Outline Application

NW Bicester Planning Application 1

Flood Risk Assessment and Surface Water Drainage Strategy

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EXECUTIVE SUMMARY

The table below provides an overview of the flood risk and drainage strategy for the proposed Bicester Application 1 site.

Item	Response
Site Location	The Application 1 site is located on land to the north of the railway line and A4095 Lord's Lane and west of B4100 Banbury Road, surrounding Lord's Farm and Hawkwell Farm, Bicester, Oxfordshire. The villages of Bucknell and Caversfield are located to the north and east of the Site respectively.
Size and Current Land Use	The Site has a total area of approximately 154.82ha and is existing open agricultural land.
Environment Agency Flood Zone	The majority of the Site is within Flood Zone 1: Low Probability. Areas of Flood Zone 2 and 3 are located adjacent to watercourses where no development is proposed other than green buffers and blue corridors.
Fluvial Flood Risk	Low risk of fluvial flooding
Tidal Flood Risk	No risk of tidal flooding
Surface Water Flood Risk	Low risk of surface water flooding
Sewer Flood Risk	The Site itself is not at risk of flooding from sewers. However, an appropriate drainage strategy is required to ensure that the development does not exacerbate downstream flood risk.
Groundwater Flood Risk	Considered unlikely although further Site specific monitoring would confirm this.
Artificial Sources Flood Risk	Low risk of flooding from artificial sources
Historical Flooding	No records of historical flooding
Proposed Development	Up to 2,600 new homes houses with employment areas and associated services and infrastructure
NPPF Flood Risk Vulnerability	More vulnerable
Sequential and Exception Tests	The proposed development types are permitted within Flood Zone 1 and therefore pass the Sequential Test. The Exception Test is not required,

1 INTRODUCTION

1.1 Background

The North West Bicester site is identified in the emerging Cherwell Local Plan 2006 - 2031 as falling within an area to provide for circa 5000 new homes, and related social and community facilities. The allocation of the site in the emerging Cherwell Local Plan 2006 - 2031 follows the identification of land at north-west Bicester as a potential eco-town in the Planning Policy Statement: Eco-Towns A Supplement to Planning Policy Statement 1 (July 2009). The PPS1 supplement includes requirements relating to sustainability, affordable housing, low and zero carbon technologies and public transport.

The emerging Cherwell Local Plan 2006 - 2031 identifies a broad area to the north west of Bicester within which the site falls. A Masterplan has been submitted to CDC in response to the requirements of the supplement to PPS1 in March 2014 with additional/ amended information provided in May 2014. It is understood that CDC is minded to adopt the Masterplan, following consultation and review (and amendment as appropriate) as non-statutory policy.

The North West Bicester Master plan area comprises some 406 ha and sets out the strategy for the development of the site.

Planning permission was granted in 2012 for the development of some 21 ha of land within the Masterplan area as an Exemplar Phase. This permission will be implemented shortly and provides for 393 new homes, land for a new primary school, together with social and community facilities, business and retail accommodation.

A2Dominion intend to bring forward further applications for planning permission as follows:

- Application 1 – Outline application comprising some 154.82 ha of land, to provide for circa 2,600 residential dwellings, land for new primary schools, associated open space, recreation and play space, social and community facilities and employment land, access and infrastructure works;
- Application 2 – Outline application comprising some 51.27 ha of land, to provide for circa 900 residential dwellings, land for a new secondary school, new primary schools, associated open space, recreation and play space, social and community facilities and employment land, access and infrastructure works;
- Strategic Infrastructure Application – Detailed application comprising a new A4095 NW Strategic Link Road.

A Flood Risk Assessment (FRA) and Surface Water Drainage Strategy report has been prepared for each of the three planning applications.

This FRA and Surface Water Drainage Strategy report has been prepared in relation to Application 1 site, to be referred to in this document as the Site.

1.2 Previous Studies

The previous studies used to inform this report are listed below:

- North West Bicester—Flood Risk Assessment (Hyder, 2013)
- North West Bicester—Surface Water Drainage Strategy (Hyder, 2013)
- North West Bicester—Water Cycle Study (Hyder, 2013)

1.3 The role of this document

The role of this FRA and Surface Water Drainage Strategy Document is to identify potential flooding mechanisms on and off Site, and how these might be affected by climate change; and hence to determine appropriate mitigation measures. This will provide a robust evidence base to demonstrate that the North West Bicester development Site can be developed with appropriate consideration of flood risk mitigation on Site, and without increasing the flood risk to third parties.

The Surface Water Drainage Strategy (SWDS) will inform the FRA for the Application 1 Site in order to meet the requirements of the National Planning Policy Framework (NPPF) which states:

'.. the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, should be incorporated in a flood risk assessment.'

2 WIDER DEVELOPMENT CONTEXT

2.1 Overall NW Bicester Master plan Site Location

The site of the proposed North West Bicester development is on the North West perimeter of Bicester, Oxfordshire and has a total site area of approximately 400ha. The Site is bounded by the A4095, B4100 and B4030 and bisected approximately north south by the mainline Birmingham to London Marylebone railway and Bucknell Road.

The existing site is predominantly Greenfield in nature, encompassing a number of small farms and associated access. Figure 2-1 shows the overall NW Bicester Development site location along with the key features referred to in the report.

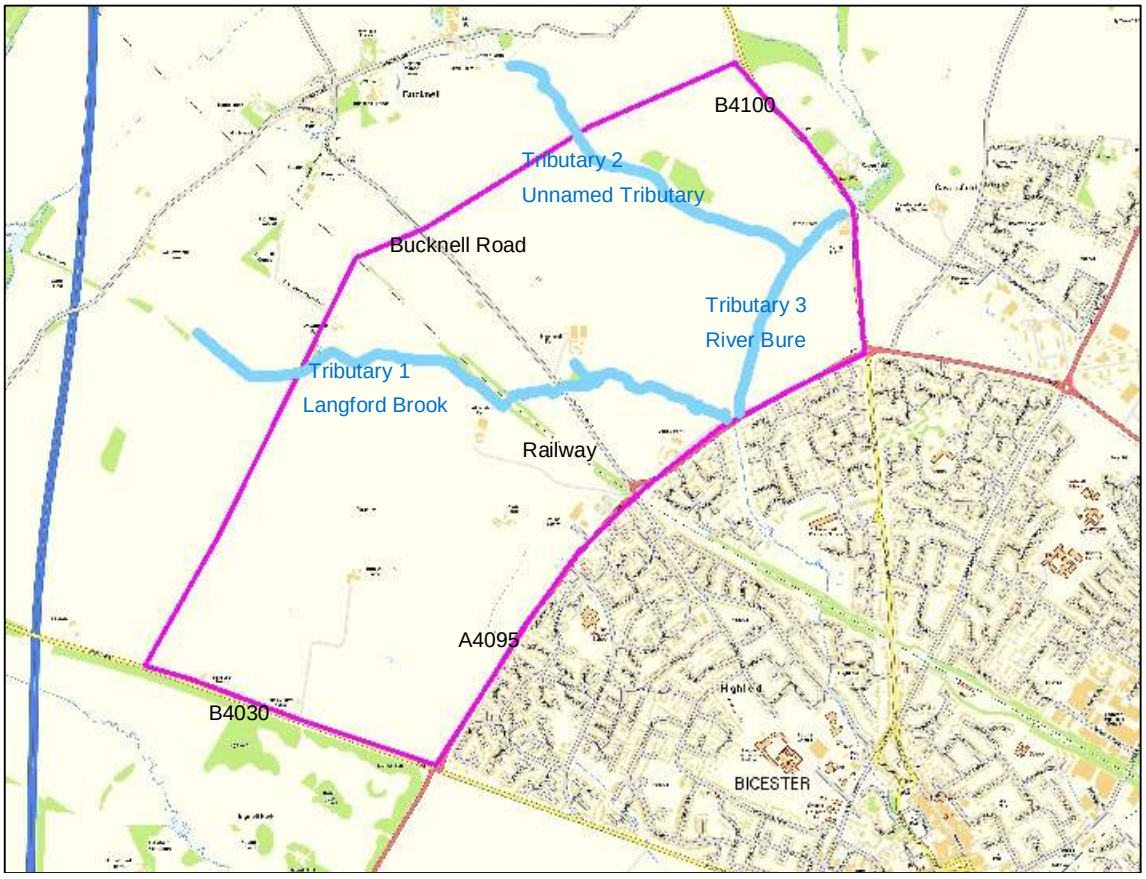

Figure 2-1 NW Bicester Development Site Location

2.2 Planning Context

This assessment has been undertaken in accordance with current international and national legislation, and national, regional and local plans and policies. A summary of the relevant legislation and policies and the requirements of these policies is provided below:

2.2.1 National Planning Policy Framework (NPPF)

The NPPF sets out Government policy on development and flood risk. Its aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk.

2.2.2 The Water Framework Directive (2000/60/EEC)

The Directive provides a framework for the protection of surface (fresh) water, estuaries, coastal water and groundwater. The objectives of the Directive are to enhance the status, and prevent further deterioration, of aquatic ecosystems, promote the sustainable use of water, reduce pollution of water (especially by 'priority' and 'priority hazardous' substances) and ensure progressive reduction of groundwater pollution. Among the main features of the Directive are that all inland and coastal waters within defined river basin districts must reach at least good ecological status by 2015. The Development will aim to attain the highest achievable level of water quality standards. This will be achieved by the incorporation of Sustainable Drainage Systems (SUDS) within the design to improve the quality of the runoff from the Site.

2.2.3 The Flood and Water Management Act (2010)

The Flood and Water Management Act provides better, more comprehensive management of flood risk for people, homes and businesses. It also helps tackle bad debt in the water industry, improves the affordability of water bills for certain groups and individuals, and helps ensure continuity of water supplies to the consumer. The Flood and Water Management Act encourages the use of sustainable drainage in new developments and re-developments. Through the preparation of the FRA and the Drainage Strategy, the Development will incorporated SUDS within the design. It has been concluded that the Development will not be exposed to an unacceptable degree of flood risk nor increase the flood risk to third parties.

2.2.4 Cherwell Local Plan Submission (2014) Policy

The emerging Cherwell Local Plan 2006 - 2031 identifies land to the north-west of Bicester as a strategic site for the provision of an eco-development under Policy Bicester 1: North West Bicester Eco-Town. This policy aims to embed the criteria of the PPS1 Supplement in local policy. The Cherwell Local Plan 2006 - 2031 is not yet adopted. Therefore, the NPPF and PPS1 Supplement are the principal planning documents against which the proposals should be considered.

2.3 Project Evolution and Overall Framework

In July 2009, the Department for Communities and Local Government published 'Planning Policy Statement (PPS): eco-towns' as a supplement to PPS1 Delivering Sustainable Development (Ref 1-2). The PPS1 supplement includes requirements on sustainability, waste reduction, zero carbon buildings and sustainable public transport.

Within the PPS1 supplement, Eco-towns are defined as sustainable developments of at least 5,000 homes. In July 2009, four 'first wave' locations were identified with the potential to have an Eco-town; one of which was NW Bicester.

The Eco-towns PPS outlines the Government's objectives for planning that are set out in PPS1:

"To promote sustainable development by:

- ensuring that eco-towns achieve sustainability standards significantly above equivalent levels of development in existing towns and cities by setting out a range of challenging and stretching minimum standards for their development, in particular by:
- providing a good quantity of green space of the highest quality in close proximity to the natural environment
- offering opportunities for space within and around the dwellings

- promoting healthy and sustainable environments through ‘Active Design’ principles and healthy living choices
- enabling opportunities for infrastructure that make best use of technologies in energy generation and conservation in ways that are not always practical or economic in other developments
- delivering a locally appropriate mix of housing type and tenure to meet the needs of all income groups and household size, and
- taking advantage of significant economies of scale and increases in land value to deliver new technology and infrastructure such as for transport, energy and community facilities.
- To reduce the carbon footprint of development by:
- ensuring that households and individuals in eco-towns are able to reduce their carbon footprint to a low level and achieve a more sustainable way of living.”

The North West Bicester development lies within the jurisdiction of Cherwell District Council (CDC), and the masterplan for the site is being progressed by A2 Dominion. A planning application (Ref: 10/01780/HYBRID) was submitted in December 2010 for the first part of the NW Bicester development, the Exemplar Phase with an Addendum submitted in April 2011. The Exemplar Phase is the first phase of the development of the Masterplan Site.

3 SITE AREA AND DEVELOPMENT PROPOSAL

3.1 Site Description

The town of Bicester lies approximately 24km to the northeast of Oxford, and 28km to the southeast of Banbury. The M40 runs approximately 2km to the southwest, with Junction 9 providing access to the town via the A41.

The Application 1 Site covers approximately 154.82ha (Figure 3-1). The land currently comprises Grade 3 agricultural land and contains a farmhouse and other buildings.

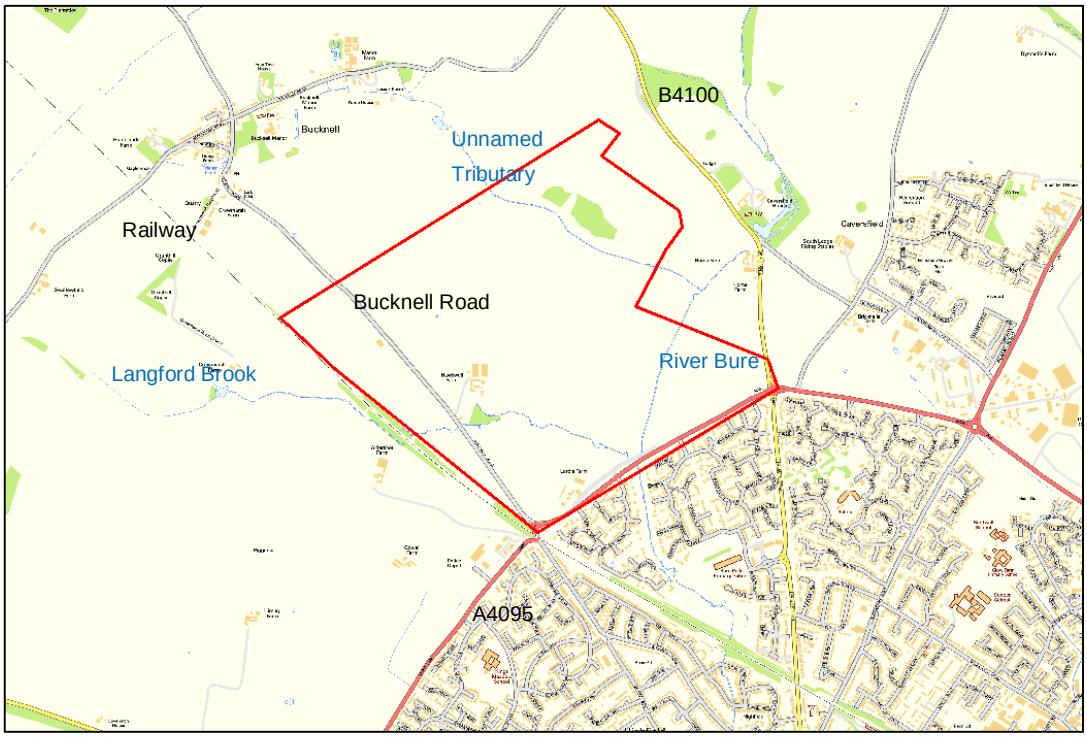

Figure 3-1 Application 1 Location (indicated by red boundary)

The Site lies North West of Bicester town, between the railway and the B4100 (Figure 3-1). The Site's southern boundary runs alongside the A4095 (Lords Lane), the western boundary runs along the railway line and eastern boundary runs briefly along the B4100 before connecting with the Exemplar Phase boundary. The Exemplar Phase, located on the north eastern edge of the Masterplan area is the first phase of the Masterplan Area development. Construction is to commence shortly and will provide for 393 residential units, energy centre, a primary and a nursery school.

3.2 Site Topography

The Application 1 Site slopes predominantly from northwest to south east with elevations ranging from around 93mAOD to 80mAOD. A detailed topographic survey of the Site has not been completed; elevations are based on LiDAR data supplied by Environment Agency Geomatics in September 2013. The main watercourses on the Site drain into the River Bure which leaves the Site via a culvert under the A4095, flowing towards Bicester town centre.

The Application 1 Site contains a number of drainage features; the River Bure and its tributaries, the Langford Brook, Hawkswell Farm and unnamed tributary), field drains, ponds and springs. The main drainage features are described below.

The Bure flows in a southerly direction from Watergate Farm to a culvert beneath the A4095. Downstream of the culvert it flows in an open channel between Lucerine Avenue and Purslane Drive before flowing beneath the railway line and through Bicester town centre. The River Bure is classed as 'Main River' from Graham Road (immediately downstream of the railway) in the centre of Bicester, upstream of this point, the river is classed as 'Ordinary Watercourse'.

3.3 Existing Drainage Features

The Site currently drains to the Langford Brook and the River Bure. The Langford Brook, an ordinary watercourse, flows in an easterly direction from Crowmarsh Farm and converges with the River Bure at the A4095 culvert.

The highways crossing and adjacent to the Site shed surface water to their grassed verges, from where it infiltrates the ground.

Information obtained from Thames Water indicates that urban areas surrounding the Site are drained by a positive drainage network of surface water pipes and manholes which discharge to nearby watercourses. The urban areas drain away from the proposed Site.

3.4 Ground Conditions

The online Environment Agency maps indicate that the bedrock below the Site is designated as a Secondary A Aquifer which is described as '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'. There are no Groundwater Source Protection Zones (SPZ) in the vicinity of the Site. Consultation with CDC has not identified any private water supply boreholes within the Site although four boreholes are located within 1.5km of the Site. A targeted, intrusive ground investigation was carried out in 2010 and the soakway tests indicated little or no soakage.

3.5 Development Proposals

Application 1 comprises land within the NW Bicester eco-development area. The development proposals for the Site include provision for the following:

- Retention of the existing storage building adjacent to Bucknall Road
- Up to 2,600 Residential dwellings (Class C3), including up to 250 on an 'Extra Care' basis
- Commercial floor space (Class A1-A5, B1 and B2)
- Social and community facilities (Class D1)
- A new Primary School (Class D1) and extension of Exemplar Phase primary school
- Green Infrastructure/ Strategic landscape
- New Vehicular, cycle and pedestrian routes
- Water Treatment Plant and Energy Centre
- Service infrastructure

The Site planning application will be submitted in outline with all matters reserved. All such development shall accord with the Application Plans and Development Parameters Schedule. Drawing BIMP6 116D in Appendix 2 illustrates the proposed Masterplan for the Site along with the proposed land-use schedule.

Proposed housing character scale and density information is presented in Appendix 3.

3.6 Development Programme

The key planning and development milestones associated with the Site development proposals have been set out in Table 3-1 below:

Development Programme	Planned Programme
Submission of Application 1 Outline Planning	August 2014
Planning Committee (Site)	Winter 2014
Submission of an Outline Planning Application 2 and Full Planning for Strategic Infrastructure	August 2014
Construction Start of Site (anticipated)	2018
Construction Period	Approximately 16 years

Table 3-1 Development Programme

Appendix 4 also includes an indicative phasing plan.

4 FLOOD RISK ANALYSIS

4.1 Historical Flooding

As the existing Site is undeveloped, it is considered unlikely that any flooding would have been reported. A review of the Oxfordshire Preliminary Flood Risk Assessment (PFRA)[1] did not highlight any flooding within the Site boundary although some surface water flooding has occurred within Bicester town.

4.2 Sources of Flooding

The Technical Guidance to NPPF requires that an FRA should 'assess the risks of all forms of flooding to and from the development'; therefore, this section presents a review of all potential sources of flood risk to the proposed development Site.

North West Bicester Master plan – Flood Risk Assessment (FRA) produced by Hyder Consulting Ltd in February 2014 looked at these sources of flooding in detail. They are summarised in this section and in detail applicable to Application 1 Site.

4.2.1 Rivers

The Site drains to the Langford Brook (a tributary of the River Bure) and the River Bure. The River Bure is a tributary of the Ray, Cherwell and ultimately the Thames.

Flood risk to the proposed Site displayed on the online EA flood maps are based upon a coarse DTM and JFLOW modelling and these maps are not considered suitable to delineate the flood plain in sufficient detail to inform a FRA in support of a planning application. Therefore a hydraulic model has been constructed to confirm the floodplain extents across the Site.

A detailed ISIS hydraulic model has been used as a baseline to define fluvial flood plains for a 1% AEP, 1% AEP plus climate change and 0.1% AEP events at the Application 1 Site. Plans contained within Appendix 6 show the modelled flood extent for the 100-year and 1,000-year events (i.e. Flood Zones 3 and 2 respectively). The modelled flood extent shows that flooding occurs predominantly on the flatter land around the confluence between the River Bure and the northernmost of the Langford brook. Away from the confluence, flooding is confined to the relatively narrow valley of the watercourses.

Examination of the modelling results using the LiDAR and modelled cross sections show that the majority of the flood extents are within the 30m wide green corridor buffer zone already incorporated in the master plan design. There are three locations where modelling indicates that the extents are more than 30m wide. These locations are discussed in Section 5.1 and it is recommended that the width of the corridor is increased in these locations

The model predicts that floodwater is generally confined to the valleys in which the watercourses flow, with ponding occurring at confluences and upstream of constricting structures. The model does not predict any overland flow occurring.

The model results have confirmed that the Site is predominantly located within the Low Flood Risk Zone (Flood Zone 1), with small areas of Medium and High risk restricted to areas immediately adjacent to the watercourse corridors. All proposed development has been located

[1] JBA Consulting (2011) Oxfordshire County Council Preliminary Flood Risk Assessment: Preliminary Assessment Report

within the areas of Low risk, and therefore the development is considered to be at low risk of flooding from fluvial sources.

4.2.2 Sea

The Site is located some 150 km from the coast and is therefore not at risk of flooding from the sea.

4.2.3 Surface Water

The existing Site is Greenfield and used for agricultural purposes, therefore there is no surface water drainage infrastructure associated with the Site. It was therefore concluded that the Site may be at risk of flooding from the land. A direct rainfall model was produced in TUFLOW to represent the existing surface water flow paths across the Site.

Surface water model results demonstrate that the key surface water flow routes within the Site follow the existing channels of the Langford Brook. Where additional key surface water flow routes have been identified, these predominantly fall within green corridors and have been used to define the location of proposed detention basins, ponds and swales as part of the Drainage Strategy. Where existing flow routes do not follow the green corridors then suitable measures will be incorporated as part of the Site detailed design to intercept and convey significant flows to the proposed SuDS features depending on the proposed ground levels within the development parcels. As the Site is almost entirely greenfield in its pre development state, the Drainage Strategy is based on the principle of attenuating any additional post development runoff to equivalent greenfield rates. This will ensure that flood risk is not increased to third parties following the increase in impermeable areas post development.

4.2.4 Groundwater

Maps of Areas Susceptible to Groundwater Flooding (AStGWF) were included within the SFRA. These maps were released by the Environment Agency in 2011 and show the proportion of each 1km grid square where geological and hydrogeological conditions indicate that groundwater might emerge. To the south west of the railway line, no groundwater flood susceptibility has been defined.

The Environment Agency on-line Groundwater Vulnerability Map has been reviewed to determine the vulnerability of the groundwater underlying the Site with the following conclusions: The superficial deposits are not classified as an aquifer. The underlying Cornbrash Formation is classified as a Secondary A Aquifer, which comprises “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.”

The SFRA and PFRA indicate some potential for groundwater flooding in the area. The currently available ground investigation suggests that the risk of groundwater flooding is likely to be small. This is also supported by no known previous groundwater flooding incidents within the Site.

Additional Site specific ground investigations that will be undertaken to inform the general Site detailed design process would provide further information necessary to quantify and inform any localised groundwater flooding risk to the Site and identify the need for any additional residual risk mitigation measures during the detailed design stage.

4.2.5 Sewers

Thames Water Utilities Limited (TWUL) owns assets within and around the development Site that are likely to be affected by the proposals. TWUL plans indicate that an existing 150mm foul water

rising main and a 150mm standby rising main run south along Bucknell Road. All other sewers shown on the plan serve the existing area of Bicester on the south east side of the A4095. There are no known flooding issues associated with the existing public sewers within the Site boundary.

The SFRA highlights a report from CDC there is a known history of sewer flooding in Bicester resulting from a limited capacity within the network. The consultations undertaken with TWU during the preparation of this FRA also confirmed that there is limited capacity available within the existing sewer network.

It is therefore concluded that known problems and infrastructure in the area may require further consideration in order to prevent potential exacerbation of any existing flooding problems.

TWUL plans indicate three potable water mains crossing the Site following an existing minor track located approximately 600m west of the railway. There is a risk that, should these pipes be damaged during the construction process, flooding to the Site could occur as a result.

It is therefore concluded that the Site is at risk of flooding from artificial sources, predominantly during the construction phase. Mitigation for this risk is discussed further in Section 5.

4.2.6 Artificial Sources

The Site is not located close to any reservoirs, canals or other raised water storage assets, therefore the Site is not at risk from artificial sources.

4.3 Specific Flood Risk Concerns and Considerations

4.3.1 Third Party Flood Risk

All development will be sited within Flood Zone 1 and all new bridges will be constructed so as to avoid any restriction in channel or floodplain flows. Therefore, there will be no loss of floodplain storage caused by the proposed development. Any increased peak surface water runoff caused by the development will also be attenuated to Greenfield rates (see Section 5). Therefore, there will be no increase in third part flood risk as a result of the development.

4.3.2 Site Access and Egress

As stated before, all development will be sited within Flood Zone 1, and any roads crossing watercourses will be raised above flood levels. Therefore, emergency access routes will not be affected by flooding.

4.3.3 Residual Risk

It is essential that the risk of flooding is minimised over the lifetime of the development (100 years) in all instances. It is important to recognise, however, that flood risk can never be fully mitigated, and there will always be a residual risk of flooding. The NPPF states that the residual risks are those remaining after applying the sequential approach and taking mitigation actions.

The residual risks to the development Site are considered to be:

- A fluvial flood event in excess of those currently modelled.
- A storm event which exceeds the capacity of the onsite drainage systems.

5 PROPOSED FLOOD RISK MANAGEMENT STRATEGY

This section considers how the proposed development will be protected from flooding over the development lifetime, including the potential impacts of climate change.

5.1 Fluvial

The proposed development Site is almost entirely within Flood Zone 1. All proposed development areas are located in Flood Zone 1 and green and blue corridors have been incorporated within Flood Zone 2 and 3 as part of the Masterplan development. Watercourse cross sections from the 1D-ISIS model have been used to estimate the fluvial flood extents in the Application 1 Site Climate change is predicted to increase the modelled flood extents by only a small amount as shown in Appendix 6. For the majority of the Site any increase in flood extents is contained within the allocated green corridors. However, in the following locations modelling indicates that the flood extents could potentially exceed the 30m green corridor buffer zone (Figure 5-1):

- The flood extents exceed the buffer zone at T1-1524, between the Railway and the Bucknell Road. In this location is it recommended that the green corridor is extended to contain the flood plain.
- At section T1-0851 there is low point where the flood extents exceed the width of the green corridor. Therefore, we recommend an extension of the green corridor by 10m to contain the flood event.
- At T2-0055, the flood extents exceed the 30m green corridor but there is sufficient space to extend the green corridor in this location.

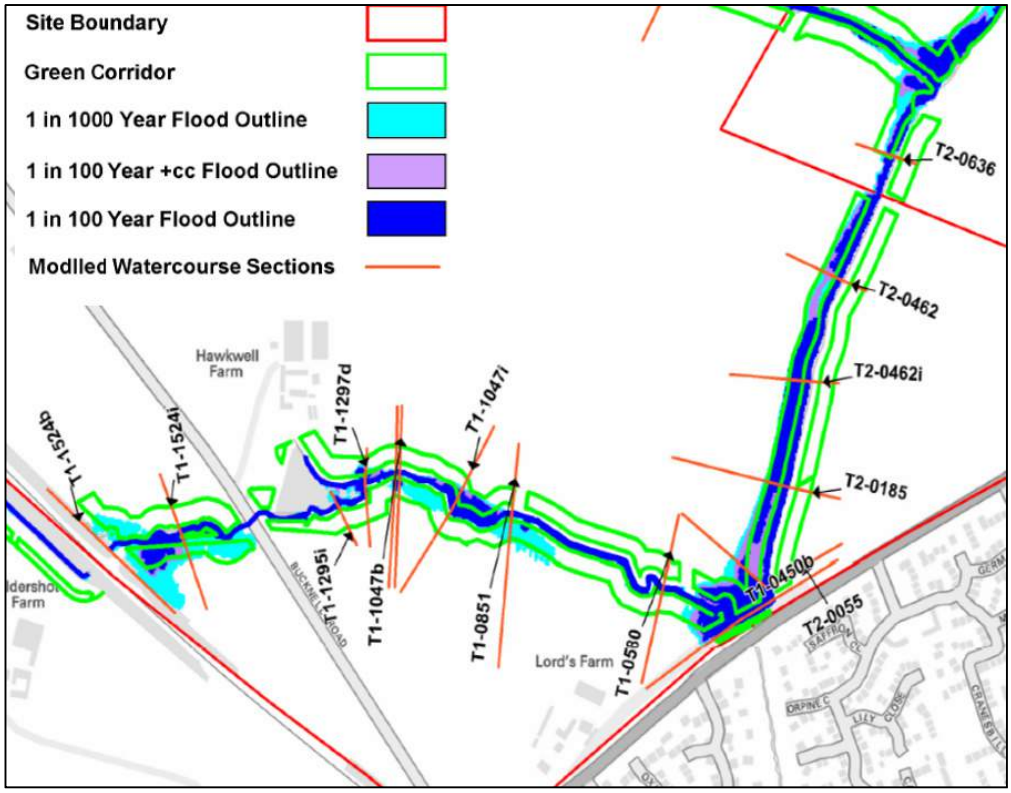

Figure 5-1 Modelled Fluvial Flood Extents

Aside from the aforementioned the flood extents for all fluvial events are contained within the 30m green corridor. Therefore, the developable area of the Site is not predicted to be at risk of flooding during the development lifetime, including the potential impacts of climate change.

Bridge crossings may be required to cross land drains and watercourses. All new bridge crossings will be designed such that the soffit is a minimum of 600mm above the modelled peak 1% AEP plus climate change water level. Furthermore, all bridge abutments will be outside the modelled 1% AEP plus climate change floodplain. This mitigation will ensure that any crossings do not increase flood risk to the Site or to third parties.

5.2 Surface Water

Surface water model results demonstrate that the key surface water flow routes within the Site follow the existing channels of the Langford Brook and also existing drainage ditches. An appropriate surface water drainage strategy has been produced in order to manage on Site surface water flood risk. The details of the strategy are outlined in the sections below.

5.2.1 Drainage Strategy

SuDS Techniques and Guidance

Schedule 3 of the Flood and Water Management Act 2010 provides for use of SuDS on future developments in England. As part of this, a set of National Standards for SuDS in England have been proposed. Consultation on these standards was carried out between 20th December 2011 and 13th March 2012. A summary of consultation responses was published on 13th August 2012 however, it is not anticipated that the final standards will be published until April 2015 or later this year.

Overall SuDS Strategy

The overall aim is to minimise Site run-off by integrating water management into the Application 1 Site and the surrounding environment and treating water as a resource. The SuDS Management Train provides the framework for the NW Bicester Drainage Strategy. Therefore the proposed Application 1 Site should first seek to reduce the amount of impermeable surfacing used within the development and secondly, where practical, replace traditional hard surfacing with permeable alternatives.

Key pathways for surface water flow through the Site were identified using the results from the 0.1% AEP, 1% AEP and 1% AEP plus climate change surface water modelling. This enabled a series of Site control measures to be identified in the form of attenuation basins and swales distributed throughout the areas highlighted for urban development in a series from the upper to lower subcatchment. Preferentially, attenuation areas were placed in locations where the model results indicate that surface water would pond naturally due to the existing topography as well as keeping the size of the attenuation areas in proportion to the developed area.

In addition, swales were preferentially located in line with corridors of green infrastructure identified on the current Site Masterplan. Where the route of a swale required a road crossing, it has been assumed that an appropriate, clear spanning crossing can be provided unless suitably sized new culvert crossing and an emergency overspill mechanism will be provided through the Site detailed design process.

Assessment of Attenuation Volume

In line with guidance set out in the CIRIA SuDS Manual[2], maximum side slopes of 1 in 4 were applied to the detention basins and attenuation ponds. A maximum depth of 0.5m was selected primarily for safety reasons. All strategic attenuation areas should be sized to accommodate the 1% AEP with an allowance for climate change subject to the final contributing catchment size and impermeability.

Swales were assumed not to contribute to the estimated overall storage requirements and were instead designed predominantly for conveyance of surface water flows to, and between, attenuation areas. This provides a conservative and robust approach to the proposed drainage strategy for the master planning purpose because any additional storage that is available from the swales will reduce the downstream flood risk.

Two types of swales have been proposed for this development; primary and secondary. The primary swales have a base width of 1m, a maximum depth of 0.5m, giving an overall top width, and thus a land take corridor, of 5m. The secondary swales have a base width of 0.5m, a maximum depth of 0.25m and an overall top width of 2.5m. In line with the SuDS Manual both the primary and secondary swales have side slopes of 1 in 4.

The sections below describe the proposed drainage strategy and attenuation storage available within each key subcatchment. Appendix 8 also shows a preliminary layout of the proposed SuDS features, together with the fluvial flood plain and main existing surface water flow routes. As noted on this drawing, 20% of the required attenuation storage for each subcatchment will be provided by individual developers using source and Site control measures at their individual development plots.

Therefore, the attenuation volumes presented below exclude the extra storage available at individual plot levels as well as within the proposed swales, which clearly illustrate that the proposed drainage strategy include sufficient attenuation storage.

SuDS Techniques

Sustainable Drainage Systems (SuDS) are based on drainage techniques which mimic runoff from the Site in its natural state. The aim of a SuDS based system is to manage rainwater on the surface, close to its source with the consequence that water is stored and released slowly thus reducing flood risk and improving water quality.

Examples of SuDS techniques include permeable paving, soakaways, green roofs, swales, detention basins and ponds.

The SuDS strategy for a development should follow the SuDS management or treatment train as shown in Figure 5-2.

[2] CIRIA (2007) C697 The SuDS Manual

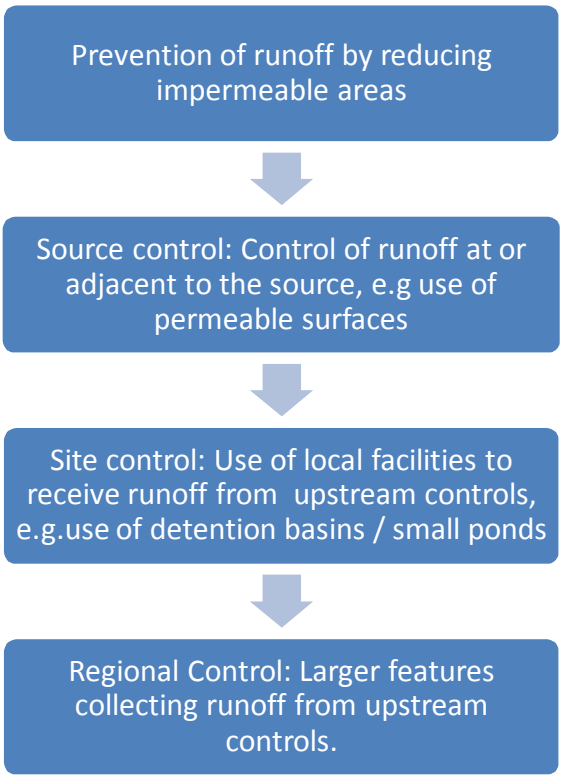

Figure 5-2 SuDS Management Train

Site Constraints

The online Environment Agency maps indicate that the bedrock below the NW Bicester Site is designated as a Secondary A Aquifer which is described as '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'.

A targeted, intrusive ground investigation indicated little or no soakage. It has therefore conservatively been assumed for the current stage that infiltration based drainage is not feasible as the main method of surface water management across the Site. Further soakaway testing is recommended during the detailed design stage to confirm the ground infiltration rates

Application 1 Site Storage Requirements and SuDS Strategy

The Site falls entirely within Catchment C (Figure 5-3) and the indicative storage volume required to maintain 1%+CC AEP Greenfield runoff rates (are given in Table 5-1).

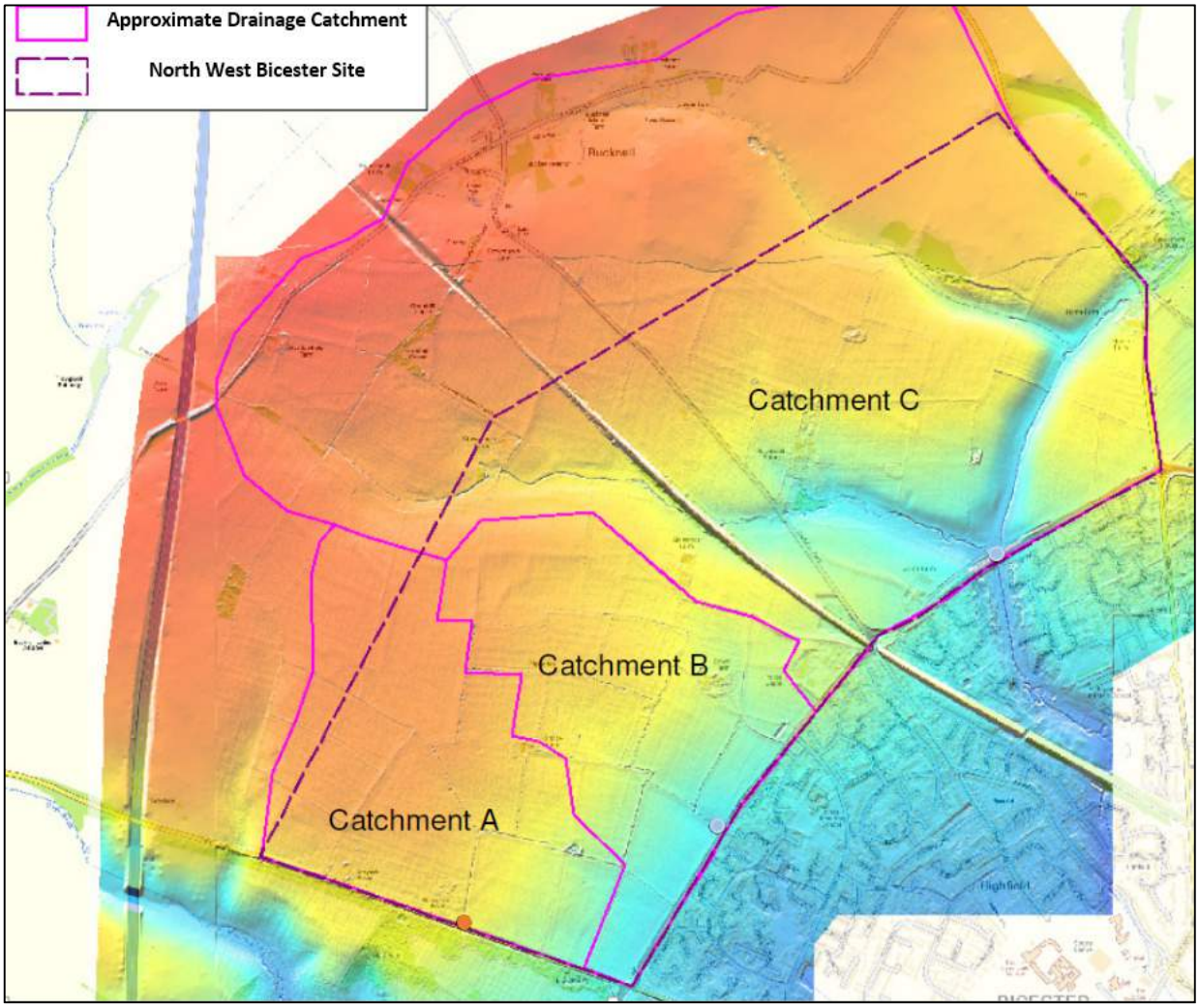

Figure 5-3 Indicative Catchment Areas

In order to calculate indicative storage volumes it has been assumed that the proposed development will consist of 60% impermeable area and 40% permeable area. It is recommended that this assumption is reviewed at the detailed design stage.

Catchment	Area of Application 1 Site	Site Attenuation (m³)	Volume Available in SuDS (m³)
C	154.82	10,904	17,720

Table 5-1 Summary Storage Requirements for the 1% AEP plus Climate Change Event- Application 1 Site

In general, attenuation features have been integrated adjacent to the existing watercourses within suitable downstream locations of Catchment C. Table 5-2 summarises the volumes available within the swales and detention basins shown in Figure 5-4.

Swale Attenuation Area ID	Total Volume (m^3)	Detention Basin Location ID	Total Volume (m^3)
C1	95	PC4b	1,059
C2	62	PC4b2	2,203
C3	25	PC5b	2,042
C4	37	PC5b2	3,210
C5	56	PC6b	1,713
C6	366	PC6b2	1,642
C8	525	PC7b	2,053
C9	327	PC8b	1,535
C10	108		
C11	74		
C12	139		
C13	118		
C14	49		
C17	166		
C19	109		
C22	7		
TOTAL	**2,263**	**TOTAL**	**15,457**

Table 5-2 Catchment C Swales: Storage Attenuation Volumes

Initial calculations indicate that the SuDS features within the Site provide adequate storage over and above the volume required. There are two key flow routes and the attenuation areas and swales follow these flow routes in order to replicate, as closely as possible, the natural flow pathways. In addition to the storage detailed in Table 5-2 above, a further 20% of storage will be provided at plot level.

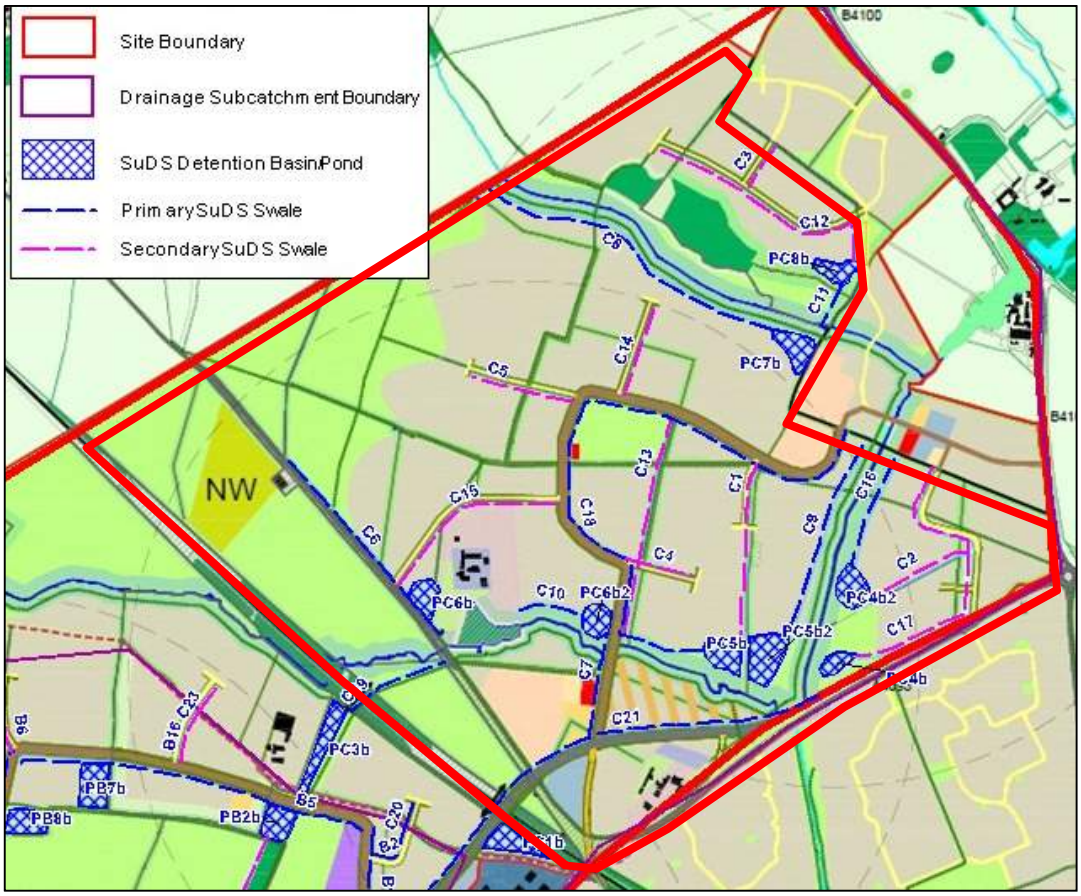

Figure 5-4 Application 1 SuDS Features

Water Quality and Treatment Drains

As well as control of runoff rates and volumes, managing storm water above ground using SuDS provides additional water quality and ecology benefits.

Source control measures are also required to prevent discharge to the receiving watercourses from the first 5mm of any rainfall event thus ensuring that the initial flush of pollutants is contained within the SuDS feature. It is generally recommended for residential developments that that there are at least two treatment stages using SuDS prior to discharge into a receiving watercourse. As discussed in sections above the proposed drainage strategy will include a series of source, Site and regional control measures involving more the recommended two minimum treatment stages prior to reaching the final outfalls. This will clearly help enhance the existing water quality and ecology in the receiving watercourses.

The current ecological quality status and predicted ecological quality status in 2015 for the River Bure downstream of Bicester Eco Town are classified as moderate under the Environment Agency River Basin Management Plan.

Maintenance and Adoption

It is essential that sufficient consideration is given to the adoption and maintenance of any SuDS features from the outset, in order to ensure their long-term maintenance and performance. Therefore, the proposed drainage strategy has been developed to enable easy maintenance access and simple operation of the SuDS features according to the current guidance and best practice.

The main attenuation areas are incorporated within the green infrastructure. Similarly, the swales are located along the access roads or green infrastructure corridors. All SuDS features will have shallow side slopes and depths to ensure safe operation and easy maintenance in accordance with CIRIA SUDS Manual.

The Flood and Water Management Act 2010 (FWMA) introduces the concept of a SuDS Approving Body (SAB), to be constituted by unitary authorities or county councils (LLFAs). This is likely to be Oxfordshire County Council (OCC) in this instance when the SAB role is formally launched by Defra and therefore further consultation and engagement with OCC is essential prior to detailed design to establish the key requirements for SuDS maintenance and adoption. This should process should start prior to the outline planning application and then continue through to detailed design and Site construction.

The role of a local SAB will be to approve local SuDS applications where construction work will have implications for the existing drainage system. They will apply strict standards that will achieve benefits for water quality as well as flood management. The SAB also has a duty to adopt SuDS providing they are constructed in accordance with the approved proposals and the system functions accordingly. As part of the approval process, the SAB can require a non-performance bond to be paid which would be refunded in full once the work was completed to the satisfaction of the approving body. The FWMA also enables SABs to devolve the responsibility of SuDS adoption to other organisations such as land owners or management companies on the condition that all partners are in agreement.

The involvement of SAB will ensure that the proposed ownership responsibilities are suitable and, in particular, that the responsibility for SuDS serving more than one property rests with an organisation that is both durable and accountable.

In December 2011, Defra published draft national standards for the design, operation and maintenance of SuDS which set out the national criteria on which the type of drainage appropriate to any given site or development can be determined. The final publication date of the standards is expected in April 2015.

If OCC or SAB are unable to adopt all SuDS features for any reason, a management company or trust should be appointed to undertake long-term maintenance of the system.

It is essential that the key SuDS facilities (e.g. strategic attenuation areas and flow conveyance routes to these) are constructed ahead of the Site construction commencement to ensure that flood risk is not increased from a potential flood event during the construction stage. A development phasing plan is currently not available to establish how this should be done. Therefore, it is recommended that a suitable SuDS phasing plan is also prepared along with a maintenance plan during the detailed design stage.

Design and Exceedance

It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground. However, the design of the Site layout provides an opportunity to manage this exceedance flow and ensure that indiscriminate flooding of property does not occur.

Therefore, as part of the detailed design of the proposed development, sufficient flood pathways (roads / footpaths / green infrastructure buffer zones) should be identified to ensure that this overland flow is safely routed away from buildings into the proposed SuDS network. The design and construction of the development should also ensure that there are no significant low spots on the Site where unplanned ponding of water could occur and threaten buildings nearby. Additional built in capacity is already provided within the proposed SuDS system but the current volumes should be checked based on the exact development area that is draining into these attenuation facilities and sufficient emergency overflow mechanisms should also be provided through the detailed design process.

As mentioned previously, SuDS networks have been located so that they mainly follow the existing key overland routes based on pre-development ground levels. This will naturally encourage containing the exceedance flows within the proposed SuDS system. However, key existing overland flow routes should also be modelled and reviewed during the detailed design stage once the proposed ground levels and SuDS features are better defined so that the key flow routes are fully intercepted and/or directed to the proposed system without increasing flood risk to the proposed development.

Phasing

It is essential that the key SuDS facilities (e.g. strategic attenuation areas and flow conveyance routes to these) are constructed ahead of the Site construction commencement to ensure that flood risk is not increased from a potential flood event during the construction stage. A development phasing plan is currently not available to establish how this should be done. Therefore, it is recommended that a suitable SuDS phasing plan is also prepared along with a maintenance plan during the detailed design stage.

5.3 Groundwater

Further investigations into the potential for shallow groundwater flooding (in particular during prolonged periods of rainfall) should be undertaken during the Site detailed design before taking any decisions regarding the need for specific mitigation measures.

5.4 Sewers

Although there are no known flooding issues associated with the existing public sewers within the Site boundary, the SFRA[3] highlights a report from CDC that there is a known history of sewer flooding in Bicester (resulting from a limited capacity within the network). It is therefore concluded that the new infrastructure within the Site will require further consideration at detailed design stage to prevent potential exacerbation of any existing flooding problems to third parties.

In order to mitigate the risk of damaging the existing TWUL water mains during construction, up to date and detailed plans of the locations of these assets should be obtained prior to construction. These plans should be used to identify suitable construction locations and methods to ensure that the pipes are not broken during the construction process.

5.5 Residual Risk

It is considered that the following measures are adequate during the detailed design process to manage these residual flood risks:

- Flood resistance and resilience measures
- Flood warning and evacuation plans;
- Designing site drainage systems which take into account events which exceed the design standard using the principles set out in 'Designing for Exceedence [4]'

To mitigate the residual risk to the buildings within the development, it is recommend that the minimum finished floor levels of buildings should be a minimum of 300mm above surrounding ground levels by suitable ground re-profiling, to account for protection against surface water

[3] URS (2012) Cherwell District Council Level 2 SFRA

[4] CIRIA (2006) C635 Designing for Exceedence in Urban Drainage

ponding during a storm event that generates runoff which exceeds the design capacity of the drainage system.

6 CONCLUSIONS

6.1 Development description and proposals

- The Application 1 Site comprises of some 154.82 ha of land, to provide for circa 2,600 residential dwellings, land for new primary schools, associated open space, recreation and play space, social and community facilities and employment, access and infrastructure works.
- The proposed Site is identified in the emerging Cherwell Local Plan 2006 - 2031.

6.2 Flood Risk

- The Site is almost entirely within Flood Zone 1; areas of Flood Zone 2 and 3 are constrained to the watercourse corridor. All development is to be located within Flood Zone 1 other than proposed green and blue corridors.
- Examination of the modelling results using the LiDAR and modelled cross sections show that the majority of the flood extents are within the 30m wide green corridor buffer zone already incorporated in the master plan design. There are two locations where modelling indicates that the extents are more than 30m wide (i.e. the section between the Railway and Bucknell Road and section T1-0851 shown on Figure 5-1).
- All new bridge crossings will be designed such that the soffit is a minimum of 600mm above the modelled peak 1% AEP plus climate change water level. Furthermore, all bridge abutments will be outside the modelled 1% AEP plus climate change floodplain.
- No detailed information is available regarding the risk of groundwater flooding at this stage although the risk is considered to be low based on the currently available information (see recommendations).
- Surface water modelling has been carried out to determine the key routes for surface water flows across the Site. These key flow routes are predominantly constrained to existing green and blue corridors and will be incorporated into the Surface Water Drainage strategy by appropriate location of the proposed SuDS features.
- The proposed surface water drainage strategy includes a preliminary layout of the proposed SuDS features and available attenuation storage, whilst giving due consideration to the fluvial flood plain and main existing surface water flow routes. The proposed strategic SuDS system will provide significantly more than the required volumes to fully attenuate the runoff for a 1% AEP plus climate change allowance flood event. A further 20% of the required attenuation storage will be provided by individual developers using source and site control measures at their individual development plots.

6.3 Assessment of the impacts of climate change

- An assessment of the potential impacts of climate change has been made by adding 20% to the estimate 1% AEP flows. The proposed development is predicted to remain flood free during the 1% AEP plus climate change event.

6.4 Assessment of residual risks

- The residual risks to the Site are a fluvial flood event in excess of those currently modelled and a storm event which exceeds the capacity of the onsite drainage systems.

- These residual risks can be adequately managed through flood resilience and resistance measures, provision of a flood warning and evacuation plan and the incorporation of exceedence flow routes in the detailed drainage strategy.

7 RECOMMENDATIONS

- All new bridge crossings of watercourses on the development site should be clear spanning with soffits set a minimum of 600mm above the peak modelled 1% AEP plus climate change water level.
- All new bridge abutments should be located outside the modelled 1% AEP plus climate change floodplain in order to prevent any impediment of floodplain flows or loss of floodplain storage.
- The surface water drainage strategy set out in Appendix 8 (including adoption and maintenance responsibilities of SuDS features) should be further consulted by the key parties and implemented to ensure that the post development runoff rates and volumes are no greater than the pre-development rates. The post-development overland flow routes should be modelled and reviewed during the detailed design stage (once the proposed ground levels and SuDS features are defined, to ensure that the key flow routes are fully intercepted and/or directed to the proposed system without increasing flood risk to third parties or to the proposed development.
- Additional site specific ground investigations should be used as part of Site detailed design to quantify and inform the risk of groundwater flooding to the Site (in particular during prolonged periods of rainfall) and the need for any additional mitigation measures.
- There are three locations where modelling indicates that the extents are more than 30m wide and it is recommended that the width of the green corridor is increased in these locations (see Section 5-1).
- Due to the limited capacity within the existing sewer network it is recommended that the new infrastructure within the Site will require further consideration at detailed design stage to prevent potential exacerbation of any existing flooding problems to third parties.

Appendix 1

Location Plan

Appendix 2

Proposed Site Masterplan and Land-use Schedule

Appendix 3

Proposed Housing Character Scale and Density

Appendix 4

Proposed Phasing Plan

Appendix 5

Proposed Levels Plan

Appendix 6

Modelled Fluvial Flood Levels and Extents

Appendix 7

Modelled Pluvial Flood Extents

Appendix 8

Proposed SW Drainage Strategy

Appendix 9

Full Masterplan FRA

Appendix 10

Full Master Plan SW Drainage Strategy

Appendix 11

Full Master Plan Water Cycle Strategy

Appendix 1

Location Plan