



RIDGE

**BICESTER MOTION
THE EXPERIENCE QUARTER**

**FLOOD RISK AND DRAINAGE
ASSESSMENT**

09 December 2020



BICESTER
MOTION

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THE EXPERIENCE QUARTER

FLOOD RISK AND DRAINAGE ASSESSMENT

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9 December 2020

Prepared for

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1. SUMMARY

Ridge and Partners LLP have been commissioned to prepare a Flood Risk and Drainage Assessment in support of the Bicester Motion Experience Quarter development at the former RAF Bicester site, Buckingham Road, Bicester, Oxfordshire, OX27 8AL.

This report has been prepared to provide a Flood Risk and drainage overview for an outline planning application with the Local Planning Authority (LPA), Cherwell District Council (CDC) for the proposed Experience Quarter development at the former RAF site.

The site is located within Flood Zone 1 as defined in the NPPF and has not been identified as being at risk of flooding associated with fluvial, pluvial, tidal, sewers or groundwater. As the site is located within Flood Zone 1, the Sequential Test was passed and there is no requirement to apply the Exception Test.

Proposals for the surface water drainage require the use of Sustainable Urban Drainage Systems (SuDS) as these will not only manage surface water run-off but also offer benefits in pollution prevention creating and sustaining better places for people and nature.

There are known capacity constraints in Thames Water's foul sewer network therefore discussions will be required with Thames Water via a predevelopment enquiry to establish how additional capacity can be provided to accommodate the development.

It is proposed to drain the foul sewage from the site to the public foul sewer network in Buckingham Road.

2. INTRODUCTION

Ridge and Partners LLP have been commissioned to prepare a Flood Risk and Drainage Assessment in support of the Bicester Motion Experience Quarter development at the former RAF Bicester site, Buckingham Road, Bicester, Oxfordshire, OX27 8AL.

This report has been prepared to provide a Flood Risk and drainage overview for an outline planning application with the Local Planning Authority (LPA), Cherwell District Council (CDC) for the proposed Experience Quarter development at the former RAF site.

The National Planning Policy Framework (NPPF) states that a site-specific Flood Risk Assessment (FRA) is required in the following circumstances:

- For proposals of 1 hectare or greater in Flood Zone 1;
- All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency); and,
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

This site falls within the Flood Zone 1 and is greater than 1ha in size. Therefore, a Site Specific FRA is required to ensure the development is safe from flooding and will not increase the risk of flooding elsewhere.

This FRA assesses the flood risk of the existing site whilst setting out the parameters for the drainage design of the future development to minimise flood risk on the site and the neighbouring properties. It not only considers the risk of fluvial flooding on the development, but also the risk of flooding from the non-fluvial sources, including overland flows, groundwater, sewer flooding and flooding from artificial sources.

The report includes a review of the existing foul flows and identifies the need for a Pre-development Enquiry with Thames Water to establish the likely capacity constraints and identify any off-site improvements that may be required to accommodate the development.

3. SITE DESCRIPTION

3.1. Site Location

Site Name: Bicester Motion at the former RAF Bicester site

Site Address : Buckingham Road, Bicester, Oxfordshire, OX27 8AL

Site National Grid Reference: Eastings: 459859, Northings: 224563

The site lies to the north of Bicester town centre within the boundary of the former RAF Bicester Site. Buildings in the south west corner of the site are currently occupied by Bicester Heritage and the existing hangars occupied by the Bicester Gliding Club. Scattered around the site are a number of listed defence structures and to the east of the site there are a number of bomb stores. The airfield taxiway is located to the east of Technical Site and west of the bomb stores.

The site is bounded by Buckingham Road (A4421) to the west, Skimmingdish Lane to the south and Bicester Road (road to Stratton Audley) to the North. The south east corner of the site is bounded by the newly constructed Bakels factory and to the north east, the site is bounded by agricultural land. The site benefits from three vehicular entrances, two from the A4421 Buckingham Road and one from Skimmingdish Lane.

The wider surrounding area is characterised by residential, commercial, agricultural land and associated road networks as illustrated below in Figure 1.

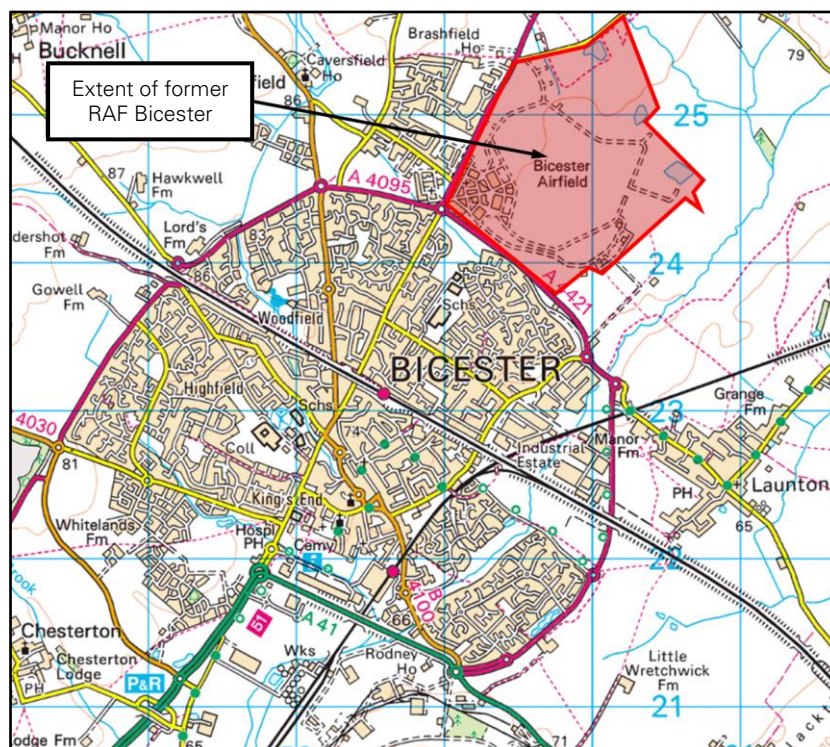


Figure 1 – Site Location

3.2. Land Use and Topography

The existing site is relatively level with ground levels sloping from 83.0m above ordnance datum (mAOD) along the western side of the site to 73.0mAOD along the eastern boundary. This equates to an average gradient across the site of approximately 1:100.

The former RAF site is approximately 1.3km wide and 1.3km in length. The approximate area of the site is 171 hectares.

Appendix A shows the topographic survey and the existing site layout.

3.3. Hydrology

The closest main river to the site is Langford Brook, which is located approximately 500m to the east of the site and is designated as Main River by the EA. This watercourse flows north to south before it joins the River Ray approximately 7.5km downstream of the site to the south.

The closest watercourse is located to the north of the site. The watercourse runs from north to south towards the centre of the site. It is currently unclear on the route the watercourse takes through the site but the topography of the site suggests the watercourse drains to the east. Further investigation is required.

The nearest standing water body is located within the site. There are three lakes adjacent to the north east boundary of the site which are former quarry pits that have been filled with water.

There are no canals within the proximity of the proposed development.

3.4. Geology

A site investigation has not been carried out for this development but upon gaining outline planning approval, a site-specific site investigation shall be carried out to determine the soil properties of the site. The site investigation should include but not be limited to the following:

- Infiltration testing to BRE 365 Digest.
- Groundwater monitoring over the course of 12 months.
- Soil testing and assessment on locations of contaminations.

Based on published geological records for the area (British Geological Survey online mapping), the site is underlain by Jurassic bedrock of the Cornbrash Formation, overlying the Forest Marble Formation. No significant superficial deposits are recorded locally. Refer to Figure 2 below:

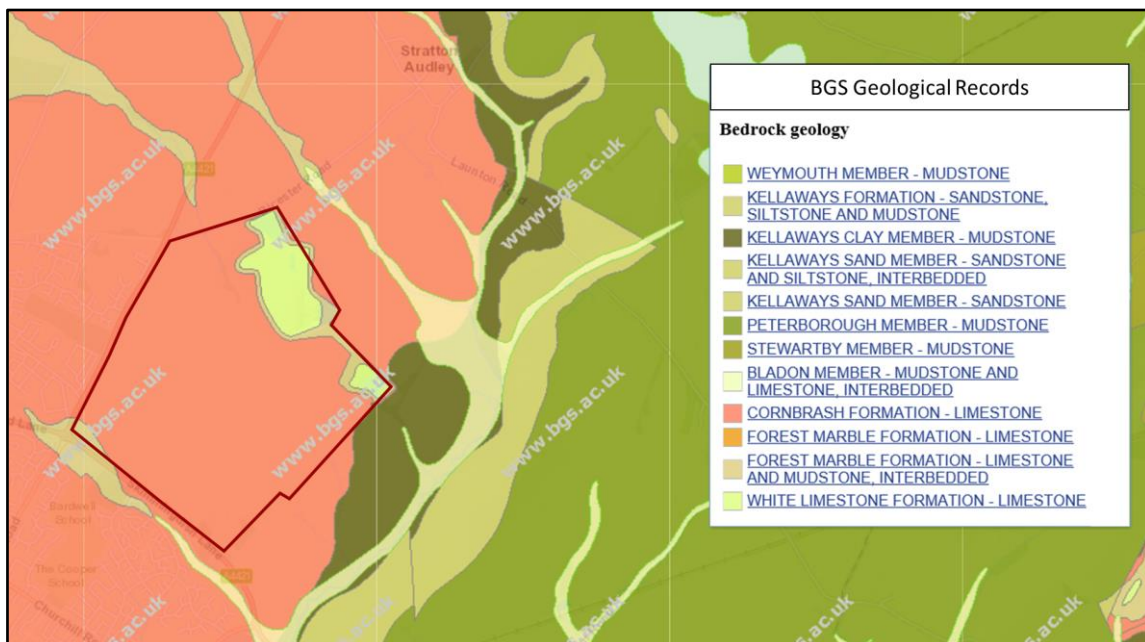


Figure 2 – British Geological Survey Records for North east Bicester (sourced from BGS website 01/02/2019)

Reference to BGS borehole scan SP52SE174, enclosed in Appendix B, located in the south east corner of the site, confirms the presence of the Cornbrash Formation layer approx. 9ft deep, Forest Marble formation layer approximately 10ft deep and white limestone layer approximately 38ft deep. The borehole also indicates that groundwater was encountered which varied during the time of year from 3ft to 12ft deep below ground level (mBGL).

A full site investigation was carried out to inform the design of the Command Works and infiltration testing has also been undertaken to support the planning application for the proposed hotel, too.

The exploratory field work for the Command Works site, which is located in the south west corner of the former RAF Bicester site, identified that the site is generally underlain by thin Topsoil (down to a maximum depth of 0.40m bgl), overlying localised Made Ground (encountered down to a maximum depth of 0.40m bgl), overlying a weathered Cornbrash Formation (down to a maximum depth of 1.0m bgl) becoming unweathered Cornbrash Formation. Rock quality strata was then proven down to 1.60m and 2.0m bgl across the site. However, no Forest Marble Formation soils were encountered. Monitoring of the groundwater level was carried out between September 2018 and January 2019 which recorded the groundwater level between 1.1 and 1.71m below ground level. A supplementary sampling exercise was carried out in August 2019 which indicated groundwater levels of between 1.4m and 2.02m below ground level. Furthermore, the composition of the underlying groundwater was deemed to be consistent of that with uncontaminated groundwater. The full supplementary sampling results can be seen in Appendix F. Three infiltration tests were carried out in accordance with the BRE365 standard with infiltration rates of between $1.02 \times 10^{-4} \text{m/s}$ to $9.78 \times 10^{-5} \text{m/s}$ within the Cornbrash Formation being achieved.

The drainage strategy, prepared by AKS ward, in support of the planning application for the Bicester Heritage Hotel, references two soakaway tests in accordance with BRE365 Digest. These tests were recorded approximately 300m south of the Experience Quarter. The results of the tests report a soil infiltration rate of between $1.43 \times 10^{-6} \text{m/s}$ and $1.81 \times 10^{-6} \text{m/s}$ at a depth of 1 metre.

3.5. Hydrogeology

According to the MAGiC database which reference Environment Agency records on Aquifer Designations, the majority of the site falls within a Secondary A bedrock aquifer and a small area towards the north east boundary of the site is designated as a Principal bedrock aquifer. No superficial aquifers fall within the vicinity of the site. In addition, there are no Groundwater Source Protection Zones within the site vicinity. An extract from the MAGiC database is shown below in Figure 3.

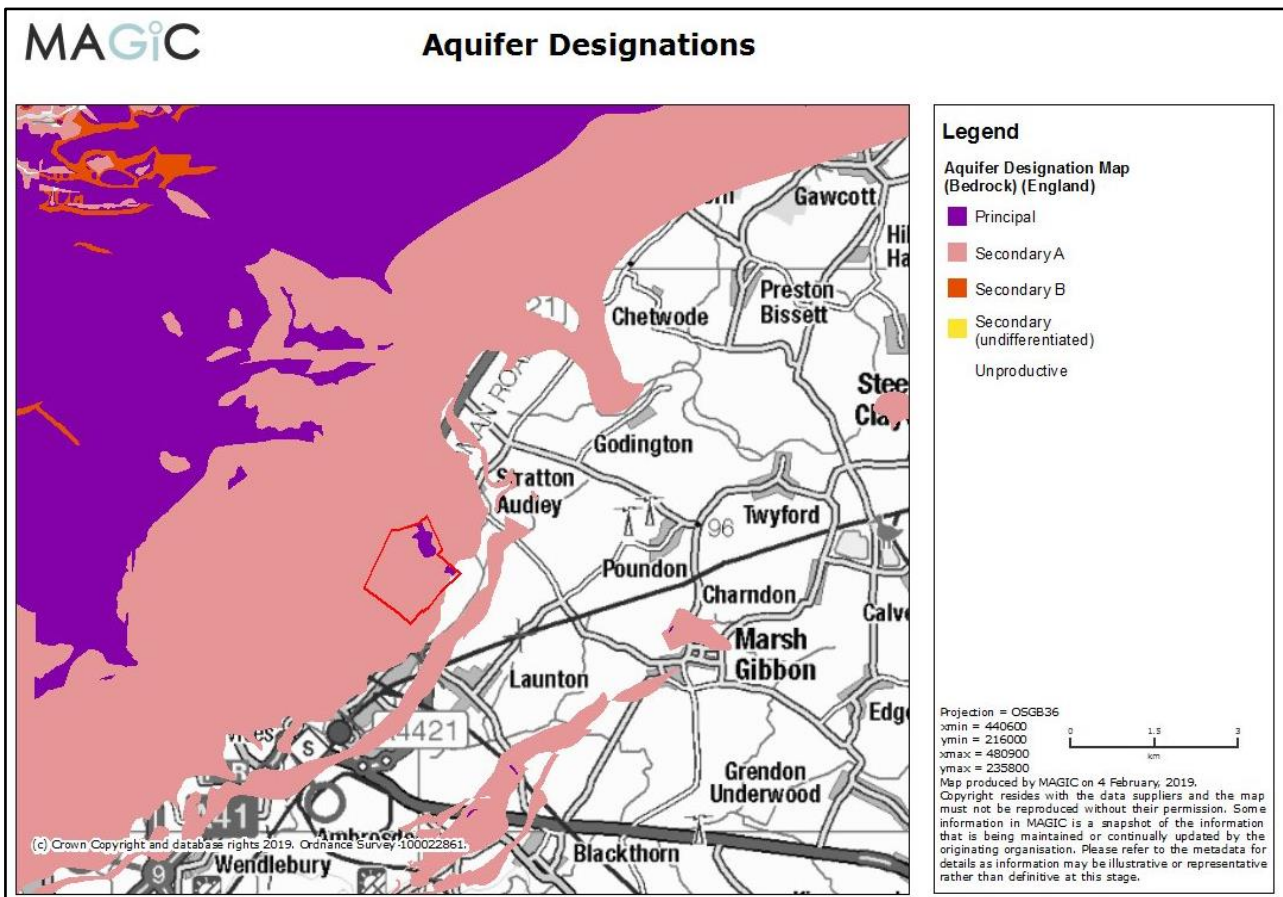


Figure 3 – Aquifer Designations (sourced from MAGiC database 04/02/2019)

3.6. Existing Drainage

Public sewer

Sewer details have been referenced from Thames Water sewer records, found in Appendix C.

Foul water

The sewer records indicate that there is a 225mm diameter foul water sewer that runs along the westerly edge of the site and then cuts across the south west corner of the site. The sewer flows from north to south.

A 450mm diameter foul water sewer is located beneath the A4421 Buckingham Road to the west of the site. This sewer runs from north to south and continues to run along the Buckingham Road towards Bicester Town.

It is understood that the sewer drains to the sewage treatment works located to the south of Bicester Town, adjacent to the Tesco Superstore.

It is apparent, based on our knowledge from the Command Works development that the Thames Water’s foul sewer network in Bicester has limited capacity for future development and therefore further discussions with Thames Water Development Team will be required through the Pre-development Enquiry application process to establish how the additional capacity can be provided.

Surface water

The sewer records do not indicate any surface water sewers within the vicinity of the site.

Private drainage

There are a number of internal foul and surface water drains that serve the former Bicester RAF site. Typically, the surface water within the site is managed using soakaways.

The network of internal foul drains connect to the foul sewers within the site.

3.7. Other Site constraints

According to the MAGiC database the site is home to a number of grade 2 listed buildings and scheduled monuments. In addition to this, there are two areas on the site that are designated as a Site of Special Scientific Interest (SSSI) which are the Stratton Audley Quarries 1 and 2. The SSSI sites are classified as destroyed which mean that lasting damage has occurred to the designated feature such that the feature has been irretrievably lost (no amount of management will bring this feature back). An Extract from the MAGiC database can be seen below in Figure 4.

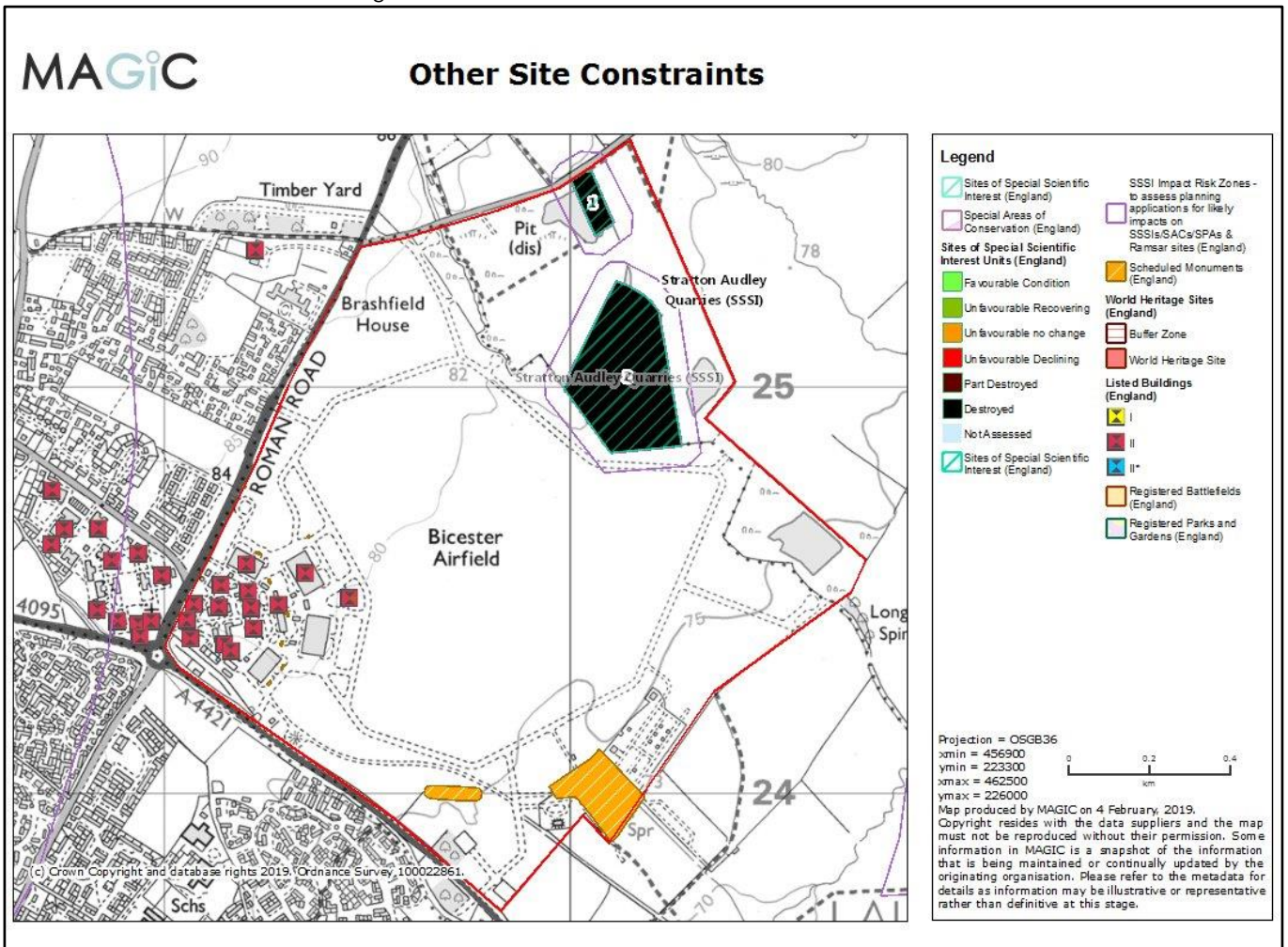


Figure 4 – Other Site Constraints (sourced from MAGiC database 04/02/2019)

4. DEVELOPMENT PROPOSALS

The proposed Bicester Motion Narrative is as follows:

The Experience Quarter

The Experience Quarter will be formed as a cluster of high-quality buildings that will house world-leading brands across the Motion sector with each building providing views across the airfield, towards the vibrant activities taking place in the air and on the tracks, visitors can enjoy wings and wheels technology.

New driver training and handling tracks will be formed for visitors to learn new skills in a safe and family focused environment, guests of all ages can get behind the wheel or simply enjoy the show from the viewing points and walkways planned.

Demonstration and event areas are planned enabling brands to showcase new and exciting technologies to the public. As we move towards a greener future we aspire that the Experience Quarter will be internationally recognised as the leading site for sustainable transport product launch and demonstrations with the benefit of the on-road and off-road tracks, demonstration zones and airfield.

The creation of new walkways and cycleways connecting the four Quarters of the site (Heritage, Innovation, Wilderness & Experience) will enable visitors to explore on foot, cycle, scooters or shuttle promoting health and well-being through the enjoyment of open green space filled with vibrant activities for all of the family.

The Airfield

The airfield operated by the Bicester Aerodrome company (a wholly owned subsidiary of Bicester Motion) will host a wide range of aviators who will demonstrate and promote aviation's past present and future bringing the history of the site to life.

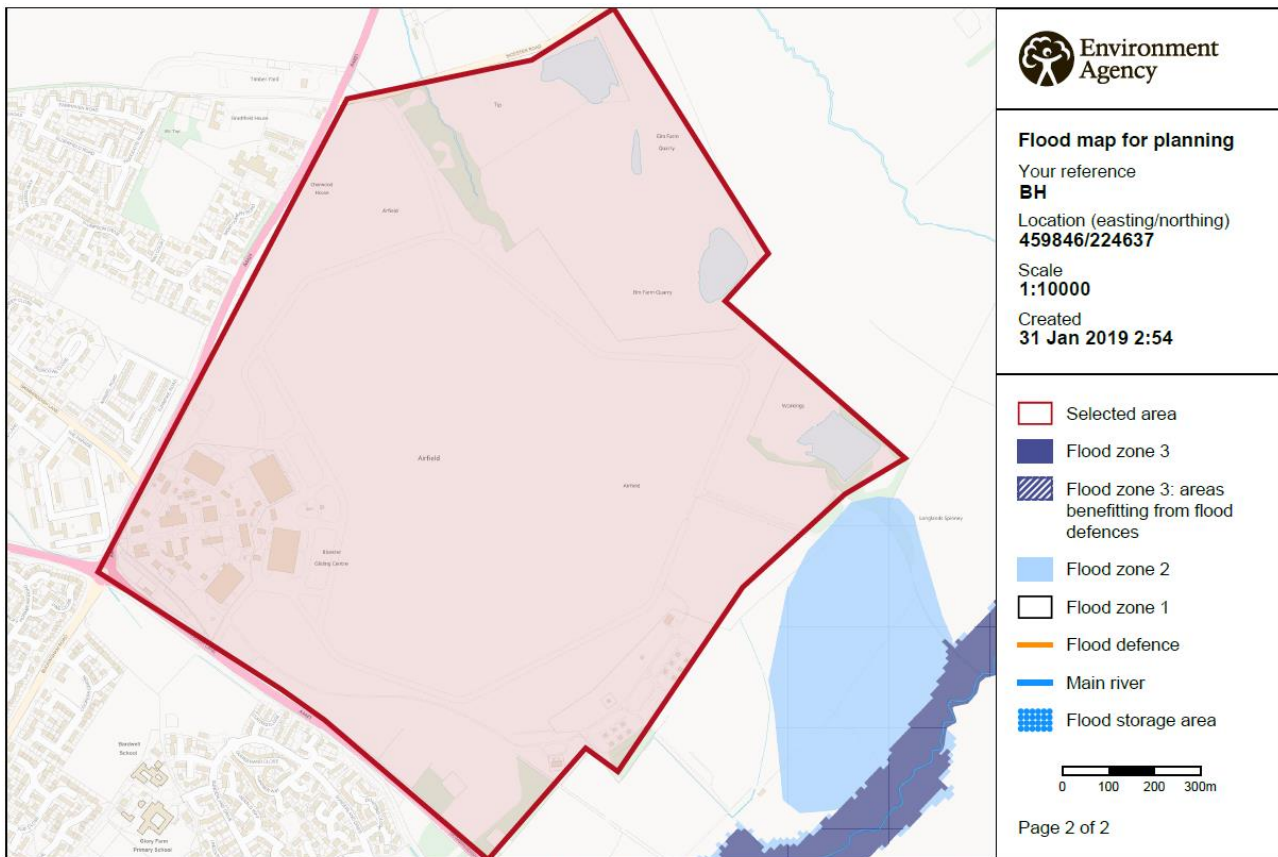
5. SOURCES OF FLOOD RISK

5.1. Flooding from rivers (fluvial flood risk)

The Environment Agency online Flood Map identifies the site outside the 0.1% Annual Exceedance Probability (AEP) flood extent associated with the Langford Brook. Refer to Figure 3 below. To the east of the site, the adjacent land is situated within an area of Flood Zone 2. The Flood Zone 2 does not fall within the site extents.

Furthermore, site contours from the topographical survey show that the site is approximately 3-10m above the Langford Brook level which was obtained from the Ordnance Survey contours for the brook. This natural topography provides protection to the former RAF site as the majority of Bicester and surrounding land would flood before the proposed development site.

On the basis of these findings it can be determined the site is not at risk of fluvial flooding.



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Figure 3 – Fluvial Flood Risk (sourced from EA website 31/01/2019)

5.2. Flooding from the sea (tidal flood risk)

The site is a considerable distance from the sea and therefore is not currently identified at risk of coastal or tidal flooding.

5.3. Flooding from the land (overland pluvial flood risk)

In the event of intense rainfall and when the infiltration capacity of the land has been exceeded, rainwater will flow overland. This rainwater will collect in depressions of the topography and at obstructions, which can inundate development in low lying areas.

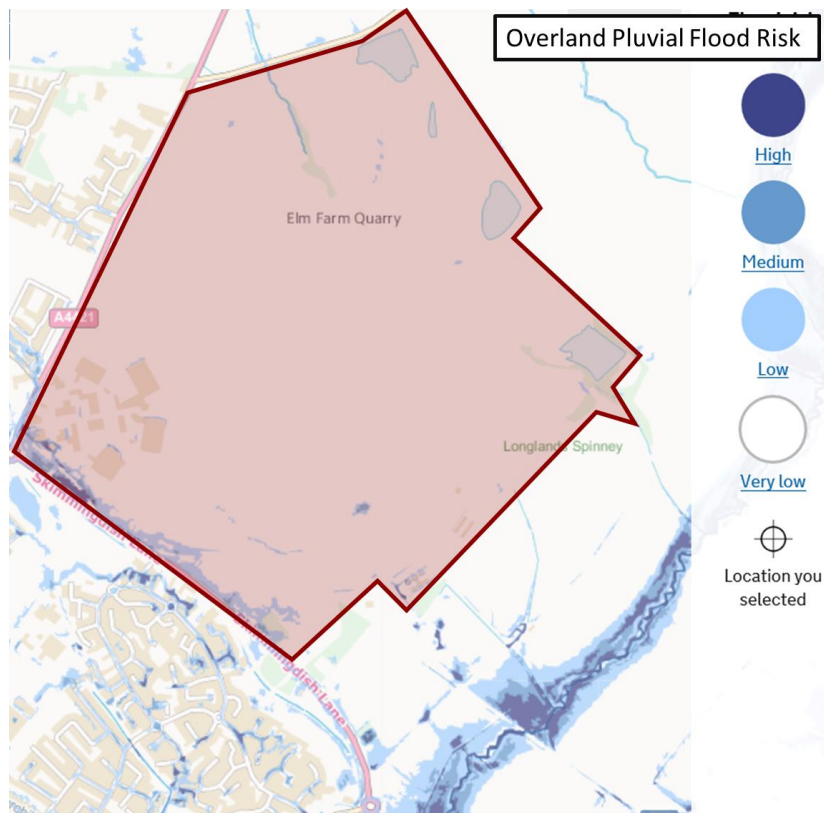


Figure 4 – Overland Pluvial Flood Risk (sourced from EA website 31/01/2019)

The Environment Agency Flood Maps for Surface Water (as shown in Figure 4) show the approximate areas that could experience surface water flooding from a range of AEP's, which is used to categorise the risk. The surface water maps identify that there is a very low risk of surface water flooding (<0.1% AEP) for the majority of the airfield. The northern side of Skimmingdish Lane, however, has been identified as medium to high risk, part of which falls within the boundary of the proposed Command Works development. These overland pluvial flood flows are managed on the site site through the use of an attenuation basin and a conveyance swale.

5.4. Flooding from groundwater

According to the Cherwell District Council Strategic Flood Risk Assessment (SFRA) (2017) Plan B8, the northeast quadrant of Bicester, which includes the site and surrounding area, is not considered at risk from groundwater flooding. The site is located within the wider slope of the valley, and as such any emerging groundwater would flow under gravity to the east, resulting in minimal flood levels if groundwater did emerge.

Monitoring of the groundwater level was carried out for the Command Works development between September 2018 and January 2019. The results of which recorded the groundwater level between 1.1 and 1.71m below ground level.

On the basis of these findings, the risk of groundwater flooding is understood to be low.

5.5. Flooding from sewers

According to the Cherwell SFRA Plan B-10, the site has had 0-5 sewer flooding incidents due to failure or capacity issues. Therefore, the site is deemed to be at low risk of sewer flooding.

5.6. Flooding from Artificial Sources

The site is not identified as being at risk of reservoir flooding from the Environment Agency Reservoir Flood Map as shown in Figure 5. The site is located a considerable distance from any canal and therefore not at risk from flooding from this source.

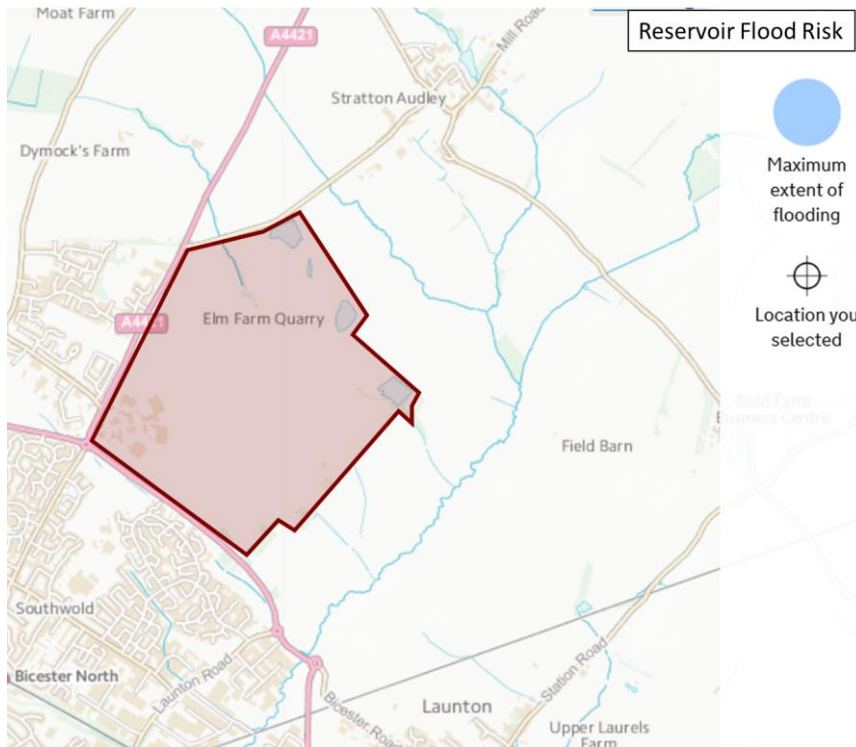


Figure 5 – Reservoir Flood Risk (sourced from EA website 31/01/2019)

5.7. Flooding History

No historic flooding has been recorded within the Cherwell SFRA for the site or surrounding area of north east Bicester. Flooding has been limited to the southern reaches of the Langford Brook floodplain within Bicester which is located over 500m east of the site, and roughly 3m lower than the lowest site levels.

5.8. Sequential Test

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of directing development to areas at little or no risk of flooding from any source in preference to areas at higher risk. NPPF Table 2 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 3 'Flood risk vulnerability and flood zone compatibility' to determine whether:

- The development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development.

The proposed development has a mixture of 'less vulnerable' commercial uses and 'more vulnerable' accommodation/resort-based development.

As the entire site lies within Flood Zone 1, the Sequential Test is passed and there is no requirement to apply the Exception Test.

6. SURFACE WATER DRAINAGE PROPOSALS

The Experience Quarter development is designated as a major planning development. The NPPF sets out the requirement for all major development to include Sustainable Urban Drainage Systems (SuDS).

The SuDS systems aim to deal with rainwater where it falls (at source), allowing as much water as possible to either evaporate or soak into the ground. Remaining runoff is then drained to the nearest water body, ideally via other forms of SuDS, at the same rate and volume or lower as would naturally have occurred prior to development. During this process, SuDS reduce pollutants in the water, such as hydrocarbons, nutrients and heavy metals, by filtering and treating runoff. This ensures that the water soaking into the ground and discharging to nearby watercourses or sewers is cleaner, protecting water quality and wildlife.

Management of surface water run-off using SuDS is just one aspect of SuDS design. If managed appropriately, SuDS can offer real value to a development through enhancing green space which supports the provision of habitats and places for wildlife to live and flourish.

The use of SuDS is also highly encouraged by the Lead Local Flood Authority (LLFA). Typical SuDS applications that could be used for this type of development are shown in Table 1 below:

SUDS FEATURE	DESCRIPTION
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water.
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. Although this does not count towards on-site storage as it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event due to the potential sporadic use of the stored water
Permeable Surfaces	Permeable surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.
Filter Drains	Linear drains/trenches filled with a permeable material, often with perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site.
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.
Swales	Shallow vegetated channels that convey and/or retain water and can permit infiltration when unlined.
Ponds	Depressions used for storing and treating water.
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.
Detention Basin	Dry depressions designed to store water for a specified retention time.
Soakaways	Sub-surface structures that store and dispose of water via infiltration.
Infiltration Trenches	Depressions that store and dispose of water via infiltration.

Table 1 – Description of SuDS Features

An outline drainage strategy has been prepared for the proposed Experience Quarter development which is presented in Appendix D.

The outline drainage strategy has been prepared with the view of using SuDS systems as referenced above. As areas around the site are recorded to have infiltration rates greater than $1 \times 10^{-6} \text{m/s}$, it is therefore proposed to drain at source is the most appropriate method of managing the surface water run-off. Infiltration tests and groundwater monitoring will be carried out to validate the feasibility of infiltration.

Table 2 below details the areas of the proposed development along with the SuDS systems proposed to manage the surface water run-off and the approximate volume of storage required. The approximate volume of storage is based on an infiltration rate of $5 \times 10^{-5} \text{m/s}$ which is the average of the infiltration rates from existing site records (refer to section 3.4).

DEVELOPMENT AREA	IMPERMEABLE AREA (m ²)	SUDS SYSTEM	APPROX. STORAGE VOL. (m ³)
Experience Centre (Driver Training School)	Building: 14,000 Road, Car Parks & Paths: 30,000	Building, Road, Car Parks & 4x4 Tracks: To drain to an infiltration basin, permeable paving, swales and ditches.	3,000
Experience Centre (Trackside Pavilions)	Buildings: 2,000 Track: 50,000	Track: run-off to drain to a surface flush filter drain on low side of track which will allow infiltration to the ground below. At the track low point, a localised ground depression or a cellular soakaway will be required to contain the higher storm events. Building: Surface run-off to drain to Track infiltration filter drain network.	3,000

Table 2 – SuDS Features and Storage Volumes

Design Requirements

The design of the surface water drainage system should be in accordance with the Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire (Oxfordshire County Council).

The peak surface water run-off rate from the proposed development for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield run-off rate for the same event

Attenuation or infiltration structures shall accommodate up to a 1 in 100 year +40% for climate change storm event and the upstream drainage networks should not flood in a 1:30 year return period.

The layout of the development should be designed so that any surface run and exceedance overland flows caused by rainfall events that exceed the design capacity are directed away from sensitive areas and conveyed to SuDS systems.

It is important for the performance of the SuDS systems that they are maintained on a regular basis. In this development the developer will be responsible for the operation and maintenance of the SuDS systems and should ensure that the management and maintenance of the SuDS systems. The designer will need to prepare a management and maintenance manual which is set out in accordance with the guidance in the CIRIA C753 "SuDS Manual".

7. FOUL DRAINAGE PROPOSALS

7.1. Proposed Foul Network

The existing site has a network of private foul water drains in the south west corner of the site which connect to the foul sewer. The Experience Quarter is mostly situated towards the north of the former RAF site and has no existing foul drainage infrastructure.

For the Experience Quarter, there is potential to connect to the gravity sewer that is located in Buckingham Road on the north western boundary, although it is likely that a foul pumping station will be required.

An assessment of the potential foul flows from the development has been calculated as per the Table 3 below. As occupancy values for development are currently unknown, the Sewers For Adoption flow rates for use class have been used as a means of calculating the development flows.

DEVELOPMENT AREA	APPROX. FOOTPRINT (M ²)	NO. OF FLOORS	FLOOR AREA	DESIGN FLOW (L/S/HA)	TOTAL FLOW RATE (L/S)
Experience Quarter					
Single Storey	4,136	1	4,136	0.6	0.25
Two storeys	9,475	2	18,950	0.6	1.14
Trackside Pavilions					
	1,800	1	1,800	0.6	0.11
Total Foul Flow Rate for the Development	15,411		24,886		1.5

Table 3 – Estimated Foul Flow Rate

The total flow rate referenced in Table 3 above is based on a gravity connection to the mains sewer.

7.2. Limitations with the Existing Foul Network

A Pre-development Enquiry with Thames Water shall be requested to understand whether the sewer network has capacity whilst informing Thames Water of the proposed development so that their programme of network improvements consider this site.

8. CONCLUSION

This flood risk and drainage assessment report has been prepared in support of an outline planning application for the Bicester Motion Experience Quarter development at the former RAF Bicester Airfield, Bicester, OX26 5HA.

Based on the information available from the Environment Agency, Cherwell District Council, County Council (Lead Local Flood Authority) and MAGiC Database, the site, which is located in Flood Zone 1, as defined in the NPPF, is not identified as being at risk of flooding associated with fluvial, pluvial, tidal, sewers or groundwater. There is an overland pluvial flood risk within the south west part of the development but the proposed drainage strategy for the Command Works Site will manage the overland flows.

As the entire site lies within Flood Zone 1, the Sequential Test was passed and there is no requirement to apply the Exception Test.

Surface water runoff from the proposed development should be managed using Sustainable Urban Drainage Systems (SuDS) as these will not only manage surface water run-off, but also offer benefits in pollution prevention creating and sustaining better places for people and nature. SuDS systems identified to manage the surface water run-off from the Bicester Motion development have been detailed on the outline drainage strategy drawing provided in Appendix D. The local geology (cornbrash formation) suggests there is a high potential for infiltration which greatly benefits use of the SuDS systems. Infiltration testing undertaken as part of the site investigation for Command Works identified that soakage systems are a suitable means of surface water disposal, subject to groundwater levels. Infiltration testing, groundwater monitoring and contamination testing are required to validate the feasibility of using infiltration techniques.

The peak rate of surface water run-off from the site should never exceed the peak greenfield run-off rate from the existing site for the 1in1 year and 1in100 year rainfall events.

Any attenuation or infiltration structures shall accommodate up to the 1in100 year return period plus climate change storm event with any surface run-off and overland flow caused by exceedance events being conveyed to the SuDS systems.

The existing foul sewer network is likely to have capacity issues; therefore a pre-development enquiry will be carried out with Thames Water to establish how additional capacity can be provided to accommodate the development.

The majority of the development is located in areas where access to a foul sewer by gravity is limited. therefore, if a gravity connection is not feasible then a pumped system will be provided to serve the development.

The anticipated foul flow from the development is approximately 1.5l/s for a gravity connection.