# Oxpens River Bridge, Oxford

## Flood Risk Assessment and Surface Water Drainage Strategy

On behalf of

Project Ref: 332610335 | Rev: P02 | Date: October 2023

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: Caversham Bridge House, Waterman Place, Reading, Berkshire RG1 8DN
T: +44 (0)118 950 0761 E: Reading.uk@stantec.com

# Document Control Sheet

**Project Name:** **332610335**

**Project Ref:** **Oxpens River Bridge, Oxford**

**Report Title:** **Flood Risk Assessment and Surface Water Drainage Strategy**

**Doc Ref:** **OXPEN-STN-GEN-ALL-RP-C-0001-P02**

**Date:** **October 2023**

| | Name | Position | Signature | Date |
|---|---|---|---|---|
| **Prepared by:** | Connor Egan | Graduate Water Scientist | ***C Egan*** | ***04/11/2022*** |
| **Reviewed by:** | Richard Fisher | Senior Associate | ***R Fisher*** | ***04/11/2022*** |
| **Approved by:** | James Skilton | Senior Associate | ***J Skilton*** | ***04/11/2022*** |
| | Amy Hensler | Director | ***A Hensler*** | ***04/11/2022*** |
| **For and on behalf of Stantec UK Limited** | | | | |

| Revision | Date | Description | Prepared | Reviewed | Approved |
|---|---|---|---|---|---|
| P01 | 13.10.2023 | S2 – Suitable for Information | CMB | RMF | JWS |
| P02 | 19.10.2023 | S2 – Suitable for Information | CMB | RMF | JWS |

# Contents

# Figures



# Tables



# Appendices

# Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Stantec UK Ltd to accompany a full planning application for a proposed pedestrian and cycle bridge over the River Thames linking to existing public highways and footpaths at Oxpens Meadows, Oxford, Oxfordshire.

The FRA demonstrates that:

(i) The development is safe;

(ii) The development does not increase flood risk; and,

(iii) The development does not detrimentally affect third parties.

The Environment Agency (EA) data confirms that the proposed bridge is located mainly within Flood Zone 3, defined in Planning Practice Guidance (PPG), Flood Risk and Coastal Change, Table 1 as follows:

**Flood Zone 3 'High Probability' greater than a 1 in 100 (1%) Annual Probability of river flooding or greater than a 1 in 200 (0.5%) Annual Probability of flooding from the sea.**

Since the proposed bridge crosses the channel of the River Thames it can be concluded that it lies partially within Flood Zone 3b 'Functional Floodplain'. The proposal for this new bridge development constitutes an 'Essential infrastructure' land use, which is considered appropriate within Flood Zone 3b subject to passing the Sequential Test and Exception Test (reference national PPG, Flood Risk and Coastal Change, Tables 2 and 3), both of which are detailed within the FRA.

The PPG 'Climate Change Allowances' guidance confirms the proposed development and site criteria ('Essential infrastructure', , Gloucestershire and the Vale Catchment) requires consideration of peak river flow climate change allowances of +41% ('Higher Central' allowance, 2080s epoch – 2070-2125).

The proposed new bridge scheme is being progressed at the same time as the enabling works for the 'Oxpens Development', a redevelopment of the land north of the River Thames. These enabling works define the wider proposed landform around the Oxpens Meadows area and the Oxpens Bridge proposal has been developed to ensure a consistent approach to floodplain storage mitigation (flood compensation).

As a standalone application, the bridge scheme addresses the planning risk that the Oxpens Development is not approved in the same approximate timeframe as the proposed bridge. This has been done by providing a standalone floodplain storage analysis and mitigation within the bridge application site red line, albeit one that is consistent in form with the wider Oxpens Development proposals.

The flood risk mitigation strategy for the development consists of the following elements:

- A soffit level of no lower than 58.2m AOD is proposed, over 1.4m above the reference 1 in 100 annual probability +41% allowance for climate change flood level and significantly exceeding the standard 600mm freeboard requirement.

- A suitable navigation headroom will be provided based on the soffit level of the upstream River Isis Railway Bridge (which is at 58.2m AOD).

- The floodplain compensation scheme demonstrates an increase in floodplain storage capacity over the site, to meet EA requirements on a level-for-level basis up to the 1 in 100 annual probability plus climate change flood level. The analysis demonstrates that this solution is demonstrated for

the combined scheme with the Oxpens Development, and for the bridge scheme in isolation, and will be verified at detailed design stage subject to the planning status of the respective elements.

In summary, the FRA demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

# Summary of Key FRA Data

| Aspect of flood risk | Applicable Guidance/ Source of Data | Summary | Section of FRA |
|---|---|---|---|
| **Site Location** | n/a | Oxpens Meadow, Oxford, Oxfordshire, OS grid ref 450800 E, 205650 N, OX1 1RQ | **3.1** |
| **Existing Ground Levels** | Topographic Survey by MK Surveys | Southern side of Thames channel ranges from approximately 56.0m AOD approximately 60.0m AOD.<br><br>Northern side of the Thames channel ranges from approximately 56.0m AOD to approximately 58.0m AOD. | **3.2** |
| **Primary source of flood risk** | n/a | River Thames | **3.3** |
| **Presence of flood defences** | n/a | No existing flood defences | **3.5** |
| **Proposed Development** | Proposals by Oxford City Council and Knight Architects | The proposal is for a new pedestrian and cycle bridge linking Osney Mead to Oxpens and the city centre. | **5** |
| **Planning Aspects** | | | |
| **Flood Risk Vulnerability** | Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' | 'Essential Infrastructure' | **5** |
| **Flood Zone** | | Partly in Flood Zone 3 'High Probability' | **4.1** |
| **Sequential Test** | | Sequential Test passed | **5** |
| **Exception Test** | | Exception Test passed | **5** |
| **Applicable Climate Change Allowances** | EA climate change allowances guidance | Gloucestershire and the Vale Management Catchment +41% (Higher Central) | **2.2** |
| **Reference Flood Levels** | | | |
| **Present Day** | EA River Thames 'Eynsham to Sandford' Model 2018 | **Node Point FP1 (flood level at proposed bridge location**<br>1 in 20 annual probability = 56.23m AOD<br>1 in 100 annual probability = 56.45m AOD<br>1 in 1000 annual probability = 56.70m AOD | **4.3** |
| **Climate Change** | | 1 in 100 annual probability +35% allowance for climate change = 56.68m AOD<br>1 in 100 annual probability +41% allowance for climate change = 56.79m AOD | **4.3** |
| **Proposed Mitigation Measures** | | | |
| **Bridge Design Criteria** | Design Manual for Roads and Bridges | Proposed bridge soffit level: min 58.20m AOD | **6.1** |
| **Floodplain Storage** | OCiC SFRA Level 1 Section 3.5 | Level-for-level floodplain compensation provided. No detrimental impact on floodplain storage capacity. | **6.2** |
| **Flood Flow Routes** | OCiC SFRA Level 1 Section 4.1 | No impact on flow routes - proposed clear span bridge downstream of major constriction. | **6.3** |
| **Safe Access** | Flood Hazard Guidance | Bridges provide pedestrian safe link across River Thames at 1 in 100 annual probability +41% climate change event. | |

# Abbreviations

| | | |
|---|---|---|
| ABI | - | Association of British Insurers |
| BGS | - | British Geological Survey |
| CDM | - | Construction (Design and Management) |
| DEFRA | - | Department for Environment, Food and Rural Affairs |
| EA | - | Environment Agency |
| FRA | - | Flood Risk Assessment |
| GIS | - | Geographic Information System |
| LLFA | - | Lead Local Flood Authority |
| m AOD | - | Metres Above Ordnance Datum (Newlyn) |
| NPPF | - | National Planning Policy Framework |
| OCiC | - | Oxford City Council |
| OCC | - | Oxford County Council |
| OFAS | - | Oxford Flood Alleviation Scheme |
| PFRA | - | Preliminary Flood Risk Assessment |
| PPG | - | Planning Practice Guidance |
| RoSWF | - | Risk of Surface Water Flooding |
| SuDS | - | Sustainable Drainage Systems |
| SFRA | - | Strategic Flood Risk Assessment |

# 1 Introduction

## 1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec UK Ltd ('Stantec') on behalf of our client, Oxford City Council, to support a full planning application for a proposed new pedestrian and cycle bridge crossing over the River Thames including new footpaths linking to existing highways and paths at Oxpens Meadow, Oxford, Oxfordshire, OX1 1RQ.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.3** and prepared in accordance with the planning policy requirements set out in **Section 2**.

1.1.3 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers, and the reviewers are members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

## 1.2 Existing Site and Proposed Development

1.2.1 The existing site includes the River Thames footpath on the southern side of the channel downstream (east) of the railway bridge river crossing and extends to land within the 'Oxpens Development' south of Oxpens Road on the northern side of the channel.

1.2.2 The site lies within the administrative boundary of Oxford City Council.

1.2.3 The proposal is for *'a new pedestrian and cycle bridge linking Osney Mead to the City Centre and Oxpens*' – see further details in **Section 5**.

1.2.4 The proposed new bridge scheme is being progressed at the same time as a redevelopment of the land north of the River Thames – the 'Oxpens Development'.

1.2.5 The standalone Oxpens River Bridge detailed application will be submitted while the adjacent Oxpens Development applications are still to be determined. These consist of

- the outline application for the mixed use development (planning ref: 22/02954/OUT);
- the detailed application for the enabling works which aims to deliver the development platform and associated flood compensation mitigation (planning ref: 22/02955/FUL).

1.2.6 The bridge scheme and enabling works schemes are closely linked and it is important that they take a consistent approach to flood compensation. This has been achieved by the Oxpens enabling works application (22/02955/FUL) making allowances for the bridge foundations within the development's flood compensation calculations. The bridge scheme provides consistency by using the same land form proposed within the Oxpens Developments flood compensation landform at the bridge's proposed north abutment.

1.2.7 The bridge scheme is a standalone application; therefore it is necessary to address the planning risk that the Oxpens Development is not approved in the same approximate timeframe as the proposed bridge. As such, a standalone floodplain storage analysis and mitigation has been developed that is within the bridge application site red line.

1.2.8 The land on the southern side of the channel, Grandpont Nature Park, is only associated with the bridge scheme and is not interlinked to the Oxpens Development. We have analysed the proposed changes to the landform on the south bank.

## 1.3 Sources of Information

1.3.1 The FRA has been prepared based on the following sources of information:

- Environment Agency (EA) published '**Open Data**' datasets available online, reproduced with OS mapping under licence to Stantec (contains Ordnance Survey data © Crown copyright and database right [2022], contains Environment Agency information © Environment Agency and database right) (see **Appendix A** );
- **Topographic survey** of the site (Drawing reference 30702) undertaken by MK Surveys in January 2022 (see **Appendix B** );
- EA hydraulic model outputs from the **Thames 'Eynsham to Sandford' 2018 Model**;
- **Development proposals** by Oxford City Council and Knight Architects (see **Appendix C** );
- The Oxfordshire County Council (OCC) **Preliminary Flood Risk Assessment (PFRA)**, dated June 2011;
- The Oxford City Council (OCiC) **Level 1 Strategic Flood Risk Assessment (SFRA),** dated November 2017;
- The Oxford City Council (OCiC) **Level 2 Strategic Flood Risk Assessment (SFRA)**, dated July 2018;

## 1.4 Caveats and Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF, the associated PPG and Local Planning Policy. The proposed flood management strategies are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

1.4.2 Activities during the construction phase may have an impact on the existing and future flood risk. Thus, an assessment of the risks and appropriate mitigation measures should be identified and managed by the contractor.

1.4.3 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.4 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and OCC in its role as Lead Local Flood Authority (LLFA). The conclusions are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals as outlined in **Section 1.2**. As such, we recommend the end user reviews the validity of the flood data on an annual basis with the EA.

# 2 Planning Policy Context

This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as detailed below.

## 2.1 National Policy and Guidance

2.1.1 National policy in relation to flood risk is contained within the **National Planning Policy Framework (NPPF),** updated September 2023, issued by the Ministry of Housing, Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change'.

2.1.2 The associated **Planning Practice Guidance (PPG)** was released in March 2014 (with reference to the 'Flood Risk and Coastal Change' section) and last updated in August 2022.

2.1.3 The NPPF and PPG demonstrate a flood risk management approach for the lifespan of the proposed development considering the effects of climate change. The document sets the framework to minimise vulnerability, provide resilience to the impacts of climate change, and to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

2.1.4 The guidance on the application of climate change allowances in FRAs is linked via the PPG and was most recently updated in May 2022:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

2.1.5 The guidance provides contingency allowances for the potential increases in peak river flow, peak rainfall intensity and sea level rise which are considered accordingly subject to the site conditions – discussed further in **Section 2.2**.

2.1.6 The NPPF sets out the requirement for the Sequential Test and Exception Test in paragraphs 162 and 163 respectively – see below.

> *"**162.** The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding).*
>
> ***163.** If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3"*

2.1.7 These Tests are to be applied where appropriate, depending on the proposed development flood risk 'vulnerability' and the Flood Zone in which it is located. This is detailed further in **Section 5**.

## 2.2 Climate Change Allowances Guidance

2.2.1 The NPPF and PPG place emphasis on the need to fully consider – and design for – the impacts of climate change as set out in the planning guidance. This guidance provides contingency allowances for potential increases due to climate change in:

- Peak river flow;
- Rainfall intensity;
- Sea level rise.

2.2.2 The first 2 elements are discussed in turn below. Sea level rise is not relevant at the site location.

## Peak River Flow

2.2.3 The peak river flow allowances provide a range of allowances based on percentile (i.e., the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The applicable values for a site are dependent on the 'River Management Catchment' in which the site is located, which can be confirmed via the online mapping tool embedded within the guidance.

2.2.4 The peak river flow allowances provide a range of scenarios based on percentile (i.e., the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The allowances are subject to the sub-catchments of river basin district (known as management catchments) and the vulnerability classification of the proposed use of the site.

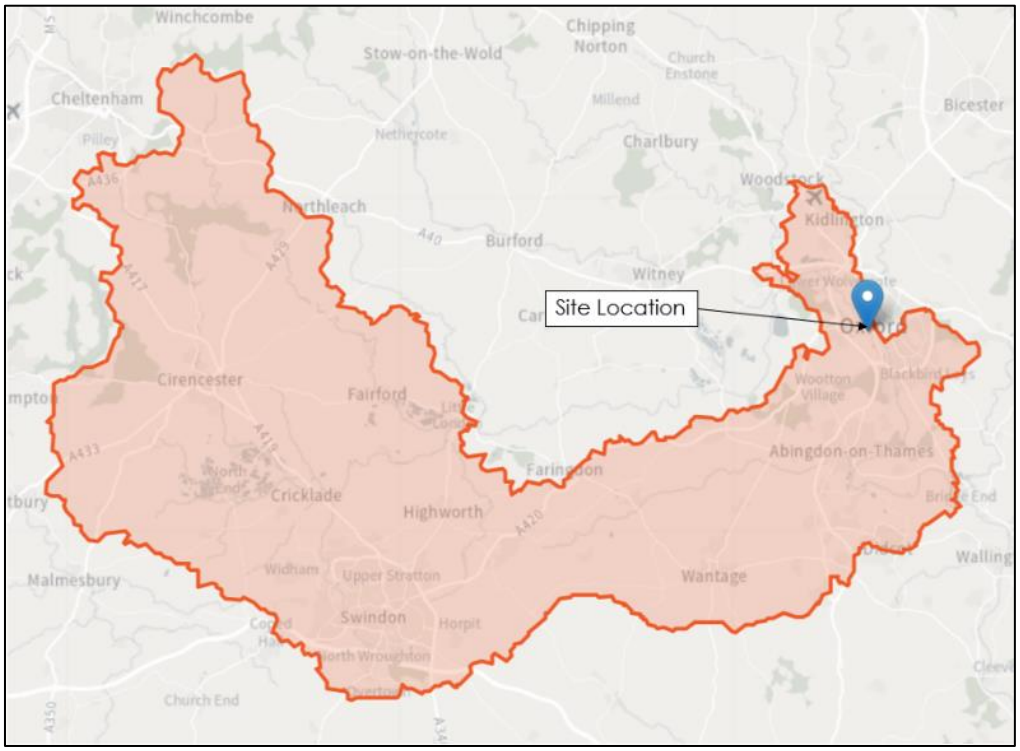
2.2.5 The applicable allowances are subject to the Flood Zone classification of a site, and the vulnerability classification of the proposed use. The Central allowance is identified as the design standard for most forms of proposed development in all appropriate Flood Zones. However, for 'Essential Infrastructure' – as is the case for the proposed bridge – the Higher Central value is applicable.

2.2.6 The conditions at the site and consequent peak river flow allowances to be considered as part of the FRA are as detailed in **Table 2-1**. The 'Gloucestershire and the Vale Management Catchment' area is shown in **Figure 2-1**.

**Table 2-1: Climate Change – Peak River Flow Allowances**

| River Management Catchment | Flood Zone | Flood Risk Vulnerability Classification | 2080s Epoch (2070-2125) | |
|---|---|---|---|---|
| | | | Central | High Central |
| **River Thames** *(Gloucestershire and the Vale Management Catchment)* | *3* | *Essential Infrastructure* | +26% | **+41%** |

**Figure 2-1: Gloucestershire and the Vale Management Catchment**




2.2.7 The assessment of the impact of climate change on peak river flow allowances, and therefore fluvial flood risk has been detailed in **Section 4.3.**

## Peak Rainfall

2.2.8 The potential increase in peak rainfall intensity needs to be considered in the surface water drainage strategy for new developments.

2.2.9 The EA climate change allowances guidance was updated in May 2022 to include a GIS based 'peak rainfall allowances' map showing the anticipated changes in rainfall intensity based on river management catchment. The anticipated changes in peak rainfall intensity in small catchments (less than 5km$^2$), or urbanised drainage catchments are summarised in **Table 2-2**. For large rural drainage catchments, the peak river flow allowances are applied.

**Table 2-2: Climate Change – Peak Rainfall Intensity Allowances (2070s Epoch)**

| ***Arun and Western Streams Management Catchment*** | **Total potential change anticipated** (2070s epoch – i.e., 2061 to 2125) | |
|---|---|---|
| | ***Central*** | ***Upper End*** |
| *3.3% (1 in 30-year) rainfall* | *25%* | *35%* |
| ***1% (1 in 100-year) rainfall*** | ***25%*** | ***40%*** |

2.2.10 The guidance specifies that for developments with a lifetime of between 2061 to 2125, the 2070s epoch is to be applied for design purposes. Therefore a +40% climate change allowance will be assessed within any surface water drainage proposals.

## 2.3 Local Policy and Guidance

### Oxford City Council Local Plan

2.3.1 Local planning policy is contained within the **Oxford Local Plan 2036** (adopted June 2020), with particular reference to **Policy RE3** - 'Flood Risk Management' and **Policy RE4** – 'Sustainable and Foul Drainage, Surface and Groundwater Flow', which state:

**Policy RE3 Flood Risk Management**

Planning permission will not be granted for development in Flood Zone 3b except where it is for water-compatible uses or essential infrastructure; or where it is on previously developed land and it will represent an improvement for the existing situation in terms of flood risk. All of the following criteria must be met: **a)** it will not lead to a net increase in the built footprint of the existing building and where possible lead to a decrease; and **b)** it will not lead to a reduction in flood storage (through the use of flood compensation measures) and where possible increase flood storage; and **c)** it will not lead to an increased risk of flooding elsewhere; and **d)** it will not put any future occupants of the development at risk

New development will be directed towards areas of low flood risk (Flood Zone 1). In considering proposals elsewhere, the sequential and exception tests will be applied.

Planning applications for development within Flood Zone 2, 3, on sites larger than 1 ha in Flood Zone 1 and, in areas identified as Critical Drainage Areas, must be accompanied by a Site Specific Flood Risk Assessment (FRA) to align with National Policy. The FRA must be undertaken in accordance with up to date flood data, national and local guidance on flooding and consider flooding from all sources. The suitability of developments proposed will be assessed according to the sequential approach and exceptions test as set out in Planning Practice Guidance.

Planning permission will only be granted where the FRA demonstrates that: **e)** the proposed development will not increase flood risk on site or off site; and **f)** safe access and egress in the event of a flood can be provided; and **g)** details of the necessary mitigation measures to be implemented have been provided.

Minor householder extensions may be permitted in Flood Zone 3b, as they have a lower risk of increasing flooding. Proposals for this type of development will be assessed on a case by case basis, taking into account the effect on flood risk on and off site.

**Policy RE4 Sustainable and Foul Drainage, Surface and Groundwater Flow**

All development proposals will be required to manage surface water through Sustainable Drainage Systems (SuDS) or techniques to limit run-off and reduce the existing rate of run-off on previously developed sites. Surface water runoff should be managed as close to its source as possible, in line with the following drainage hierarchy: **a)** store rainwater for later use; then: **b)** discharge into the ground (infiltration); then: **c)** discharge to a surface water body; then: **d)** discharge to a surface water sewer, highway drain or other drainage system; and finally: **e)** discharge to a combined sewer.

*Details of the SuDS shall be submitted as part of a drainage strategy or FRA where required.*

Applicants must demonstrate that they have had regard to the SuDS Design and Evaluation Guide SPD/ TAN for minor development and Oxfordshire County Council guidance for major development.

*Surface and groundwater flow and groundwater recharge:*

Planning permission will not be granted or development that would have an adverse impact on groundwater flow. The City Council will, where necessary, require effective preventative measures to be taken to ensure that the flow of groundwater will not be obstructed.

Within the surface and groundwater catchment area for the Lye Valley SSSI development will only be permitted if it includes SuDS and where an assessment can demonstrate that there will be no adverse impact on the surface and groundwater flow to the Lye Valley SSSI.

Development on the North Oxford gravel terrace that could influence groundwater flow to the Oxford Meadows Special Area of Conservation (SAC) will only be permitted if it includes SuDS and if a hydrological survey can demonstrate that there will be no significant adverse impact upon the integrity of the SAC.

*Foul Drainage*

Developers are encouraged to separate foul and surface water sewers on all brownfield sites delivering new development. For clarity this does not include householder extensions or conversions that input into the existing network.

A Foul and Surface Water Drainage Strategy must be provided for all new build residential development of 100 dwellings or more; non-residential development of 7,200sqm or more; or student accommodation of 250 study bedrooms or more.

## Oxford City Council Strategic Flood Risk Assessment

2.3.2 The **Oxford City Council Level 1 Strategic Flood Risk Assessment (SFRA)** was released in November 2017 and forms part of the Local Plan evidence base, to inform future spatial planning and to assist in developing planning policies to address flood risk. Moreover, the document provides an overall understanding of the flood risk within the study area taking into account all potential sources.

2.3.3 The **Oxford City Council Level 2 SFRA** was released in July 2018 and forms part of the Local Plan evidence base to inform the Sequential and Exception Tests for proposed development sites within the Oxford Local Plan that have the highest flood risk (Flood Zones 2 and 3). The land within the 'Oxpens Development' to the south of Oxpens Road is addressed within the OCiC Level 2 SFRA because it is one of the areas at high risk of flooding. Therefore, the OCiC Level 2 SFRA is relevant to this FRA.

2.3.4 It is essential therefore that the Council are in a position to take informed decisions, providing a careful balance between the risk of flooding and other unrelated planning constraints that may place pressure upon *'at risk'* areas.

## Oxford County Council Preliminary Flood Risk Assessment

2.3.5 The Oxford County Council (OCC) is defined as the Lead Local Flood Authority (LLFA) under the Flood and Water Management Act 2010. The first element of the Flood Risk Regulations (2009) is for LLFAs to produce a **Preliminary Flood Risk Assessment (PFRA)** providing a high-level overview of flood risk from local sources including surface water, groundwater and ordinary (minor) watercourses.

# 3 Site Setting

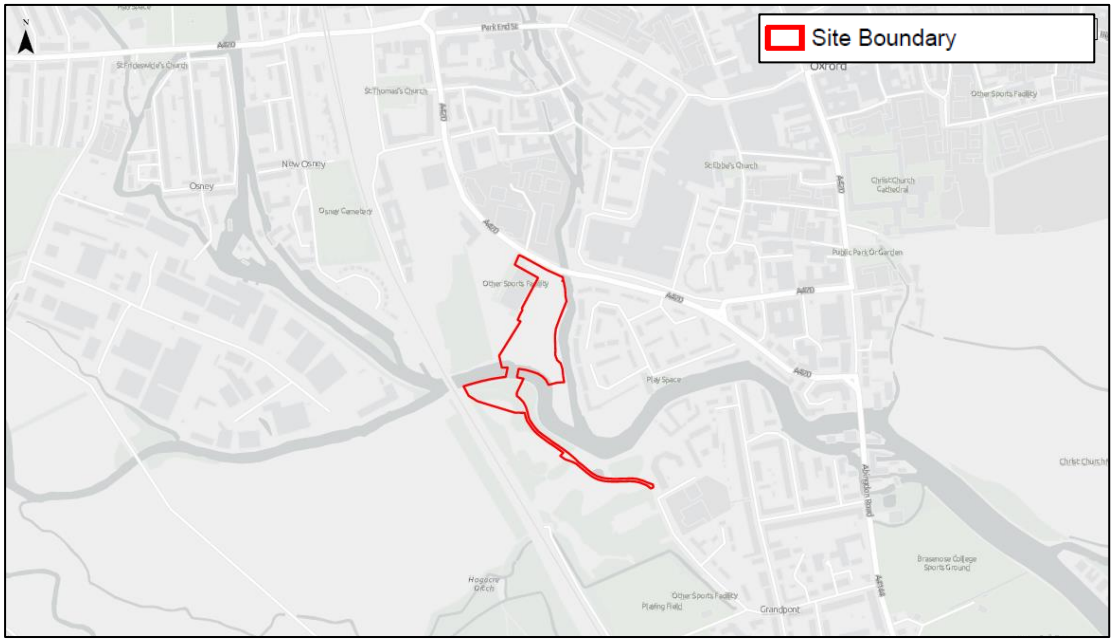
## 3.1 Site Description

3.1.1 The site consists of a proposed route of a new bridge crossing, extending from a section of the River Thames footpath on the south side of the Thames channel, downstream (east) of the River Isis Railway Bridge, crossing the River Thames channel and running north to meet the A420 Oxpens Road in Oxford, Oxfordshire (nearest postcode OX1 1RQ, site centre OS Grid Reference 450,800 E, 205,650 N) – see **Figure 3-1**.

3.1.2 The land behind the footpath on the south side of the river lies within the Grandpont Nature Park and consists of vegetated landscaping.

3.1.3 The land on the north side of the River Thames consists of landscaping across the Oxpens Meadow area south/east of the Oxford Ice Rink. The 'Oxpens Development' a proposed mixed use redevelopment is to the west of our scheme.

**Figure 3-1: Site Location Plan (not to scale)**




## 3.2 Topography

3.2.1 The topographic survey in **Appendix B** by MK Surveys indicates that the towpath on the southern side of the River Thames is typically at a level of 56.0m AOD, with the ground to the rear of the towpath rising up into the adjacent nature park area to a peak level of just under 60.0m AOD.

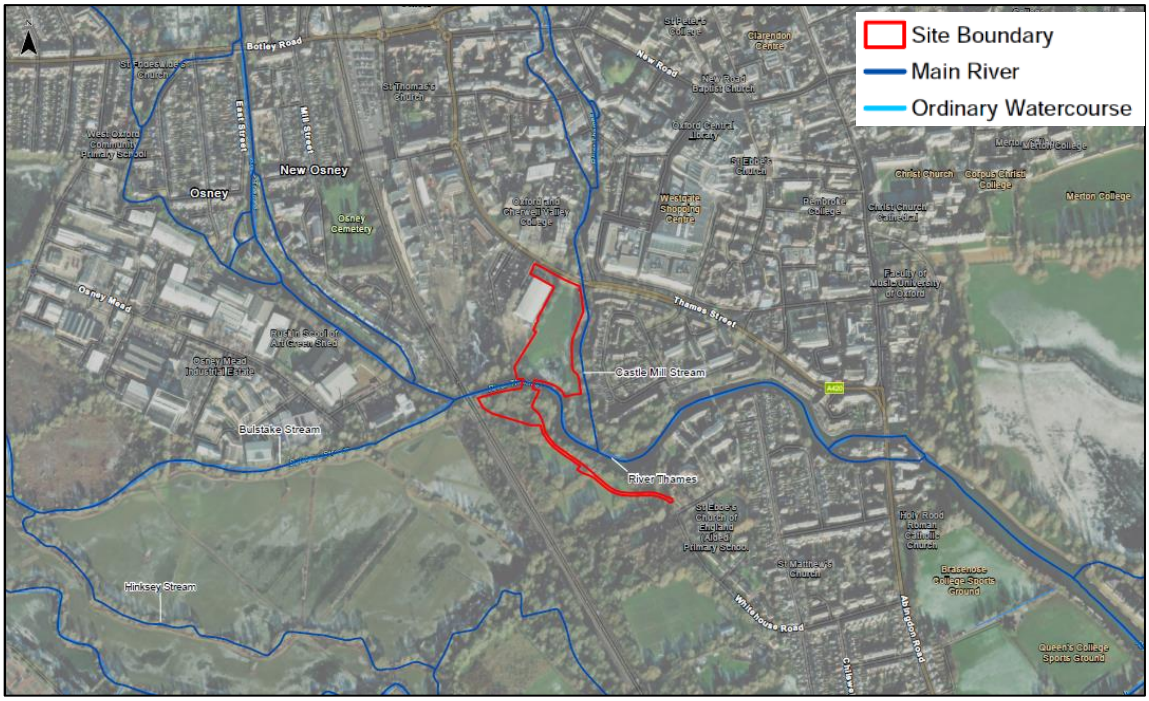
3.2.2 The land on the north side of the River Thames varies from approximately 56.0m AOD at the edge of the watercourse, rising to 57.5m AOD at Oxpens Road. The area where the proposed bridge lands is at approximately 56.8m AOD.

## 3.3 Hydrological Setting

3.3.1 The **River Thames** flows east at the proposed bridge location after passing under the River Isis Railway Bridge, which lies approximately 100m upstream (west).

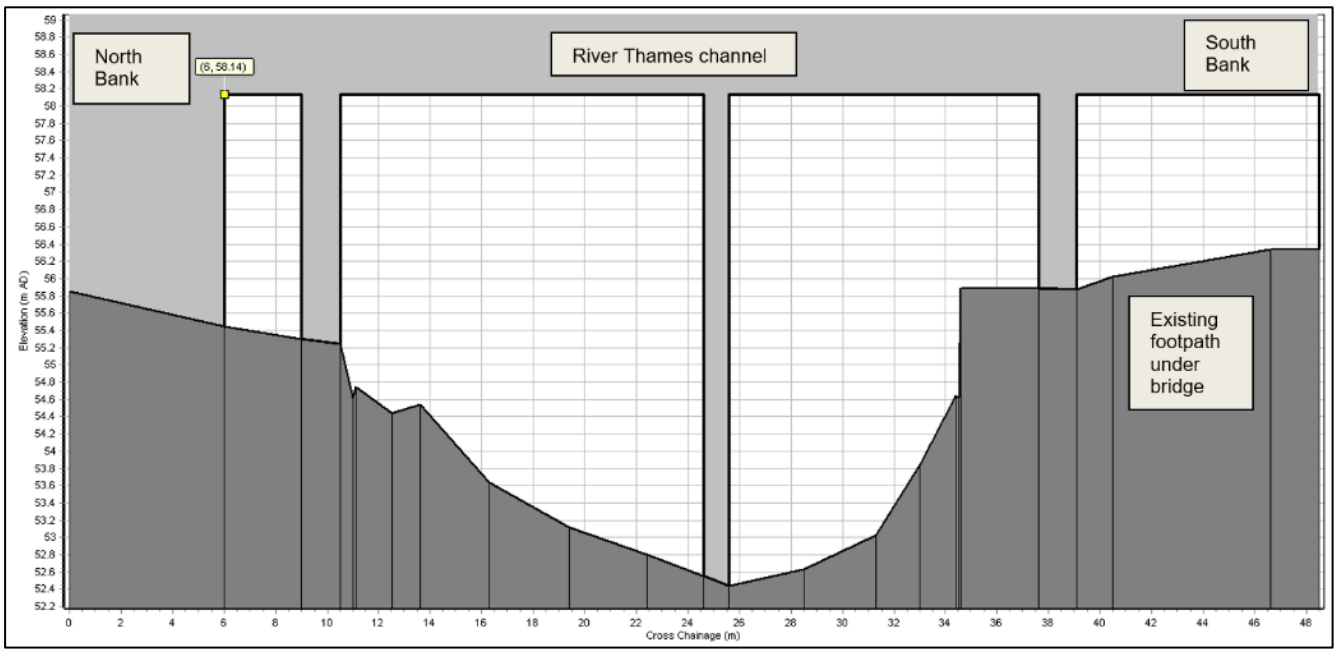
3.3.2 **Bulstake Stream** flows east into the River Thames immediately upstream (west) of the River Isis Railway Bridge. **Castle Mill Stream** flows south into the River Thames approximately 160m downstream (south-east) of the proposed bridge location. **Hinksey Stream** flows west and joins Bulstake Stream approximately 1km upstream (west) of the proposed bridge location – see **Figure 3-2**.

**Figure 3-2: Summary of Local Watercourses**




3.3.3 **River Isis Railway Bridge** lies upstream of the site and represents a significant flow control due to the continuous raised embankment of the railway line across the floodplain. The cross section of the River Isis Railway Bridge structure is represented in **Figure 3-3** below (extracted from the base EA model), indicating a soffit at 58.14m AOD with a number of piers within the channel.

**Figure 3-3: EA Thames Model Cross Section at River Isis Railway Bridge**



3.3.4 The **Oxford Gasworks Bridge**, which lies approximately 180m downstream (south-east) of the proposed bridge location, crosses the River Thames between Friars Wharf (north) and Baltic Wharf (south) to the south of Oxford City Centre.

## 3.4 Geology and Hydrogeology

### Geological Map

3.4.1 The 1:50,000 scale geological mapping from the British Geological Survey (BGS) indicates that both sides of the Thames channel are underlain by superficial deposits of Alluvium (clay, silt, sand and gravel) with the solid bedrock Geology of the Oxford Clay Formation and West Walton Formation (mudstone).

3.4.2 Made Ground is denoted near the banks of the northern side of the Thames channel and along the railway line to the west. It is expected that the Made Ground is associated with land rising at the former gas works and the railway embankment. In addition, it is expected that Made Ground is locally present elsewhere associated with current and other historical developments on the northern side of the Thames channel.

#### Ground Conditions

3.4.3 A summary of the ground conditions based on the BGS historical ground investigations is summarised in **Table 3-1** below.

**Table 3-1: Summary of Ground Conditions**

| Strata | Approximate Base (m bgl) | Typical Description |
|---|---|---|
| Made Ground | 0.5 to 1.1 | Variable - Firm dark brown silty sandy CLAY with gravel<br>OR GRAVEL with low cobble content. Gravel of flint and fragments of brick, concrete, glass and other man made materials. Locally with coal, ash and clinker. |
| | Locally 2.6 to 3.5<br>in the vicinity of the former gas holders and former infilled channel | Fill – ash, brick, soil, clay and gravel. |
| Alluvium | 1.0 to 3.4 | Very soft and soft organic silty CLAY locally with gravel. |
| Oxford Clay Formation | >25.0 | Stiff becoming hard bluish grey calcareous shaly CLAY with selenite iron pyrites and shell debris. |

### Hydrogeology

#### Aquifer Classification

3.4.4 The EA classifies the Alluvium as a Secondary B Aquifer whilst the Northmoor Sand and Gravel Member is classified as a Secondary A Aquifer. Secondary A aquifers typically comprise layers with moderate permeability that can support local water supplies and may form an important source of base flow to rivers. Secondary B Aquifers typically have low to moderate permeability that may store and yield limited amounts of groundwater.

3.4.5 The Oxford Clay Formation is classified as an unproductive stratum. These deposits have low permeability that have negligible significance for water supply or river base flow.

3.4.6 The development is not situated within a Source Protection Zones (SPZ) set out by the EA for the protection of groundwater abstractions.

**Groundwater Flow**

3.4.7 Based on the information available it is expected that the groundwater level in the superficial deposits is typically between about 1.0 to 3.0 m below ground level (bgl) in the lower parts of the site

3.4.8 It is expected that in general the groundwater in the Alluvium flows towards and is in hydraulic continuity with the River Thames. However, the presence of a continuous sheet pile wall along the southern bank is likely to provide a degree of isolation between the aquifer in the superficial deposits and the River Thames.

## 3.5 Flood Defences

3.5.1 The River Isis Railway Bridge performs an important conveyance function as the River Thames flows south-east through the centre of Oxford, with excess flows from upstream of the city routed further west around the western flank of the city via the Hinksey Stream.

3.5.2 This western corridor is one of the key elements of the Oxford Flood Alleviation Scheme (OFAS) - see details at https://www.gov.uk/government/publications/oxford-flood-scheme. This states that the scheme details as follows:

*"The Oxford Flood Alleviation Scheme will create a new stream with wetland wildlife corridor, running through the existing floodplain to the west of Oxford. This will create more space for floodwater away from built-up areas, reducing flood risk in Oxford and surrounding areas for many decades to come.*

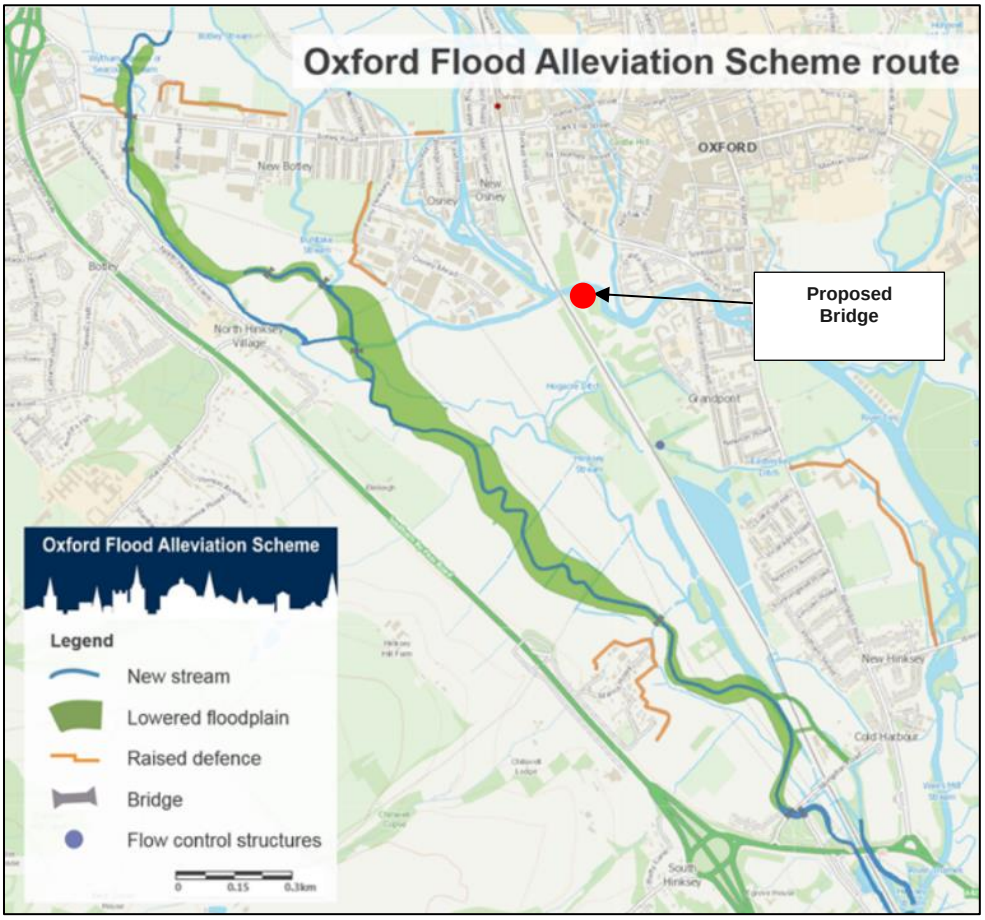
*The scheme will be approximately 5km long. It begins north of Botley Road and ends south of the A423 near Kennington, where the new stream joins the River Thames.*

*Most of this area is farmland and flood meadow. We have designed the scheme to be as natural as possible in appearance and to blend into the surrounding fields. Material will be dug out to create:*

- *a new stream which will always carry water - this will look and behave like a natural stream*
- *a gently sloping floodplain of wetland habitat, grazing meadow and wildflowers running alongside the new stream - most of the time this will be dry*

*When water levels in the River Thames and other existing streams are high, water will overflow from the new stream and start to fill the lowered floodplain next to it. The scheme does not need to be turned 'on' or 'off' when floods occur. Water will simply enter the lowered floodplain as river levels rise. This draws floodwater away from built-up areas that would otherwise flood. In major floods water will still also use the wider existing floodplain, which is mostly farmland and flood meadow. In this way the scheme is designed to work together with the natural floodplain. Reducing flood risk to homes, businesses and infrastructure, while fitting with the existing landscape."*

**Figure 3-4: Overview of Oxford Flood Alleviation Scheme**




3.5.3 The proposed development utilises the existing scenario flood data from the EA and is therefore precautionary as it makes no allowance for the potential betterment provided by the OFAS scheme.

# 4 Assessment of Flood Risk

The assessment of flood risk has been undertaken based on the sources of information listed in **Section 1.3.**

## 4.1 EA Open Data Flood Maps

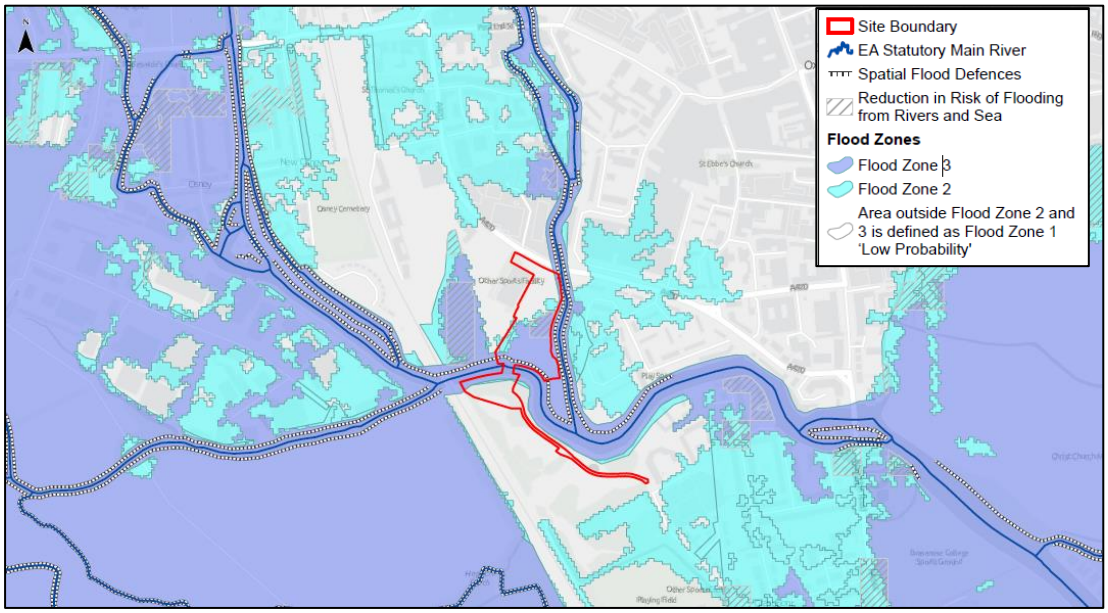
4.1.1 The following maps have been taken from the Stantec GIS flood maps report in **Appendix A** based on the EA Open Data datasets available online and reproduced with OS mapping under licence to Stantec.

### Flood Zone Map

4.1.2 The first phase in identifying whether a site is potentially at risk of flooding is to consult the .GOV.UK 'Flood Map for Planning' website (https://flood-map-for-planning.service.gov.uk/). This provides an initial indication of the extent of the Flood Zones, which is refined through the use of more detailed site-specific level survey and modelled flood levels. The Flood Zones are defined in Table 1 of the Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' section as follows:

- **Flood Zone 1 'Low Probability'** – Land at less than 1 in 1000 (0.1%) annual probability of river or sea flooding;
- **Flood Zone 2 'Medium Probability'** – Land between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding, or between 1 in 200 (0.5%) and 1 in 1000 (0.1%) annual probability of sea flooding;
- **Flood Zone 3 'High Probability'** – Land at 1 in 100 (1%) or greater annual probability of river flooding, or 1 in 200 (0.5%) or greater annual probability of sea flooding;

**Figure 4-1: EA Flood Zone Map**




4.1.3 The EA Flood Zone map (**Figure 4-1**) indicates the towpath on the southern side of the channel is in **Flood Zone 3 'High Probability'**, while the higher land behind the towpath rises into **Flood Zone 1 'Low Probability'**.

4.1.4 Although the Flood Zone mapping identifies 'spatial flood defences' along the edge of watercourses in the area, this refers solely to the existing maintained river banks which offer a nominal level of protection above normal river levels.

4.1.5 The land north of the Thames is in Flood Zone 3 but the bridge landing location is at the edge of **Flood Zone 2 'Medium Probability'** with the section between the landing to Oxpens Road within **Flood Zone 1 'Low Probability'**.

4.1.6 The Flood Zone map does not differentiate between Flood Zone 3a 'High Probability' and Flood Zone 3b 'Functional Floodplain' (the defined Flood Zone 3 is effectively a composite of Zone 3a and Zone 3b, further review of the SFRA is required to define the extent of Zone 3b) The OCiC's definition of Flood Zone 3b is provided in **Section 4.2**.

### Flood Risk from Reservoirs Map

4.1.7 The EA provides maps showing the risk of flooding in the event of a reservoir failure. The reservoir breach extents captured in the baseline flood maps have been taken from the Stantec GIS flood maps report in **Appendix A** .

4.1.8 The EA reservoir maps show two flooding scenarios, a 'dry-day' and a 'wet-day'.

4.1.9 The 'dry-day' scenario predicts the flooding that would occur if the dam or reservoir failed when rivers are at normal levels, and indicates flooding of the towpaths along the Thames as well as through Oxpens Meadows.

4.1.10 The 'wet day' scenario predicts how much worse the flooding might be if a river is already experiencing an extreme natural flood, and indicates more extensive flooding of the area, extending north into central Oxford.

4.1.11 It should be emphasised that the risk of flooding from a reservoir breach is very small. The EA is the enforcement authority for the Reservoirs Act (1975) and there is a mandatory requirement for all large raised reservoirs (where greater than 25,000m$^3$ of water is stored above natural ground level) to be inspected and supervised by reservoir panel engineers. The reservoir owner has a duty of care under the Health and Safety at Work Act 1974 to ensure others are not placed at risk from their assets or actions.

4.1.12 Whilst the consequences of a reservoir breach could be severe, the probability of such an occurrence is considered to be very low and therefore the risk is negligible.

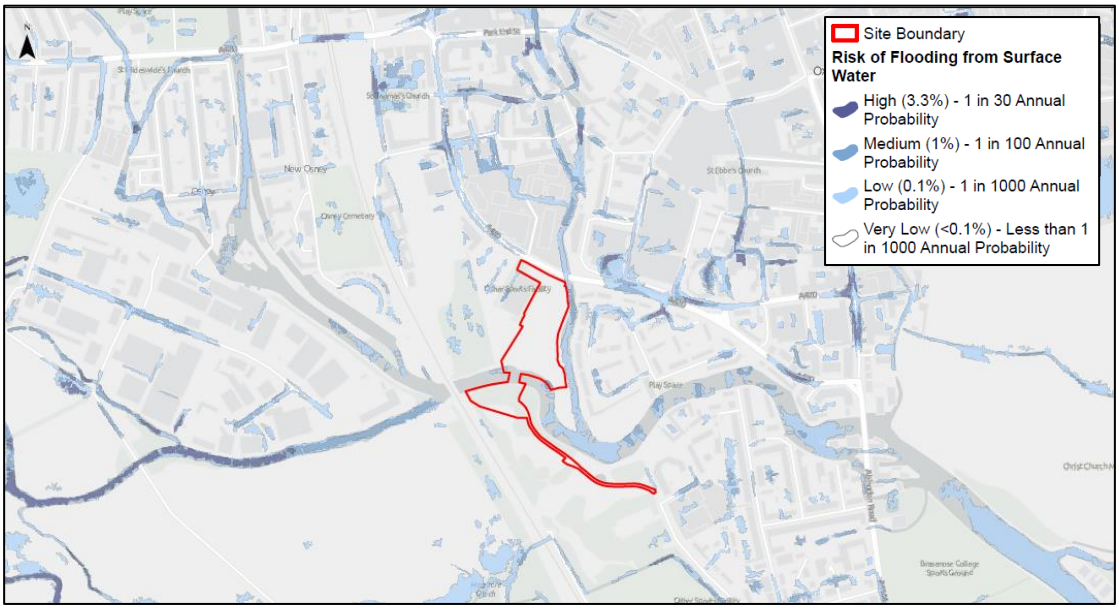
### Flood Risk from Surface Water

4.1.13 The EA 'Risk of Flooding from Surface Water' map shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event. The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

- 'High' Risk: 1 in 30 (3.3%) or greater AP rainfall event;
- 'Medium' Risk: Between a 1 in 100 (1%) and 1 in 30 (3.3%) AP rainfall event;
- 'Low' Risk: Between 1 in 1000 (0.1%) and 1 in 100 (1%) AP rainfall event;
- 'Very Low' Risk: Lower than 1 in 1000 (0.1%) AP rainfall event.

4.1.14 The EA mapping shows that all of the site and surrounding area is predicted to be at a 'Very Low' risk of surface water flooding – see **Figure 4-2**.

**Figure 4-2: EA Risk of Flooding from Surface Water Map**




### Historic Flood Map

4.1.15 The EA 'Historic Flood Map' is a dataset showing the maximum extent of all individual recorded flood outlines from river, the sea and groundwater and shows areas of land that have previously been subject to flooding.

4.1.16 This map indicates that recorded floods on the Thames, assumed to be from the 1947 flood event (as the most severe on the Thames in Oxford of the 20th Century), have impacted the Thames corridor and extending north into the site across the Oxpens Meadows – see **Stantec Figure 008** in **Appendix A** .

## 4.2 Strategic Flood Risk Assessment

4.2.1 The OCiC Strategic Flood Risk Assessment (SFRA) Level 1 report was updated in November 2017 and provides advice to the OCiC on flood risk issues within the city. The Level 1 SFRA document has been reviewed and key information of relevance to the site has been extracted.

- **SFRA Appendix 2A** shows the Flood Zones across the site area, indicating the towpath and the bridge landing area on the northern side of the Thames channel is on the edge of the Flood Zone 2 and 3 extents. However, in comparison with the data discussed in **Section 4.1**, Appendix 2A shows the southern side of the channel is entirely within Flood Zone 1, indicating that it is based on older modelling now superseded by the data on which the latest EA Flood Zones in **Section 4.1** have been based (see EA modelling detailed in **Section 5.3**);

- **SFRA Appendix 4A** provides the surface water flood risk through the district. These outputs are consistent with the surface water flood map discussed in **Section 4.1**.

- **SFRA Appendix 5** shows the flood risk associated with reservoir breach in the area. The mapping shows the towpath and the higher ground on the southern side of the Thames channel are impacted by maximum reservoir flood extents. This has been superseded by the data discussed in **Section 4.1**;

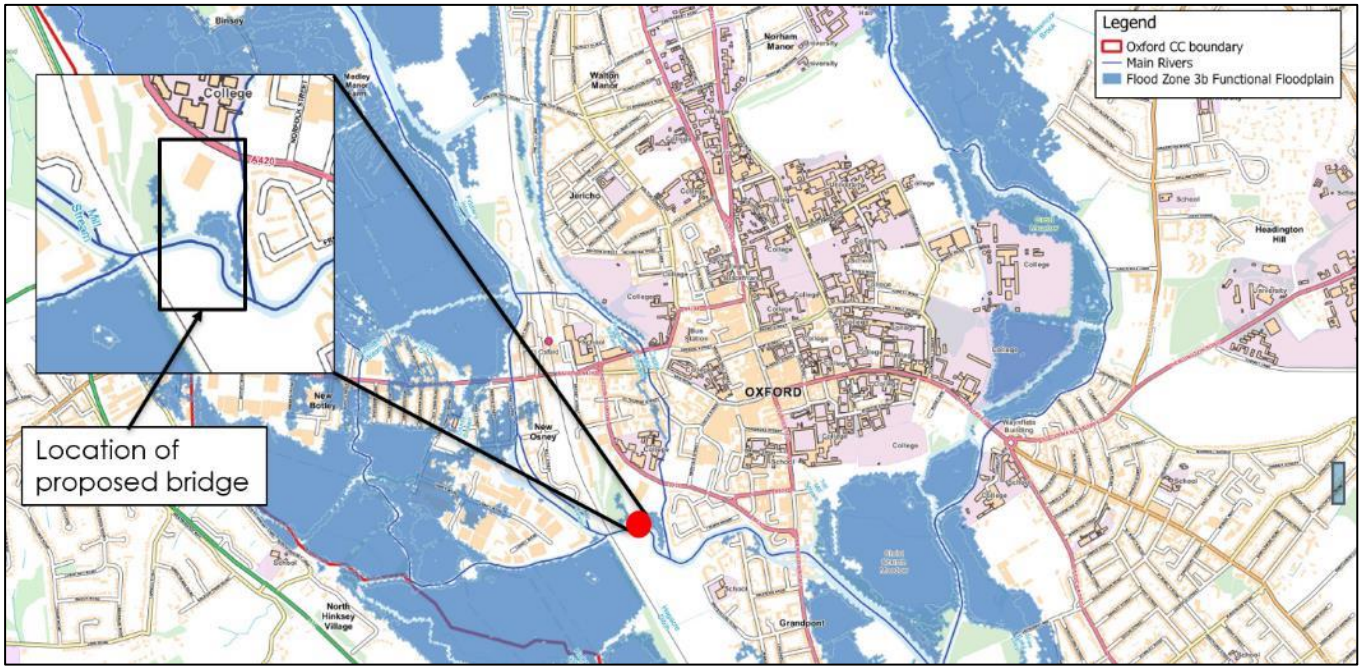
- **SFRA Appendix 7** provides the EA historic floodplain map. The outputs are consistent with the data discussed in **Section 4.1** as the mapping indicates that the historical floods have

impacted the towpath on the northern side of the Thames channel and the south-western area of the towpath on the southern side of the Thames channel. .

- **SFRA Appendix 9B** provides the modelled 1 in 100 annual probability +35% allowance for climate change flood extents through the district. The outputs follow the same pattern as the EA Flood Zone 3 area, with the towpath and Oxpens Meadows area on the northern side of the Thames channel within the floodplain – however, the relevant the base 2017 EA modelling has been superseded as discussed in **Section 4.3**.

- **SFRA Appendix 10** shows the Flood Zone 3b 'Functional Floodplain' map. The OCiC defines Flood Zone 3b as '*land where water has to flow or be stored in times of flood, also known as functional floodplain*.' The mapping indicates that the towpath and bridge landing area on the northern side of the Thames channel are within a Flood Zone 3b floodplain – see **Figure 4-3**.

**Figure 4-3: OCiC SFRA Appendix 10 - Flood Zone 3b - Functional Floodplain**




4.2.2 The OCiC Level 2 SFRA was prepared in 2018 and includes specific reference to the 'Oxpens Development' on the northern side of the Thames channel as one of the development sites under consideration. This review concluded that development over the Oxpens site "*is appropriate but may require significant mitigation and/or analysis to demonstrate compliance with the Exception Test*." As such, the Oxpens Development site has passed the Sequential Test and the Exception Test requires completion as part of any planning submission.

## 4.3 EA River Thames 'Eynsham to Sandford' Model 2018

4.3.1 Data has been extracted from the EA River Thames 'Eynsham to Sandford' 2018 Model. This includes modelled flood extents and flood levels. The 2018 model has been produced more recently than the model used to generate mapping within the SFRA and forms the basis of the latest EA Flood Zone mapping. This model is therefore considered to be the best available information for assessing flood risk to the site.

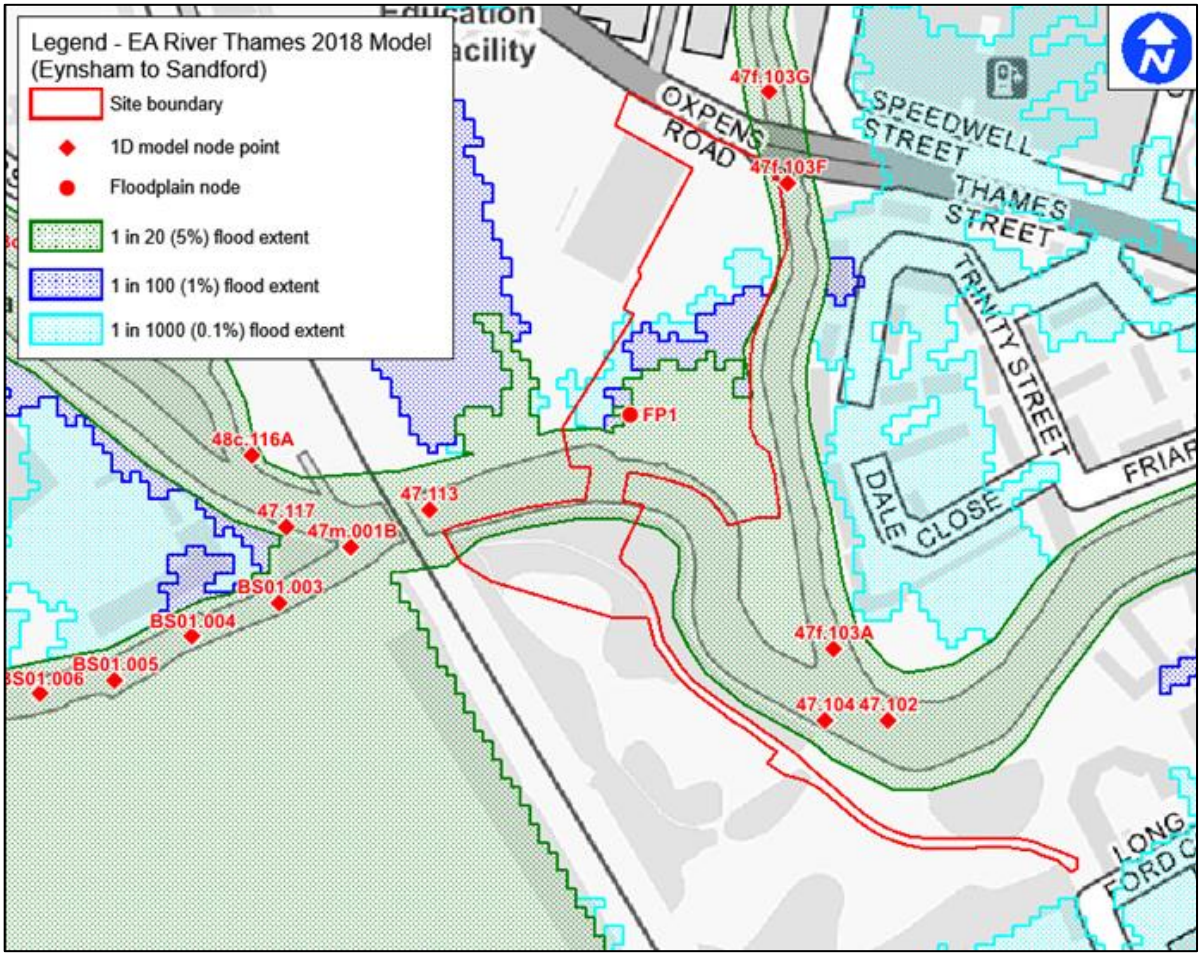
### Present Day Scenarios

4.3.2 **Figure 4-4** below shows the present day flood extents from the 2018 model. These extents indicate the footpath south of Oxpens Road on the northern side of the Thames channel and

the higher ground behind the towpath on the southern side of the channel are outside all present day flood events up to and including the 1 in 100 annual probability event.

4.3.3 However, on the northern side of the channel, the bridge landing area lies within the 1 in 100 annual probability flood extent, and the towpath is within the 1 in 20 annual probability flood extent. On the southern side of the Thames channel, the 1 in 20 annual probability flood event affects the towpath and the Thames footpath but there is no flooding above this event.

**Figure 4-4: EA Modelled Flood Extents – Thames 2018 Model – Present Day**




**4.3.4** The modelled flood levels across the site are summarised in **Table 4-1.**

**Table 4-1: EA Modelled Flood Levels – Thames 2018 Model – Present Day**

| Flood Event (Annual Probability) | Modelled Flood Level, (m AOD) | |
|---|---|---|
| | Node 47.113 (River Channel) | FP1 (Northern Floodplain) |
| 1 in 20 (5%) | **56.28** | **56.23** |
| 1 in 100 (1%) | **56.50** | **56.45** |
| 1 in 1000 (0.1%) | **56.74** | **56.70** |

4.3.5 Node 47.113 is a precautionary and appropriate level for the design of the main span and adjacent towpaths, Node FP1 is appropriate for assessing the flood levels in the floodplain on the northern side of the bridge.

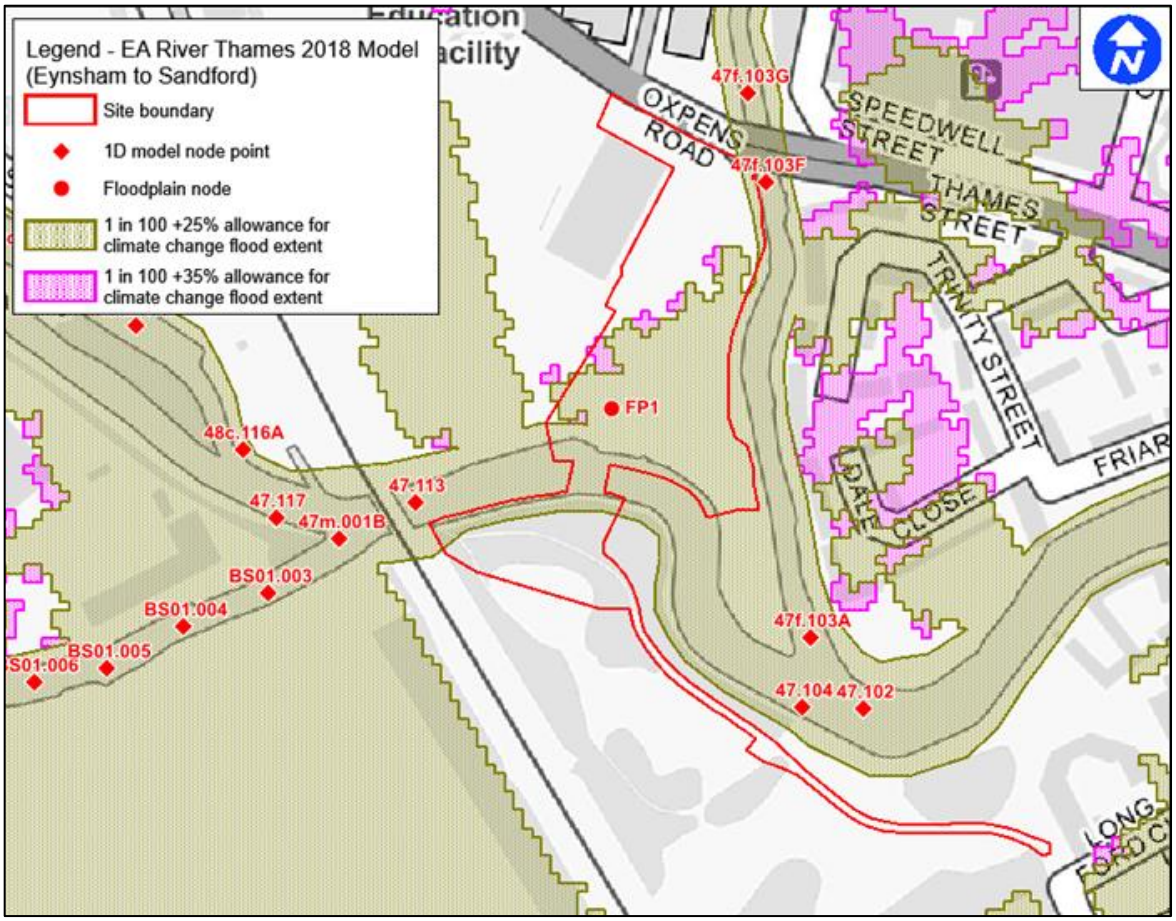
4.3.6 The topographic survey in **Appendix B** indicates that that the land/towpath adjacent to the River Thames is typically at a level of 56.0m AOD and rises to the north to approximately 56.4m AOD at the proposed bridge landing. Comparison with the modelled flood levels indicates:

- **1 in 20 annual probability event:** The land adjacent to the Thames channel lies below the 1 in 20 annual probability flood level by 280mm, with the depths reducing as ground levels rise to the north. The proposed bridge landing lies on land over 100mm above the flood level.
- **1 in 100 annual probability event:** The land adjacent to the Thames channel is below the flood level of 56.50m AOD by 500mm. The location of the north bridge landing is impacted to shallow depths of less than 100mm in this event.
- **1 in 1000 annual probability event:** The land adjacent to the Thames channel lies below the 1 in 1000 annual probability flood level by 740mm, with the depths reducing as ground levels rise to the north. The proposed bridge landing lies on land impacted to approximately 300mm at this flood level.

## Climate Change Scenarios

4.3.7 **Figure 4-5** shows the EA-modelled 1 in 100 annual probability +25% and +35% climate change allowance scenarios from the EA 2018 model. The extents shown in **Figure 4-5** indicate the footpath south of Oxpens Road on the northern side of the Thames channel and the higher ground behind the towpath on the southern side of the Thames channel are outside the 1 in 100 annual probability +35% allowance for climate change flood event.

**Figure 4-5: EA Modelled Flood Extents – Thames 2018 Model – Climate Change**




4.3.8 On the northern side of the Thames channel the bridge landing area and towpath are encroach into the 1 in 100 annual probability +35% allowance for climate change flood event, which extends across Oxpens Meadows.

4.3.9 The applicable 1 in 100 annual probability +41% allowance for climate change flood event has not been modelled as part of this original EA exercise, but the scenario was assessed by the consultants for the Oxpens Development through rerunning the EA Thames model, and the resulting flood level applicable to the site has been advised - for further details see 'Oxpens Development – FRA', AKS Ward, revision P06, August 2023, submitted under planning application reference 22/02955/FUL.

4.3.10 The modelled flood levels on the River Thames, downstream of the railway bridge are summarised in **Table 4-2** below:

**Table 4-2: EA Modelled Flood Levels – Thames 2018 Model – Climate Change**

| Flood Event (Annual Probability) | Modelled Flood Level (m AOD) |
|---|---|
| 1 in 100 annual probability +35% allowance for climate change | 56.73 |
| **1 in 100 annual probability +41% allowance for climate change** | **56.79** |

4.3.11 Comparison of the ground levels with the modelled flood levels indicates the towpath on the southern side of the Thames channel is impacted to a maximum depth of 790mm in the reference +41% scenario. The land on the north side is impacted by over 1m depth of flooding adjacent to the channel, with the depths reducing as ground levels rise to the north. At the north bridge abutment location, flooding is anticipated to depths of approximately 400mm.

4.3.12 The potential impacts of climate change over the lifetime of the proposed development have been considered so that mitigation measures can be designed accordingly and are discussed in **Section 7**.

# 5 Proposed Development and Vulnerability

## Proposed Development

5.1.1 This FRA accompanies a full planning application for:

> *"A new pedestrian and cycle bridge linking Osney Mead to the City Centre and Oxpens"*

5.1.2 As discussed in **Section 1.2**, the proposed new bridge scheme is being progressed through the planning process at the same approximately time as the applications for the Oxpens Development on the land north of the River Thames and it is the intention that the schemes will tie together in a cohesive manner.

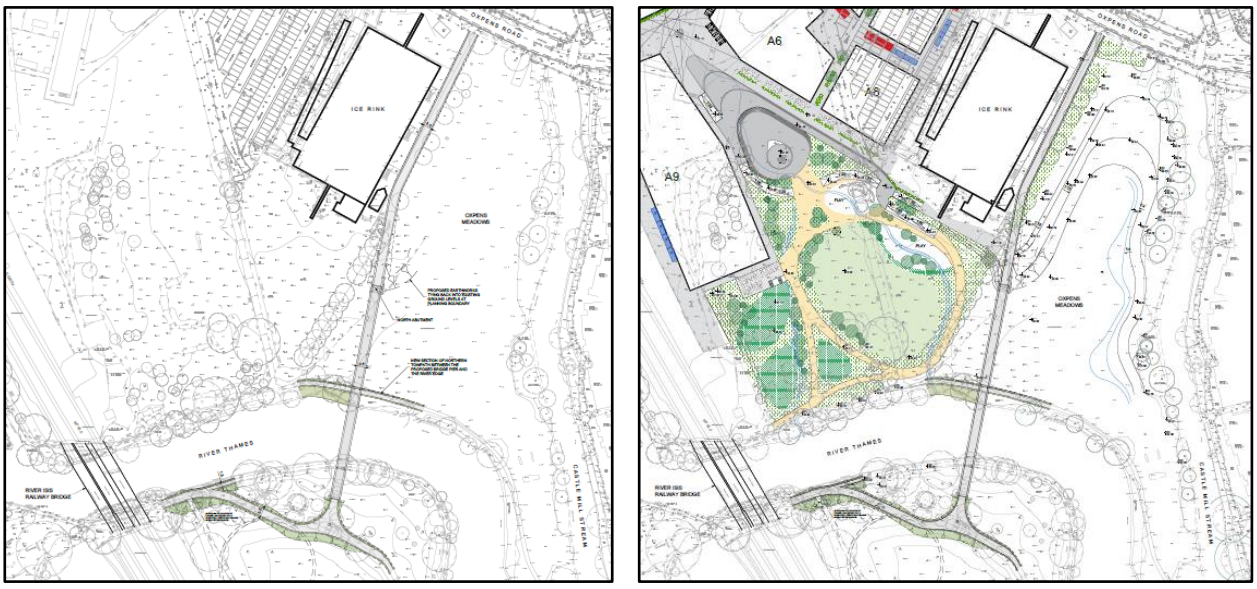
5.1.3 The Oxpens Development Enabling Works detailed application has been submitted under planning application reference 22/02955/FUL, and aims to deliver the development platform and associated flood compensation mitigation.

5.1.4 The bridge scheme and enabling works schemes are closely linked and it is important that they take a consistent approach to flood compensation. As such, the bridge scheme provides consistency by using the same land form proposed within the Oxpens Developments flood compensation landform at the bridge's proposed north abutment. The bridge scheme also includes a landscaping design to ensure consistency with the Oxpens proposals around the northern abutment within the bridge red line boundary, while providing a standalone floodplain storage analysis and mitigation within the bridge application site red line.

5.1.5 The land on the southern side of the channel, Grandpont Nature Park, is only associated with the bridge scheme and is not interlinked to the Oxpens Development.

5.1.6 Details of the proposals by Knight Architects are included in **Appendix C** , while an extract of the proposed bridge layout in the context of the two scenarios discussed above is shown in **Figure 5-1**.

**Figure 5-1: Proposed Bridge General Arrangement – in isolation (left) and within the Oxpens Masterplan (right)**




5.1.7 The works also include footpath improvements and reconstruction and reinstatement of the north bank after the proposed bridge pier is constructed. These works will also deliver new river edge habitat.

5.1.8 The proposed mitigation is based on a design life for the development of 100 years, and the climate change allowances described in **Section 2.2** are also based on this assumption.

## Flood Risk Vulnerability

5.1.9 PPG 'Flood Risk and Coastal Change' Annex 3 confirms the *'Flood risk vulnerability classification'* of a site, depending upon the proposed usage.

- The proposed development is classed as '**Essential Infrastructure**'.

5.1.10 This classification is subsequently applied to PPG 'Flood Risk and Coastal Change' Table 2 to determine whether:

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

5.1.11 The location of the proposed 'Essential Infrastructure' development is partly in Flood Zone 3, and since this crosses the channel of the River Thames it can be concluded that it is within Flood Zone 3b 'Functional Floodplain'. Table 2 confirms Essential Infrastructure is appropriate in Flood Zone 3b, subject to the Sequential Test and Exception Test being passed.

## NPPF Sequential Test

5.1.12 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

5.1.13 The PPG states that 'Essential Infrastructure' uses are appropriate for Flood Zone 3b, but the Sequential Test will be required. As a proposed bridge traversing a watercourse, it is clear that the Sequential Test is not strictly relevant, as any bridge location would similarly need to cross an area of the highest classification of flood risk (i.e. the river channel).

5.1.14 The location of the bridge has been confirmed following extensive discussion with OCiC, in order to meet the Council's strategic objectives related to city centre connectivity, and is the most suitable area for the proposed development. Therefore, the Sequential Test has been passed.

## NPPF Exception Test

5.1.15 The site is shown on the EA Flood Zone maps as falling partly within Flood Zone 3 'High Probability'. The Exception Test has been carried out in accordance with the NPPF to demonstrate the significant benefits of the proposed development. The NPPF paragraph 160 states:

> *"For the Exception Test to be passed it should be demonstrated that:*
>
> *the development would provide wider sustainability benefits to the community that outweigh flood risk; and*
>
> *the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*

5.1.16 The first part of the Exception Test is addressed by the significant benefits provided by the new development, which provide wider public connectivity across central Oxford, and are addressed in the supporting planning application documentation.

5.1.17 The PPG specifically requires that "*Essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to*:

- *remain operational and safe for users in times of flood;*
- *result in no net loss of floodplain storage;*
- *not impede water flows and not increase flood risk elsewhere."*

5.1.18 The details provided within this FRA address the second part of the Exception Test and demonstrate that the site is safe for its lifetime. The relevant parts of **Section 6** confirm that the proposals have no detrimental impact on floodplain storage or flow routes, and the route of the bridge from Oxpens Road to the north and the Grandpont Nature reserve to the south will be unaffected by flooding (although wider access routes within Oxford could be impacted in an extreme flood event), thus meeting the aforementioned requirements.

# 6 Flood Mitigation Strategy

## 6.1 Bridge Design Criteria

6.1.1 Any development located in the vicinity of, or over, a watercourse should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage; either of which could potentially cause an increase in flood levels on-site or elsewhere. This is considered up to the benchmark of the 1 in 100 annual probability plus allowance for climate change fluvial flood level.

6.1.2 The standard EA requirement is for bridge soffit levels to be typically set at a minimum of 600mm above the modelled 1 in 100 annual probability plus allowance for climate change floodplain (based on the advised 1 in 100 annual probability +41% climate change level of 56.79m AOD – see **Section 4.3**). The minimum river soffit level for the proposed bridge will be set at 58.20m AOD, significantly exceeding requirements at 1410mm above this 1 in 100 annual probability +41% allowance for climate change flood level.

6.1.3 Outside flood risk, the other main concern of the EA is likely to be in relation to impact on navigation, both in terms of no reduction in either the available width of navigable channel, or the navigable headway. Comparing the normal water level of 54.6m AOD at Iffley Lock, approximately 3km downstream (south-east) of the proposed bridge location, and the proposed bridge soffit level of 58.20m AOD, the minimum navigation headroom for the proposed bridge will be 3.6m.

6.1.4 The absolute minimum headroom required for pedestrians and cyclists to safely pass under a bridge is 2.2m in accordance with DMRB CD195. The headroom(s) provided on the towpaths will be greater than 2.4m; the desirable minimum in CD195.

## 6.2 Floodplain Storage

6.2.1 Any new development located in the vicinity of a watercourse should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage over a site; either of which could potentially cause an increase in flood levels on-site or elsewhere.

6.2.2 This is considered up to the benchmark of the 1 in 100 annual probability +41% allowance for climate change fluvial flood level of 56.79m AOD.

6.2.3 An allowance for the floodplain storage impacts for the proposed bridge was incorporated into the wider mitigation proposals for the Oxpens Development Enabling Works (submitted under planning application reference 22/02955/FUL - see 'Oxpens Development – FRA, AKS Ward, revision P07, August 2023) – this consisted of uniform level band losses based on an allowance for 2no. 500mm columns over the Oxpens Meadows floodplain, as well as a loss of 80m$^2$ resulting from an infill area where the bridge deck headroom is below 1.8m. Comparison with the updated scheme design confirms that this assumption remains appropriate, incidcating that the latest bridge design would not compromise the original approach for the Oxpens scheme in relation to floodplain storage.

6.2.4 Since the bridge scheme is a standalone application, a standalone floodplain storage analysis and associated mitigation has been developed within the bridge application site red line, while still ensuring consistency with the wider landform proposals in the Oxpens Development proposals.

6.2.5 This is detailed on **Stantec Drawing OXPEN-STN-GEN-ALL-DR-C-3000 'Floodplain Compensation'**, included in **Appendix D.**

6.2.6 The analysis demonstrates that the scheme will result in a significant gain in floodplain storage capacity of 77.9m$^3$.

6.2.7 In conclusion, the analysis demonstrates that the proposed bridge scheme fully meets the EA level-for-level flood compensation requirements, which can be delivered either in isolation (since the works are all contained within the application red line), or as part of the wider Oxpens Development.

6.2.8 The floodplain storage analysis will be verified at detailed design stage to allow for further design refinements and subject to the planning status of the Oxpens Development.

## 6.3 Flood Flow Routes

6.3.1 Any new development located within the vicinity of or over a watercourse should be constructed such that it does not detrimentally impact on flow routes, which could potentially cause an increase in flood levels on-site or elsewhere.

6.3.2 The proposed bridge is an open span structure across the Thames channel and open floodplain on the north side of the channel, with the impacts within the floodplain area limited to the modifications to existing footpath levels and the bridge support pillars – the effect of which is negligible to flood flows. The north bridge abutment encroaches into the floodplain at severe events, but lies on the edge of this floodplain in an area utilised for storage, rather than as a flow route.

6.3.3 In addition, it is noted that the bridge lies a short distance downstream of the River Isis Railway Bridge. This structure and the associated railway line result in a continuous flow obstruction on the River Thames, funnelling all flows passing west to east within the main River Thames channel to the available aperture of the approximate 40m span of the railway bridge (see **Figure 3-3**).

6.3.4 As such, it is clear that the proposal will not have a detrimental impact on flood flow routes.

## 6.4 Flood Risk Activity Permit (FRAP) Requirements

6.4.1 Proposed works in, over, under or near a main river or a flood defense require a ‘Flood Risk Activity Permit’ (FRAP) application to be made to the EA (this replaced the previous ‘Flood Defence Consent’ (FDC) procedure).

6.4.2 This is required to demonstrate any new development does not have a detrimental impact on flood risk, and a FRAP application will be progressed in due course to ensure the approach and methods of working/construction are compliant with EA requirements.

6.4.3 The FRAP will be submitted to cover the temporary works and main bridge works, and this will also include the proposals for river bank reinstatement, and footpath works on the north and south sides of the River Thames.

# 7 Surface Water Management

7.1.1 The Lead Local Flood Authority (LLFA) is the statutory consultee on planning applications for surface water management. As the LLFA, Oxfordshire County Council is therefore responsible for the approval of surface water drainage systems within new development and as such have been consulted on the strategy as part of the planning application process with the Local Planning Authority (LPA).

7.1.2 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.

## 7.2 Existing Drainage Regime

7.2.1 Rainfall landing within the site area either infiltrates into the made ground or contributes to the river flow either directly, or indirectly via overland flow, or groundwater flow into the river.

7.2.2 It is expected that in general the groundwater in the Alluvium flows towards and is in hydraulic continuity with the River Thames.

7.2.3 The existing vegetation and trees will also uptake some rainfall falling on the site through evapotranspiration.

7.2.4 There is no existing positive drainage within the area and the existing river towpaths are not drained, with rainfall simply running off into the adjacent verge / landscape areas.

## 7.3 Proposed Drainage Strategy

7.3.1 The proposed surface water drainage scheme has been designed in accordance with the Defra Non-Statutory Technical Standards for Sustainable Drainage Systems, the National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG).

### Proposed Discharge Destination

7.3.2 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the NPPF PPG states the following (consistent with the Building Regulations H3 hierarchy):

> *"...The types of sustainable drainage system which it may be appropriate to consider, will depend on the proposed development and its location, as well as any planning policies and guidance that apply locally. Where possible, preference should be given to multi-functional sustainable drainage systems, and to solutions that allow surface water to be discharged according to the following hierarchy of drainage options::*
>
> *- into the ground (infiltration),*
>
> *- to a surface water body,*
>
> *- to a surface water sewer, highway drain or another drainage system,*
>
> *- to a combined sewer"*

7.3.3 In accordance with the discharge destination hierarchy an assessment of the suitability of the site to utilise infiltration drainage techniques has been undertaken.

7.3.4 Review of the BGS records shows that the site's geology comprises Made Ground, over Alluvium underlain by Oxford Clay Formation (refer to **Section 3.4**). Comparison of the

descriptions of these strata, as stated in **Table 3-1**, with The SuDS Manual (Ciria C753) Table 25.1, Typical Infiltration Coefficients Based on Soil Texture, shows that a typical infiltration rate within the Made Ground and Alluvium would be $1x10^{-5}$m/s.

7.3.5 Based on the information available it is expected that the groundwater level in the superficial deposits (Made Ground and Alluvium) is typically between about 1.0 to 3.0m below ground level in the lower parts of the site (Refer to **Section 3.4**). This shallow groundwater level would usually preclude the use of infiltration drainage techniques as a minimum 1m unsaturated zone is required between the base of an infiltrating device and the groundwater level. However, the proximity of the site to the River Thames, it's location within the existing floodplain and the expected hydraulic connectivity between the groundwater and the River Thames, indicates that the site currently drains into the groundwater and subsequently the River Thames and therefore infiltrating into the groundwater would maintain the existing discharge regime. As such infiltration techniques are considered suitable for use as part of the proposed surface water drainage strategy.

### Proposed Surface Water Drainage Strategy

7.3.6 The majority of the proposed bridge deck and footpath approaches are located within the existing floodplain of the River Thames.

7.3.7 The proposed drainage strategy therefore seeks to replicate the site's existing drainage regime without positive collection, conveyance or discharge of runoff. As such, despite there being new infrastructure introduced into the floodplain there will be no change in the rate or volume of runoff discharged off-site or to the river.

7.3.8 The bridge deck will drain from the centre to both the north and south abutments, where runoff will be channelled into infiltrating surface features located either side of the path, within the adjacent landscaping.

7.3.9 These infiltrating features will be formed from rock filled gabion baskets lined with a permeable geomembrane that are located with the top of the baskets at ground level, connected via pipe work to geocellular crate soakaways. Runoff will be channelled off the bridge deck over the surface onto the top of the rock filled basket, which will dissipate the flow and promote infiltration, prior to conveyance to the geocellular crate soakaways.

7.3.10 Copies of the Proposed Surface Water Drainage Layout (OXPEN-STN-GEN-ALL-DR-C-0007) and accompanying MicroDrainage Calculations are contained in **Appendix E** and **F**.

### Flood Risk Within the Development

7.3.11 The proposed surface water drainage strategy provides storage below ground up to and including the 1 in 30 year + 35% climate change rainfall event.

7.3.12 The proposed site levels and drainage strategy have been designed so that in larger rainfall events flooding from the system will be directed to the River Thames and its associated floodplain in the form of overland flow.

# 8 Conclusions

8.1.1 This Flood Risk Assessment has been prepared by Stantec to accompany a full planning application for a proposed new pedestrian and cycle bridge crossing over the River Thames including new footpaths linking to existing highways and paths at Oxpens Meadow, Oxford, Oxfordshire, OX1 1RQ.

8.1.2 The proposed new bridge scheme is being progressed at the same time as a redevelopment of the land north of the River Thames – the 'Oxpens Development'. The Oxpens Development Enabling Works detailed application aims to deliver the development platform and associated flood compensation mitigation for the wider area and was submitted under planning application reference 22/02955/FUL.

8.1.3 The bridge scheme and enabling works schemes are closely linked and it is important that they take a consistent approach to flood compensation. As such, the bridge design has been developed within the geometric parameters set by the Oxpens Development's flood compensation calculations (i.e. the proposed landform around the northern abutment).

8.1.4 As a separate application, a standalone floodplain storage analysis and mitigation has been developed within the bridge application site red line. This approach demonstrates that a robust strategy compliant with national and local flood risk policy has been adopted for the proposed bridge, irrespective of the planning status of the Oxpens Development.

## Flood Risk

8.1.5 The proposed bridge location lies partly in Flood Zone 3 'High Probability' (greater than a 1 in 100 (1%) annual probability of river flooding). As the site crosses the River Thames, it can be concluded that it is partly within Flood Zone 3b 'Functional Floodplain'.

8.1.6 The data shows the bridge towpaths on both sides of the Thames channel are within Flood Zone 3, while the higher ground behind the towpath on the southern side of the Thames channel and the footpath south of Oxpens Road on the northern side of the Thames channel are within Flood Zone 1.

8.1.7 The applicable 1 in 100 annual probability +41% allowance for climate change flood event was assessed by the consultants for the Oxpens Development through rerunning the EA Thames model, and a flood level of 56.79m AOD has been advised and applied to the design of mitigation measures.

8.1.8 The remaining sources of flood risk, including surface water flooding, are considered to be a low risk.

## Vulnerability and Sequential Test

8.1.9 The proposals are for 'Essential Infrastructure' as defined in Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' Table 2. Such development in Flood Zone 3b 'Functional Floodplain' is acceptable provided the Sequential Test and Exception Test are passed. Details of these Tests are provided in **Section 5**.

## Bridge Design Criteria and Mitigation Strategy

8.1.10 To mitigate against the risk of fluvial flooding, the river soffit level of the proposed bridge will be set at a minimum of 58.2m AOD, over 1.4m above the reference modelled 1 in 100 annual probability +41% allowance for climate change flood level and in excess of the 600mm freeboard requirement.

8.1.11 A minimum headroom of 3.6m will be provided to allow safe navigation under the proposed bridge for rivercraft. Pedestrians and cyclists will be provided with at least 2.4m headroom on the north and south towpaths.

8.1.12 A floodplain storage analysis has been developed that it consistent with the wider Oxpens Development proposed landform around the northern abutment of the bridge, while providing the requirements for level-for-level flood compensation within the bridge scheme red line boundary (so it is not in any way reliant on the planning status of the Oxpens Development to be deliverable).

8.1.13 This demonstrates that the proposals provide an improvement in storage capacity under both (i) the combined scheme with the Oxpens Development, and (ii) the bridge scheme in isolation. The floodplain storage analysis will be reviewed at detailed design stage to allow for further design refinements and subject to the planning status of the respective elements.

## Proposed Surface Water Drainage Strategy

8.1.14 The majority of the proposed bridge deck and footpath approaches are located within the existing floodplain of the River Thames.

8.1.15 The proposed surface water drainage strategy seeks to mimic the site's existing drainage regime through the discharge of surface water via infiltration techniques.

8.1.16 The proposed footpaths will be constructed with porous asphalt surfaces continuing to allow direct infiltration of rainfall into the Made Ground above the Alluvium.

8.1.17 The bridge deck will drain from the centre to both the north and south abutments, where runoff will be channelled into infiltrating surface features located either side of the path, within the adjacent landscaping.

8.1.18 The proposed surface water drainage strategy provides storage below ground up to and including the 1 in 30 year + 35% climate change rainfall event.

8.1.19 The proposed site levels and drainage strategy have been designed so that in larger rainfall events flooding from the system will be directed to the River Thames and its associated floodplain in the form of overland flow.

## Summary

8.1.20 In conclusion, the proposed development will be safe and the development will not increase flood risk elsewhere. It is demonstrated that the proposal complies with the National Planning Policy Framework (NPPF), Planning practice Guidance (PPG) and the local planning policy with respect to flood risk and is an appropriate development at this location.

# Appendix A Open Data Flood Maps

- Site Location Plan
- Site Location (Aerial Photography)
- Area Topography (LiDAR)
- EA Flood Zone Map
- EA Surface Water Flood Risk
- Reservoir Flood Map
- EA Historic Flood Map


Stantec

Client

OXFORD CITY COUNCIL

Balfour Beatty

**OXPENS RIVER BRIDGE**

Site Location

0 250 500 m



| | |
|---|---|
| 1:5,000 @ A3 | Date: 04/10/2023 |
| Drawn: ZW | Checked: RF |
| Figure: 01 | Rev: A |

Document Path: C:\Users\zawang\OneDrive - Stantec\Documents\ArcGIS\Projects\332610335\332610335.aprx


Stantec

Client

OXFORD CITY COUNCIL www.oxford.gov.uk Balfour Beatty

**OXPENS RIVER BRIDGE**

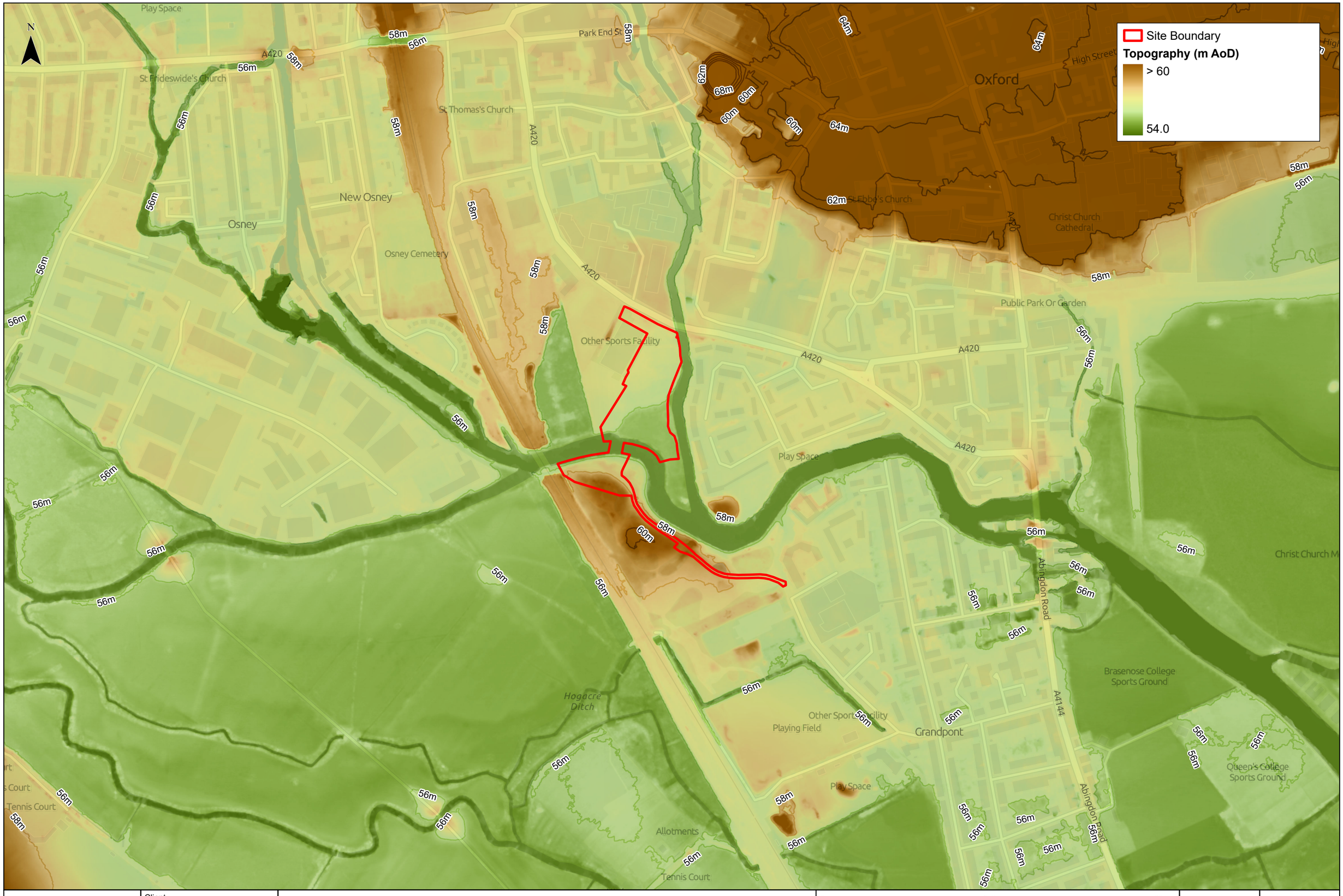
Site Location - Aerial

0 250 500 m

Maxar, Microsoft, Esri Community Maps Contributors, Esri UK, Esri, HERE, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

| | |
|---|---|
| 1:5,000 @ A3 | Date: 04/10/2023 |
| Drawn: ZW | Checked: RF |
| Figure: 02 | Rev: A |

Document Path: C:\Users\zawang\OneDrive - Stantec\Documents\ArcGIS\Projects\332610335\332610335.aprx




Stantec

Client

www.oxford.gov.uk OXFORD CITY COUNCIL Balfour Beatty

**OXPENS RIVER BRIDGE**

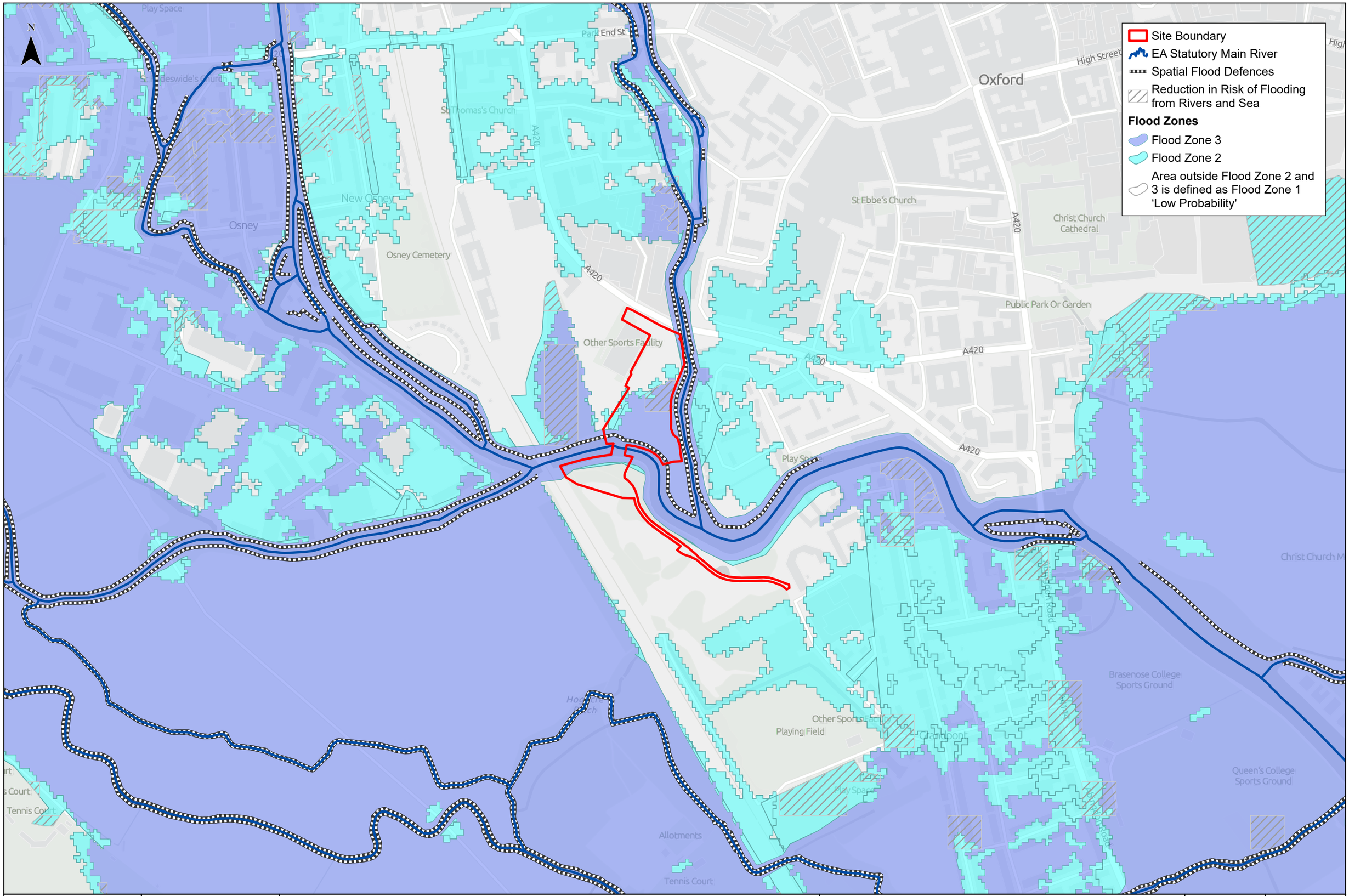
Topography

0 250 500 m



| | |
|---|---|
| 1:5,000 @ A3 | Date: 05/10/2023 |
| Drawn: ZW | Checked: RF |
| Figure: 03 | Rev: A |

Document Path: C:\Users\zawang\OneDrive - Stantec\Documents\ArcGIS\Projects\332610335\332610335.aprx




Stantec

Client

Balfour Beatty

**OXPENS RIVER BRIDGE**

Environment Agency Flood Map for Planning

0 250 500 m


Flood Zones refer to the probability of river and/or sea flooding, ignoring the presence of defences.

| | |
|---|---|
| 1:5,000 @ A3 | Date: 05/10/2023 |
| Drawn: ZW | Checked: RF |
| Figure: 04 | Rev: A |

Document Path: C:\Users\zawang\OneDrive - Stantec\Documents\ArcGIS\Projects\332610335\332610335.aprx