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Flood Risk Assessment

Symmetry Park, Ardley

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Contents

Executive Summary

A commercial development would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable and the development would be in accordance with the requirements of the NPPF.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.

1. Introduction

1.1 Background

This Flood Risk Assessment (FRA) has been prepared by Tier Consult at the request of Tritax Symmetry Ardley Ltd for the proposed development of Symmetry Park, Ardley. This FRA has been carried out in accordance with guidance contained in the National Planning Policy Framework (NPPF)[1], associated National Planning Practice Guidance (NPPG)[2] and the NPPG 'Site-specific flood risk assessment checklist (para 068 Reference ID: 7-068-20140306. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

It is recognised that developments which are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.

1.2 Planning Policy Context

The Flood and Water Management Act 2010

The legislative framework for flood and coastal risk management is set out principally in The Flood and Water Management Act 2010 The legislation endorses the principle of an integrated approach to water and drainage management. The intentions of the Act are summarised below:

- Deliver improved security, service and sustainability for people and their communities;
- Clarify responsibilities for managing all sources of flood risk;
- Protect essential water supplies by enabling water companies to control more non-essential uses of water during droughts;
    - Modernise the law for managing the safety of reservoirs;
    - Encourage more sustainable forms of drainage in new developments through new arrangements for adoption and future operation of such features; and
    - Make it easier to resolve misconnections to sewers.

[1] Ministry of Housing, Communities and Local Government (2021) National Planning Policy Framework.
[2] Department for Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.

Water Framework Directive

The Water Framework Directive 2000/60/EC is a European Union directive designed to improve and integrate the way water, from all sources, is managed throughout Europe. In the UK, much of the implementation work is undertaken by competent authorities such as the Environment Agency and Local Authorities. It came into force in December 2000 and was transposed into UK law in 2003. Member States are required to achieve good chemical and ecological status for their inland and coastal waters by 2015.

Water Resources Act 1991

Under the Act, it is an offence to "cause or knowingly permit poisonous, noxious or polluting matter or any solid waste to enter controlled waters" unless it is covered by a consent to discharge issued by the Environment Agency. Failure to comply may result in a fine. This includes discharge to surface water drains.

National Planning Policy Framework

The National Planning Policy Framework (NPPF) aims to ensure that flood risk is taken into account by all relevant statutory bodies from regional to local authority planning departments to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of high risk. Where new development is, exceptionally necessary in high risk areas, the policy framework aims to make it safe, ensure that it will not increase flood risk elsewhere and, where possible, reduce overall flood risk in the local area (see Paragraph 159 of the NPPF).

A risk-based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FRA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all sources;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- if necessary, provide the evidence to the Local Planning Authority (LPA) that the Sequential Test can be applied; and
- whether the development will be safe and pass part c) of the Exception Test if this is appropriate.

Local Authorities should only consider development in flood risk areas as appropriate where it is informed by a Site-specific Flood Risk Assessment, based upon the Environment Agency's Standing Advice on flood risk. The Assessment should identify and assess the risks of all forms of flooding to and from the development and demonstrate how flood risks will be managed so that the development

remains safe throughout its lifetime, taking climate change into account (see Paragraph 167 of the NPPF).

Adopted Cherwell Local Plan 2011-2031 (Part 1)

The Adopted Cherwell Local Plan 2011-2031 (Part 1) contains strategic planning policies for development and the use of land. It forms part of the statutory Development Plan for Cherwell to which regard must be given in the determination of planning applications.

The Plan was formally adopted by the Council on 20 July 2015. Policy Bicester 13 was re-adopted on 19 December 2016.

Policy ESD 6: Sustainable Flood Risk Management states:

"The Council will manage and reduce flood risk in the District through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF and NPPG. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.

In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting of watercourses should be avoided and the removal of existing culverts will be encouraged.

Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.

Site specific flood risk assessments will be required to accompany development proposals in the following situations:

- *All development proposals located in flood zones 2 or 3*
- *Development proposals of 1 hectare or more located in flood zone 1*
- *Development sites located in an area known to have experienced flooding problems*
- *Development sites located within 9m of any watercourses.*

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

- *There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)*

- *Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.*

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

1.3 Report Structure

This FRA has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 describes the location area and the existing and proposed development;
- Section 4 outlines the flood risk to the existing and proposed development;
- Section 5 details the proposed surface water drainage for the site;
- Section 6 describes the risk management methods used to mitigate all sources of flood risk; and
- Section 7 presents a summary and conclusions.

2. Sources of Information

2.1 Environment Agency

The Flood and Water Management Act 2010 gives the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is the statutory consultee with regards to flood risk and planning. Information regarding the current flood risk at the application site, local flood defences and flood risk has been obtained from the Environment Agency.

2.2 Cherwell District Council

Cherwell District Council is the Local Planning Authority (LPA) Planning guidance written by Cherwell District Council regarding flood risk was consulted to assess the policies in place. The Cherwell District Council Strategic Flood Risk Assessment (SFRA) which covers the site has been reviewed.

2.3 Oxfordshire County Council

Oxfordshire County Council is the Lead Local Flood Authority (LLFA) and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourses. Planning guidance written by Oxfordshire County Council regarding flood risk was consulted to assess the policies in place. The Oxfordshire County Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

2.4 Thames Water

Thames Water is responsible for the disposal of waste water and supply of clean for this area. Information with regards to sewer and water main flooding contained within the Cherwell District Council SFRA and the Oxfordshire County Council PFRA have been consulted. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

3. Location & Description

3.1 Site Location

The site is located on land near Junction 10 of the M40 and east of the A43 (NGR: 4450420, 229168) (see Drawing T/2503/FRA/1). The site is located approximately 1km to the north of Ardley in Oxfordshire. The area of land within the red line boundary is 83.279 hectares (ha).

3.2 Existing Development

The existing site is currently agricultural fields in a greenfield state.

3.3 Proposed Development

The proposals seek outline planning permission (all matters reserved) for the erection of buildings comprising logistics (Use Class B8) and ancillary office (Use Class E(g)(i)) floorspace (see Appendix B).

3.4 Ground Levels

The site has ground levels between 110 and 119 metres Above Ordnance Datum (mAOD).

3.5 Catchment Hydrology / Drainage

The nearest surface watercourse is the Padbury Brook which is located adjacent to the south eastern boundary of the site at approximately 2m below the site ground levels. Padbury Brook is a tributary of the River Great Ouse, and is designated as an Ordinary Watercourse. Padbury Brook rises near Fringford, Oxfordshire and flows eastwards for approximately 26km to discharge into the River Great Ouse near Buckingham.

A field drainage ditch has been identified on the western boundary of the site, this is generally 0.50m to 1.00m in depth and is not known to carry significant flows of water and discharges into the Padbury Brook.

The majority of rainfall is currently infiltrating into the ground where geological and hydrogeological conditions allow, and then runs off once the infiltration capacity of the ground has been exceeded.

There are no public sewers located on the site or within the vicinity of the site. Two surface water attenuation ponds are located to the south of the site, adjacent to Padbury Brook, at Junction 10 of the M40. It is assumed that these provide surface water attenuation for the nearby road network.

3.6 Ground Conditions

The British Geological Survey (BGS) Map[3] indicates that no superficial deposits underlay the site. The superficial deposits adjacent to The Twins / Padbury Brook is designated as Alluvium - clay, silt, sand

[3] https://mapapps.bgs.ac.uk/geologyofbritain/home.html?&_ga=2.139251635.1668470032.1639045844-557297800.1574946602. Last accessed 10/12/2021.

and gravel. The bedrock deposits that underlay the Site consists of the Great Oolite Group Sandstone, Limestone and Argillaceous Rocks.

The superficial deposits adjacent to The Twins / Padbury Brook are designated as a Secondary A Aquifer. The bedrock deposits are designated as a Principal Aquifer and Secondary A Aquifer.

A Principal Aquifer is defined as geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally principal aquifers were previously major aquifers. A Secondary A Aquifer is designated 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. These are generally aquifers formerly classified as minor aquifers.

Information from the National Soil Resources Institute[4] details the site area as being situated on freely draining lime-rich loamy soils.

[4] National Soil Resources Institute (NSRI) 2013. The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. Last accessed 10/12/2021.

4. Flood Risk

4.1 Sources of Flooding

All sources of flooding have been considered, these are; fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure failure.

4.2 Historic Flooding

There are no records of anecdotal information of flooding at the site including within the British Hydrological Society "Chronology of British Hydrological Events[4]". No other historical records of flooding for the site have been recorded. Therefore, it has been assumed that the site has not flooded within the recent past.

4.3 Existing and Planned Flood Defence Measures

It is understood that there are no Environment Agency maintained defences in this area. Further risk management measures will be used to protect the site from flooding these are discussed in Section 6.0.

4.4 Environment Agency Flood Zones

A review of the Environment Agency's flood map indicates that the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding as shown in see Drawing T/2503/FRA/2. Flood Zone 1 has less than 1 in 1000 annual probability of river/tidal in any year (<0.1%).

The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. The Environment Agency Flood Zones and acceptable development types are explained in Table 4.1. Table 4.1 shows that all development types are generally acceptable in Flood Zone 1.

In the Planning Practice Guidance to the NPPF (Table 1) appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in Table 2 and 3 of the Planning Practice Guidance to the NPPF, the development is classified as 'less vulnerable'. Table 4.2 of this report and Table 3 of the Planning Practice Guidance to the NPPF states that 'less vulnerable' uses are appropriate within Flood Zone 1.

Table 4.1 - Environment Agency Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than a 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable

Table 4.2 - Flood Risk Vulnerability and Flood Zone 'Compatibility' as identified in Table 3 of the Planning Practice Guidance to the NPPF

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	×	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	×	×	×

Key: ✓: Development is appropriate, ×: Development should not be permitted.

4.5 Climate Change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF[5].

Table 4.3 shows peak river flow climate change allowances by river basin district. The flood risk assessments: climate change allowances guidance recommends that for 'less vulnerable' uses in Flood Zone 1 that the central allowances are used. Therefore, the design flood level for the site is the 1 in 100 year (+15%) event.

Table 4.3 - Peak River Flow Allowances by River Basin District (use 1961 to 1990 baseline)

River Basin District	Allowance Category	2020s	2050s	2080s
Cherwell and Ray Management Catchment	Upper	+24%	+27%	+49%
	Higher	+11%	+10%	+25%
	Central	+6%	+4%	+15%

4.6 Fluvial (river) Flooding

The nearest surface watercourse is a watercourse known as The Twins or Padbury Brook located adjacent to the south eastern boundary of the site. The top of bank of the watercourse is approximately 2m below the minimum ground level of the site. The site is not located within the vicinity of fluvial flooding sources and would not be inundate with floodwater during the 1 in 100 year (+15%) or the 1 in 1000 year events. The risk of fluvial flooding is considered to be not significant.

4.7 Tidal (coastal) Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be not significant.

4.8 Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded. Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers).

[5] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances.

The susceptibility of the site to groundwater flooding, based on the underlying geological conditions, is negligible. There are no records of groundwater flooding at or near to the site. It can therefore be concluded that the risk of groundwater flooding is not significant.

4.9 Surface Water (pluvial) Flooding

The soil condition at the site and within the vicinity of the site and the topography of the site suggest that the site is relatively well drained and surface water flooding would not be expected to accumulate to any significant depths. Surface water flooding tends to occur sporadically in both location and time such surface water would tend to be confined to the streets around the development.

Drawing T/2503/FRA/3 confirms that the majority of the site has a very low risk of surface water flooding with a chance of flooding of less than 1 in 1000 years (0.1%). However, small areas of the site, on the boundaries of the site, have a low to medium risk of surface water flooding with a chance of flooding of 1 in 1000 (0.1%) years to 1 in 30 (3.3%) years.

It can therefore be concluded that the risk of surface water flooding is of low significance. The risk from the surface water sources will be managed and mitigated by using a number of flood mitigation measures to manage and reduce the overall flood risk at the site (see Section 6.0).

4.10 Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

There are existing public sewers within roads adjacent to the site these will inevitably have a limited capacity so in extreme conditions there would be surcharges, which may in turn cause flooding. Flood flows could also be generated by burst water mains, but these would tend to be of a restricted and much lower volume than weather generated events and so can be discounted for the purposes of this assessment. Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 30 years.

The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less. Therefore, sewer flooding poses a low flood risk to the site. It can therefore be concluded that the risk of sewer flooding is not significant.

4.11 Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, water channels and artificial drainage systems that could be considered a flood risk to the site. The Environment Agency Reservoir flood map shows that

the site is not at risk of reservoir flooding (see Drawing T/2503/FRA/4). The risk of flooding from reservoir failure is considered to be not significant.

4.12 Effects of the Development on Flood Risk

The site is located within Flood Zone 1, there will be no loss of floodplain storage capacity and the proposed development will have no impact on the movement of water.

4.13 Summary of Site Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 4.3.

Table 4.3 - Risk Posed by Flooding Sources

Sources of Flooding	Potential Flood Risk	Potential Source	Probability/Significance
Fluvial (river) Flooding	Yes	The Twins / Padbury Brook	Not significant
Tidal (coastal) Flooding	No	None Reported	Not significant
Groundwater Flooding	No	None Reported	Not significant
Surface Water (pluvial) Flooding	Yes	Low Spots	Low
Sewer Flooding	No	None Reported	Not significant
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	None Reported	Not significant

The site is not at risk of flooding from a major source (e.g. fluvial and/or tidal). The site has a 'low probability' of fluvial flooding as the site is located within Flood Zone 1 with less than a 1 in 1000 annual probability of river/tidal flooding in any year (<0.1%). A secondary flooding source has been identified which may pose a low risk to the site. This is:

- Surface Water (pluvial) Flooding

The risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zone 1 after the completion of a satisfactory FRA. The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

5. Surface Water Drainage

5.1 Surface Water Drainage Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A SuDS Strategy for the site proposals should be developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates should be undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance and the National Sustainable Drainage Systems (SuDS) Standards.

5.2 Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations, this hierarchy is also promoted within the NPPF. Rainwater shall discharge to one of the following, listed in order of priority:

- an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- a watercourse; or where that is not reasonably practicable,
- a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

5.3 Soakaway/Infiltration System

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. Infiltration methods are likely to be suitable across the majority of the site due to

the likely presence of high permeability strata. Therefore, it will be possible to discharge surface water runoff from the site via infiltration methods and this is the preferred option. It is proposed that the surface water runoff from the site will discharge into attenuation basins and/or swales which will allow infiltration of the surface water into the soil substrate. The system will overflow into the drainage ditch.

5.4 Watercourse

Should infiltration be found to be unsuitable, the next option is discharge to a watercourse. A drainage ditch is located on the western boundary of the site which ultimately discharges into Padbury Brook. Therefore, it will be possible to discharge surface water runoff from the site into a watercourse. All surface water runoff that cannot be discharged via infiltration will be managed on site and discharged to the drainage ditch via an overflow at Greenfield runoff rates for all events up to and including the 1 in 100 year (+40%) event.

5.5 Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public sewer is the next option. However, there is no surface water sewer within a reasonable distance from the site furthermore, it is proposed to discharge the surface water via infiltration/watercourse therefore, this option is not required.

5.6 SuDS and Water Quality

Current guidance promotes sustainable water management through the use of SuDS. SuDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

1. A hierarchy of techniques is identified6:

2. Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

3. Source Control – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).

4. Site Control – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).

5. Regional Control – management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

[6] CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

It is generally accepted that the implementation of SUDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity. The application of the SuDS Manual requires that the runoff from sites is not only restricted to meet the pre-development runoff characteristics but also that SuDS systems are utilised to improve the quality of the runoff prior to outfall to watercourses. The SuDS Manual and Environment Agency guidance applies a sustainability hierarchy to the various types of SuDS systems, this is summarised in Table 5.1.

Table 5.1 - Sustainability Hierarchy

	SuDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
Most Sustainable	Green / Living Roofs / Living Walls	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration Devices - Soakaways	✓	✓	✓
	Permeable Surfaces and Filter Drains - Gravelled areas - Solid paving blocks - Permeable paving	✓	✓	
Least Sustainable	Tanked systems - Over-sized pipes/tanks - Cellular storage	✓		

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

The usual approach is to consider the 'SUDS train' where each of the above options are considered in turn until a suitable solution is found. Thus, source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds. The various options are considered in outlined in Table 5.2.

Table 5.2 - SuDS Techniques

SuDS Technique	Comments	Suitability for Development
Green / Living Roofs / Living Wall	A green roof is a multi-layered system that covers the top of a building with soil and vegetation and which can provide a degree of rain storm attenuation and a reduction in site runoff. Can be used to reduce the volume and rate of runoff so that other SUDS techniques in the scheme can be significantly reduced in size.	Not a practical option for the proposed development. A green/living roof/living wall would not provide all of the attenuation storage requirements alone.
Basins / Ponds	Provides storage of runoff and flow attenuation. Vegetated surfaces can be used to support the prevention of runoff from the site for small rainfall events (interception) and improve water quality associated with the removal of sediment and buoyant materials.	The required area is available and it is proposed to use attenuation basins within the SuDS Strategy.
Filter Strips / Swales	Good removal of urban pollutants, reduces runoff rates and volumes.	The required area is available and it is proposed to use swales within the SuDS Strategy.
Infiltration Devices (e.g. soakaways)	Reduces total runoff volume from the development.	Soakaways are suitable due to site ground conditions.
Permeable Surfaces and Filter Drains	Permeable surfaces together with their associated substructures are an efficient means of intercepting runoff, reducing the volume and frequency of runoff and providing a treatment medium.	Suitable due to the site ground conditions
Tanked / Cellular Systems	Ideal for sites with insufficient space for basins etc., provide a volume of below ground storage with a high void ratio.	Potential to be installed under the site with clearance from the foundations.
Flow Reduction	Manages and reduces the flood risk to the local surface water sewers and watercourses.	A hydrobrake can be installed downstream of attenuation tanks and control flows to the

		natural greenfield run off rates. It is proposed to use hydrobrakes.

5.7 SuDS Strategy

The objective of this SuDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. The SuDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy with discharge via infiltration methods with an overflow to the drainage ditch being utilised and will take the form of:

- Attenuation basins and/or swales.
- Overflow into the drainage ditch at Greenfield runoff rates.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be incorporated into the site layout of attenuation storage will be provided. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The adoption of a SuDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

5.8 Designing for Local Drainage System Failure/Design Exceedance

The exceedance flow routes are shown in Appendix F. When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SuDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the SuDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design 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[7].

The attenuation requirements have been designed to accommodate the 1 in 100 year event plus climate change (+40%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the drains connecting the buildings to the attenuation basins and/or swales. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the drains would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings.

Exceedance flows would be contained within the highways within the site and adjacent to the site and would flow to the lower ground levels where the landscaped areas are located. In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+40%) event, there is safety factor for attenuation basins and swales, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this. If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Drainage gullies, manholes and pipework will provide additional water storage and provide betterment. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

[7] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

The above manages and mitigates the flood risk from surface water runoff from surface water runoff generated by the site development and to offsite locations as well as the risk from surface water runoff generated offsite.

6. Risk Management

6.1 Introduction

In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout, form of the development and the use of flood mitigation measures including SuDS techniques. The flooding sources will have to mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. These will be used to ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and;
- Minimal disruption to natural heritage.

6.2 Minimum Floor Level

There is no minimum finished floor level required. However, it is recommended that generally floor levels are located above the highways by 150mm (apart from HGV loading areas) to enable the full capacity of any secondary flood conveyance to be utilised.

6.3 Flood Resilience and Resistance

The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed. Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site.

6.4 Access and Egress

The site and surrounding area is located within Flood Zone 1 therefore a permanently safe and dry access can be maintained.

6.5 Flooding Consequences

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable. In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1, with a low annual probability of flooding and from all sources.

7. Sequential Approach

7.1 Sequential Test

The risk-based Sequential Test in accordance with the NPPF aims to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1). The proposed development site complies with the sequential approach which should be applied at all stages of planning. Therefore, the Sequential Test will not need to be undertaken as part of this planning application.

7.2 Exception Test

Applications located within Flood Zone 1 are not subject to the Exception Test as confirmed within Table 4.2 of this report and Table 3 of the Planning Practice Guidance to the NPPF.

8. Summary and Conclusion

8.1 Introduction

This report presents an FRA in accordance with the NPPF for the proposed development of Symmetry Park, Ardley. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will need to be managed so that the development remains safe throughout the lifetime, taking climate change into account.

8.2 Flood Risk

The site is not at risk of flooding from a major source (e.g. fluvial and/or tidal). The site has a 'low probability' of fluvial flooding as the site is located within Flood Zone 1 with less than a 1 in 1000 annual probability of river/tidal flooding in any year (<0.1%). A secondary flooding source has been identified which may pose a low risk to the site. This is:

- Surface Water (pluvial) Flooding

The risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zone 1 after the completion of a satisfactory FRA. The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

8.3 SuDS Strategy

The SuDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. The SuDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy with discharge via infiltration methods with an overflow to the drainage ditch being utilised and will take the form of:

- Attenuation basins and/or swales.
- Overflow into the drainage ditch at Greenfield runoff rates.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be incorporated into the site layout of attenuation storage will be provided. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The adoption of a SuDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

8.4 Risk Management

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:

Minimum Floor Level - There is no minimum finished floor level proposed as a result of flooding. However, it is recommended that generally all buildings are located above the highways by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

Flood Resilience and Resistance - The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed.

Access and Egress - The site and surrounding area is located within Flood Zone 1 therefore a permanently safe and dry access can be maintained.

8.5 Sequential and Exception Tests

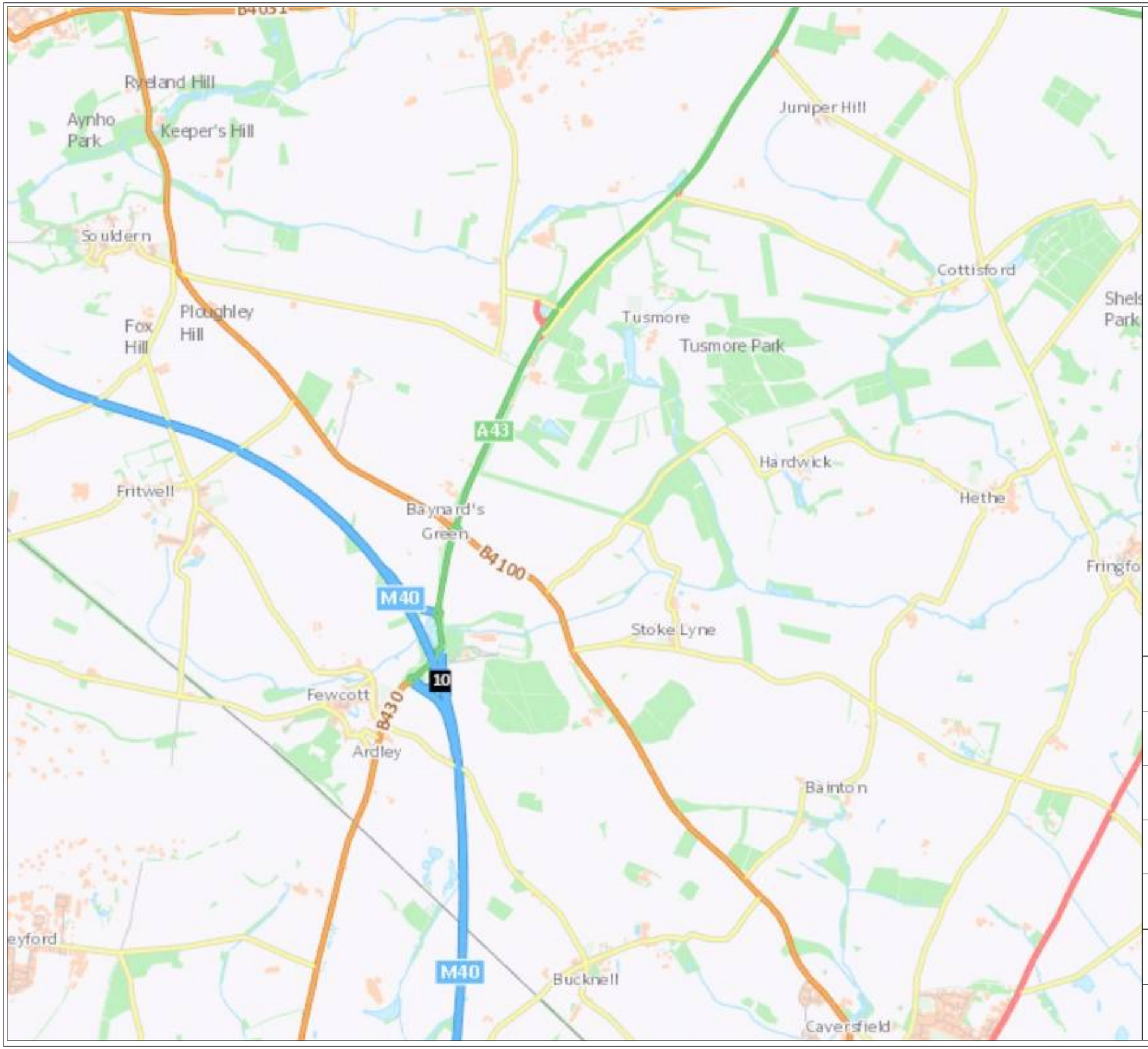
The development proposals should be considered by the LPA to satisfy the Sequential and Exception Tests as set out in the NPPF.

8.6 Conclusion

In conclusion, a commercial development, would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable and the development would be in accordance with the requirements of the NPPF.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.

Appendix A – Drawings



KEY

Site Boundary

TIER CONSULT

PROJECT
Symmetry Park, Ardley

CLIENT
Tritax Symmetry Ardley Ltd

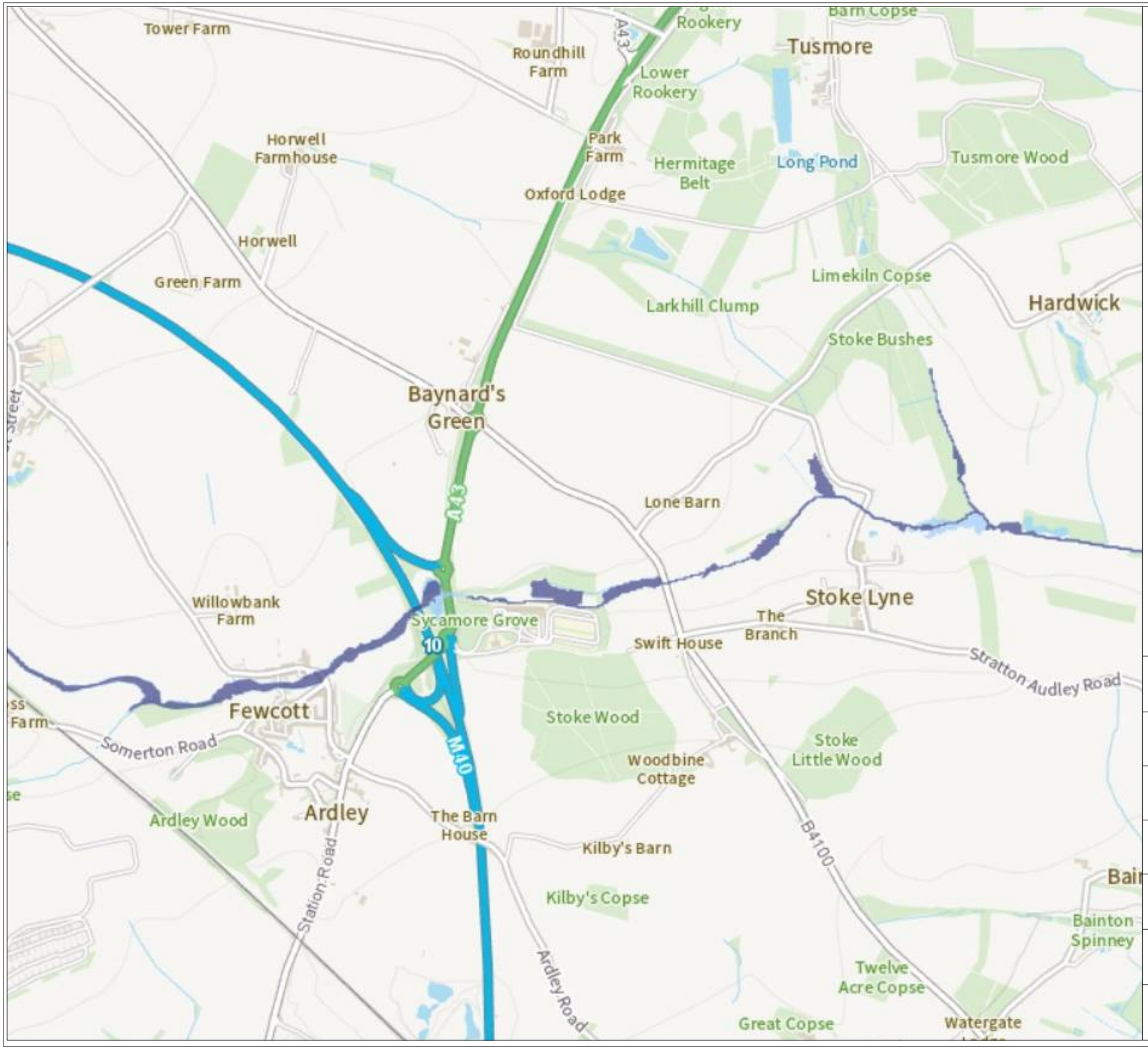
TITLE
Site Location

PROJECT REF
T/2503/FRA

DRAWING NO
T/2503/FRA/1

SCALE
NTS@A3

DATE
December 2021

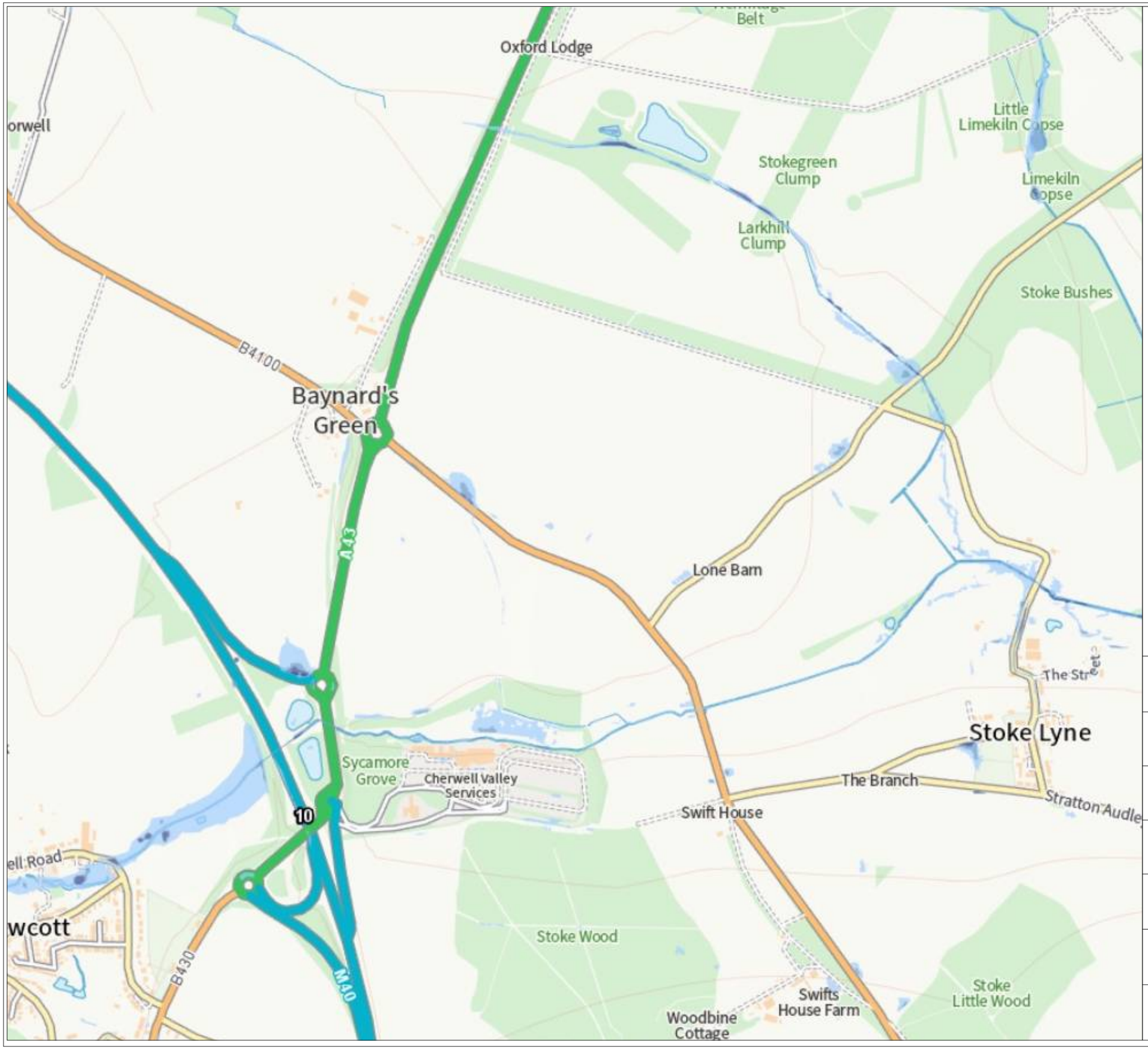


KEY

- Site Boundary
- Flood Zone 3
- Flood Zone 2
- Flood Zone 1

TIER CONSULT

PROJECT	Symmetry Park, Ardley
CLIENT	Tritax Symmetry Ardley Ltd
TITLE	Environment Agency Flood Zones
PROJECT REF	T/2503/FRA
DRAWING NO	T/2503/FRA/2
SCALE	NTS@A3
DATE	December 2021

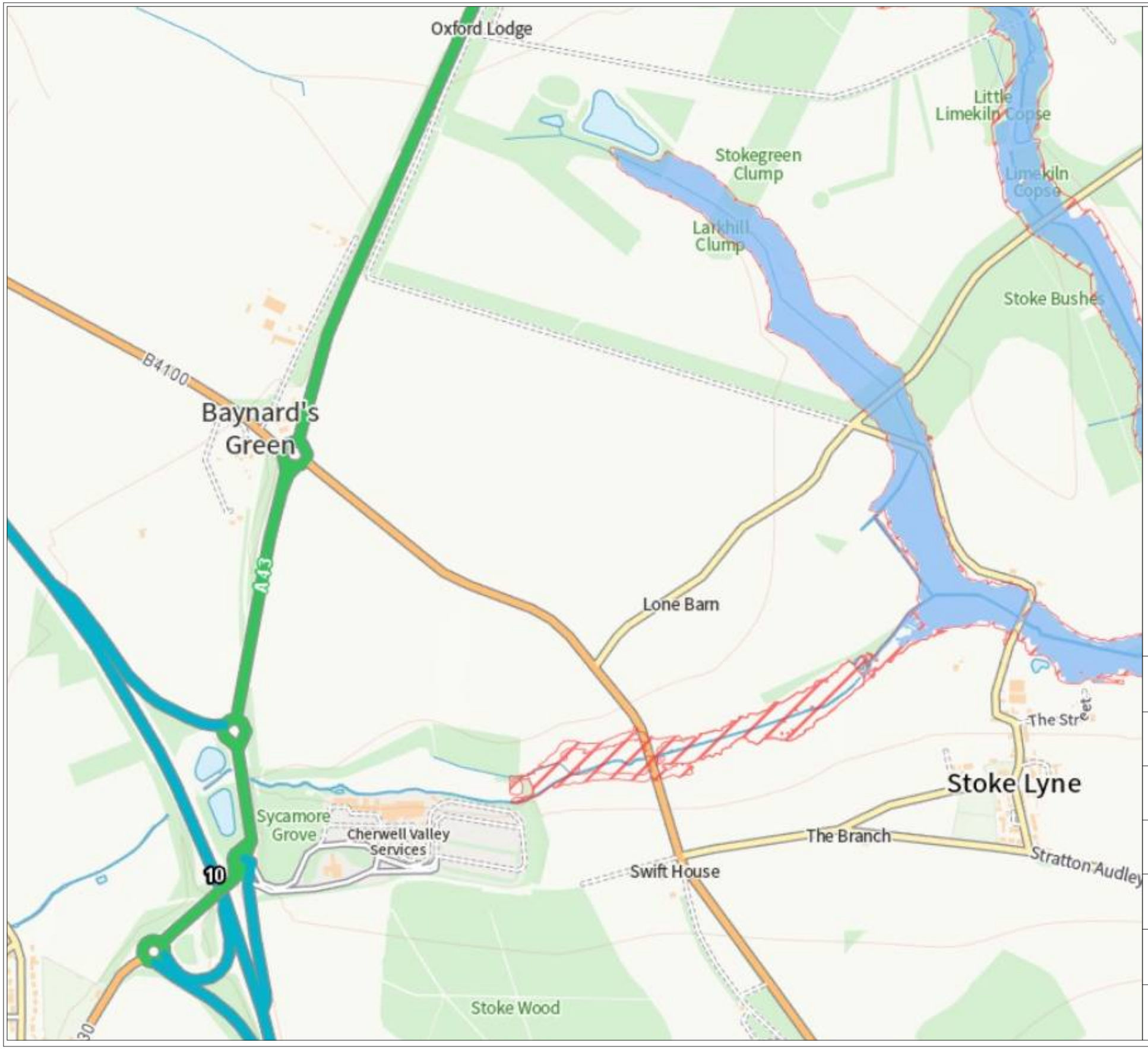


KEY

- Site Boundary
- Very Low
- Low
- Medium
- High

TIER CONSULT

PROJECT	Symmetry Park, Ardley
CLIENT	Tritax Symmetry Ardley Ltd
TITLE	Environment Agency Surface Water Flood Map
PROJECT REF	T/2503/FRA
DRAWING NO	T/2503/FRA/3
SCALE	NTS@A3
DATE	December 2021



KEY

Site Boundary

Reservoir Flood Outline

TIER CONSULT

PROJECT	Symmetry Park, Ardley
CLIENT	Tritax Symmetry Ardley Ltd
TITLE	Environment Agency Reservoir Flood Map
PROJECT REF	T/2503/FRA
DRAWING NO	T/2503/FRA/4
SCALE	NTS@A3
DATE	December 2021

Appendix B – Proposed Site Layout

Rev	Date	By	Description

Unit 01
1,004,080 sq.ft.

Unit 02
500,000
sq.ft.

Unit 03
220,280
sq.ft.

ENERGY CENTRE

Lorry Park

Unit 04
214,000
sq.ft.

Unit 05
245,000
sq.ft.

Unit 06
300,000
sq.ft.

Unit 07
115,000
sq.ft.

Unit 08
382,000 sq.ft.

45375

50979

206100

139300

Pond

Filling Station

Cottages

Love Barn

Islands

A43

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Symmetry Park,
M40 Junction 10

Drawing Name:
Illustrative Masterplan - Option 2 - NSA

Drawing Stage:	PLANNING
Suitability:	S0 - Work In Progress
SGP File Ref:	14-019-SGP-XX-XX-DR-A-001010-P2 Planning Issue.dwg

SGP Project No:	Date:	Drawn:	Team:	Scale:	Rev:
14-019	02/2022	MMS	MMS	1:2000 @ A1	**P2**

Drawing Number:

Project Code	Originator	Volume	Level	Type	Role	Number
14-019	- SGP -	XX -	XX -	DR -	A -	001010