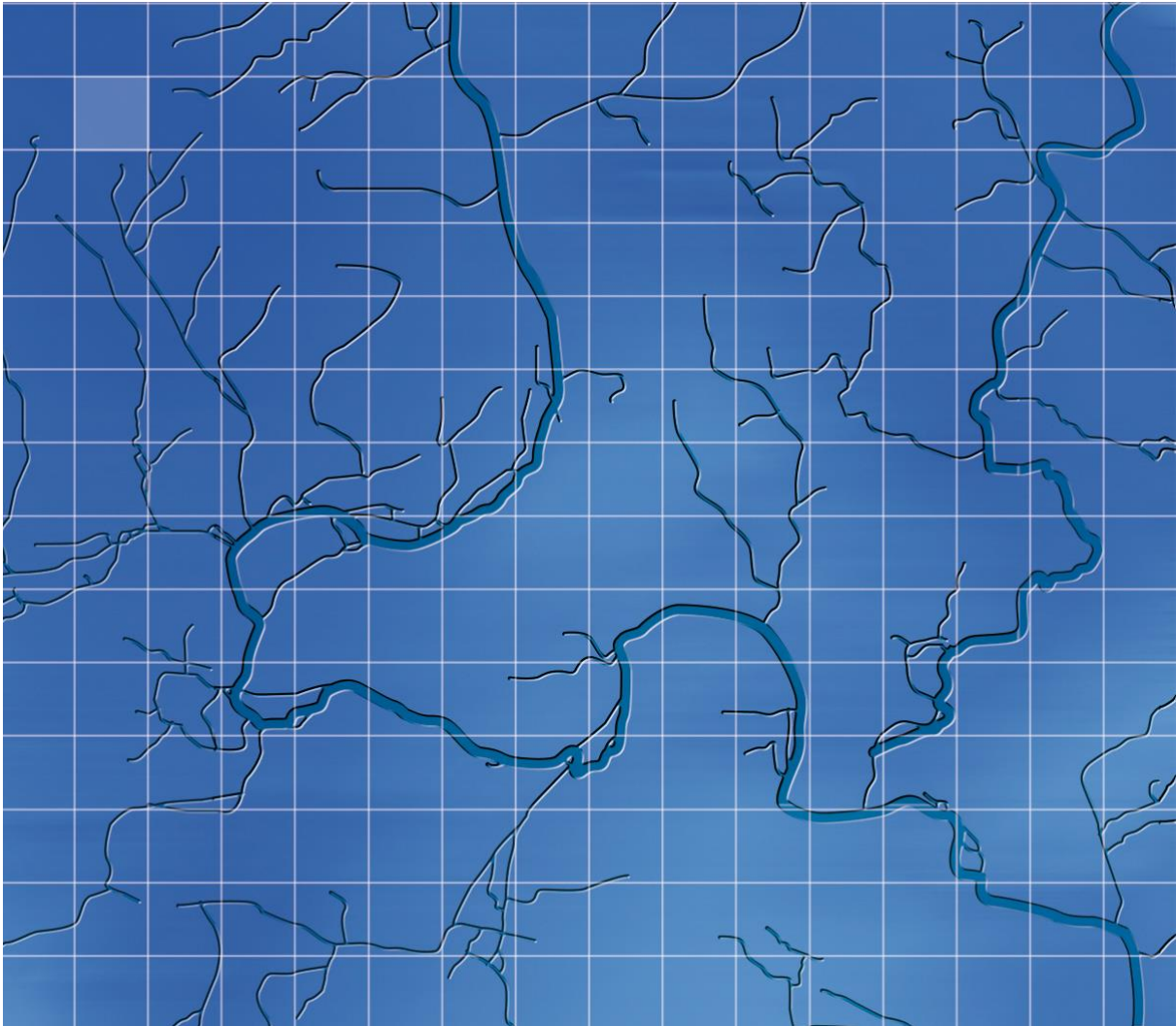


**Oxford City Council**

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# **Oxford City Strategic Flood Risk Assessment Addendum**



# Oxford City Council

## Oxford City Strategic Flood Risk Assessment Addendum

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For and on behalf of Wallingford HydroSolutions Ltd.

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**Appendix 1 – Cowley Marsh Depot (SPS11) Site Assessment**

## 1 Introduction

- 1.1 Wallingford HydroSolutions (WHS) has been commissioned by Oxford City Council (OCC) to complete an addendum to the Strategic Flood Risk Assessment (SFRA) for the Oxford Local Plan 2040 and its Sustainability Appraisal.
- 1.2 The purpose of the addendum is to i) assess flood risk at the Cowley Marsh Depot site (SPS11) and ii) provide further clarification and additional detail to address a number of comments raised by the Environment Agency (EA) following completion of the level 1 and level 2 SFRA reporting.
- 1.3 The Cowley Marsh site was brought forward for consideration, as it was found that the immediate access/egress to this site off Marsh Road is in Flood Zone 3b. The review of flood risk follows the same methodology outlined in the level 2 SFRA. A detailed assessment of flooding at the site based on available model data, flood defence information, surface water flood mapping and historical flood data has been undertaken. The assessment also includes guidance for the preparation of site-specific Flood Risk Assessments (FRAs), including information about the use of SuDS and the need for mitigation measures. From this information the appropriateness of development on the site and likelihood of passing the Exception Test has been determined. The findings of the review are outlined in section 2, with the full site assessment provided in Appendix 1.
- 1.4 To address the comments raised by the EA in their Regulation 19 feedback on the SFRA<sup>1</sup>, the addendum reviews several key areas and how they are covered in the existing reporting, adding additional detail where required. This includes other sources of flood risk (section 3), access and egress (section 4), land raising and compensatory storage (section 5), classification of flood risk & high-risk sites (section 6).

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<sup>1</sup> EA (2024) *EA comments and City Council responses WHS.docx*

## 2 Cowley Marsh Depot (SPS11) Site Assessment

- 2.1 For the Cowley Marsh Depot site (SPS11), a detailed assessment of the nature of flood risk was undertaken. This included using the relevant fluvial modelling data to assess flood risk.
- 2.2 The modelling data available comes from the 2010 Boundary Brook model. It is a 1D hydraulic model for which only flood extent information is available. Therefore, flood levels and depths have been inferred based on comparing the extents against LIDAR levels. Speed of onset are reviewed qualitatively based upon a review of the Boundary Brook’s catchment characteristics.
- 2.3 To assess climate change at this site, the model results for the 1.0% AEP (plus 20% Climate Change) Event and 0.1% AEP Event were used. The 20% allowance is the old blanket allowance applied pre-2016. It aligns closely with the current central allowance of 26% for the Gloucestershire and the Vale management catchment so is considered appropriate for the purposes of the SFRA.
- 2.4 In addition to the analysis of modelling data, the location, standard and condition of existing flood defences was assessed. Other sources of flooding were also reviewed at each site. This included an assessment of surface water flooding, reservoir flooding and groundwater flooding based on available hydrogeological information. Potential access/egress routes were identified with respect to the risk posed from all sources of flooding.
- 2.5 Following a review of flood risk, flood defences and the identification of access/egress routes, an assessment was made on whether it is likely that a future site-specific FRA would be able to show that the site can be allocated for development. The assessment also takes into account the NPPF’s flood risk vulnerability and flood zone compatibility classifications along with any requirements for the Exception Test.
- 2.6 In this respect, guidance is provided for the preparation of FRAs, including information about the use of SuDS, and requirements to consider at the planning application stage including any layout and ground raising considerations.
- 2.7 The assessment of flood risk at the site is collated in Table 1. The development site is considered to be at low risk from all sources of flooding, although the site access is compromised. The site’s access route is inundated for the initial 130m along Marsh Road and Crescent Road, lying in Flood Zone 3. Depths and velocities are expected to be low, however early flood warnings will be important to allow site users to utilise the route before floodwaters inundate the access route. As it should be possible to locate all development on site outside of the flood extents safe refuge on site should also be possible.
- 2.8 Despite the site being categorised as low risk, it should be noted that the risk levels are indicative at this stage especially given the age of the modelling. More refined model data would improve confidence in any assessment and confirm any mitigation requirements. This is why the site has been categorised as ‘Amber’ in terms of whether it is developable. This indicates that the proposed development is appropriate but may require further analysis and/or mitigation to demonstrate compliance with the Exception Test. The full site assessment is provided in Appendix 1.

Table 1- Flood Risk Summary for Cowley Marsh Depot

Site Name	Fluvial	Pluvial	Groundwater	Reservoir	Developable
SPS11	Low	Low	Low	No	Proposed development type should be appropriate. To increase the confidence of assessment more refined model data and a further review of pluvial flood risk should be performed.

### 3 Other Sources of Flood Risk

- 3.1 The EA has raised concerns that a full sequential test that considers all sources of flood risk and the impacts of climate change has not been undertaken. The level 1 SFRA has made use of the latest available flood risk data to inform the sequential test. How the data has been used is clarified below for each source of flooding.

#### Surface water flooding

- 3.2 As covered in section 2.1.3 of the level 1 SFRA, for surface water flood risk the EA's nationally produced surface water flood mapping has been used. The mapping is the best single source of information on surface water flooding, incorporating the latest EA modelling techniques and local data. The surface water flood map shows areas of High Risk which relates to land estimated to flood in a 3.3% AEP pluvial event, Medium Risk which relates to land estimated to flood in a 1.0% AEP pluvial event and Low Risk which relates to land estimated to flood in a 0.1% AEP pluvial event. These areas have been considered when applying the sequential test.
- 3.3 It is highlighted in the level 1 SFRA (section 2.1.3) that the maps only indicate where surface water flooding would occur as a result of local rainfall and are based on a number of assumptions. Due to the modelling techniques used, the mapping picks out depressions in the ground surface and simulates some flow along natural drainage channels and rivers. Where this is the case, the dominant flooding mechanism is considered to be fluvial. These areas are therefore ignored in the assessment of surface water flooding throughout Oxford City. This is common in Oxford and was the case for several of the sites included in the level 2 SFRA.
- 3.4 Note, the surface water mapping is used in some of these cases to inform fluvial flood risk from ordinary watercourses not captured in the fluvial modelling data or the EA's fluvial flood maps.
- 3.5 In terms of climate change, the surface water flood maps do not include the impacts of climate change. To assess climate change in relation to surface water flood risk explicitly, it would be necessary to develop a bespoke detailed hydraulic model at each site. This is considered outside of the scope of the level 1 SFRA, however where sites are at risk it is recommended that site specific FRAs should factor in the latest climate change guidance<sup>2</sup> (section 5.28).
- 3.6 Despite these assumptions and limitations, the mapping is considered appropriate for strategic purposes and application of the sequential test with further assessment of surface water flooding undertaken as part of a level 2 SFRA assessment or for a site-specific FRA should the mapping indicate significant risk.
- 3.7 For the level 2 SFRA, surface water flood risk was initially reviewed using the surface water flood maps, with the Low Risk (0.1% AEP) areas used as a proxy to assess climate change. As none of the sites were considered to be at significant risk, a further assessment involving detailed hydraulic modelling was not considered necessary.

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<sup>2</sup> EA (2022) *Flood risk assessments: climate change allowances*, <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

### **Groundwater flooding**

- 3.8 As covered in section 2.1.5 of the level 1 SFRA, there are limited local data with respect to groundwater flooding. However, for a strategic level assessment of the potential for groundwater flooding, the BGS UK Geoviewer has been used to determine the bedrock across the study area, with the Landis Soils map used to determine the soils present.
- 3.9 This information has been considered when applying the sequential test however is given a lower weighting relative to fluvial flood risk and surface water flooding. Groundwater flooding can be highly location specific, and a full investigation of groundwater flood risk would require in-situ site data on groundwater levels, the soils present and infiltration rates. This is considered outside of the scope for a level 1 and level 2 SFRA assessment, however, is highlighted as a requirement for future site-specific FRAs where the potential for groundwater flooding has been identified as being significant.

### **Sewer flooding**

- 3.10 As covered in section 2.1.6 of the level 1 SFRA, sewer flooding has been reviewed based on DG5 flooding records provided by Thames Water. This information has been considered when applying the sequential test. However, it should be noted that the records are somewhat dependent on reporting and are given for broad post code areas. In this regard, caution should be exercised when ascribing a sewer flood risk to a particular location.
- 3.11 Given the limited extent of sewer flooding during most events and the low level of risk of sewer flooding at most locations, a detailed assessment of sewer capacity at each site is considered outside the scope of the level 1 and level 2 SFRA. However, it is highlighted as a requirement for future site-specific FRAs where issues with local sewer capacity are identified.

### **Reservoir & Canal flooding**

- 3.12 As covered in section 2.1.7 of the level 1 SFRA, reservoir flooding has been assessed based on the EA's 2021 maps showing the flood risk associated with reservoirs. Whereas canal flooding, (section 2.1.8) has been reviewed based on incident data provided by the Canal and River Trust.
- 3.13 Whilst canal and reservoir flood risk are considered in both the level 1 and level 2 SFRA, they are considered a rare event with a very low probability of occurrence. Hence, they were not considered in the application of the sequential test.

## 4 Access and egress

### Current Assessment

- 4.1 The EA has highlighted that the level 1 SFRA does not assess safe access and egress in detail. The level 1 SFRA report focuses largely on a review of flood risk across the Oxford City Administrative area and site allocations were not considered at that time. In this regard a detailed review of potential access and egress routes was not possible.
- 4.2 However, the mapped outputs from the level 1 study were used in OCC's subsequent application of the sequential test. This did consider available access and egress routes and where the levels of risk were considered significant, a further assessment was recommended as part of the level 2 SFRA.
- 4.3 For the level 2 sites, potential access and egress routes were identified. These considered the speed of onset, measured as the time between a river breaking its bank and floodwater encroaching onto the site boundary and flood hazard based on maximum depths and velocities during the design flood event. The flood extent for an extreme 0.1% AEP event was also considered along with the proposed development type and existing development at and around the site.
- 4.4 Whilst many of the sites do not have dry access and egress, generally inundation is limited in extent and hazard values low. Furthermore, where sites are not adjacent to or very close to a watercourse, speed of onset tends to be slow. As noted in many of the assessments, the River Thames catchment is dominated by chalk, it has relatively slow river response times to storm events, being groundwater, rather than surface water dominated. This increases the time taken for inundation which affords more time for adequate warnings and preparation in an extreme flood event.
- 4.5 There are several sites (SPCW6, SPCW7, SPCW8 & SPS8) where access and egress routes are compromised due to a large proportion of the route being inundated, significant flood hazard and/or fast speed of onset. At these sites further assessment of access and egress as part of a site-specific FRA will be essential and is recommended. The section below provides additional information on what needs to be considered and will be factored into any development proposals.

### Additional Information

- 4.6 The information and recommendations provided in this section have been prepared based on the National Planning Policy Framework (NPPF)<sup>3</sup> and Planning Practice Guidance (PPG)<sup>4</sup>.
- 4.7 When assessing access and egress in any location, the practicality of safe evacuation from an area will depend on:
  - The type of flood risk present, and the extent to which advance warning can be given.
  - The number of people that would require evacuation from the area potentially at risk;
  - The adequacy of both evacuation routes and identified places that people from evacuated places use/are taken to (and taking into account the length of time that the evacuation may last).

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<sup>3</sup> Ministry of Housing, Communities & Local Government (2023) *National Planning Policy Framework*, [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1182995/NPPF\\_Sept\\_23.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1182995/NPPF_Sept_23.pdf)

<sup>4</sup> Ministry of Housing, Communities & Local Government (2022) *Flood risk and coastal change*, <https://www.gov.uk/guidance/flood-risk-and-coastal-change>



- 4.8 Access considerations should include the voluntary and free movement of people during a 'design flood', as well as the potential for evacuation before a more extreme flood, considering the effects of climate change for the lifetime of the development. In terms of access routes, these need to be designed to be functional for changing circumstances over the development's lifetime. Specifically:
- Access routes should allow occupants to safely access and exit their dwellings in design flood conditions.
  - Vehicular access to allow the emergency services to safely reach the development during design flood conditions will also normally be required.
  - Wherever possible, safe access routes should be provided that are located above design flood levels and which avoid flow paths. Where this is not possible, limited depths of flooding may be acceptable. The acceptable flood depth for safe access will vary depending on flood velocities and the risk of debris within the flood water.
  - If it is proposed that access routes be raised, the impact of this on local flood risk and provision of compensatory storage may need to be considered (see section 5)
- 4.9 Where safe access is not possible for all events, safe refuge may need to be considered. This will look to ensure that any single storey buildings or ground floors without access to upper floors can access a safe refuge area above the estimated flood level. The planning process should consider whether the development can be considered safe given the predicted duration of flooding and the vulnerability of occupants/users. In doing so, accounting for the likely impacts of flooding on essential services such as electricity and water supply. Any place of safe refuge needs to be designed to facilitate rescue if it is unlikely to be safe for occupants/users to wait until flood waters have receded sufficiently for safe access/escape to be possible.
- 4.10 Proposals that are likely to increase the number of people living or working in areas of flood risk require particularly careful consideration, as they could increase the scale of any evacuation required. To mitigate this impact, it is especially important to look at ways in which the development could help to reduce the overall consequences of flooding in the locality, either through its design (recognising that some forms of development may be more resistant or resilient to floods than others) or through off-site works that benefit the area more generally. Where the impact cannot be wholly mitigated and where emergency flood response is an important component of making a development safe, developers may need to provide an emergency flood plan.
- 4.11 This plan will look to make sure occupants of a building in a flood risk area remain safe and don't put extra demand on the emergency services. The plan will typically look to cover:
- Sources of flooding
  - Roles and responsibilities
  - Flood defence & resilience measures
  - Flood evacuation options
  - Safe routes that lead to safe refuge areas
  - Reoccupation
- 4.12 In consultation with emergency planners and services, OCC would need to ensure that agreed emergency plans are secured and implemented through appropriate planning conditions or planning agreements. Avoiding additional burdens on emergency services will be prioritised, however opportunities for development proposals to address any shortfall in emergency service and infrastructure capacity could be explored.

## 5 Land Raising and Compensatory Storage

- 5.1 The EA has highlighted that a demonstration of how development will not increase flood risk offsite is absent in the level 2 SFRA. This relates to ground levels within some of the sites lying below the design flood level. Where this is the case, the level 2 site assessments have referred to a potential requirement for land raising and compensatory storage.
- 5.2 At two of the sites, Osney Mead (SPCW7) and Botley Road Retail Park (SPCW8), land raising will likely be required. However, for the majority of sites, only small sections of the site lie below the design flood level, therefore it may be possible to reduce or negate land raising entirely by strategically siting more vulnerable development uses outside of these zones. However, at this stage development layouts are unknown, therefore the full extent of land raising, and a quantitative assessment of third-party impacts cannot be made.
- 5.3 If land raising is proposed in the design flood extent it will be necessary to demonstrate how the development will be safe and not increase flood risk offsite. In this regard post-development modelling may be necessary, whereby the proposed site layout and levels are represented in a hydraulic model. The modelling will firstly confirm whether the land raising proposed is sufficient to ensure all proposed buildings are above the design flood level (with appropriate freeboard). Subsequently, the changes in flood levels relative to the baseline scenario will be reviewed. If significant offsite detriment is observed, especially when it affects existing development, mitigation modelling will be required.
- 5.4 In terms of mitigation, the ability to provide level for level compensation to offset any detriment caused by land raising will need to be explored. For larger sites such as Osney Mead (SPCW7) and the Botley Retail Park (SPCW8) which are shown to be at significant risk, space may be available to provide compensatory storage. It will be more challenging at smaller sites (e.g. SPCW6) without compromising the developable area. At all sites, a sequential approach which locates the most vulnerable development in the areas at lowest flood risk should be taken seeking to limit any ground raising requirements. Alongside this, a thorough review of flood warning and site access will be essential.
- 5.5 It should be noted that many of the sites are already developed so there may be more opportunities to reduce current flood risk at the site and to the surrounding local area. For example, by providing a minimum betterment on existing brownfield runoff rates or through the provision of property flood resilience measures.

## 6 Classification of flood risk & High-risk sites

- 6.1 As requested by the EA, this section provides more information on the classification of flood risk listed in Table 2 of the level 2 SFRA. The level 2 SFRA presents an assessment of the risk of flooding from all relevant sources. The level of flood risk associated with each source of flooding has been classified based on a pragmatic and conservative approach which accounts for the flood source being considered, the nature of the data available and the flood vulnerability classification associated with the proposed development. The criteria used to classify risk for each relevant source is detailed below.
- 6.2 As shown in Table 2 below, fluvial flood risk is initially classified based on the proportion of each site falling in the 1.0% AEP (+26% Climate Change) extent estimated using GIS software. As outlined in section 2.2 of the level 2 SFRA, based on the latest NPPF and PPG the central climate change allowance is to be applied to more vulnerable infrastructure and less vulnerable infrastructure which covers the development proposed across all of the sites. In this regard the 1.0% AEP (plus 26% Climate Change) Event is the design event.
- 6.3 As detailed in section 2.3 of the level 2 SFRA, in addition to extent, the speed of onset, flood depth, flood velocity and the overall flood hazard (ZUK0) are also considered, along with flood risk to the access routes serving a site.

Table 2- Classification of fluvial water flood risk

Classification	Criteria
High	<ul style="list-style-type: none"> <li>More than 50% of site area located in 1.0% AEP (+26%) extent</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>More than 10% of site area is within 1.0% AEP (+26%) extent</li> </ul>
Low	<ul style="list-style-type: none"> <li>Less than 10% of site area is within 1.0% AEP (+26%) extent</li> </ul>

- 6.4 An initial review of surface water flood risk and from small ordinary watercourses (not included in the fluvial flood map) has been undertaken at each of the sites. Flood risk at the preferred sites has been assessed using the EA surface water flood map with the proportion of each site falling in respective flood zones estimated using GIS software. The overall surface water flood risk to the site has been further classified based on the criteria listed in Table 3 below.

Table 3- Classification of surface water flood risk

Classification	Criteria
High	<ul style="list-style-type: none"> <li>More than 20% of site area at risk during 3.3% AEP pluvial event (adjudged to be pluvial in origin)</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>More than 5% of the site area at risk during 1.0% AEP pluvial event (adjudged to be pluvial in origin)</li> </ul>
Low	<ul style="list-style-type: none"> <li>At risk during 1000-Yr pluvial event (adjudged to be pluvial in origin)</li> </ul>

- 6.5 To assess groundwater flooding the BGS UK Geoviewer has been used to determine the bedrock at each of the sites, and the Landis Soils map used to determine the soils present. Based on this information, a high-level assessment of the potential for groundwater flooding is made, with the potential flood risk defined at site level as High, Moderate or Low based on the criteria shown in Table 4. At sites where soils and bedrock are freely draining and permeable, groundwater flood risk is considered higher as the water table is likely to be more mobile relative to a site where drainage is impeded and surface water flood risk may be more pronounced.

Table 4- Classification of Groundwater Flood Risk

Classification	Criteria
High	Meets all of the criteria below: <ul style="list-style-type: none"> <li>• Soils-Freely Draining</li> <li>• Bedrock-Permeable substrate</li> </ul>
Moderate	Meets only one of the criteria below: <ul style="list-style-type: none"> <li>• Soils-Freely Draining</li> <li>• Bedrock-Permeable substrate</li> </ul>
Low	Meets all of the criteria below: <ul style="list-style-type: none"> <li>• Soils-Impeded Drainage</li> <li>• Bedrock-Impermeable substrate</li> </ul>

- 6.6 It should be stressed that the assessment of groundwater flooding is strategic at this stage and should be refined as part of a site-specific FRA. In a locality, groundwater flooding is highly variable and heavily dependent upon local conditions at any particular time. The BGS and soils mapping are limited in resolution and both are descriptions of geology rather than groundwater conditions specifically.
- 6.7 Following the assessment of flood risk, an assessment was made on how developable each site was and the likelihood of passing the Exception Test. A traffic light system was used, with the three categories defined as follows:
- Red - Proposed development is not appropriate and is unlikely to pass the Exception Test
  - Amber - Proposed development is appropriate but may require significant mitigation and/or analysis to demonstrate compliance with the Exception Test
  - Green - Proposed development is appropriate and likely to be justified in a site-specific FRA
- 6.8 The EA have flagged that two of the sites, Osney Mead (SPCW7) and Botley Road Retail Park (SPCW8) are shown as red but are still proposed in the local plan. These sites are shown in red in relation to being at High Risk of fluvial flooding. They are not shown as red in the developable categorisation which would indicate that the proposed development is not appropriate. In this category, both sites have been classed as amber. For these sites it is accepted that significant barriers exist. However, development has not been ruled out based on the following:
- Development is already established at both sites, for SPCW8 specifically the use of the site will remain the same development type (commercial) and involve a reduction in the amount of development at flood risk. As part of the developments proposed for both SPCW7 and SPCW8, there may be opportunities to improve flood risk at the sites and to surrounding areas (e.g. betterment on brownfield runoff rates, provision of flood resilience measures).
  - A sequential approach is implemented with regards to the site layout, locating the most vulnerable infrastructure to the areas at lowest risk onsite.
  - The requirement for land raising and compensatory storage are reviewed in more detail as part of a site-specific flood risk assessment with additional post-development and mitigation modelling likely required to determine off-site detriment.
  - A detailed assessment of access and egress to the sites is undertaken as part of a site-specific FRA. This will consider the speed of onset rates for the site and wider area in the context of available flood alerts and warnings. The requirement and provision of a flood evacuation plan will also be considered.
- 6.9 The findings of a site-specific FRA will in turn confirm whether the sites are able to pass part two of the exception test ensuring that the developments will be safe for their lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

**Appendix 1 – Cowley Marsh Depot (SPS11) Site Assessment**