate that the a drainage strategy can be successfully designed and applied for the development site.

1.7 The FRA will then be the subject of a reserved matters application where detailed design layouts and criteria will be provided.

2 Background Information

Location and Details

2.1 The proposed development lies to the north-west of the Bicester in Oxfordshire. For the purpose of this description the red line has been spilt into two areas. The eastern area is bound by Bucknell village to the north, agricultural fields to the east, to the A4095 and the Lords Land roundabout to the south and Bicester Road/Bucknell Road to the west. The western area is bound by the railway line to the west, agricultural fields to the north, Bicester Road/ Bucknell Road to the east and Lords Land roundabout to the south.

2.2 The site is currently undeveloped agricultural land and is not thought to have been historically subject to any significant built development.

2.3 The site location and boundary is shown indicatively on **Figure 2-1**.

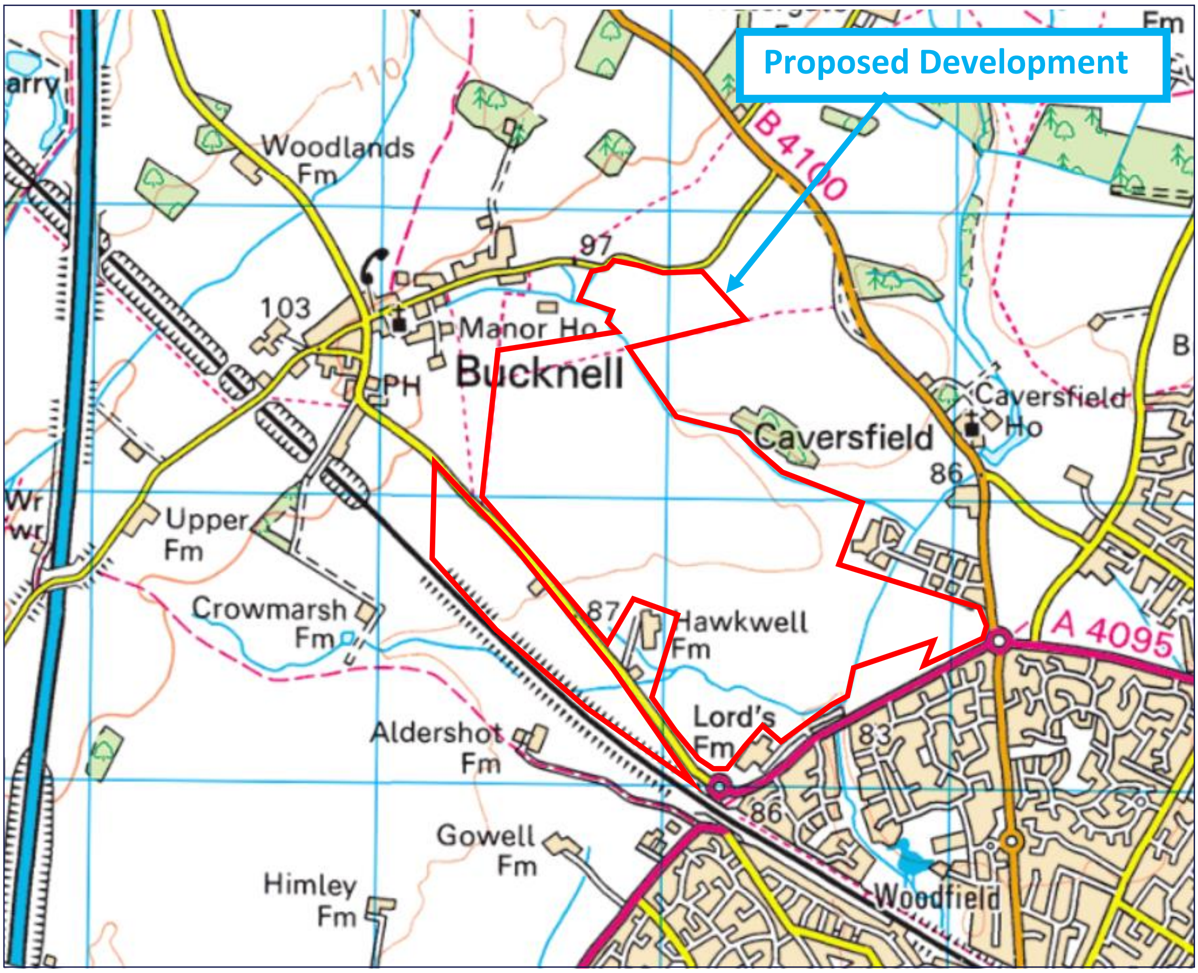

Figure 2-1: Site Location

Development Criteria

2.4 The following development is proposed at the site:

- Up to 3,100 new homes
- A mixed use local centre
- A school Site
- A school playing field extension to the existing Gagle Brook Primary School
- Extensive green area to the north comprising sports, recreation and play areas and a country park
- Allotments and community farm
- Burial ground
- 4 LEAPs, 2 NEAPs and a MUGA across the Site
- Employment/business use area
- Retention and enhancement of existing hedgerows
- Green corridor alongside the river
- Primary Street

Sources of Information

2.5 The following bodies have been consulted while completing the study:

- Thames Water - Storm & foul water drainage
- Environment Agency - Flood risk and storm drainage
- Cherwell District Council - Flood risk, drainage and associated policy

2.6 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- Strategic Flood Risk Assessment - Oxfordshire County Council

3 National Planning Policy

National Planning Policy

3.1 The National Planning Policy Framework (NPPF), updated in July 2021, sets out Governmental Policy on a range of matters, including Development and Flood Risk. The policies were largely carried over from the former PPS25: Development & Flood Risk, albeit with certain simplification. The allocation of development sites and local planning authorities' development control decisions must be considered against a risk-based search sequence, as provided by the document.

3.2 Allocation and planning of development must be considered against a risk-based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows in **Table 3-1**.

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Table 3-1: NPPF Flood Risk Parameters

3.3 The Guidance states that Planning Authorities should "apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."

3.4 According to the NPPF guidance, residential development at the proposed site, being designated as "More Vulnerable" classifications, should lie outside the envelope of the predicted 1 in 100 year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year events and within Flood Zone 1.

3.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test".

3.6 The site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits
- The development will be safe, not increase flood risk and where possible reduce flood risk.

Regional & Local Policy

3.7 **Regional Flood Risk Assessment**: The South East of England Regional Assembly published their Regional Flood Risk Assessment (RFRA) in October 2008. The document is a high level review of flood risk and strategy. In this document, concerns over the effects of flood risk and potential of climate change are identified across the wider South East region.

3.8 As with many RFRA's, this document outlines the broad understanding of flooding risk across areas of potential higher growth however makes no specific reference to the proposed site at Bicester. The report does identify that:

"New development is specifically proposed for a South of Oxford Strategic Development Area (4,000 homes), and in surrounding towns such as Bicester, Didcot, Wantage and Grove."

3.9 **Catchment Flood Management Plans**: A Catchment Flood Management Plan (CFMP) is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

3.10 The Thames Flood Management Plan (December 2009), outlines that the River Basin District has been divided into 9 sub-catchments. The Site is shown to be situated within the towns and villages in open floodplain (north and west) catchment which is covered by the following policy:

*"**Policy 6**: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.*

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists) but would only be implemented in specific locations within the area, after more detailed appraisal and consultation."

4 Local Planning Policy Compliance

4.1 Bicester lies within the District of Cherwell in Oxfordshire, in which Oxfordshire County Council (OCC) is the Lead Local Flood Authority (LLFA). A **Preliminary Flood Risk Assessment** (PFRA) was produced in April 2011 by OCC according to the guidance and information provided by DEFRA. The PFRA identifies flood risk from local flood sources and extreme events occurrence.

4.2 Indicative Flood Risk Areas consist of an area where flood risk is most concentrated, and over 30,000 people are predicted to be at risk of flooding. Bicester has a population of less than 42,000, according to the 2011 Census and does not fall into a high risk area.

4.3 **Strategic Flood Risk Assessment**: To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Plan and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

4.4 Cherwell District Council, published their Level 1 and Level 2 Strategic Flood Risk Assessment in May 2017. The document generally underpins national guidance and provides recommendations to developers with regards to SuDS and design which will be explored further in this report under the Storm Drainage section.

4.5 The document makes no specific reference to the site however assess the risk of flooding in Banbury, which forms one of three major urban centres in the district of Cherwell. The following sources will be discussed further in this document:

- Fluvial Flooding
- Sewer Flooding
- Pluvial Flooding
- Groundwater Flooding
- Artificial Sources

4.6 The guidance generally promotes good practice methodology in line with the more current SFRA's and Water Management SPD's. As such, the development proposals contained in this FRA are in full compliance with the Local Policies.

4.7 The site design has had full regard to the recommendations set out within the SFRA.

4.8 Oxfordshire County Council published the **Local Flood Risk Management Strategy** (LFRMS) which offers Guiding Principals in managing flood risk and a structure of managing strategy, in addition to that provided in the SFRA.

4.9 The LFRMS Objectives for managing flood risk are outlined below:

1) *Improve understanding of flood risks and ensure that all stakeholders understand their roles and responsibilities for flood risk management.*

2) *Take a collaborative approach to reducing flood risks, using all available resources and funds in an integrated way and in so doing derive enhanced overall benefit.*

3) *Prevent an increase in flood risk from development where possible, by preventing additional flow entering existing drainage systems and watercourses.*

4) *Take a sustainable and holistic approach to flood risk management, seeking to deliver wider environmental and social benefits, climate change mitigation and improvements under the Water Framework Directive.*

4.10 The objectives detailed above will be delivered through a series of local measures and actions. Site level Specific Management Actions are introduced so they could be implemented within locally important flood risk areas in order to translate the aims of the overall strategic actions onto a local scale.

4.11 OCC published their Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire in November 2018.

4.12 The guidance outlines the surface water drainage design standards for Oxfordshire.

4.13 Cherwell District Council published their Local Plan 2011-2031 in July 2015. The following policy is related the proposed SuDS design for the site.

Policy ESD 7: Sustainable Drainage Systems (SuDS)

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.

4.14 **Development Flood Risk Assessment**: At a local site by site level, the NPPF and guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). The NPPF requires that developments covering an area of greater than one hectare prepare a FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

4.15 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

Supplementary Planning Document (SPD)

4.16 The proposed drainage strategy and will be designed in full compliance of Development Requirement 10 – Water and 11 – Flood Risk Management within the North West Bicester SPD.

4.17 Below outlines the *SPD/policies* and how BCL have met those requirements.

Development Requirement 10 Water

Planning applications should be accompanied by a water cycle strategy (WCS) that provides a plan for the necessary water services infrastructure improvements. The WCS should be prepared and developed in partnership with interested parties, including the local planning authority, the Environmental Agency (EA) and the relevant water and sewerage companies through a water cycle study. The strategy should:

- *Assess the impact the proposed development will have on the water demand within the framework of the water company's water resource management plans and set out the proposed measures which will limit additional water demand from both new housing and new non-domestic buildings and show how* the scheme can address the aim of water neutrality;

4.18 Wastewater from the new dwellings will be set at 110 litres per person per day and the scheme will work with Thames Water in order to design a scheme that can be adopted and ensure that the system can accommodate with the additional flows.

- *Demonstrate that the development will not result in any deterioration in the status of any surface waters or ground-waters affected by it; and*

4.19 The proposed SuDS network will provide a minimum of 2 levels of treatment before surface water discharged into the existing watercourses and 1 level of treatment within any infiltration feature. This is explained in further detail in Chapter 9.

- *Set out proposed measures for improving water quality and avoiding surface water flooding from surface water, groundwater or local water courses.*

4.20 A SuDS network has been designed (Chapter 8) which will attenuate surface water for the 1 in 100 year + 40% climate change storm event and discharge at QBAR, therefore reducing the risk of flooding further downstream.

- *Demonstrate that adequate sewerage Infrastructure capacity exists on and/or off the site to serve the development that would not lead to problems for existing users.*

4.21 The scheme will work alongside Thames Water to ensure that an appropriate sewage infrastructure will be developed. Thames Water are currently carrying out an assessment of the current capacity of the network and the delivery of a solution to effectively accommodate the site flows.

4.22 Development proposals shall incorporate:

- *Measures in the Water Cycle Strategy for improving water quality and managing surface water, ground water and local watercourses to prevent surface water flooding from those sources and*

- *Sustainable Urban Drainage Systems (SUDS) designed to maximise the opportunities for biodiversity.*

4.23 A SuDS network has been designed in order to provide treatment for attenuated surface water before being discharged into the watercourses. In attenuation basin locations where infiltration is not viable there is an option to include permanent water within the basins. This will be investigated in further detail at the detailed design stage.

Development Requirement 11 Flood Risk Management

Planning applications should demonstrate that the proposed development will not increase food risk on and off the site.

They should demonstrate that the peak discharge rate for all events up to and including the 1 in 100 chance in any year critical storm event, including an appropriate allowance for climate change will not exceed that of the existing site.

As the development includes proposed residential development with an assumed lifetime of 100 years, the surface water drainage strategy should include a 30% allowance for climate change in accordance with guidance in the NPPF.

Planning applications must demonstrate in a surface water drainage strategy that the proposed development will not increase the risk of flooding from surface water on or off the site.

In preparing planning applications, the following guidance should be referred to:

- *"Preliminary rainfall runoff management for developments", DEFRA, Environment Agency providing guidance on the preparation of surface water strategies;*
- *NPPF National Planning Guidance on Climate Change allowances*
- *"C635 Designing for exceedance in urban drainage – Good Practice", CIRIA"*
- *"Sustainable Drainage Systems – design manual for England and Wales CIRIA C522*
- *SUDS manual, CIRIA C753*

4.24 The SuDS network has been designed in order to accommodate surface water for the 1 in 100 year + 40% climate change storm event. Discharge from the basins have been designed at a rate of 2.94 l/s/ha (QBAR).

4.25 Attenuation basins have been designed to 1.5m depth with a 1.2m water level and 1 in 4 slopes in line with the SuDS manual.

5 Baseline Conditions

Present Day

5.1 As identified above the majority of the site is currently undeveloped agricultural land, the site is crossed by two ordinary watercourses, one located at the north-east boundary flowing south easterly direction, and the second watercourse is located at the south of the development flowing easterly direction. Both watercourses are tributaries of the same watercourse which is located at the east of the site flowing direction south towards Bicester.

5.2 **Figure 5-1** below illustrates the site at present.

Figure 5-1: Site Boundary

Topography & Site Survey

5.3 The site falls towards the two onsite watercourses. The exception to this is in the western field where there is a ridge in the centre of the field. East of this ridge falls away from the ordinary watercourse.

Geology & Hydrogeology

5.4 With reference to the British Geological Survey map, the site is shown to be underlain by limestone bedrock geology belonging to the Cornbrash Formation. There are outcrops of Limestone and Mudstone belonging to the Forest Marble Formation following line of the ordinary watercourses.

5.5 A band of Alluvium deposits are shown within the watercourses which comprises of clay, silt, sand and gravel.

5.6 The published site geology is illustrated on **Figure 5-2**.

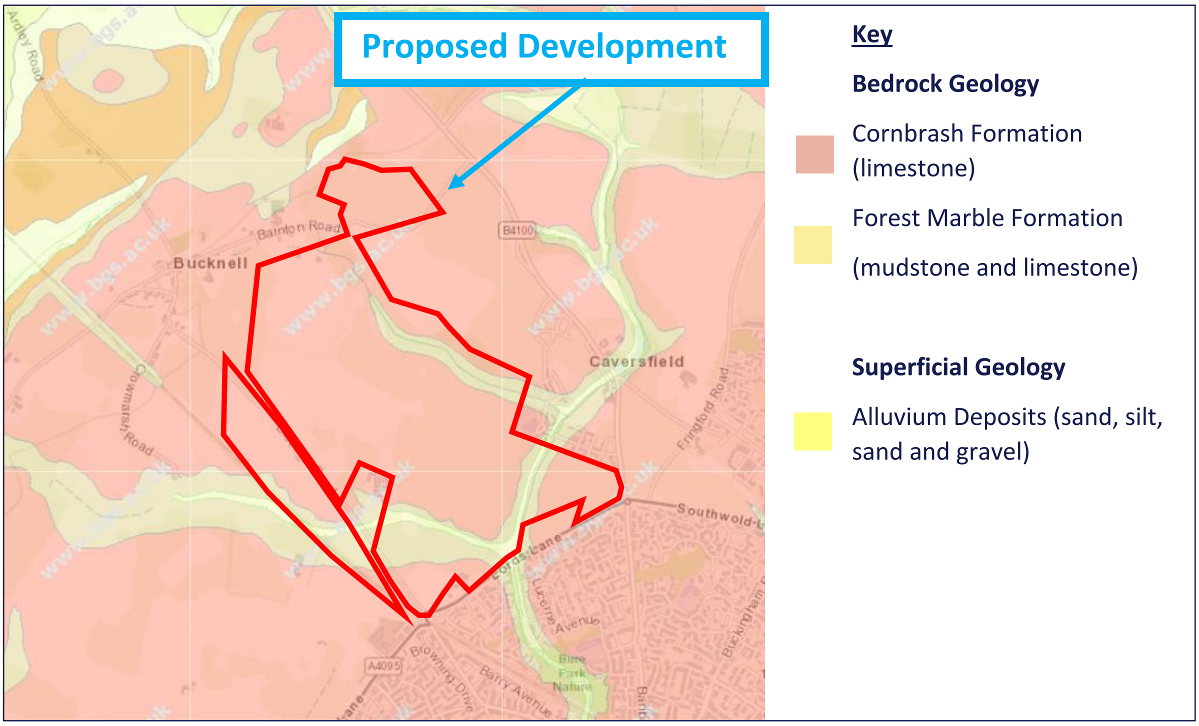

Figure 5-2: BGS Published Geology

5.7 The underlying bedrock geology forms a secondary A aquifer across the whole site and the superficial deposits form a secondary A Aquifer (**Figure 5-2**).

5.8 The EA provides the following definitions for Aquifers:

Secondary Aquifers *- "These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:*

Secondary A *- permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers."*

Secondary B *- predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.*

Secondary Undifferentiated *- has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been* *designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.*

5.9 The EA Groundwater Vulnerability Zones (GVZ) Mapping summarises the overall risk to groundwater, taking into account groundwater vulnerability, the types of aquifer present (superficial and/or bedrock) and their designation status, as discussed previously.

5.10 The site is shown (**Figure 5-3**) to be situated within a 'high risk', in terms of groundwater vulnerability.

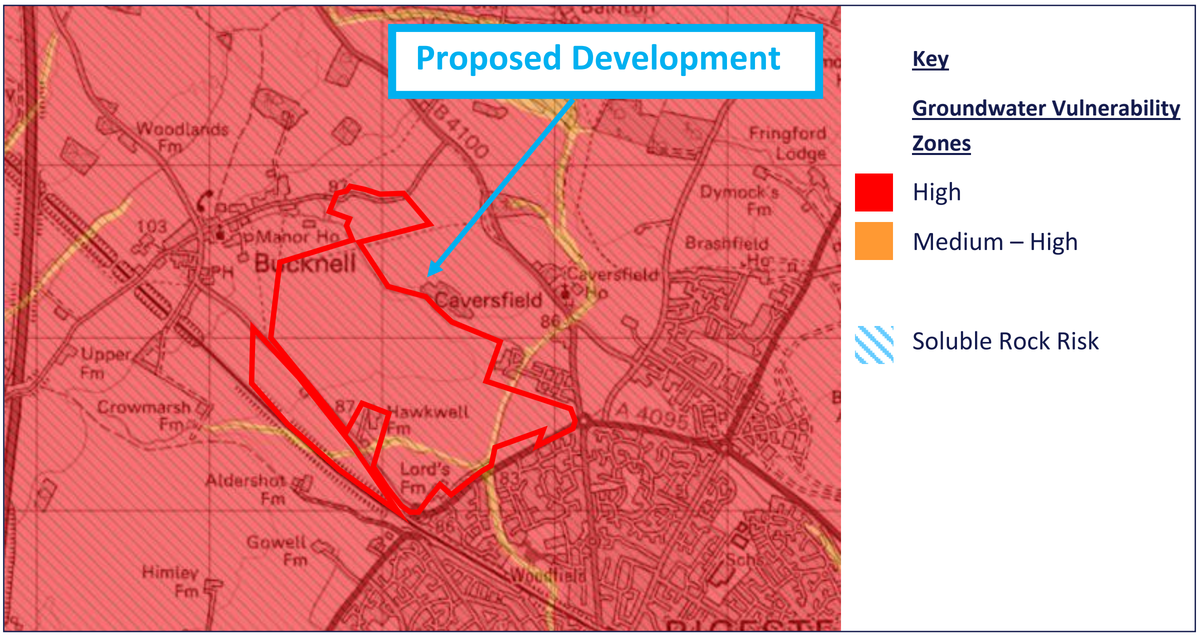

Figure 5-3: EA Groundwater Vulnerability Zones Map

5.11 The EA provides the following definition for the underlying GVZ:

High *– These are high priority groundwater resources that have very limited natural protection. This results in a high overall pollution risk to groundwater from surface activities. Operations or activities in these areas are likely to require additional measures over and above good practice pollution prevention requirements to ensure that groundwater isn't impacted.*

Medium-high - *These are high priority groundwater resources that have limited natural protection. This results in a medium-high overall pollution risk to groundwater from surface activities. Activities in these areas may require additional measures over and above good practice to ensure they do not cause groundwater pollution.*

Medium *– these are medium priority groundwater resources that have some natural protection resulting in a moderate overall groundwater risk. Activities in these areas should as a minimum follow good practice to ensure they do not cause groundwater pollution.*

Medium-low *- these are lower priority groundwater resources that have some natural protection resulting in a moderate to low overall groundwater pollution risk. Activities in these areas should follow good practice to ensure they do not cause groundwater pollution.*

__Low__ – these are low priority groundwater resources that have a high degree of natural protection. This reduces their overall risk of pollution from surface activities. However, activities in these areas may be a risk to surface water due to increased run-off from lower permeability soils and near-surface deposits. Activities in these areas should be adequately managed to ensure they do not cause either surface or groundwater pollution.

Drainage Network and FEH Catchment Data

5.12 Reference to the online Flood Estimation Handbook shows the Site to lie within the catchment of the River Ray south of Bicester. Part of the drainage network belonging to the River Ray flows via the River Bure through the site and southwards through Bicester.

5.13 The Site is shown to have limited development on Site, but is located on the outskirts Bicester.

5.14 **Figure 5-4** below illustrates the watercourses and feature described above.

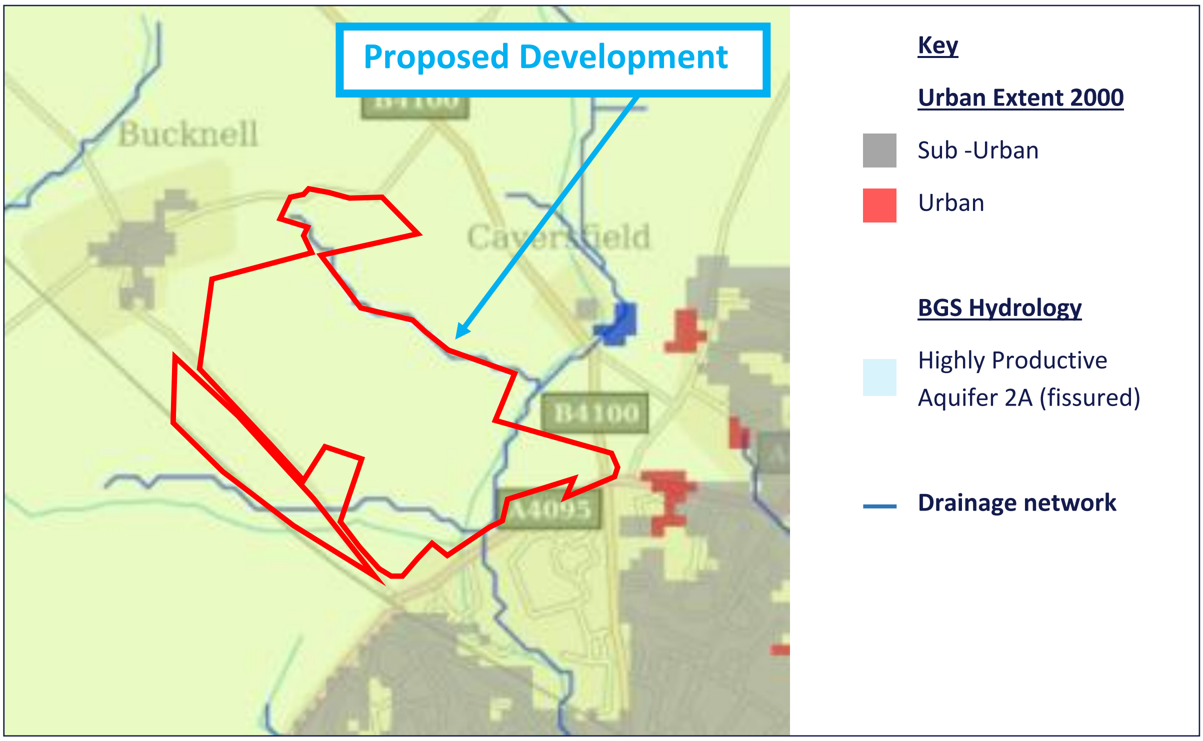

Figure 5-4: Urban Extent 2000 and BGS Hydrology and Drainage Network

6 Flood Risk

Flood Mechanisms

6.1 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified as follows in **Table 6-1**.

Mechanisms	Potential	Comment
Fluvial	Y	There is a small area of flood zones 2 and 3 in the eastern half of the site adjacent to the onsite watercourse.
Coastal & Tidal	N	No tidal watercourses lie within an influencing distance of the proposed development.
Overland Flow (Pluvial)	Y	Surface water flood mapping shows as such the risk relating to overland flow is considered low. There are small areas of medium risk flooding in the low lying regions of the site
Groundwater	N	Geology underlying the site is of a potentially low permeability. No groundwater flooding was identified within the SFRA and therefore the risk of same is considered low.
Sewers	N	No sewers lies within the site.
Reservoirs, Canals etc	N	There is no risk of flooding from reservoirs.

Table 6-1: Flooding Mechanisms

6.2 Where potential risks are identified in **Table 6-1**, above, more detailed assessments have been completed and are outlined and discussed further within the following sections.

Fluvial Flooding

6.3 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

6.4 The mapping below on **Figure 6-1** shows that majority of the site to lie within Flood Zone 1; being an area of Low Probability of flooding and outside both the 1 in 100 (1% AEP) and 1 in 1,000 (0.1% AEP) year flood events.

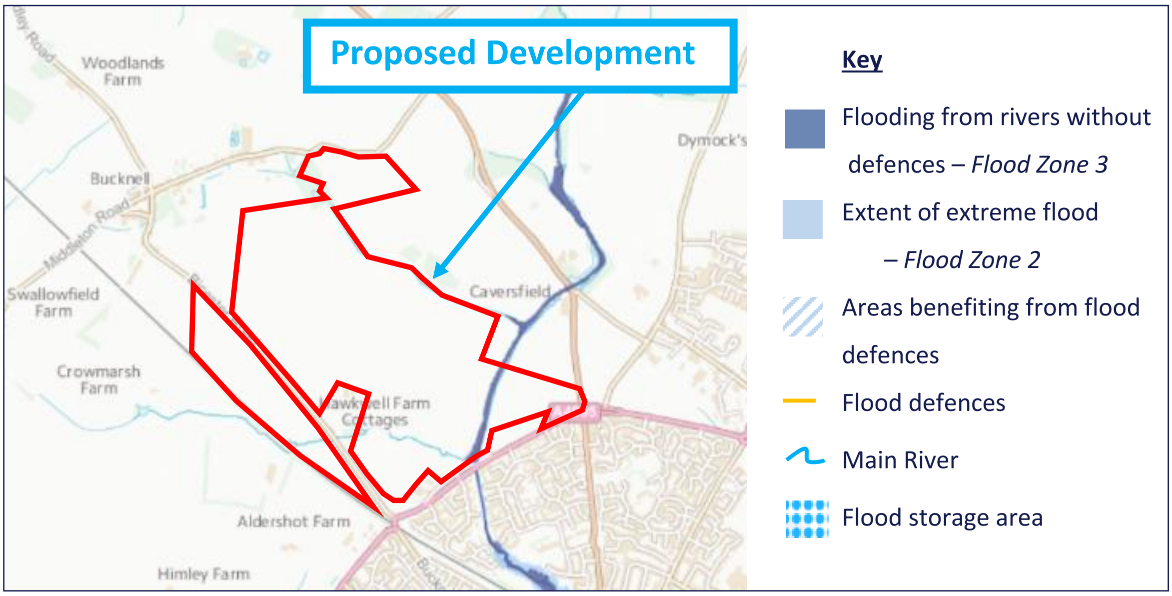

Figure 6-1: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000 year floodplains

Coastal Flooding

6.5 The site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no risk of tidal or coastal flooding at this location.

Overland Flow (Pluvial)

6.6 Overland flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage systems in paved areas to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

6.7 The Environment Agency, in partnership with lead local flood authorities, produced a series of surface water flood maps for many parts of the UK.

6.8 **Figure 6-2** identifies that most of the Site has a very low risk of surface water flooding. However, there are small areas across the site that are shown to have a Medium Risk from surface water flooding.

6.9 Initial investigations suggest that the risk of overland flow relates primarily to the topography of the site; low areas of the site naturally store water limiting the surface runoff in concentrated areas. As part of the development, the topography will be altered, providing a rationalised surface for water runoff.

6.10 Recognising the risk of overland flow mechanisms, published guidance in the form of the Design and Construction Guidance for Foul and Surface Water Sewers and the Environment Agency document Improving the Flood Performance of New Buildings: Flood Resilient Construction et al advocate the design of developments that implement infrastructure routes through the development that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors. Further to protect the Proposed Development, current good practice measures defined by guidance will be incorporated. However, the development design will take this into consideration in the final design.

6.11 Given the baseline site characteristics and further mitigating measures to be implemented residual flood risk from an overland flow mechanism is considered of a low probability.

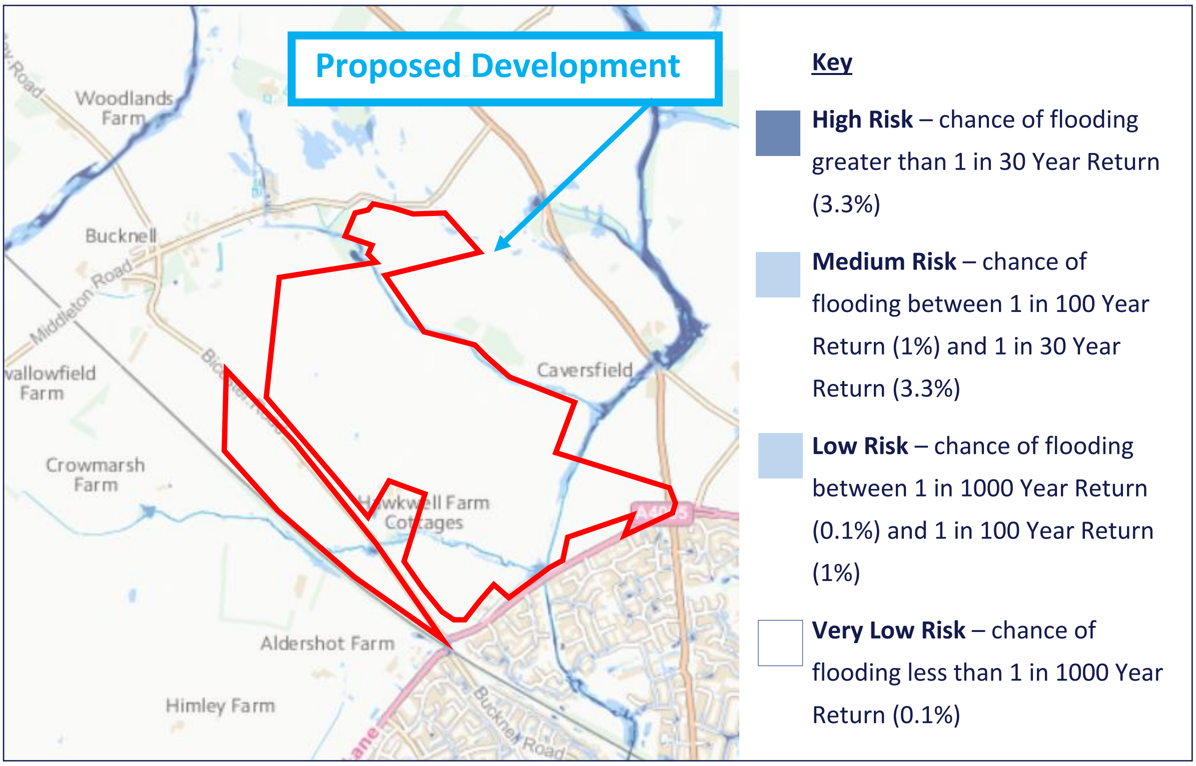

Figure 6-2: EA Long Term Flood Risk Maps – Flood risk from Surface Water (Gov.Uk website)

Groundwater

6.12 Groundwater flooding is characterised by low-lying areas often associated with shallow unconsolidated sedimentary aquifers which overly non-aquifers. These aquifers are reported to be susceptible to flooding, especially during the winter months, due to limited storage capacity.

6.13 Groundwater related flooding is fortunately quite rare, although where flooding is present, persistent issues can arise that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen effect on the local geology or hydrogeology.

6.14 The Environment Agency's national dataset, Areas Susceptible to Groundwater Flooding (AStGWF), provides the main dataset used to assess the future risk of groundwater flooding. The AStGWF map uses four susceptibility categories to show the proportion of each 1 km grid square where geological and hydrogeological conditions show that groundwater might emerge.

6.15 This mapping (**Figure 6-3**) identifies that the area lies within a of a < 25% susceptibility to groundwater flooding.

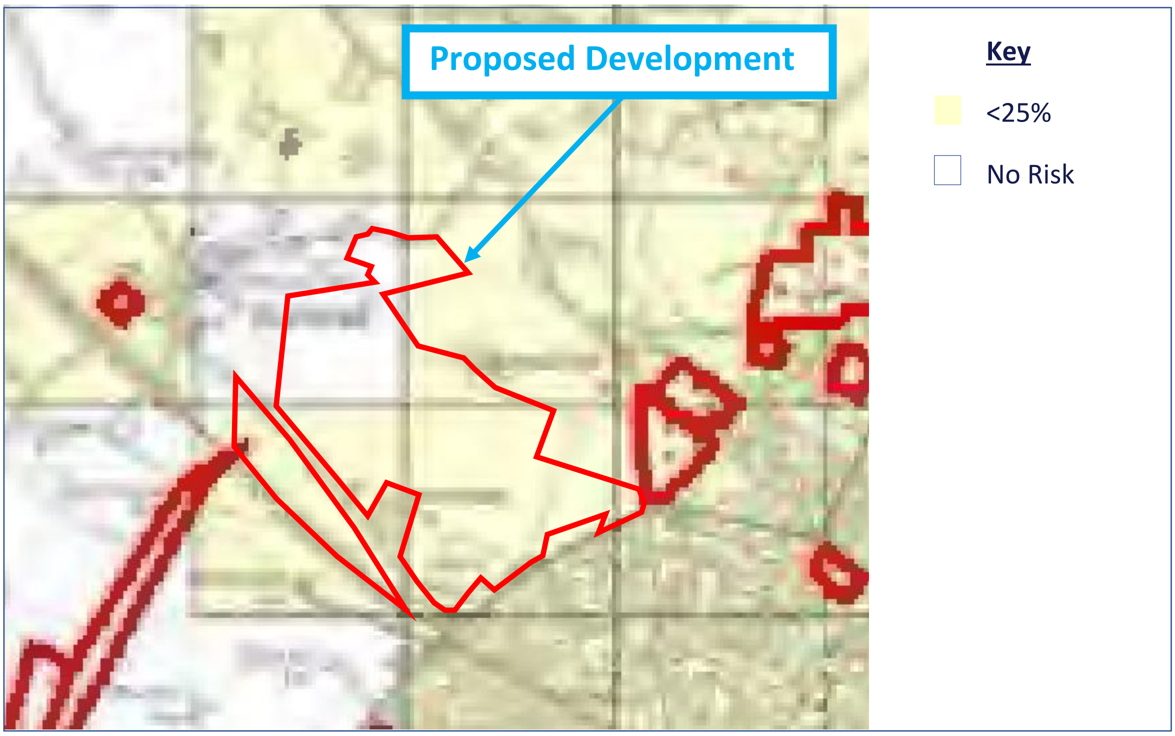

Figure 6-3: Groundwater Flooding Susceptible

6.16 Given the baseline site characteristics and further mitigating measures to be implemented, such as infiltration systems, swales and detention basins, will ensure that the residual flood risk from a ground water mechanism is considered to be of a low probability.

Sewerage Systems

6.17 Flooding related to sewerage systems is a result of there being insufficient capacity within an existing sewerage system (combined and surface water sewers) or from there being a blockage within the system.

6.18 The SFRA investigated flooding from sewers by collecting historic flooding incidents data from Thames Water. The historical sewer flooding incidents mapping identifies that the site lies within an area of 10-15 incidences.

6.19 Positive drainage measures incorporated on site, coupled with sustainable drainage systems (SuDS) will ensure that no increase in surface water will result from the site. Flood risk associated with sewer flooding is therefore considered to be a low probability.

Artificial Water Bodies - Reservoirs & Canals

6.20 Non-natural or artificial sources of flooding comprises of reservoirs, canals and lakes where water is retained above the natural ground level. However unlikely, reservoirs, canals and other artificial sources have a potential to cause flooding due to the release of large volumes of water, resulting from a dam or bank failure.

6.21 The Environment Agency has produced mapping to indicate a worst case scenario of flooding that would be caused, as a result of unlikely structural failure or damage of a reservoir.

6.22 The site is shown to lie a considerable distance from the potential maximum extent the reservoirs in the vicinity of the site.

Summary

6.23 In terms of fluvial flood risk, the majority of the site lies within Flood Zone 1 and therefore has a low probability of flooding from this mechanism. Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

6.24 Accordingly, the Proposed Development land is in a preferable location for development when appraised in accordance with the NPPF Sequential Test and local policy.

Objectives

6.25 The key development objectives that are recommended in relation to flooding are:

- Work collaboratively with the Environment Agency to identify potential flooding.
- Compliance with the Design and Construction Guidance for Foul and Surface Water Sewers and EA guidance in relation to flood routing through the Proposed Development in the event of sewer blockages.

7 Storm Drainage

Background

7.1 To understand the baseline provision for storm drainage in the area, a copy of Thames Water network records will need to be obtained.

7.2 As the site is currently greenfield, it is thought that storm water currently drains to the ground and into the existing ordinary watercourses and drainage ditches across the site.

SuDS Components

7.3 It is proposed to implement a SuDS scheme consistent with local and national policy at the proposed development.

7.4 At the head of the drainage network, across the site, source control measures could be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems.

7.5 Through consultations with the LLFA at outline planning stage, it has been agreed that the nature of source control measures to be implemented will need to remain flexible, providing each house builder with a ‘toolkit’ of options to reach an agreed target for peak discharge reduction and water treatment.

7.6 **Table 7-1** is an extract of Table 7.1 from the CIRIA SuDS Manual C753 which outlines a number of options available.

Component Types	Description	Collection Mechanism	Design Criteria					
			Water Quantity			Water Quality	Amenity	Biodiversity
			Peak Runoff Rate	Runoff Volumes				
				Small Events	Large Events			
Rainwater Harvesting Systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●	
Green Roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●
Infiltration Systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●
Proprietary Treatment System	Subsurface structures designed to provide treatment of runoff	P				●		

Filter Strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○
Filter Drains	Shallow stone filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●
Bioretention Systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●
Trees	Trees within soil-filled tree pots, tree planters or structural soils used to collect, store and treat runoff	P	●	●		●	●	●
Pervious Pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○
Attenuation Storage Tanks	Large, below ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	P	●					
Detention Basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●
Ponds and Wetlands	Permanent pools of water used to facilitate treatment runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●

Table 7-1: Ciria Guidance Table 7.1 (SuDS Component Delivery of Design Criteria)

* Key

P - Point, L - Lateral, S – Surface

● Likely Valuable Contribution ○ Some Potential Contribution to Delivery of Design Criterion T

Drainage Hierarchy

7.7 The following paragraphs in this section outline the proposed drainage strategy to meet national and local design requirements and guidance.

7.8 Current guidance[1] requires that new developments implement means of storm water control, known as SuDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of water discharged from the land.

7.9 When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations 2002 (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

b) a watercourse; or where that is not reasonably practicable,

c) a sewer. "

7.10 Dealing with the search order in sequence:

a) Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of same can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such. Site ground investigations suggests the presence of potentially impermeable formations within the site. While the ground formations may not be possible for a wholesale infiltration-based drainage strategy, where subsequent investigations show infiltration is viable locally to work, this may be incorporated fully into the design at the detailed design stage.

As such, source control measures will therefore be primarily restricted to detention and conveyance systems placed close to source by way of measures such as lined permeable pavements and conveyance strips.

b) Next in the search sequence, defined by Part H, is discharge to a watercourse or suitable receiving water body. Where coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

There are 2 ordinary watercourses that flow through the proposed development site and as such represents an appropriate receptor for storm water discharge, have the potential to receive flows from the proposed development once restricted to the pre-existing 'greenfield' rates of run-off.

[1] NPPF, CIRIA C522, C609, C753 et al.

c) Last in the search sequence is discharge to a sewer. In the context of SuDS this is the least preferable scheme as it relies on ‘engineered’ methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

7.11 **Table 7-2** outlines which options will be used within the outline application and which will be considered at reserved matters.

Component Types	To be Considered at Outline	To be Considered at Reserved Matters
Rainwater Harvesting Systems		✓
Green Roofs		
Infiltration Systems	✓	✓
Proprietary Treatment System		
Filter Strips		
Filter Drains		✓
Swales	✓	✓
Bioretention Systems		
Trees		✓
Pervious Pavements		✓
Attenuation Storage Tanks		
Detention Basins	✓	✓
Ponds and Wetlands		

Table 7-2: Types of SuDS Components to be Considered

7.12 The search sequence outlined above indicates that the onsite drainage network is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and on-line SuDS to control peak discharges to no greater than the baseline conditions.

7.13 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the site utilises a SuDS system as the primary storm water management scheme.

7.14 Accordingly, a plan showing the conceptual drainage masterplan for the site is contained within **Appendix A** as drawing 10663-DR-01 D.

7.15 Coupled with the storm water control benefits, the use of SuDS can also provide betterment on water quality. National guidance in the form of CIRIA 753 outlines that by implementing SuDS, storm water from the site can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology.

8 Preliminary Drainage Proposals

Primary Drainage Systems (source control)

8.1 The common aims of a Primary Drainage System are:

- Reduction in peak discharges to the agreed site wide run-off rate from the development areas.
- Provide water quality treatment where appropriate

8.2 Preliminary assessment of the requirements for storm drainage have been based on the following criteria as shown in **Table 8-1**.

Criteria	Measure/Rate/Factor
Application Site Area	177.13 ha
Developed Area	86.14 ha
Landscaped Area	90.99 ha
Impermeability - Residential	0.60
Impermeability - Commercial	0.85
Impermeability - Education	0.50
Sewer design return period(2)	1 in 1 year
Sewer flood protection(2)	1 in 30 years
Fluvial / Development flood protection (1)	1 in 100 years
C (1km)*	-0.023
D1 (1km)*	0.325
D2 (1km)*	0.323
D3 (1km) *	0.249
E (1km) *	0.292
F (1km)*	2.469
Minimum cover to sewers (1)	1.2 m
Minimum velocity (1)	1.0 m/sec
Pipe ks value (1)	0.6 mm
Allowance for climate change (3)	40%

[2][2] Design and Construction Guidance for Foul and Surface Water Sewers
[3] NPPF requirements for residential development

Table 8-1: Drainage Criteria and Measure
* FEH Catchment Descriptors- Site constants for calculating rainfall depths

Infiltration Testing

8.3 Infiltration testing, to BRE365, was completed by GEG in April 2021 with ten trial pits completed across the site.

8.4 The trial pit location plan and infiltration results can be seen in **Appendix C**.

8.5 During infiltration testing, groundwater was encountered in trial pit 3. However, it is noted that for a future detailed design submission further winter water monitoring would be required to ensure the basins are designed above groundwater levels.

8.6 Infiltration testing results can be seen in **Table 8-2** below.

Location	Test Number	Time (Mins)	Infiltration Rate (m/s)
1	1	264	N/A
2	1	74	3.66 x 10-5
	2	73	3.64 x 10-5
	3	82	3.13 x 10-5
3	1	383	N/A
4	1	333	N/A
5	1	402	7.20 x 10-6
6	1	141	1.45 x 10-5
	2	92	2.06 x 10-5
7	1	193	1.34 x 10-5
	2	227	1.08 x 10-5
8	1	343	8.87 x 10-6
9	1	20	1.45 x 10-4
	2	18	1.81 x 10-4
	3	19	2.03 x 10-4
10	1	500	6.16 x 10-6
11	1	158	1.93 x 10-5
	2	142	2.21 x 10-5
12	1	27	1.09 x 10-4
	2	27	1.08 x 10-4
	3	29	1.06 x 10-4

Table 8-2: Infiltration Testing Results

Detention Basins

8.7 National policy[1] requires that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

8.8 "The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data".

8.9 On undeveloped and ungauged catchments of less than 0.5km2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697.

8.10 The baseline IoH run-off rates are shown on **Table 8-3** below:

Event	IoH 124 (165ha)	IoH 124 Scaled to 1ha
1 in 1 year (l/s)	680.24	2.56
Qbar (l/s)	781.89	2.94
1 in 100 year (l/s)	2783.74	10.47

Table 8-3: IoH124 baseline discharge rates

8.11 In order to determine the permitted rates of run-off from the development, the future impermeable catchment areas must be derived. This has been based on a BCL measured ratio from previous projects. Calculations below show these ratios and areas and how these correlate to the rates of discharge.

8.12 The calculations for this are shown in **Table 8-4**:

Catchment	Land Use	Developable Area (ha)	Impermeable Area with Urban Creep (10%)	Existing 100 Year Run-off (l/s)	Proposed 100 Year Run-off (l/s)
A	Residential	8.50	5.61	58.71	16.49
B	Residential	11.80	7.79	81.50	22.89
C	Residential	7.64	5.04	52.77	14.82
D	Residential	8.86	5.85	61.20	17.19
E	Residential	9.66	6.38	66.72	18.74
F	Residential	8.30	5.48	57.33	16.10
G	Residential	5.21	3.44	35.99	10.11
H	Residential	5.45	3.60	37.64	10.57
I	Residential	1.75	1.16	12.09	3.40
J	School	2.36	1.18	12.35	3.47
K	Mixed Use	5.33	3.75	39.24	11.02
L	Residential	2.52	1.66	17.41	4.89
M	Mixed Use	2.41	1.73	1.73	18.10
N	Residential	6.35	3.81	4.19	43.86
		86.14	**56.48**	**538.87**	**211.65**

Table 8-4: Run-off calculation

8.13 Using these methods, development at the site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

8.14 Assessments have thereafter been completed to determine the characteristics of proposed SuDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for both the 1 in 1 and 1 in 100 years + 40% climate change.

8.15 The summary calculations are contained in **Appendix B.**

Catchment A

8.16 Calculations demonstrate that storm water detention storage extending to maximum 4,888m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 16.50l/s, being equivalent to the mean annual storm (Qbar). **Table 8-5**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
8.50	5.61	16.50	4,888

Table 8-5: Summary run-off & detention assessment output

Catchment B

8.17 Calculations demonstrate that storm water detention storage extending to maximum 6,862m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 22.90l/s, being equivalent to the mean annual storm (Qbar). **Table 8-6**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
11.80	7.79	22.90	6,862

Table 8-6: Summary run-off & detention assessment output

Catchment C

8.18 Calculations demonstrate that storm water detention storage extending to maximum 4,398m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 14.82l/s, being equivalent to the mean annual storm (Qbar). **Table 8-7**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
7.64	5.04	14.82	4,398

Table 8-7: Summary run-off & detention assessment output.

Catchment D

8.19 Calculations demonstrate that storm water detention storage extending to maximum 5,105m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm +

40% climate change. This will limit the peak discharges to 17.19l/s, being equivalent to the mean annual storm (Qbar). **Table 8-8**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
8.86	5.85	17.19	5,105

Table 8-8: **Summary run-off & detention assessment output.**

Catchment E1

8.20 Calculations demonstrate that storm water detention storage extending to maximum 2,737m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 9.30l/s, being equivalent to the mean annual storm (Qbar). **Table 8-9**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
4.79	3.16	9.30	2,737

Table 8-9: Summary run-off & detention assessment output.

Catchment E2

8.21 Calculations demonstrate that storm water detention storage extending to maximum 2,774m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 9.30l/s, being equivalent to the mean annual storm (Qbar). **Table 8-10**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
4.85	3.20	9.30	2,774

Table 8-10: Summary run-off & detention assessment output

Catchment F

8.22 Calculations demonstrate that storm water detention storage extending to maximum 4,791m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 16.10l/s, being equivalent to the mean annual storm (Qbar). **Table 8-11**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
8.30	5.48	16.10	4,791

Table 8-11: Summary run-off & detention assessment output

Catchment G

8.23 Calculations demonstrate that storm water detention storage extending to maximum 3,127m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 10.11l/s, being equivalent to the mean annual storm (Qbar). **Table 8-12**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
5.21	3.44	10.11	3,127

Table 8-12: Summary run-off & detention assessment output.

Catchment I

8.24 Calculations demonstrate that storm water detention storage extending to maximum 998m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 3.40l/s, being equivalent to the mean annual storm (Qbar). **Table 8-13**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
1.75	1.16	3.40	998

Table 8-13: Summary run-off & detention assessment output.

Catchment J

8.25 Calculations demonstrate that storm water detention storage extending to maximum 1,011m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 3.47l/s, being equivalent to the mean annual storm (Qbar). **Table 8-14**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
2.36	1.18	3.47	1,011

Table 8-14: Summary run-off & detention assessment output

Catchment M

8.26 Calculations demonstrate that storm water detention storage extending to maximum 1,491m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 5.09l/s, being equivalent to the mean annual storm (Qbar). **Table 8-15**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
2.41	1.73	5.09	1,491

Table 8-15: Summary run-off & detention assessment output.

Catchment N

8.27 Calculations demonstrate that storm water detention storage extending to maximum 3,645m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm + 40% climate change. This will limit the peak discharges to 12.32l/s, being equivalent to the mean annual storm (Qbar). **Table 8-16**, below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
6.35	4.19	12.32	3,645

Table 8-16: **Summary run-off & detention assessment output.**

8.28 In accordance with legislative requirements, the detention proposals have been assessed for the potential effects of climate change. The 1 in 100 year (1% AEP) return events have been modelled for 40% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are contained within the Appendix. Climate change assessments show each detention feature to perform adequately by retaining the additional flows within the system without overflow.

8.29 A hydrobrake will be provided on the detention features, at a level above the 1 in 100 year + 40% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

8.30 The proposed strategic drainage masterplan is shown illustratively on drawing 10663-DR-01 D contained in **Appendix A**.

Infiltration Basins

Basin H

8.31 An infiltration rate of 1.76 X 10-4 was used.

For 60 minute winter storm
Half drain down time: 0 days, 0 hours, 76 minutes

Basin K+L

8.32 An infiltration rate of 1.07 X 10-4 was used.

For 120 minute winter storm
Half drain down time: 0 days, 2 hours, 03 minutes

Summary

8.33 A strategy for storm drainage at the site has been developed to meet both national and local policy. The above options outline the viability of the site to employ means of drainage to comply with NPPF guidance, together with Cherwell District Council and other national and local guidance.

8.34 The development drainage system will manage storm water by way of a SuDS management train and ensure peak discharges from the developed land is not increase from the appraised baseline rates. The system will also provide to maintain the quality of water discharged from the development.

Objectives

8.35 The key objectives for the site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the site to a rate commensurate with the baseline conditions.
- Development of storm water management proposals that maintain water quality and biodiversity of the site.
- Implementation of the storm water management system prior to first use of the site.

9 SuDS Management

Water Quality

9.1 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

9.2 The SuDS Manual C753 describes a 'Simple Index Approach' for assessing the pollution risk of surface run-off to the receiving environment using indices for likely pollution levels for different land uses and SuDS performance capabilities.

9.3 CIRIA document C753 Table 26.2, as shown in **Table 9-1** below, indicates the minimum treatment indices appropriate for contributing pollution hazards for different land use classifications. To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index.

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail) all roads except low traffic roads and trunk roads/motorways.	Medium	0.7	0.6	0.7

Table 9-1: CIRIA 753 Table 26.2 Pollution Hazard Indices

9.4 For a residential type development, roof water requires a very low treatment of 0.2 for total suspended solids, 0.2 for heavy metals and 0.05 for hydrocarbons, and run-off from low traffic roads such as cul-de-sacs and individual property driveways requires low treatment of 0.5 for total suspended solids, 0.4 for heavy metals and 0.4 for hydrocarbons.

9.5 To provide the correct level of treatment, an assessment needs to be made of the mitigation provided by each SuDS feature. Tables 26.3 and 26.4 of The SuDS Manual CIRIA document C753 shown as **Table 9-2** and **9-3** for discharges to surface waters and groundwater respectively indicate the treatment mitigation indices provided by each SuDS feature.

Type of SuDS component	Total suspended solids (TSS)	Metals	Hydro-carbons
Swale	0.5	0.6	0.6
Detention basin	0.5	0.5	0.6
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the one in 1-year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 9-2: CIRIA 753 Table 26.3 SuDS Mitigation Indices for discharges to surface waters.

Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates	Total suspended solids (TSS)	Metals	Hydro-carbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300 mm in depth	0.4	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, i.e. graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20mm gravel) underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.4	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the one in 1-year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 9-3: **CIRIA 753 Table 26.4 SuDS Mitigation Indices for discharges to groundwater**

9.6 Where more than one mitigation feature is to be used, CIRIA guidance states that the total mitigation index shall be calculated as follows:

Total SuDS mitigation index = Mitigation Index 1 + 0.5 x Mitigation Index 2

9.7 At present, the site does not benefit from any additional measures of stormwater treatment.

9.8 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development so as to have a positive impact on the surrounding natural environment.

9.9 The site will employ SuDS features, such as formal swales and detention basins. These are widely accepted to be of high pollutant removal efficiency (CIRIA 609). This provides for one stage of treatment onsite. Coupled with this however, the unknown watercourse that crosses the development site should also be seen as an additional stage of treatment as the sedimentation process is not limited to artificial drainage systems but is taken from the natural processes observed within the water cycle. This gives 2-3 stages of treatment, providing an extensive system by which to effectively decrease pollutant load within stormwater run-off.

9.10 As the site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Exceedance Flows

9.11 Careful regard has to be made in respect of potential exceedance flows, being events that are more extreme than current design criteria. Various national guidance has been published on the matter of exceedance flows and measures that should be incorporated into a development to ensure the safety of occupiers and those using the infrastructure.

9.12 The principal aim is to direct any exceedance flows away from properties and along defined corridors. At a local level, this may mean water being conveyed along a length of highway, as long as the predicted flow depths and velocities are acceptable. More strategically, the implementation of conveyance corridors is important in avoiding deep and high velocity flows that present a high risk. The drainage system being promoted for Bicester provides a good opportunity to incorporate exceedance flow routes into the design.

9.13 Careful and considered design in other areas, can also reduce the risk. For example the strategic SuDS system being promoted for Bicester, provides a layered and disbursed system of treatment across the site, thereby avoiding a traditional and more risky design that might, for example, have all storm water being collected in a strategic spine sewer that conveys flows to a large basin at the bottom of the catchment. This latter system concentrates peak discharges into a single corridor, that if blocked can have unacceptable consequences.

9.14 Other more local measures also should be incorporated. Hydrobrakes or the like will be provided on drainage systems, at a level above the 1 in 100 year + 40% flood level, safely to allow more extreme event flows be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas.

9.15 Clearly, many of the measures for dealing with exceedance flows must be dealt with at the detailed design stage. However, the strategic layout for proposed development at Bicester provides the framework of a network that can effectively deal with any future exceedance problems.

Implementation Proposals

9.16 The conceptual drainage proposals have been developed in a manner that will allow the site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by removing the low-level silts, oils which could be attributed to track/parking area run off of this nature. Final design will provide for appropriate geometry and planting to maximise this benefit.

9.17 The storm water management features will be constructed and operational prior to the first use of the site, derived on a phase-by-phase requirement.

9.18 It has previously been the case that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by the Local Authority, Drainage Authority, or a private maintenance company as appropriate. It is proposed that, for this development, a private maintenance company will be appointed to carry out the maintenance regime below in **Table 9-4**.

9.19 It is usual for the following maintenance regime to be implemented:

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of
2 years	Tree pruning.
5-10 years	Desilting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Table 9-4: Framework maintenance of detention / retention system

9.20 At the Landscape Management Plan additional information regarding the maintenance regime will be provided.

9.21 The conceptual drainage masterplan proposals outlined in this report will be used for final drainage design and detailing. The storm water management system will be constructed and operational in full prior to first use of the relevant phase of development.

10 Foul Drainage

Background

10.1 Thames Water sewer records indicate that there is a foul sewer along Bucknell Road which lies within the western third of the site.

10.2 There is a Thames Water sewage treatment plant located to the south of Bicester approximately 3km south of the site.

Design Criteria / Network Requirements

10.3 Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:

Domestic peak (peak)	=	*4,000 litres / dwelling / day*

10.4 Assessed in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers requirements, the development will have a design peak discharge of approximately 120.40 l/s.

Network Requirements / Options

10.5 Ofwat has recently instigated significant changes into the charging regimes of the water companies. Whereas prior to April 2018, the water companies would charge developers for any reinforcement works to the existing network directly attributable to the new demand, under the new charging rules the developer has to only fund infrastructure works to the nearest practicable point of connection (defined as network of an equal or greater size to the infrastructure supplying the Site). As such, any reinforcement works are covered by the Infrastructure Charge, payable per plot for all new connections.

Treatment Requirements

10.6 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 et al., to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. The five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

10.7 Where development programming requirements necessitate the reinforcement of facilities ahead of allocation in an AMP period, mechanisms are available to ensure the infrastructure can be delivered in a timely fashion, to meet the development programme.

Implementation Proposals

10.8 The proposed drainage network across the site will be designed to current Design and Construction Guidance for Foul and Surface Water Sewers standards, employing a point of connection agreed with Thames Water.

10.9 The system will be offered for the adoption of Thames Water under S104 of the Water Industry Act 1991.

Summary

10.10 A site drainage strategy has been developed that meets with current regulatory requirements by discharging drainage to a sewerage network with capacity to accommodate the flows.

10.11 Once development is complete, the network conveying flows from the site will be adopted by Thames Water and be maintained as part of their statutory duties.

Objectives

10.12 The key development objectives required for the site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Thames Water network which is designed and maintained to an appropriate standard.

11 Summary

11.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site for the proposed developments.

11.2 Assessment of fluvial flood risk shows the land to lie within Flood Zone 1 and hence be a preferable location for residential development when considered in the context of the NPPF Sequential Test.

11.3 Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, groundwater and sewer flooding.

11.4 Storm water discharged from development will be disposed of by way of SuDS measures into the existing drainage network, comprising of ordinary watercourses and drainage ditches located within the site boundaries.

11.5 Means to discharge foul water drainage will comply with current guidance and requirements of Thames Water. Foul water will discharge to the existing network, following formal confirmation from Thames Water.

11.6 The site is fully able to comply with NPPF guidance together with associated local and national policy guidance.

12 Limitations

12.1 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

12.2 Third party information has been used in the preparation of this report, which Brookbanks, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, Brookbanks accepts no liability for same.

12.3 The benefits of this report are provided solely to Hallam Land Management Ltd for the proposed development at Land at North West Bicester only.

12.4 Brookbanks excludes third party rights for the information contained in the report.