Hillingdon Hospital

The Hillingdon Hospitals NHS Foundation Trust

Level 2 Flood Risk Assessment

Report Status: FINAL

Project Number: 60642181

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Quality information

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Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGS	British Geological Society
CDA	Critical Drainage Area
EA	Environment Agency
FFL	Finished Floor Levels
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
GLA	Greater London Authority
LBH	London Borough of Hillingdon
LiDAR	Light Detection and Ranging
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RoFfSW	Risk of Flooding from Surface Water
RBMP	River Basin Management Plan
SuDS	Sustainable Drainage Systems
SFRA	Strategic Flood Risk Assessment
SWMP	Surface Water Management Plan
TPO	Tree Preservation Order

Glossary

Flood Zone	Environment Agency defined zone of flood risk used for planning.
Main River	Main rivers are usually larger rivers and streams. The EA carries out maintenance, improvement or construction work on main rivers to manage flood risk.
Ordinary Watercourse	Ordinary watercourses include every river, stream, ditch, drain, cut, dike/dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river.

1. Introduction

AECOM has been commissioned by the Hillingdon Hospitals NHS Foundation Trust to undertake a Level 2 Flood Risk Assessment (FRA) in support of a hybrid planning application for the redevelopment of Hillingdon Hospital. The construction of the Proposed Development has been divided into a phased approach; Phase 1 and Phase 2, whereby Phase 1 has been further sub-divided into three phases, a, b, and c. This facilitates the construction of the Proposed Development whilst the existing hospital remains functional and operational.

Phase 1 predominantly comprises the construction of a replacement eight-storey hospital facility to the west of the site, whilst the existing hospital in the east remains in-situ and operational. The subdivision of this Phase is further described in **Section 1.2**. Upon completion of Phase 1, Phase 2 includes the decommissioning of the original hospital and construction of mixed-use development including residential units to the east of the site. Please note, the existing Grade II Furze building which is situated to the east of the site and the existing re-located nursery school to the south of the site will form part of a separate planning application and has not been included within the scope of works for the FRA. Phase 1 will be submitted as part of a full detailed planning application whilst Phase 2 will be submitted as part of an outline planning application. Hydraulic modelling has been undertaken to inform the assessment of flood risk for both Phases.

This FRA is intended to assess the level of flood risk posed to and from the Proposed Development for both Phase 1 and Phase 2 during its operational phase. Appropriate mitigation measures to offset flood risk will be outlined where necessary. The flood risk has been assessed in accordance with the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (PPG). This FRA is based on the best available flood risk information at the time of writing. Data has been provided by online Environment Agency (EA) resources, publicly available external sources and hydraulic modelled outputs retrieved from a 1D-2D fluvial model built for the purposes of the Proposed Development in Phase 1 and 2. The Hydraulic Model Report Ref: THHR_01_ACM_ZZ_XX_RP_Y_000023 should be read in conjunction with this FRA.

1.1 Description of the Proposed Site

The site is situated approximately 6 kilometres (km) north of Heathrow Airport, in the Colham Green area of Uxbridge and sits within the administrative area of the London Borough of Hillingdon (LBH) and the Greater London Authority (GLA). The site has a National Grid Reference (NGR) TQ 06841 81847 and has an approximate area of 9.6 hectares (ha). The site is currently in operation as Hillingdon Hospital, and as such, the need to adopt a phased approach to enable the hospital to continue operating during the proposed works is required.

Following a review of the EA Flood Map for Planning (FMfP) and Ordnance Survey (OS) Mapping, the closest watercourse with Main River status is the River Pinn which is situated approximately 0.45 km west of the Proposed Development. There is an unnamed Ordinary Watercourse which runs through the Proposed Development site, hereafter referred to as Ordinary Watercourse A. The Ordinary Watercourse is urban in nature and flows in a south westerly direction along the southern boundary of the Proposed Development site. Ordinary Watercourse A is culverted in sections, specifically downstream of Colham Green Park and immediately downstream of the site boundary, before discharging into the River Pinn Main River approximately 0.45 km south west of the Proposed Development. Two unnamed Ordinary Watercourses are also shown in the vicinity of the Proposed Development which are hereafter referred to as Ordinary Watercourse B and C; refer to **Figure 1-1**.

A review of the LiDAR Digital Terrain Model (DTM) of 1 m (metres) grid resolution, derived from the EA Open Data[1] shows that the Proposed Development is located approximately 37 m Above Ordnance Datum (m AOD). The site is relatively flat, with higher ground shown to the north at approximately 40 m AOD along the northern site boundary. To the west of the site, the topography gradually falls to approximately 36 m AOD, at the south western corner of the site where Ordinary Watercourse A becomes culverted under the nearby residential area near Apple Tree Avenue; refer to **Figure 1-2**.

[1] Environment Agency Open Data (2021). LiDAR Digital Terrain Model (DTM). [Online] Available from: https://data.gov.uk/dataset/3fc40781-7980-42fc-83d9-0498785c600c/lidar-composite-dtm-2019-1m

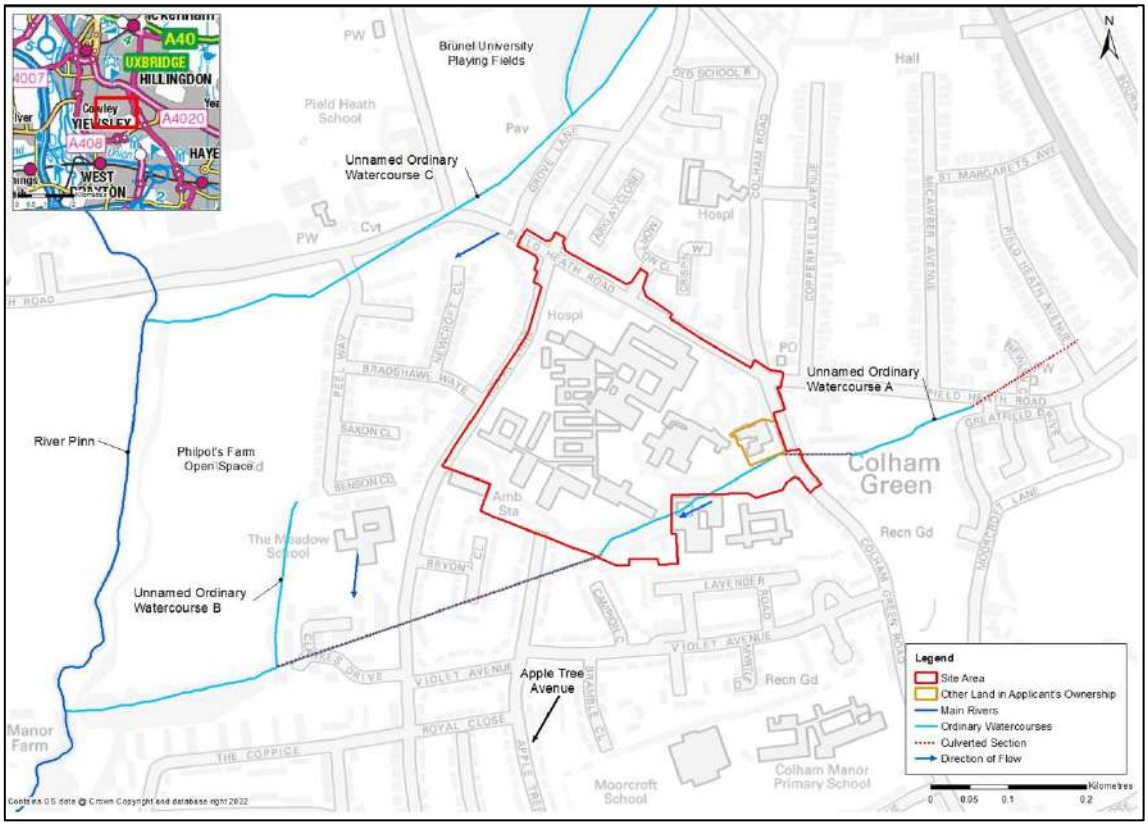

Figure 1-1 – Site Location Plan

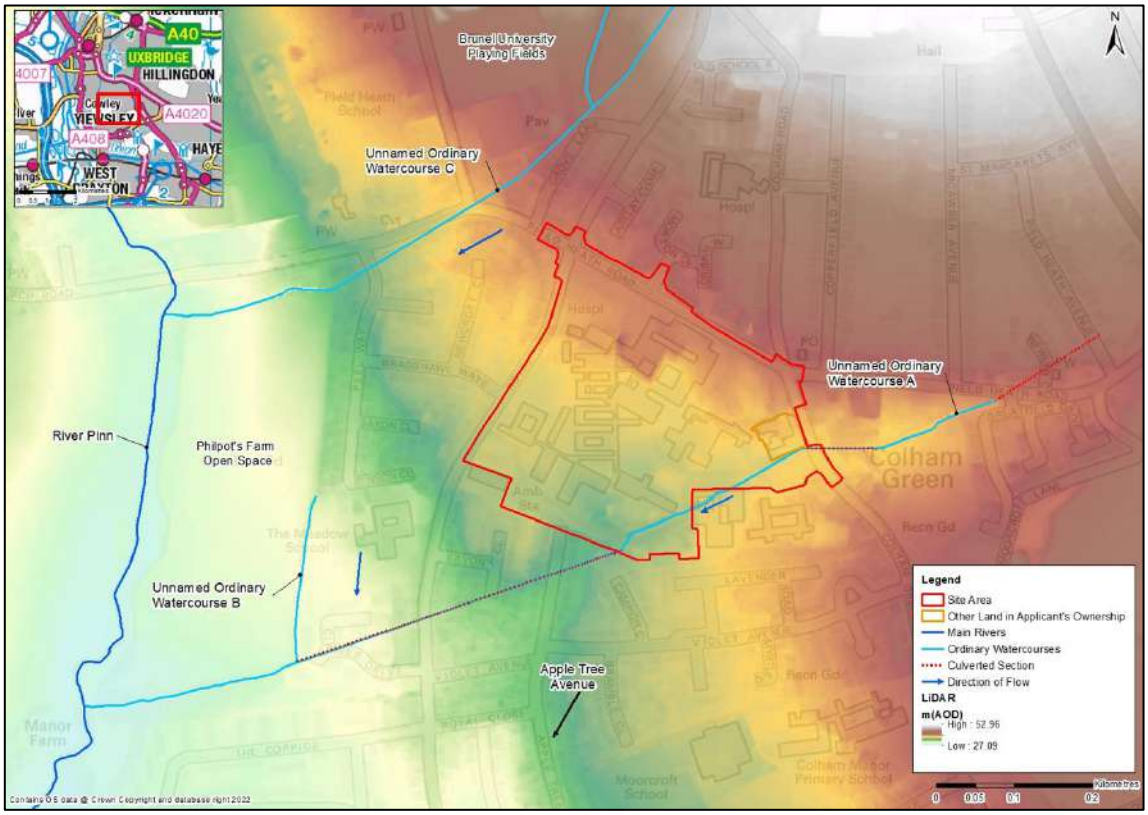

Figure 1-2 – Topography of the Site and Surrounding Area

1.2 Description of Proposed Works

The Proposed Development will involve the redevelopment of Hillingdon Hospital which will be divided among two phases (Phase 1 and 2) to ensure the continuity and functioning of the existing hospital. The phases are further divided and summarised below:

- Phase 1 a – Fixed Development that will not be required to change in the future. This includes the Proposed Hospital Ward, Multi-Storey Car Park and Southern Access Road.
- Phase 1 b – Interim elements that will eventually be modified or replaced by the final phase of the detailed application (Phase 1 c). This includes modifying road layouts and junctions.
- Phase 1 c – Elements that can only be built upon the demolition of the existing hospital which form part of the detailed application. This includes the Proposed Development within the central section of the site.
- Phase 2 – Outline Planning Application for Residential Development to be built upon the demolition of the existing hospital.

A Phasing Plan, Ref [THHR_01_IBI-XX-XX-DR-A-100007] illustrating the above phases are shown in **Appendix A.**

A description of the Proposed Works is further outlined in *Table 1-1*.

Table 1-1 - Description of the Proposed Development

Phase 1a (Detailed Planning Application)
• *79,600m² eight storey hospital facility including a basement* covering a partial area, approx. 6100m² of the building's footprint.*
• *Associated multi-storey car park*
• *Widening of the existing southern access road*
• *Extension of 2 No. existing culverts beneath the southern access road (proposed lengths of 4.4 m and 11.4 m)**
• *Resurfacing and highway works along Pield Heath North*
• *Vehicle Access*
• *Storage for Oxygen Tanks*
• *FM Yard which includes generators, substation, medical gasses, hearse bays, HGV parking and a ramp to the basement level*
• *Surface water and foul drainage network*
• *Associated landscaping and public open space*
• *Decommissioning of existing hospital buildings situated to the west of the site*
• *On-site Flood Risk Mitigation Works*
Phase 1b (Detailed Planning Application)
• *Widening of Access Road near Colham Green Road Junction*
• *Bus Stop*
• *Bus Lane*

Phase 1c (Detailed Planning Application)
Decommissioning of buildings and structures at the centre of the remaining site
• *'Triangular' public open space*
• *Surface Car Park*
• *Bus Stop and Bus Lane*
• *On-site Flood Risk Mitigation Works including Fluvial Basin*
• *Public Open Space and Public Open Woodland Space*
Phase 2 (Outline Planning Application)
• *Decommissioning of buildings and structures on the remaining site (excluding the Grade II Furze and Tudor Centre)*
• *Mixed use development comprising residential (up to 327 units) and supporting commercial, business and service uses (up to 800 sqm of town centre uses) in a series of buildings in height from 3 up to 8 storeys*
• *Undercroft parking at Mixed use development*
• *Surface water and foul drainage network*
• *Associated landscaping*

For the purposes of the FRA, the presentation of the hydraulic model outputs has been overlaid on Phase 1 and Phase 2 MasterMaps Ref: THHR_01-IBI-XX-XX-DR-A-100002 P21 and THHR_01-IBI-XX-XX-DR-A-100003 P08 respectively which are presented in **Appendix B.** Phase 1a and 1b are presented in the Phase 1 MasterMap whilst Phase 1c and Phase 2 are shown within the Phase 2 MasterMap.

*The site layout plan [THHR_01-IBI-WB-B1-DR-A-251009] showing the location of the basement and the extended culverts are also presented in **Appendix C and Appendix D** respectively.

2. Evaluation of Flood Policy

The aim of this section of the report is to introduce the main aspects of the national and local planning policies that are relevant to the Proposed Development in terms of flood risk.

2.1 National Planning Policy Framework

Section 14 of the 2021 updated NPPF[2] and the 2021 Flood Risk and Coastal Change PPG[3] both advise how the planning process can take account of the risks associated with flooding. The main sources of flooding that are used to steer development at the planning stage are Main Rivers and the Sea. The predicted flood risk from these sources are shown on the EA's Fluvial and Coastal Flood Map, also known as the Flood Map for Planning (FMfP) which outlines three main zones of risk. These are as follows:

- **Flood Zone 1 'low probability of flooding'** – This zone comprises land assessed as having a less than 1 in 1,000 chance of river or sea flooding in any year (<0.1% annual exceedance probability).
- **Flood Zone 2 'medium probability of flooding'** – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 chance of river flooding (1% - 0.1% AEP) in any year, or between a 1 in 200 and 1 in 1,000 chance of sea flooding in any year (0.5% - 0.1% AEP).
- **Flood Zone 3a 'high probability of flooding'** – This zone comprises land assessed as having a 1 in 100 year or greater chance of river flooding in any year (>1% AEP), or a 1 in 200 year or greater chance of flooding from the sea in any year (0.5% AEP).
- **Flood Zone 3b 'functional floodplain'** – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of a flood. This zone is not usually included within the FMfP and is calculated where necessary during detailed hydraulic modelling.

The NPPF dictates what development is suitable within each Flood Zone based upon the level of vulnerability of the development. This is shown in **Table 2-1**. Given the complexity of the Proposed Development, there are a range of developments that fit within different vulnerability classifications. As discussed in **Section 1.2**, the Proposed Development will comprise a 'hospital', 'generating power stations', 'basement', 'residential' and 'buildings used for shops'. The vulnerability classifications suggest 'generating power stations' are considered 'Essential Infrastructure', 'basement dwellings' are considered 'Highly Vulnerable', 'Hospital and Residential Units' are considered 'More Vulnerable' and 'Buildings used for shops' are considered 'Less Vulnerable'

Table 2-1 - Flood Risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
Zone 3b	Exception Test Required	✓	✗	✗	✗

In accordance with **Table 2-1,** the EA FMfP shows that the Proposed Development lies within land classified as being within Flood Zone 1, all of the proposed uses at the site outlined above are considered appropriate. Please note, as the FMfP does not include modelled outputs for the unnamed Ordinary Watercourse A, fluvial hydraulic

[2] Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. [Online] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf.
[3] Ministry of Housing, Communities and Local Government (2019). Planning Practice Guidance: Flood Risk and Coastal Change. [Online] Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change. Accessed 07/10/21.

modelling has been undertaken for Phase 1 and 2 to show the extent of flooding up to and including the 1 in 100 year event plus CC event (1% AEP flood event).

This FRA will be used to consider the flood risk to and from the Proposed Development. As well as fluvial and tidal flooding, it is also necessary to consider flood risk from all other sources, including surface water, groundwater, Ordinary Watercourses, artificial drainage systems and infrastructure failure.

2.2 Regional and Local Planning Policy

The Proposed Development lies within the boundary of the LBH, which holds the role of both Lead Local Flood Authority (LLFA) and Local Planning Authority (LPA). Therefore, LBH has the responsibility for the preparation of local plans and policies to manage flooding in their role as LLFA and LPA. In addition, as the Proposed Development is located within Greater London, proposals will also need to follow guidance as set out by the GLA in the London Plan. The FRA has been limited to extracting policies and guidance that are relevant to the Proposed Development only.

2.2.1 The London Plan (2021)

The GLA is the regional governing body of the London Boroughs which sets out numerous planning policies within The London Plan 2021[4] to support the spatial development strategy for Greater London. These are as follows:

Policy GG6 Increasing Efficiency and Resilience

"Ensure buildings and infrastructure are designed to adapt to a changing climate, making efficient use of water, reducing impacts from natural hazards like flooding and heatwaves, while mitigating and avoiding contributing to the urban heat island effect"

Policy D10 Basement Development

"Boroughs should establish policies in their Development Plans to address the negative impacts of large-scale development beneath existing buildings, where this is identified as an issue locally […]. Large scale basements can cause particular issues […] on land and structural stability as well as causing localised flooding or drainage issues."

"*Where particular and cumulative flood risk issues exist, boroughs should consider restricting the use of basements for non-habitable uses"*

Policy SI 12 Flood Risk Management

"Current and expected flood risk from all sources across London should be managed in a sustainable and cost-effective way in collaboration with the Environment Agency, the Lead Local Flood Authorities, developers and infrastructure providers"

"*Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses"*

"Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood"

"Natural flood management methods should be employed in development proposal due to their multiple benefits including increasing flood storage and creating recreational areas and habitat"

[4] The London Plan 2021 Retrieved: https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf Accessed: 16/02/2022

Policy SI 13 Sustainable Drainage

"Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features in line with the following drainage hierarchy:

1. *Rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)*
2. *Rainwater infiltration to ground at or close to source*
3. *Rainwater attenuation in green infrastructure features for gradual release (for example green roods, rain gardens)*
4. *Rainwater discharge direct to a watercourse (unless not appropriate)*
5. *Controlled rainwater discharge to a surface water sewer or drain*
6. *Controlled rainwater discharge to a combined sewer"*

"Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways."

"Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation."

2.2.2 London Borough of Hillingdon Local Plan (2012)

The Hillingdon Local Plan is divided between two parts; Part 1[5] was adopted in 2012 and sets out the strategic objectives and core polices to inform growth within the borough up to 2026. The Local Plan Part 2[6], was adopted in January 2020, and supports Part 1 by setting out more detailed policies and allocations.

At the time of writing (February 2022), an emerging Local Plan is being prepared by LBH with a review of the current Local Plans in 2021. The new emerging Hillingdon Local Plan will cover the period from 2023 – 2038 and will combine the existing Local Plan Part 1 and 2.

Local Plan Part 1 – Strategic Policies

The Hillingdon Local Plan Part 1 contains the planning strategy and vision for the Borough through setting out strategic policies which aim to steer and shape development in Hillingdon. The relevant policies from this document are as follows:

Policy BE1: Built Environment

"All developments should [...] not result in the inappropriate development of gardens and green spaces that erode the character and biodiversity of suburban areas and increase the risk of flooding through the loss of permeable areas."

Policy EM1: Climate Change Adaptation and Mitigation

"The Borough will ensure that climate change adaptation is addressed at every stage of the development process by [...]

-Locating and designing development to minimise the probability and impacts of flooding.

- Requiring major development proposals to consider the whole water cycle impact which includes flood risk management, foul and surface water drainage and water consumption.

[5] Hillingdon Local Plan Part 1 Strategic Policies (2012) [Online] https://www.hillingdon.gov.uk/local-plan Accessed 01/02/2022
[6] Hillingdon Local Plan Part 2 (2020) [Online] Local Plan - Hillingdon Council Accessed 01/02/2022

-Promoting the use of living walls and roofs, alongside sustainable forms of drainage to manage surface water run-off and increase the amount of carbon sinks."

Policy EM6: Flood Risk Management

"The Council will require new development to be directed away from Flood Zones 2 and 3 in accordance with the principles of the National Planning Policy Framework (NPPF)"

"Sites will only be allocated within Flood Zones 2 or 3 where there are overriding issues that outweigh flood risk. In these instances, policy criteria will be set requiring future applicants of these sites to demonstrate that flood risk can be suitably mitigated."

"The Council will require all development across the borough to use sustainable urban drainage systems (SUDS) unless demonstrated that it is not viable."

"The Hillingdon Local Plan has a role to play in reducing future levels of flood risk. Detailed policies to address the location of new development, design and layout will be developed through the Hillingdon Local Plan: Part 2- Development Management Policies LDD."

"It will be necessary to ensure that new development takes into account the increased risks of flooding as a result of changes to the climate, and how this affects Hillingdon and to protect vulnerable areas from river flooding. […]"

"All development proposals in Flood Zones 2, 3a and 3b (medium and high probability) should be accompanied by a Flood Risk Assessment (FRA) in accordance with the NPPF. Development of over 1 hectare or identified as being within a problem surface water area should also be accompanied by an FRA."

"New development should be designed and located with flood risk in mind and more space provided for water through better management of land for water storage and flood protection. […]"

"The impacts of climate change will add to the pressure on the drainage systems and it is therefore essential that all new development it managed to minimise the problems."

"Where possible SUDS solutions for a site should seek to […] reduce flood risk (to the site and neighbouring areas); […]"

Local Plan Part 2

The Local Plan Part 2 comprises Development Management Policies, Site Allocations and Designations and the Policies Map which aims to deliver the detail of the strategic policies in the Local Plan Part 1.

Development Management Policies

Policy DMEI 8: Waterside Development

"Development on sites that adjoin or include a watercourse should:

[…] where feasible, implement a scheme for restoring culverted sections of river or watercourses which must include an adequate buffer for flooding and maintenance purposes."

"Development located in or adjacent to watercourses should enhance the waterside environment and biodiversity by demonstrating a high design quality which respects the historic significance of the canal and character of the waterway and provides access and improved amenity to the waterfront."

Policy DMEI 9: Management of Flood Risk

"Development proposals in Flood Zones 2 and 3a will be required to demonstrate that there are no suitable sites available in areas of lower flood risk. Where no appropriate sites are available, development should be located on the areas of lowest flood risk within the site."

"Development proposals in these areas will be required to submit an appropriate level Flood Risk Assessment (FRA) to demonstrate that the development is resilient to all sources of flooding."

"Proposals that fail to make appropriate provision for flood risk mitigation, or which would increase the risk or consequences of flooding, will be refused."

Policy DMEI 10: Water Management, Efficiency and Quality

"Applications for all new build developments (not conversions, change of use, or refurbishment) are required to include a drainage assessment demonstrating that appropriate sustainable drainage systems (SuDS) have been incorporated in accordance with the London Plan Hierarchy."

"All major new build developments, as well as minor developments in Critical Drainage Areas or an area identified at risk from surface water flooding must be designed to reduce surface water runoff rates to no higher than the pre-development greenfield run-off rate in a 1:100 year storm scenario, plus an appropriate allowance for climate change for the worst storm duration"

"Proposals that would fail to make adequate provision for the control and reduction of surface water run-off rates will be refused."

"Developments should be drained by a SuDS system and must include appropriate methods to avoid pollution of the water environment."

Site Allocations and Designations

The Site Allocations and Designations document sets out sites for development to meet the Borough's needs until 2026.

Hillingdon Hospital has not been designated as a specific site for development however;

"The Council recognises the need for improved facilities at […] Hillingdon Hospital. The Council will work with the relevant providers to address the recognised need for these facilities."

2.2.3 Preliminary Flood Risk Assessment (PFRA) 2011

The purpose of a Preliminary Flood Risk Assessment (PFRA)[7] document is to provide a high-level summary of significant flood risk based on available and derivable information describing both the probability and potential harmful consequences of past and future flooding. The PFRA forms part of the local flood risk management strategies that the LLFA is required to prepare by the Flood and Water Management Act 2010.

The PFRA was commissioned in 2011 by the LBH and provides a high-level summary of significant flood risk based on past and future flooding within the HCC administrative area.

The PFRA shows a summary table of past flooding from surface water, sewer or groundwater sources. The Proposed Development has not been identified within an area impacted from a significant historic flood event. However, it is noted within this PFRA that the summary does not fully represent every flooding incident in the London Borough of Hillingdon.

Data showing potential sites at risk of flooding in the future is available in the Hillingdon Surface Water Management Plan (SWMP) in **Section 2.2.6** below.

2.2.4 West London Strategic Flood Risk Assessment (SFRA) 2018

A Level 1 Strategic Flood Risk Assessment[8] was commissioned by the West Boroughs of Barnet, Brent, Ealing, Harrow, Hillingdon and Hounslow (hereinafter 'the Boroughs') which form the North West London Flood Risk Management Strategic Partnership group. This SFRA updates the borough specific SFRA's which were completed in 2008. A SFRA is a required evidence document for the Local Plan which collates information on all known sources of flooding that may affect existing or future development within the area.

[7] Preliminary Flood Risk Assessment for Hillingdon (2011) [Online] https://modgov.hillingdon.gov.uk/documents/s8733/08%20-%20REPORT%202011%20May%20Cabinet%20Report%20PFRA.pdf Accessed 01/02/2022
[8] West London Strategic Flood Risk Assessment (2018) [Online] https://westlondonsfra.london/ Accessed 01/02/2022

The purpose of the Level 1 SFRA provides a strategic overview of all forms of flood risk throughout the study area, now and in the future. The SFRA will also be used by the Boroughs to inform Local Plans and to initiate the sequential risk-based approach to land allocation.

The SFRA has identified areas within the Boroughs that are most susceptible to the extents of fluvial, surface water, groundwater and artificial drainage flooding as well as showing climate change scenarios up to 2100. The southern perimeter of the Proposed Development site is shown to flood in the 1 in 30 year surface water flood event and most of the site is considered to have a 25% to 50% susceptibility to groundwater flooding. The northern extent of the site is also located in a Source Protection Zone area. There are no recorded incidents of historic sewer water flooding at or near the Proposed Development site. Historic flood investigation reports also showed no reported historic incidents at the time of writing of fluvial or surface water flooding at or near the Proposed Development site.

2.2.5 Local Flood Risk Management Strategy (LFRMS) 2015

The Hillingdon Local Flood Risk Management Strategy[9] (LFRMS) sets out the responsibilities of the different parties on how flood risk can be reduced in Hillingdon whilst also meeting the needs of the communities, the economy and the environment.

The LFRMS identifies that the most significant sources of flooding within Hillingdon are Main Rivers in addition to excess rainfall and surface water which can encourage sewer flooding. However, it is noted that Ordinary Watercourses are important to recognise in the management of flood risk due to their interaction with Main Rivers.

The LFRMS Objectives are outlined in Appendix 3[10] of the LFRMS (2016). The objectives are:

2 Develop knowledge and awareness of different flood risks, and roles and responsibilities in managing flooding.

3 Maintain and improve communication and cooperative working between Risk Management Authorities (RMA) and LLFA and the public.

4 Development in Hillingdon understands and takes account of flood risk issues and plans to reduce flood risk.

5 Identify and implement new flood risk management measures.

6 Promote the effective management of flood risk assets.

7 Ensuring that emergency plans and responses to flood incidents are effective and that communities understand their role in an emergency.

2.2.6 Surface Water Management Plan (SWMP)

The Surface Water Management Plan (SWMP)[11] for Hillingdon is divided into two parts, an Evidence Base and an Option and Action Plan, which aim to help LBH manage surface water flood risk.

Surface Water Management Plan Evidence Base - Part 1 (2013)

The SWMP illustrates that the Proposed Development is not located within a topographical low point susceptible to surface water flooding. However, the SWMP identifies part of the Proposed Development site as an area of Increased Potential for Elevated Groundwater as permeable superficial deposits underlain part of the site. The

[9] Hillingdon Local Flood Risk Management Strategy (2015) [Online] https://www.bing.com/search?q=hillingdon+local+flood+risk+management&qs=NWT&pq=hillingdon+local+flood+risk+man&sc=1-31&cvid=01606125659A405A8933AEB74118A78D&FORM=QBRE&sp=1 Accessed 01/02/2022

[10] Hillingdon Local Flood Risk Management Strategy Appendix 3 (2016) [Online] https://archive.hillingdon.gov.uk/media/35171/LFRMS-Appendix3-Local-Flood-Risk-Management-Strategy-Objectives-and-Measures/pdf/LFRMSAppendix3LocalFloodRiskManagementStrategyObjectivesandMeasures.pdf Accessed 01/02/2022

[11] Hillingdon Surface Water Management Plan (2013/2014) [Online] https://www.hillingdon.gov.uk/article/3271/Surface-water-management-plan Accessed 01/01/2022

SWMP notes how flooding is not just confined to CDAs and therefore the aim of reducing the impact of surface water flooding is Borough wide.

Surface Water Management Plan Options and Action Plan – Part 2 (2014)

Part 2 of the SWMP discarded the two options of 'Do Nothing' and 'Do the Minimum' and acknowledged that additional actions are required to ensure flood risk is managed effectively. The SWMP suggests Site Specific, Resident and Council actions to reduce surface water flooding across the Borough which are split into short, medium and long-term actions.

2.2.7 London Regional Flood Risk Appraisal 2014

The London Regional Flood Risk Appraisal[12] provides a broad overview of flood risk issues and potential mitigation measures to combat future flood risk.

The LBH is identified as being affected by the River Crane, Colne and Pinn Main Rivers. Further action is recommended to sustain the current scale of flood risk into the future.

2.2.8 Thames River Basin Management Plans (RBMP) 2016

The Thames River Basin Management Plan (RBMP)[13] was conducted by DEFRA and the EA in 2016. The RBMP has been prepared to fulfil the requirements of the Water Framework Directive and contributes to the directives of other EU directives. It is an update of and replaces the river basin management plan published in 2009.

A review of the main programmes within the report suggests that there is a focus on SuDS, stating:

"Outfalls will generally be treated with sustainable drainage systems (SuDS) […] SuDS are moderately resilient to climate change as they use natural processes and cope well with fluctuations, although prolonged drought may restrict their effectiveness."

2.2.9 Thames Catchment Flood Management Plan (CFMP) 2009

The Thames Catchment Flood Management[14] was created in 2009 by the EA and aims to give an overview of flood risk for the Thames Catchment as well as set out a preferred plan for sustainable flood risk management in the future.

The Thames CFMP identifies the London Borough of Hillingdon as having 500 to 1,000 properties at risk in a 1% annual probability of river flood.

The London Borough of Hillingdon is part of sub area 5 which is characterised as 'Urbanised places with some flood defences' in the Thames CFMP. One of the main issues identified in this sub-area is flooding from surface water drainage systems as they can be easily overwhelmed. The approach to flood risk management in these areas is to use the open spaces in the floodplain as natural protection and aim to make the existing drainage systems more effective in built up areas.

[12] London Regional Flood Risk Appraisal (2014) [Online] https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Regional%20Flood%20Risk%20Assessment%20-%20First%20Review%20-%20August%202014.pdf Accessed 01/02/2022

[13] Thames River Basin Management Plan (2016) [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718342/Thames_RBD_Part_1_river_basin_management_plan.pdf 01/02/2022

[14] Thames Catchment Flood Management Plan (2009) [Online] Thames_Catchment_Flood_Management_Plan.pdf (publishing.service.gov.uk) Accessed 01/02/2022

3. Climate Change

3.1 Context

The NPPF requires site specific FRAs to assess the risk of all sources of flooding to and from the development and to demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

The EA published updated climate change guidance in October 2021[15]. The guidance indicates that climate change is likely to increase river flows, sea levels, rainfall intensity, wave height and wind speed.

3.2 Peak River Flow Allowances by River Basin District

The peak river flow allowances show the anticipated changes to peak flow by river basin district. The range of climate change allowances are based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it.

- Central allowance is based on the 50th percentile.
- Higher central is based on the 70th percentile.
- Upper end is based on the 95th percentile.

The Proposed Development lies within the Colne Management Catchment within the Thames River Basin District. **Table 3-1** shows the climate change allowances for the Colne Management Catchment.

Table 3-1 – Peak River Flow Allowances for the Proposed Development

Allowance Category	Total Potential Change Anticipated for '2020s' (2015 to 2039)	Total Potential Change Anticipated for '2050s' (2040 to 2069)	Total Potential Change Anticipated for '2080s' (2070 to 2115)
Upper End	30%	38%	72%
Higher	16%	16%	35%
Central	10%	8%	21%

3.3 Peak River Flow Allowances for the Proposed Development

For Developments located in Flood Zone 1 the EA guidance for climate change allowance states that peak river flow allowances should be applied for locations currently located in Flood Zone 1 but could be in Flood Zone 2 or 3 in the future. As the Proposed Development is located within Flood Zone 1, a Central Allowance has been assessed.

The design lifetime of the structural and civil elements of the Proposed Development is 65 years and based upon the EA guidance, the peak river flow climate change allowances for the lifetime of the Proposed Development should be assessed as shown in

Table *3-2*. Furthermore, at the time of writing, the hydraulic modelling study has incorporated the most recent climate change allowances which have been agreed with LBH as per a meeting on the 19th August 2021.

[15] Environment Agency (2021) Flood risk assessments: climate change allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. Accessed 02/02/2022.

Table 3-2 – Proposed Development Climate Change Assessment Criteria

Proposed Development

River Basin District	Thames River Basin
Management Catchment	Colne Management Catchment
Flood Zone	1
Flood Risk Vulnerability	A Variety of Classifications depending on the Development; 'Essential Infrastructure'; 'Highly Vulnerable', 'More Vulnerable' and "Less Vulnerable'
Lifetime of Development	65 years (Civil & Structural Elements)
Climate Change Allowance	21% CC

3.4 Peak Rainfall Intensity Allowances for the Proposed Development

The predicted increase in the frequency and intensity of storm events could increase the volumes of rainfall to enter the surface water and foul drainage network. **Table 3-3** shows the anticipated changes in peak rainfall intensity in small catchments less than 5 km².

Table 3-3 - Peak Rainfall Allowances for the Proposed Development

Applies across all of England	Total Potential Change Anticipated for '2020s' (2015 to 2039)	Total Potential Change Anticipated for '2050s' (2040 to 2069)	Total Potential Change Anticipated for '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

Current guidance provided by the EA indicates that the receiving drainage network should be able to accommodate up to the 1 in 100 year plus 40 % CC event. The proposed drainage system is designed to accommodate this event, therefore despite the anticipated increase in rainfall intensity, climate change will unlikely increase the risk of flooding to the Proposed Development.

4. Assessment of Flood Risk

This section of the report considers the potential risks posed to the Proposed Development from all sources of flooding. Appropriate mitigation measures to offset flood risk have been outlined where necessary.

4.1 Flood Risk from Main Rivers

Fluvial flooding occurs when the capacity of a river is exceeded either due to high flows from the catchment draining into the river or a combination of high flows and high tides which causes the river to overflow or overtop the banks.

Following a review of aerial imagery and OS mapping, the nearest EA Main River to the Proposed Development is the River Pinn which is located approximately 450 m west of the Proposed Development; refer to **Figure 4-1.**

The River Pinn Main River is considered to originate approximately 10.5 km north east of the Proposed Development, where the river flows in a south westerly direction before converging to the Frays Main River approximately 1.4 km downstream. A review of the EA FMfP suggests that the Proposed Development lies outside of the predicted extent of flooding from the River Pinn and is located within Flood Zone 1 which is land defined as having a less than 1 in 1,000 greater annual probability of river or sea flooding (>0.1% AEP) in any year. In addition, there are no likely plausible flow routes between the Main River and the Proposed Development given the River Pinn is located at a lower elevation of approximately 30 m AOD, compared to the Proposed Development site at approximately 38 m AOD.

As the site lies outside of the predicted extent of flooding from Main Rivers, the Proposed Development is considered to be at low risk of flooding from Main Rivers and therefore no mitigation is required.

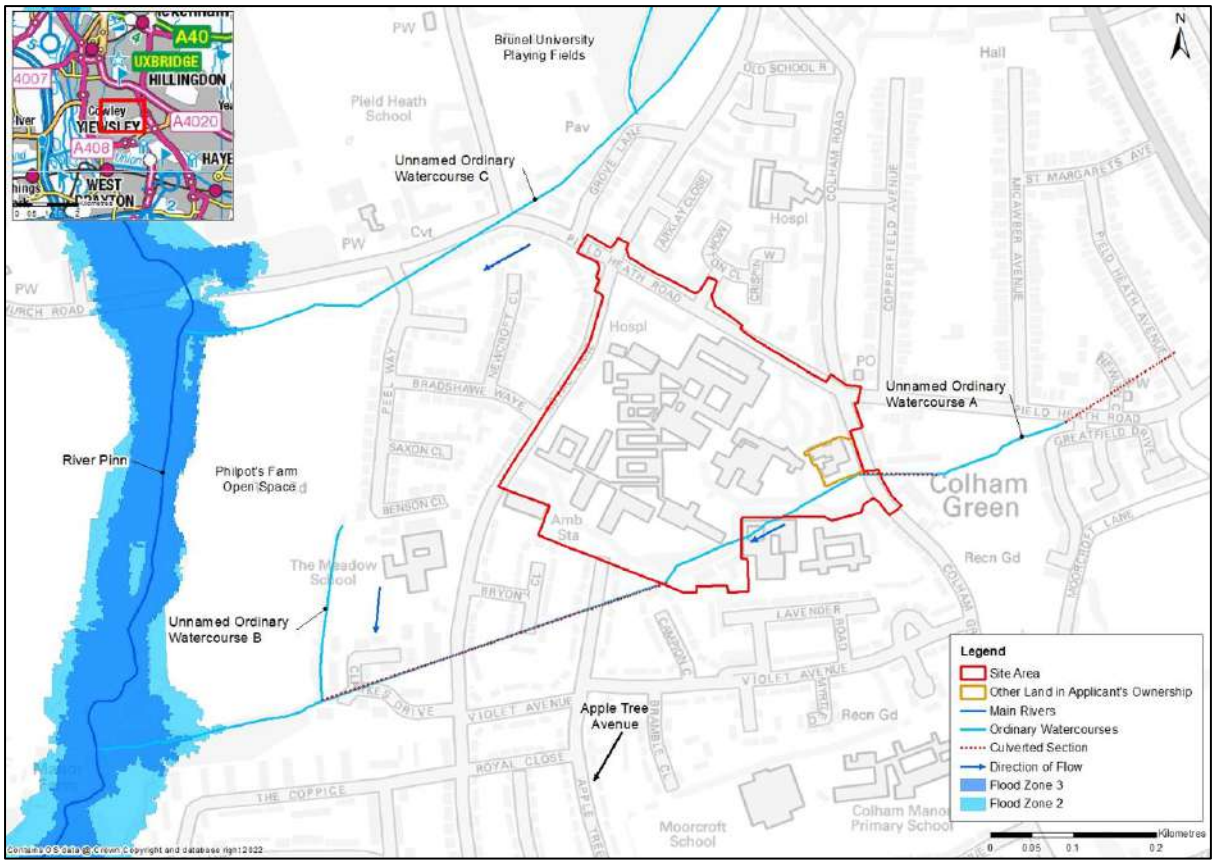

Figure 4-1 - Environment Agency Flood Map for Planning

4.2 Flood Risk from Ordinary Watercourses and Land Drainage Systems

Ordinary watercourses include every river, stream, brook, cut, dike/dyke, sluice which do not form part of a Main River network. Internal Drainage Boards (IDB) or LLFAs have lead responsibility for managing the risk of flooding from Ordinary Watercourses. Given there are no IDBs within the vicinity of the London Borough of Hillingdon, the responsibility for Ordinary Watercourses lies with the LLFA.

Following a review of OS mapping and aerial imagery, there are three Ordinary Watercourses located within close proximity to the Proposed Development, shown in **Figure 4-1**. Given these Ordinary Watercourses are unnamed, for the purposes of this FRA they have been named A, B and C.

- Unnamed Ordinary Watercourse A – The Ordinary Watercourse flows through the northern boundary of Colham Green recreational park before becoming culverted beneath Colham Green Road and reaching open channel within the eastern boundary of Hillingdon Hospital immediately south of the Grade II Furze building. The Ordinary Watercourse remains open channel throughout the site, with the exception of culverted sections beneath the southern access road. A culverted section of approximately 474 m immediately south of Hillingdon Hospital site boundary conveys the Ordinary Watercourse in a south westerly direction, before the convergence of unnamed Ordinary Watercourse B. Unnamed Ordinary Watercourse A continues in a westerly direction before discharging to the River Pinn Main River.
- Unnamed Ordinary Watercourse B – The Ordinary Watercourse is situated approximately 0.42 km south west of the Proposed Development site at the eastern boundary of Philpot's farm Open Space where the watercourse flows in a southerly direction before discharging to unnamed Ordinary Watercourse A.
- Unnamed Ordinary Watercourse C – The Ordinary Watercourse originates from Brunel University and is situated approximately 0.14 km north of the Proposed Development site. The watercourse flows in a south westerly direction before discharging to the River Pinn in the west.

As these unnamed Ordinary Watercourses are not classified as Main Rivers, no mapping showing the predicted extent of flooding is available from the EA or LLFA. For the purposes of this study, a 1D-2D Hydraulic Model has been built for the unnamed Ordinary Watercourses A and B. As such, the outputs of this hydraulic modelling study will inform the fluvial flood risk posed to the Proposed Development. Unnamed Ordinary Watercourse C has not formed part of the scope for the hydraulic modelling exercise however it is possible to use the EA Risk of Flooding from Surface Water (RoFfSW) map as a proxy to understand the risk of flooding (**Figure 4-32**). This is further described in **Section 4.2.3.**

4.2.1 Baseline Hydraulic Modelling Outputs – Unnamed Ordinary Watercourse A

A 1D – 2D linked hydraulic model has been built for both unnamed Ordinary Watercourses A and B to understand the fluvial risk posed to the Proposed Development up to and including the 1 in 100 year plus 21% CC event. In the baseline scenario, flooding can be observed on site in all flood events, including the 1 in 5 year (20% AEP) (**Figure 4-2**), from unnamed Ordinary Watercourse A.

Fluvial flood risk associated from unnamed Ordinary Watercourse A originates in the open channel section immediately south of the Grade II Furze where flows exceed the channel capacity and spills over the right channel bank allowing flood water to flow across the south western section of the hospital site. Flows are conveyed along the existing southern access road flowing west and then south towards Ordinary Watercourse A along the southern site boundary. An overland flow route continues outside of the site boundary alongside residential areas including Apple Tree Avenue.

LBH provided historical flood records within the vicinity of Hillingdon Hospital in September 2021 where records show in 2018, two residential properties were flooded along Apple Tree Avenue which may have been exacerbated by the blockage of culverts. These records help ground truth the hydraulic model baseline scenario which estimates these flood extents are associated from the 1 in 5 year return period.

In the 1 in 20 year event and the 1 in 100 year plus 21% CC event (**Figure 4-3** and **Figure 4-4**), flows begin to surcharge at the culvert inlet in Colham Green recreational park. Whilst the recreational green space begins to flood, a flow route bypasses the culvert headwall and flows in a westerly direction across Colham Green Road and onto the Hillingdon Hospital site, further contributing to existing flood extents. The progression of the flood

mechanisms on site in the baseline scenario for the 1 in 100 year event plus 21% CC is shown in **Appendix E** by using relevant timesteps from the hydraulic model.

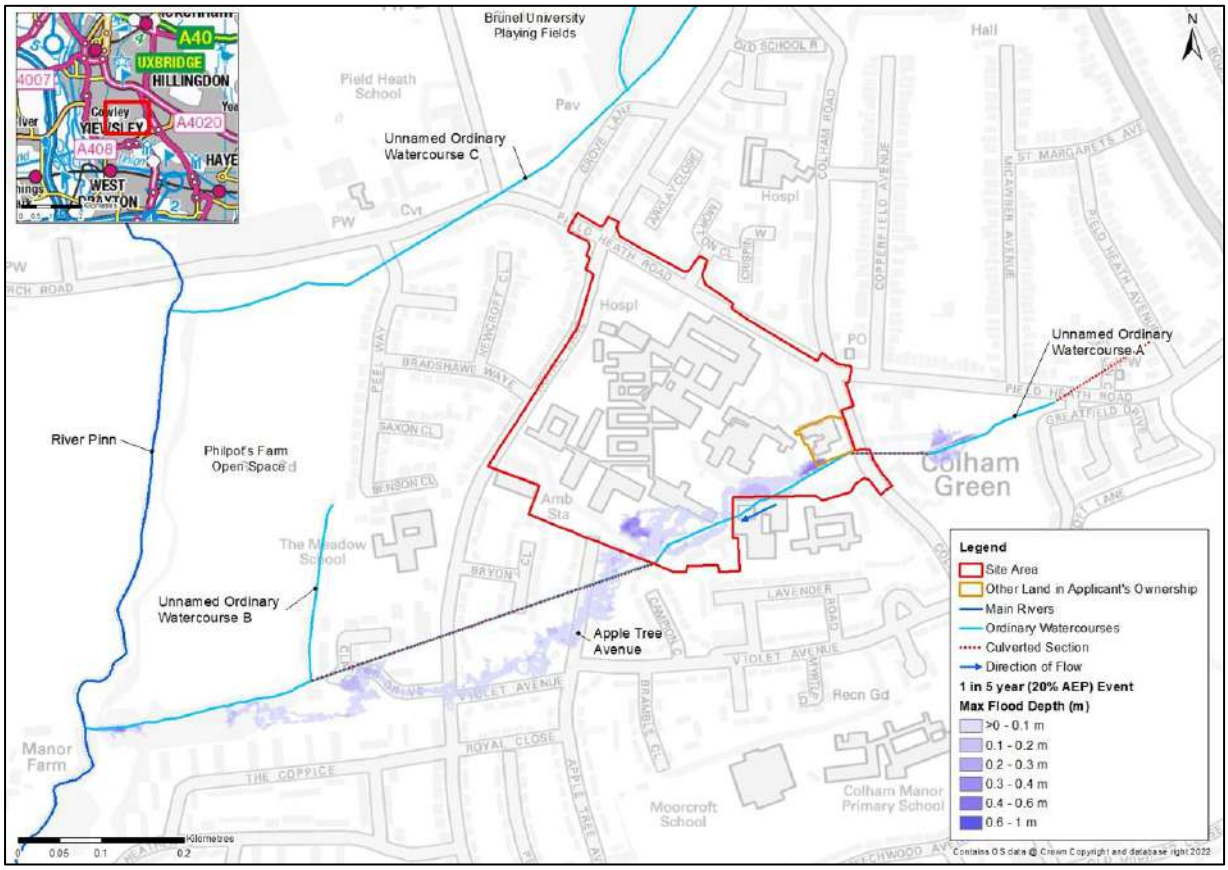

Figure 4-2 - 1 in 5 year (20% AEP) Baseline Flood Depth Extent

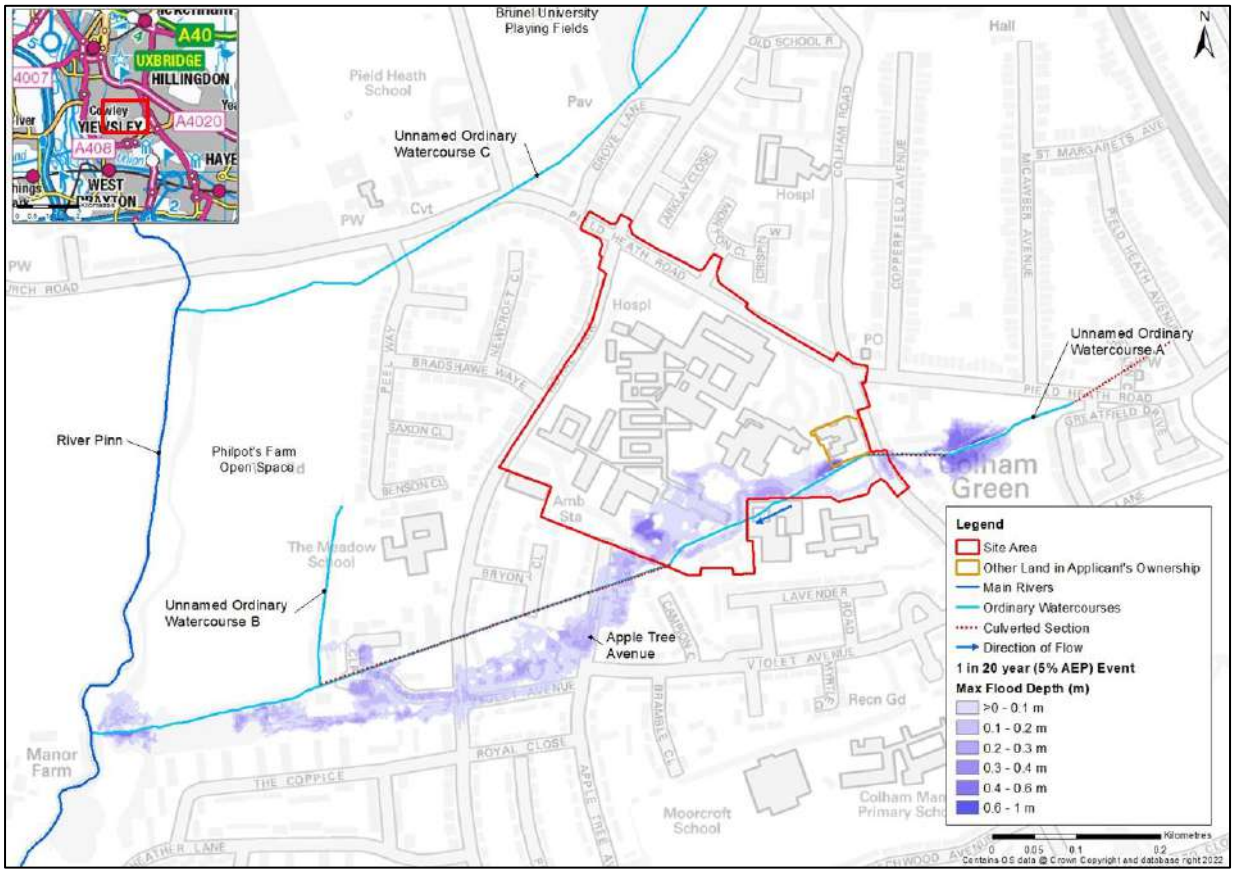

Figure 4-3 – 1 in 20 year (5% AEP) Baseline Flood Depth Extent

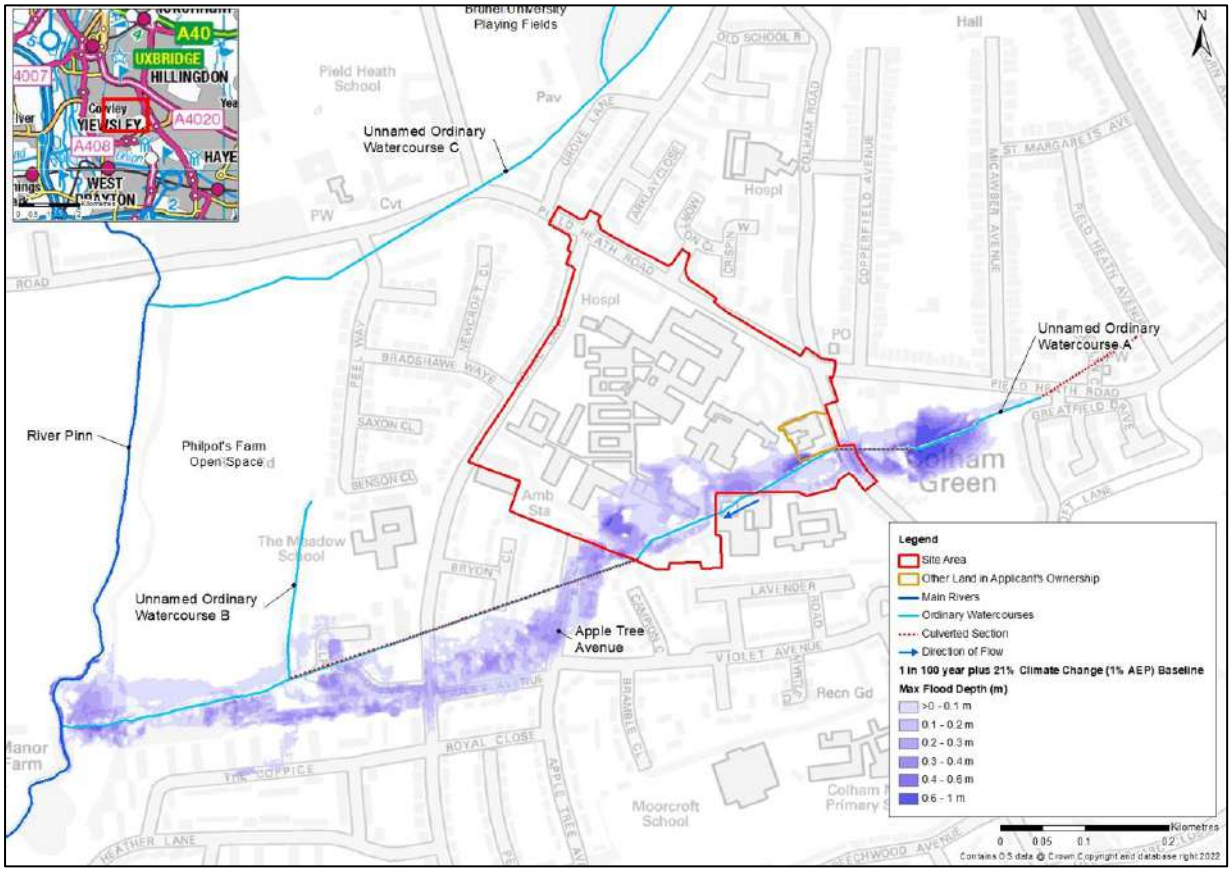

Figure 4-4 – 1 in 100 year + 21% CC Baseline Flood Depth Extent

Flood Hazard Mapped Outputs have also informed the FRA using guidance in the Flood Risks to Peoples FD23211[16] document where the depth and velocity of flood water has been determined to calculate a flood hazard rating. For the purposes of flood mapping, a flood hazard rating is calculated according to an equation as shown below:

Flood Hazard Rating = Depth * (Velocity + 0.5) + Debris Factor

Where depths are lower than 0.25 m, a Debris Factor of 0.5 has been applied. Where depths are greater than 0.25 m, a Debris Factor of 1 has been applied. ***Table 4-1*** shows the representation of the Flood Hazard Maps used within the FRA.

Table 4-1 - Flood Hazard Rating

Flood Hazard Rating	Hazard to People	Warning
Low Hazard	< 0.75	Caution
Moderate Hazard	0.75 – 1.25	Danger to Some
Significant Hazard	1.25 – 2.5	Danger to Most
Extreme Hazard	> 2.5	Danger to All

A Flood Hazard Map for the baseline 1 in 100 year plus 21% CC event is shown in **Figure 4-5**, which has used the above methodology. Whilst most of the site is considered a 'Low Hazard', localised areas where the hazard rating increases to 'Danger to Most' can be observed. Given the existing fluvial flood risk associated from this watercourse is shown to encroach upon the boundary of Hillingdon Hospital, the FRA will assess the location and vulnerability of the Proposed Development for both phases to ensure policy compliance and the development is safe throughout its lifetime. The fluvial flood risk posed to the Proposed Development from

[16] Flood Risks to Peoples FD23211[16] guidance. Accessed: https://assets.publishing.service.gov.uk/media/602bbc3de90e07055f646148/Flood_risks_to_people_-_Phase_2_Guidance_Document_Technical_report.pdf Retrieved on 19th April 2022.

unnamed Ordinary Watercourse A is considered **moderate**, as such **mitigation is required**. This is described in further detail in **Section 4.3.**

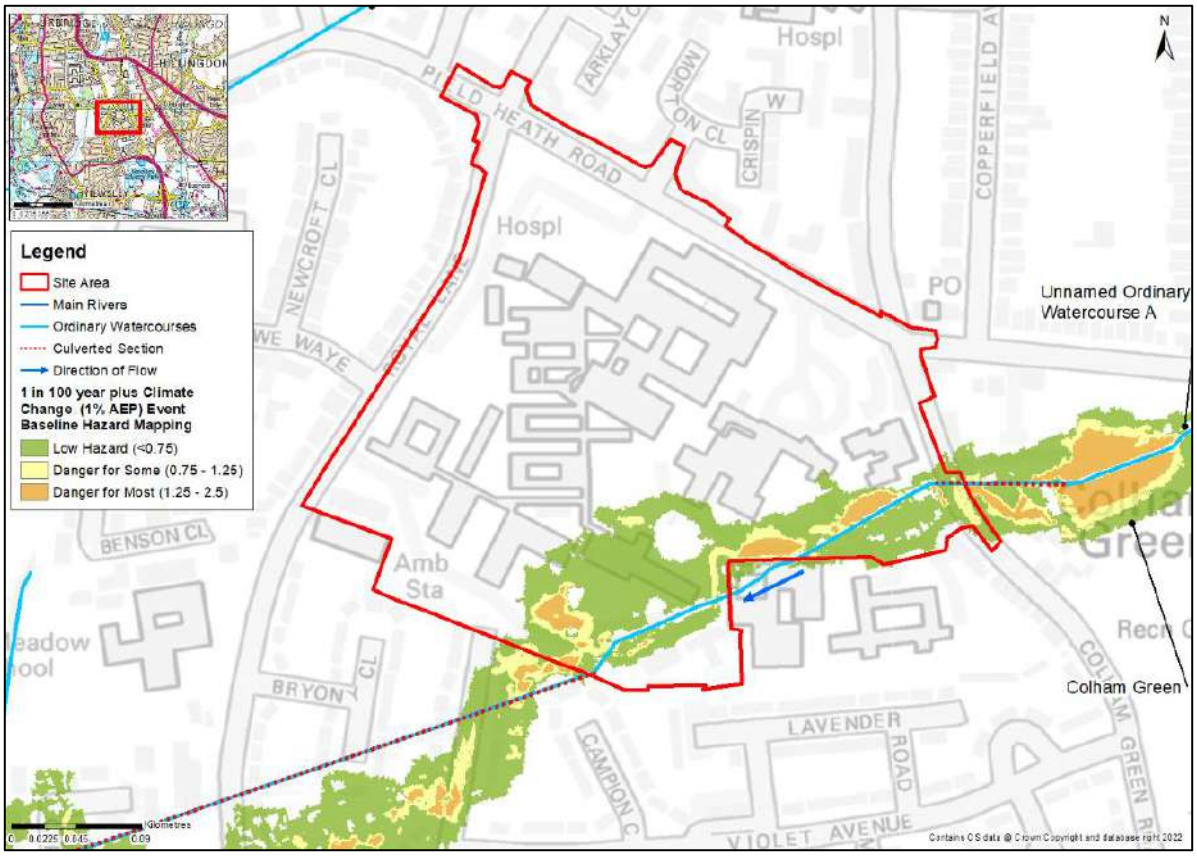

Figure 4-5 – Flood Hazard Map – 1 in 100 year + 21% CC Baseline Event

4.2.2 Baseline Hydraulic Modelling Outputs – Unnamed Ordinary Watercourse B

The baseline scenarios for the smaller return periods including the 1 in 20 year event show that flows remain in channel for the unnamed Ordinary Watercourse B, see **Figure 4-3**. In the larger return periods, including the 1 in 100 year plus 21% CC event, out of bank flooding is shown at the downstream extent of unnamed Ordinary Watercourse B, however this is largely to surrounding fields namely Philpot's Open Farm Land owned by Brunel University **(Figure 4-4).** Given the gentle fall in gradient towards the River Pinn in the west, exceedance flows are shown to flow away from the Proposed Development.

As such, the fluvial flood risk posed from unnamed Ordinary Watercourse B to the Proposed Development is considered **low** and no mitigation is required.

4.2.3 Baseline Fluvial Flood Risk – Unnamed Ordinary Watercourse C

Given unnamed Ordinary Watercourse C has not formed part of the hydraulic modelling exercise, the RoFfSW dataset has been used as a proxy to assess the fluvial risk posed from this watercourse to the Proposed Development. The EA RoFfSW dataset (**Figure 4-32**) predicts a prominent surface water flow path in the 1 in 100 and 1 in 1000 year event along this watercourse, specifically where the watercourse traverses through Brunel University playing Fields. Where the watercourse is assumed to be culverted beneath Pield Heath Road, surface water flooding in all the flood events up to the 1 in 1000 year event are shown to flow along Pield Heath Road, away from the Proposed Development site, towards the River Pinn as opposed to falling back into the downstream extent of the watercourse. Given the fall in topography along Pield Heath Road in the west and the heavily urbanised area likely to impede surface water flow paths, there are no likely plausible flow routes from exceedance flows associated from unnamed Ordinary Watercourse C to the Proposed Development.

As such, the fluvial flood risk associated from unnamed Ordinary Watercourse C is considered **low** and no mitigation is required.

4.3 Proposed Scenario – Unnamed Ordinary Watercourse A

To demonstrate the Proposed Development for Phase 1 is compliant with planning policy and safe throughout its lifetime from a flood risk perspective, the hydraulic modelling study has assessed the proposed scenario. This includes the new hospital ward to the west and extension of two existing culverts beneath the southern access road which maintains the same cross-sectional area. The location of these culverts is shown in **Appendix D.** The hydraulic model has also incorporated the proposed restricted surface water drainage discharge rates to the unnamed Ordinary Watercourse A. Please note, at the time of undertaking the hydraulic modelling, brownfield rates with 80% betterment were used in the model. As such a total catchment contribution at a rate of 67.05 l/s has been used. The Drainage Strategy has since been updated with a restricted greenfield discharge rate for the total catchment of 22.94 l/s. This assessment is therefore considered conservative.

Figure 4-6 shows that the proposed hospital facility is situated outside of the flood extents for the 1 in 100 year plus 21% CC event. The flood extent does come in close proximity to the hospital entrance, although maximum depths at this location are only predicted to be 0.05 m.

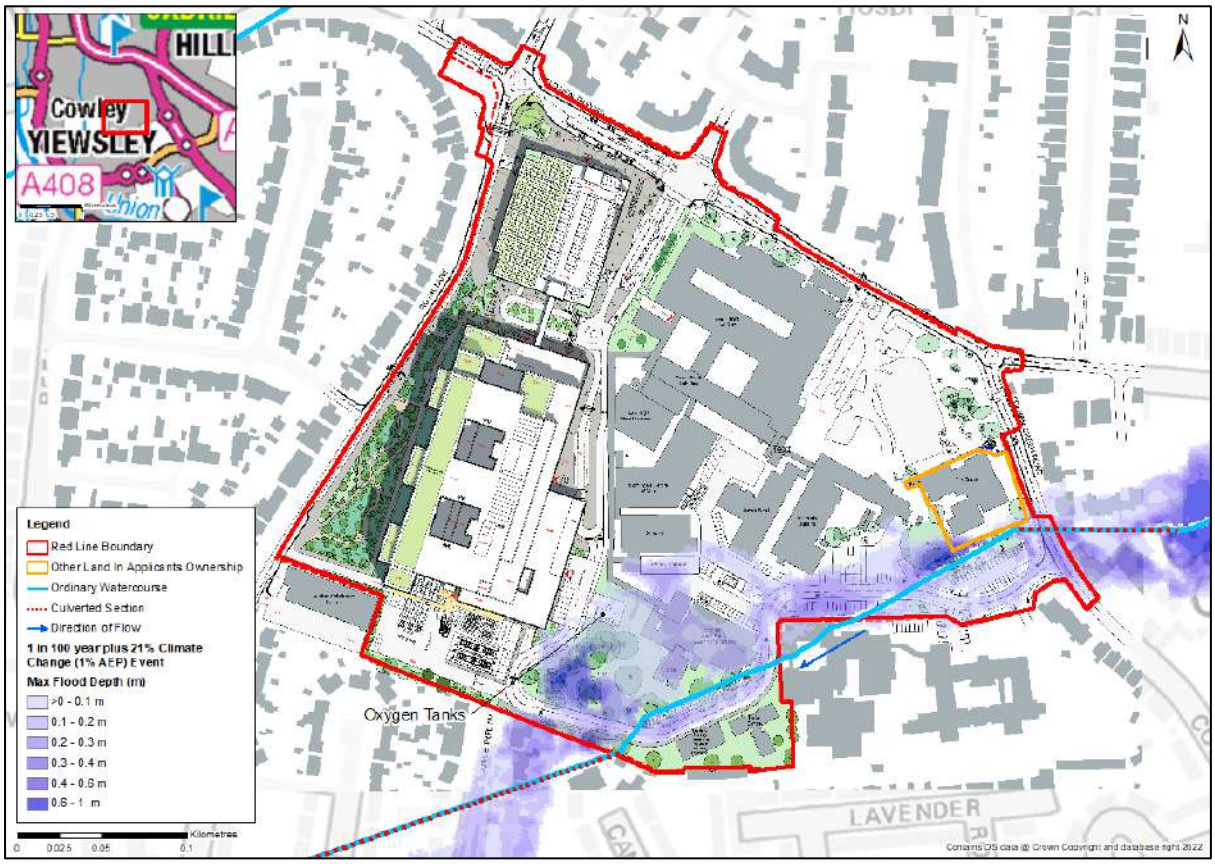

Figure 4-6 - 1 in 100 year + 21% CC Proposed Flood Depth Extent Without Mitigation on Phase 1a and 1b

The location of oxygen tanks is vulnerable to water ingress in the 1 in 100 year plus 21% CC flood extent. Given the importance of these assets and the need to remain dry during a flood event is fundamental, therefore **mitigation measures are required**. These will be discussed in **Section 4.3.1.**

The existing southern access road is identified to flood in the return periods up to and including the 1 in 100 year plus 21% CC event. Maximum localised flood depths within the 1 in 100 year plus 21% CC event along the southern access road are shown at 0.35 m, however as shown in **Figure 4-7**, the southern access road is predominantly classified as 'Low Hazard' with some areas identified as 'Danger for Some'. The EA's guidance (FD2321) states vehicles "will stop and/or float in relatively shallow water (as low as 0.5m in depth) while emergency vehicles may survive in slightly deeper waters". Given the maximum flood depths are estimated as 0.35 m, the southern access road should remain usable with care. Flood depths in the 1 in 5 and 1 in 20 year are 0.10 m and 0.17 m respectively, as shown in **Appendix F**. To provide further resilience, alternative safe access and egress routes will be provided for emergency service vehicles from Pield Heath Road as described in **Section 4.4.3.**

Whilst the flood extents and flood depths are no greater in comparison to the baseline scenario, opportunities to reduce the risk of flooding have been explored and are discussed in **Section 4.3.1** and **Section 4.3.2.**

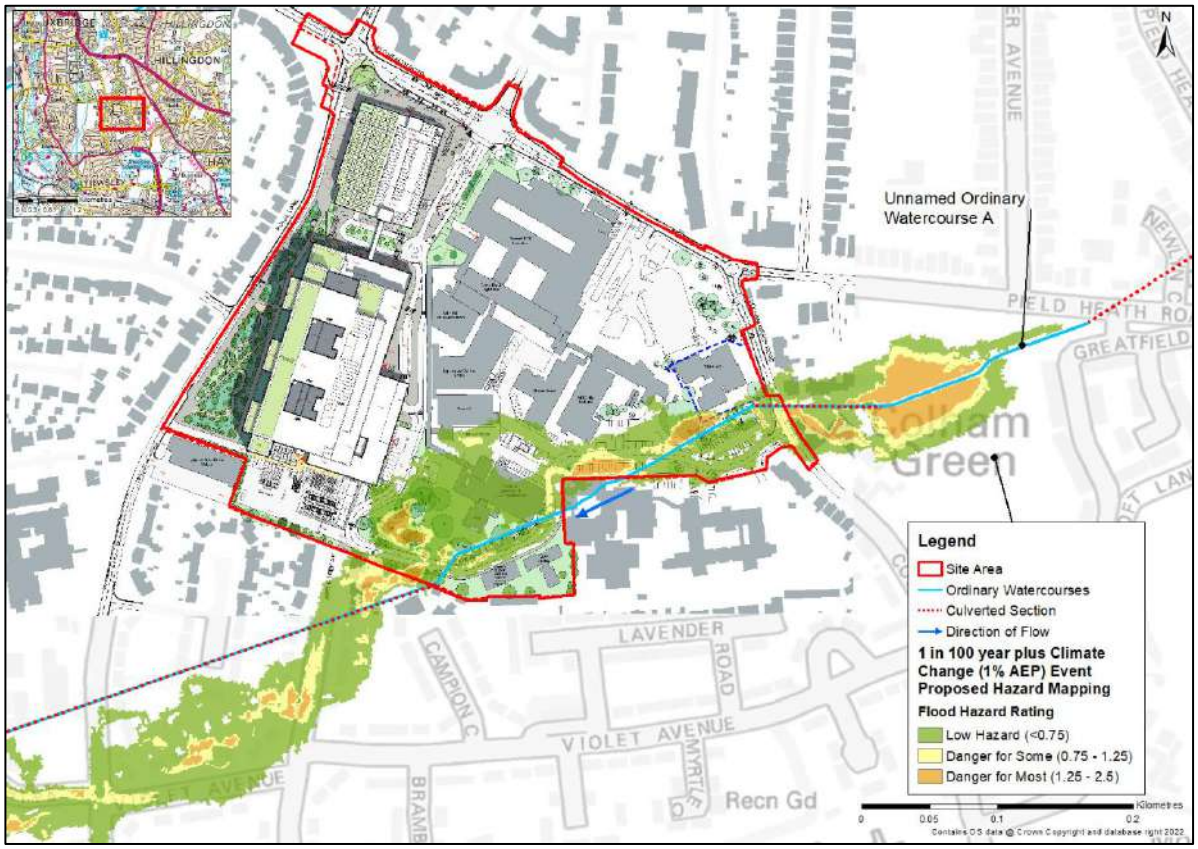

Figure 4-7 – 1 in 100 year + 21% CC Proposed Event - Flood Hazard Mapping for Phase 1a and 1b

4.3.1 Phase 1 – On-site Mitigation Measures

To minimise the fluvial flood risk posed to Phase 1 development, up to and including the 1 in 100 year plus 21% CC event, on-site mitigation measures have been explored. As a precautionary measure, a 300 mm heighted flood bund will be constructed at the south-eastern corner of the proposed hospital, adjacent to the access road for approximately 30 m. This will minimise the risk of fluvial flooding associated from the unnamed Ordinary Watercourse A.

In addition, the oxygen tanks will be raised on a 150 mm platform, approximately 36.8 m AOD, to ensure these remain dry during a 1 in 100 year plus 21% CC flood event without displacing flood extents outside the site boundary. The hydraulic modelling outputs are shown in **Figure 4-8** and is further discussed in **Section 5.2.1**. Assuming these mitigation measures are implemented, the fluvial flood risk posed to the new hospital facility is considered **low** and no further mitigation is required. The fluvial flood risk posed to the southern access road is considered **medium** although should remain usable during a flood event as discussed in **Section 4.3.** Signage advising users the road is liable to flooding is recommended. In accordance with the NPPF, an alternative access route (as shown in **Figure 4-30**) will be provided from the north at Pield Heath Road to ensure vehicular access including emergency vehicles can be achieved during an extreme flood event. Whilst this approach demonstrates the proposed Phase 1 development will be safe for its lifetime and is compliant with planning policy, additional mitigation measures could be explored to minimise the fluvial flood risk especially in the lower return periods. As part of Phase 1c, additional mitigation measures have been considered and are discussed in **Section 4.4.**

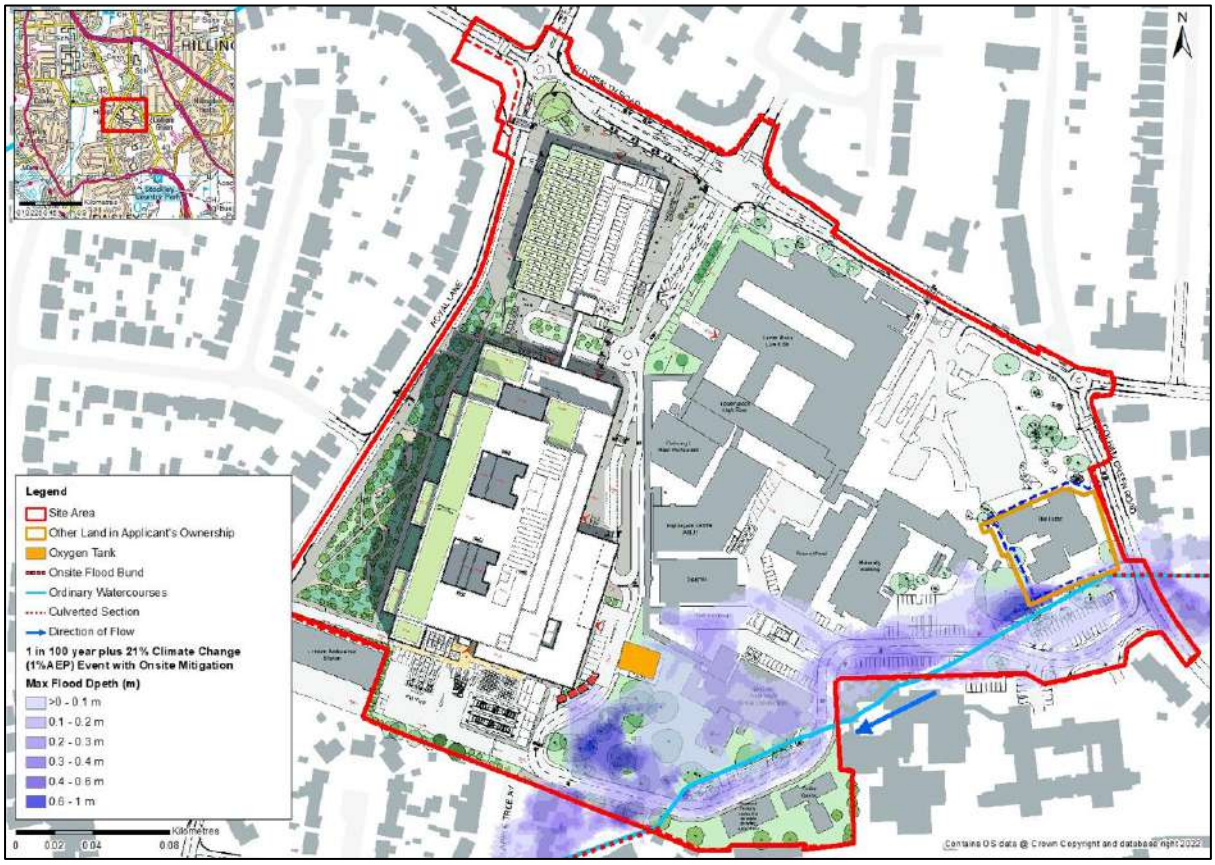

Figure 4-8 - 1 in 100 year + 21% CC Proposed Flood Depth Extent With On- Site Mitigation on Phase 1 MasterMap

4.3.2 Phase 1 – Off-site Mitigation Measures

It is recognised that opportunities to seek additional betterment where feasible, especially to alleviate flood risk along the southern access road and the neighbouring community, could be explored. As discussed with the LBH on 11th February 2022, a high-level conceptual design to explore off-site mitigation measures have been modelled up to and including the 1 in 100 year plus 21% CC event.

Numerous options and combination of options have been explored as detailed within the Hydraulic Modelling Study Report (THHR_01_ACM_ZZ_XX_RP_Y_000023). The most effective of these options includes the construction of earth bunds and upstream attenuation in Colham Green, located approximately 100 m east of the Proposed Development site.

The maximum volume of water stored within the basin in the 1 in 100 year plus 21% CC event is estimated to be 11,408m^3, with an invert level of 38.5 m and a basin depth of 1.17 m. To encourage the conveyance of exceedance flows from Ordinary Watercourse A to the storage basin, without increasing flood risk to nearby residential properties, two flood bunds are included; a 231 m length flood bund along the northern and western perimeter of Colham Green and an 81 m length flood bund along the residential properties to the east of Colham Green. Both flood bunds have been modelled at a height of 1 m to prevent overtopping.

An additional storage crate beneath an existing car park to the north of Greatfields Drive has also been modelled to attenuate upstream exceedance flows to the east of Colham Green as a result of the proposed flood bunds. The proposed below-ground storage crates have a depth of 0.5 m and an approximate flood volume of 213 m^3 to provide attenuation during the 1 in 100 year plus 21% CC event. The high-level schematic of this option is shown in **Figure 4-9.** Please note, the basic principles and constraints have been investigated as part of this hydraulic modelling study, however a detailed design, feasibility assessment and updated hydraulic modelling would be required to take this forward.

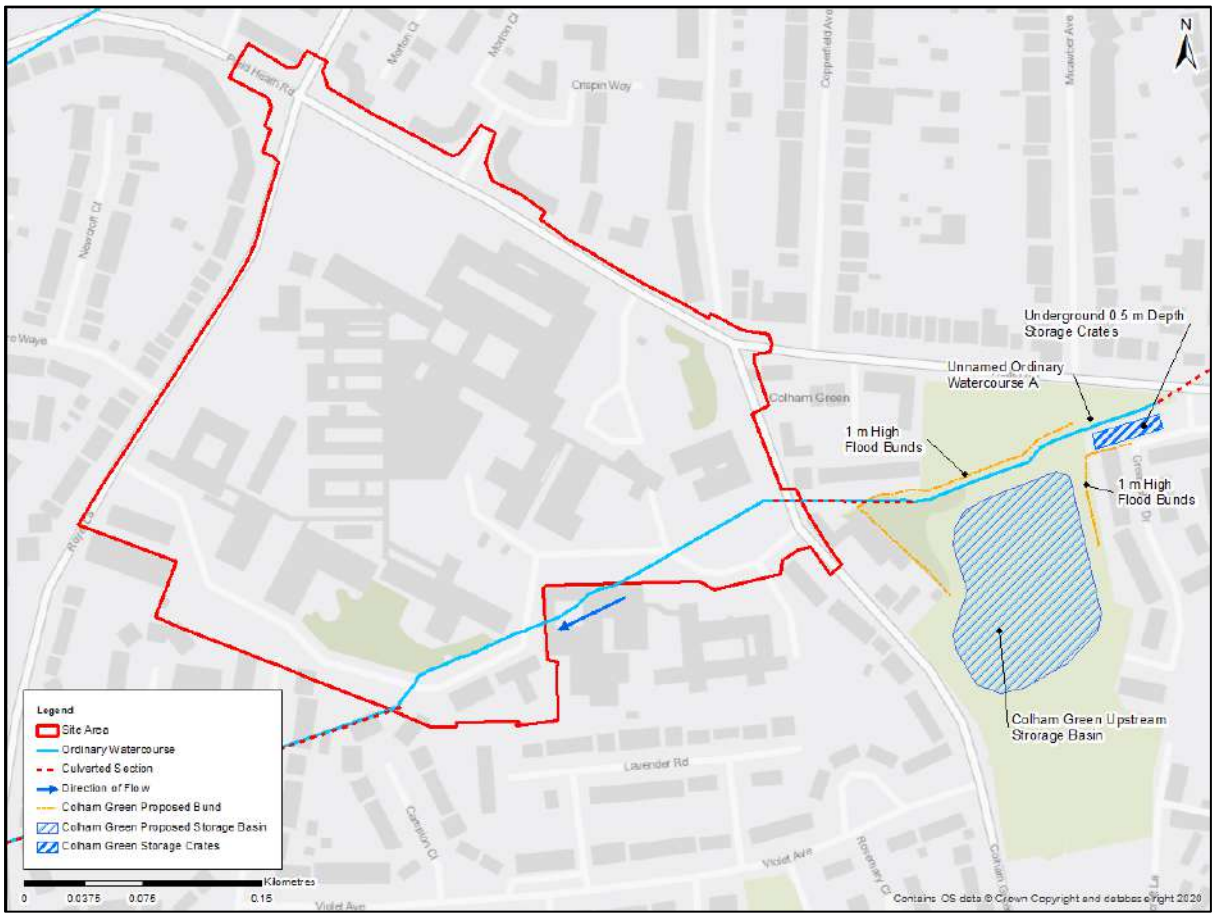

Figure 4-9 - Phase 1 Off-site Mitigation Measures Schematic Plan

Results show that the off-site mitigation measures provide a betterment to flood risk, especially in the lower return periods including the 1 in 5 year event. As shown in **Figure 4-10**, the flood extents along the southern access road are reduced by 0.14 m whereby most of the access road remains dry during this return period. Localised flood depths immediately south of the existing southern woodland are shown at approximately 0.02 m, similar to the baseline scenario.

However, in the larger return periods, including the 1 in 100 year plus 21% CC event, only a marginal betterment in flood depths is shown, where reduced depths of approximately 0.04 m are achieved on site. Maximum flood depths within this return period along the southern access road are shown at approximately 0.27 m, refer to **Figure 4-11**. The difference in the flood extents when comparing the 1 in 100 year plus 21% CC event baseline to the Phase 1 offsite mitigation results downstream of the Proposed Site, near Apple Tree Avenue are marginal with flood depths only reduced by approximately 0.02 m, refer to **Figure 4-12**. The flood extents near the existing allotments in Colham Green are shown to decrease with flood depths in this area reduced by 0.16 m.

Given flows already surcharge at an existing culvert in Colham Green and flood the existing recreational green space, there is limited space to attenuate additional flood volumes. The hydraulic modelling study suggests the flooding problem within the locality of the Proposed Development Site is due to catchment wide characteristics and challenges. Flood flows during the 1 in 100 year + 21% CC event are identified as 2.5 m^3/s which are difficult to manage in isolation within the Proposed Development Site locality, as demonstrated through the numerous mitigation options modelled within Colham Green. Furthermore, a large area (approx. 9750 m^2) of Colham Green would be required to facilitate the storage basin plus additional boundary alterations for the earth bunds which is likely to cause a detriment to the existing amenities.

Considering the **negligible flood risk benefit,** it is likely that an alternative catchment wide scheme would prove more effective at managing the risk of flooding holistically. Furthermore, in context of the amenity and green space detriment, a catchment wide flood risk scheme may also support a better use of the public realm and community benefits. As discussed in **Section 4.3**, the off-site mitigation measures in Colham Green are not required to demonstrate that the Proposed Development is safe for its lifetime but were explored to understand if betterment could be reasonably achieved. Results found a negligible flood risk benefit therefore the off-site mitigation measures have not been taken forward. The findings of the hydraulic modelling study were discussed with LBH during a meeting on the 18th March 2022 and it was agreed that a financial contribution towards an alternative catchment wide flood risk management scheme may be a more beneficial solution and would be secured via Section 106 agreement. The final S106 contribution and strategy will be discussed during the course of the application. Notwithstanding the commentary above regarding the preferred solution of a catchment wide flood risk management scheme, the project team is reviewing the potential costs of the scheme at Colham Green Road.

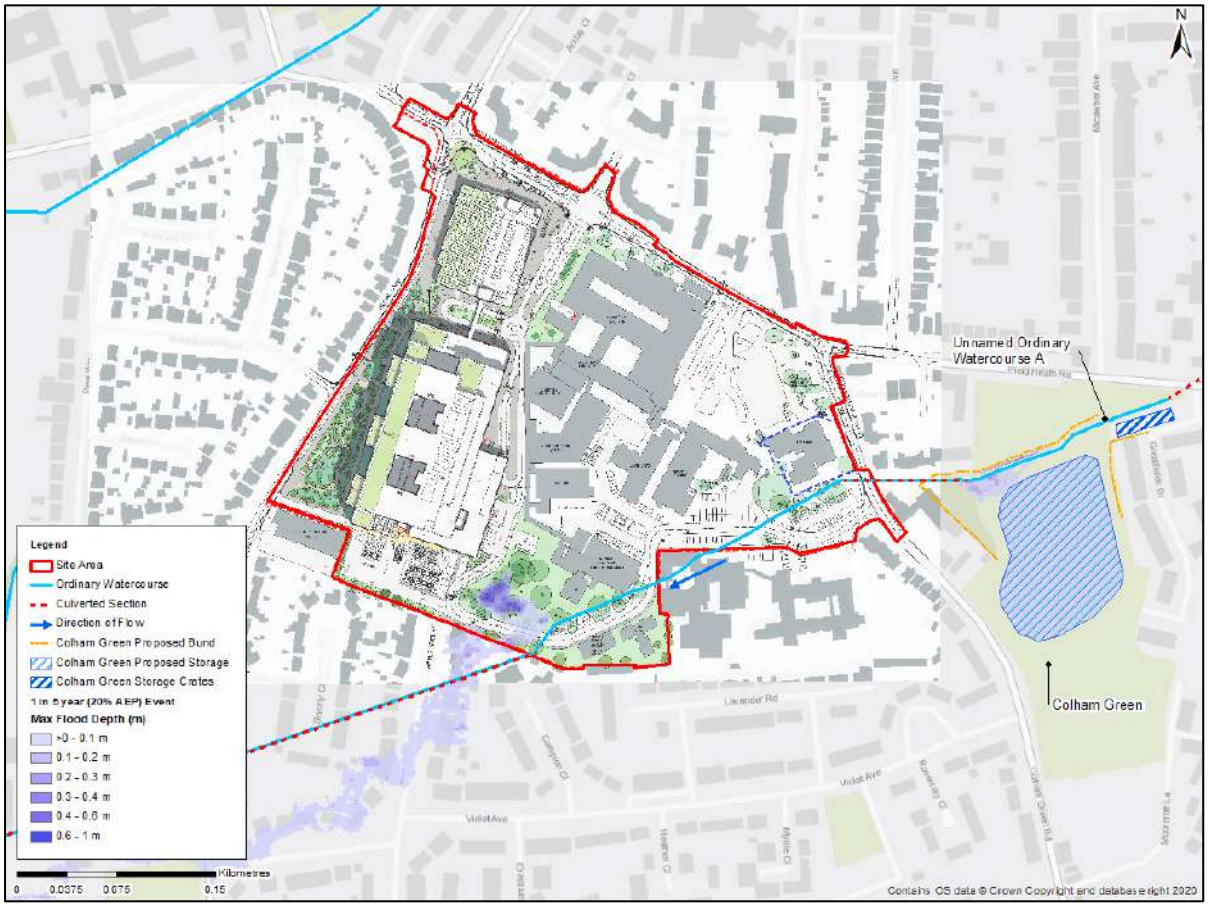

Figure 4-10 – Phase 1 Offsite Mitigation - 1 in 5 year event – Flood Extents and Depths

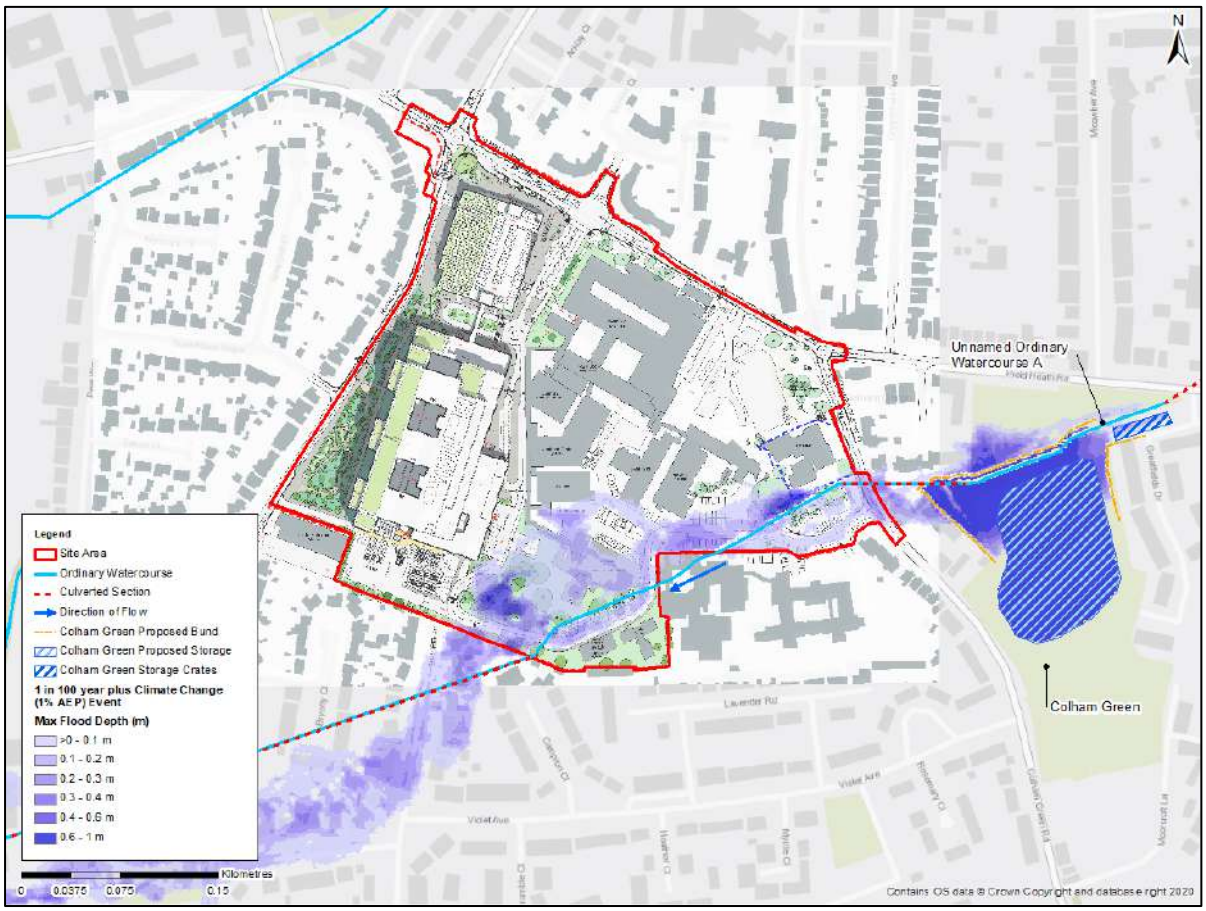

Figure 4-11 – Phase 1 Offsite Mitigation - 1 in 100 year plus 21% CC event – Flood Extents and Depths

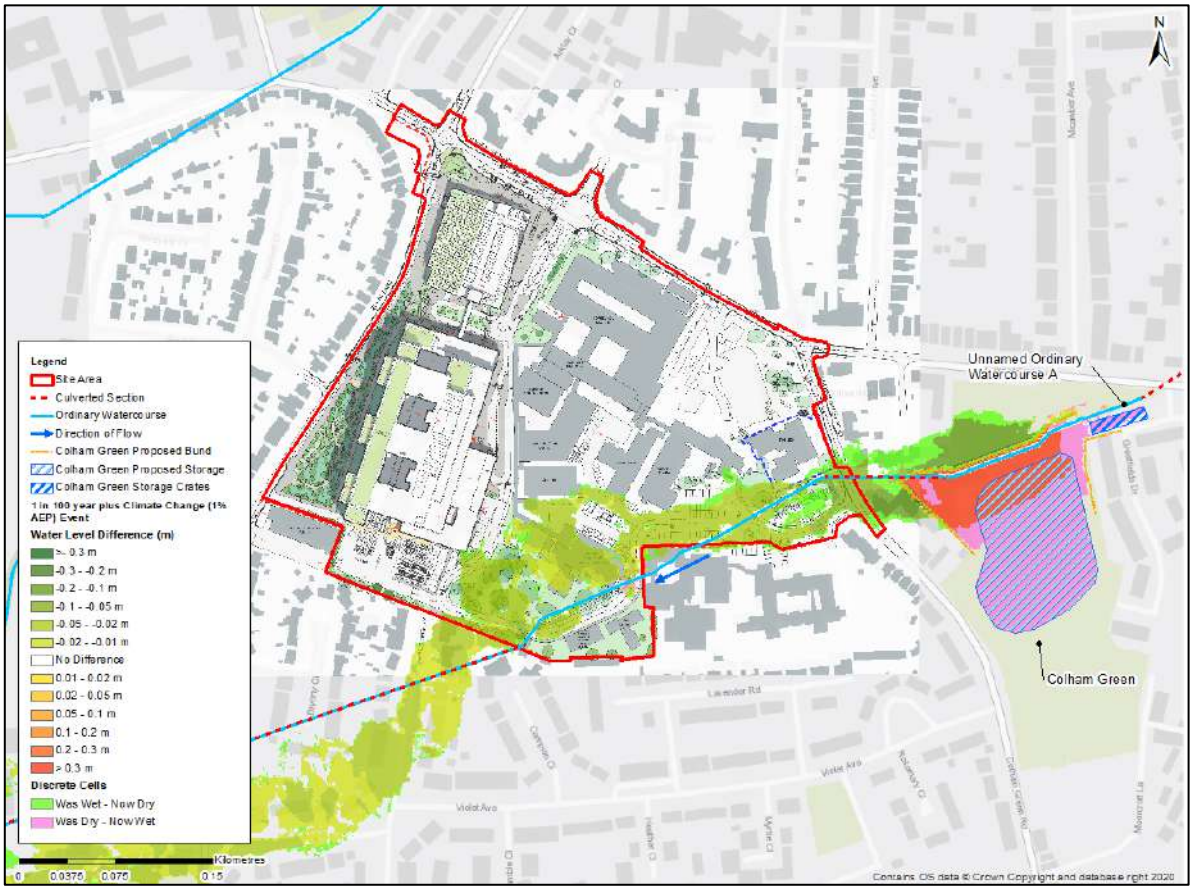

Figure 4-12 - 1 in 100 year plus 21% CC event Water Depth Difference (Phase 1 Offsite Mitigation Measures vs Baseline)

4.4 Phase 1c and Phase 2 – Proposed Scenario

Phase 1c and Phase 2 involves the decommissioning of the existing Hillingdon Hospital which unlocks more space available for the Proposed Development, including the construction of residential units and green space which could be used for flood risk mitigation.

To ensure the Proposed Development for Phase 1c and Phase 2 is safe throughout its lifetime from a flood risk perspective and provide additional betterment, the hydraulic modelling study has modelled the Proposed Development associated from these two phases in addition to the Proposed Development outlined for Phase 1. Please note, the Phase 1 offsite mitigation measures which includes an upstream storage basin in Colham Green have been excluded from the model as these do not form part of the planning application and may evolve into a catchment flood risk management scheme.

As described in **Section 4.2.1,** the risk of fluvial flooding associated from Ordinary Watercourse A, is predominately shown along the southern perimeter of the site. As such, given this is shown in close proximity to the residential area of Plot P03, the Finished Floor Levels (FFLs) must be raised by 300 mm above the 1 in 100 year plus 21% CC event to 38.213 m AOD. To minimise the fluvial flood risk to Plot P03, a 500 mm wall is also proposed along the entire southern boundary which will also form the exterior walls of undercroft parking situated on the ground floor. The wall should be dry-proofed and designed to prevent the ingress of fluvial water. To ensure the mitigation measures stipulated above are effective in minimising fluvial flood risk to the Proposed Development, the 1 in 5 year, 1 in 20 year and 1 in 100 year plus 21% CC have been simulated.

As shown in **Figure 4-13, Figure 4-14, Figure 4-15,** from the 1 in 5 year event, an overland flow route is conveyed where an existing culvert surcharges south of the Furze and flows are conveyed along the southern access road and encroaches upon the southern green open space. Whilst the flood depths in this return period along the southern access road are relatively shallow between 0.01 m to 0.11 m, the flood extents and depths increase in the 1 in 100 year plus CC event, with flood depths ranging between 0.09 m and 0.2 m along the surface car park. In comparison to the Phase 1 baseline, a marginal betterment in flood depths are observed in the 1 in 100 year

plus 21% CC event, especially in the southern green space where an average reduction in flood depths of approximately 0.02 – 0.05 m are shown, which is likely a result of the removal of Modular Building South no longer impeding flows, refer to **Figure 4-16**.

Results further show that the residential units at Plot P03 are no longer shown to flood up to and including the 1 in 100 year plus 21% CC event, although due to raising the levels and implementing a 500 mm wall along the southern perimeter, a localised area to the east of Plot P03 is shown to increase flood depths by approximately 50 mm, likely due to the displacement of flood water. The off-site impact of the Phase 2 development is described in further detail in **Section 5**. At the time of writing, this location corresponds to an entrance for undercroft parking. As such, there may be a plausible flow route to the proposed car parking at Plot P03, therefore it is recommended that flood risk mitigations are developed during the detailed design. This may include a Flood Management Plan to advise users on safe access and egress routes and flood warnings within the area.

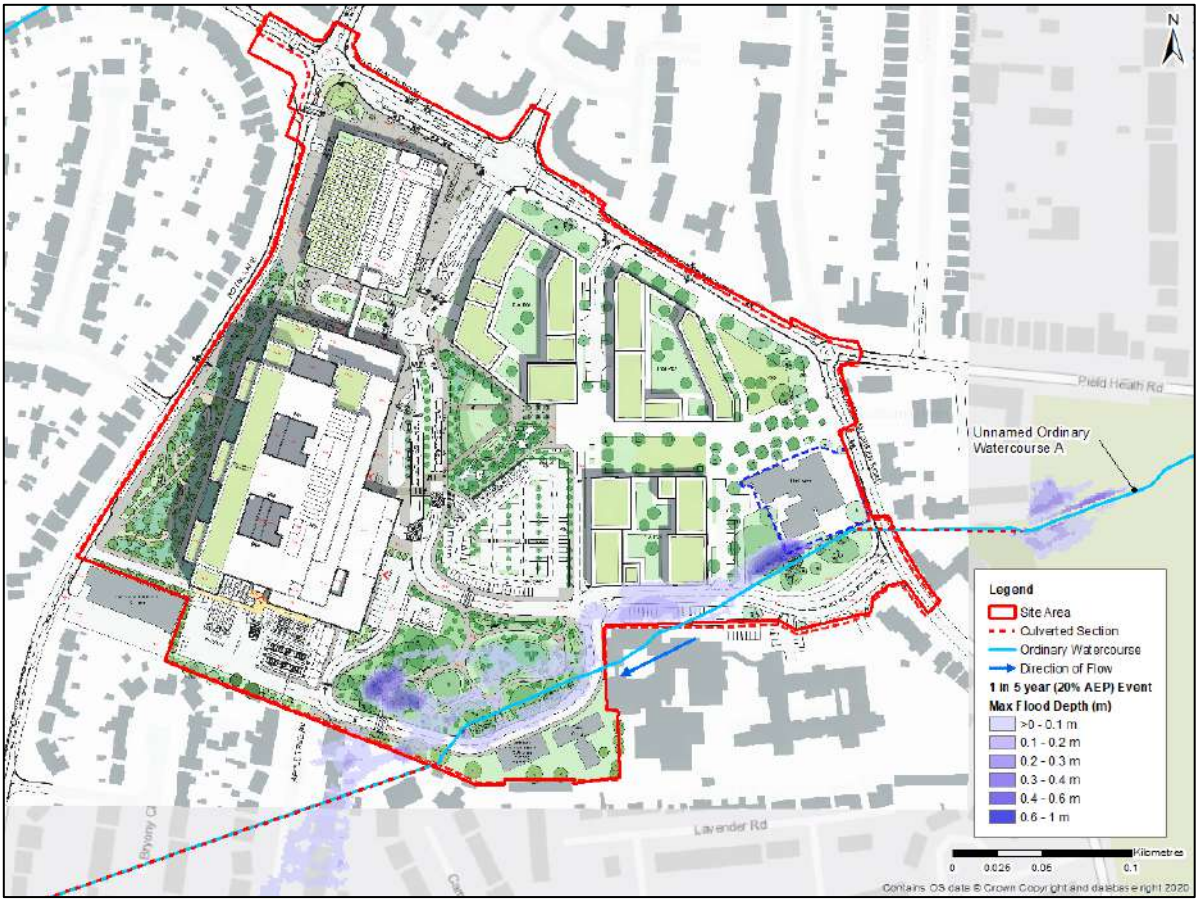

Figure 4-13 – Phase 1c and Phase 2 Flood Extents and Depths - 1 in 5 year event

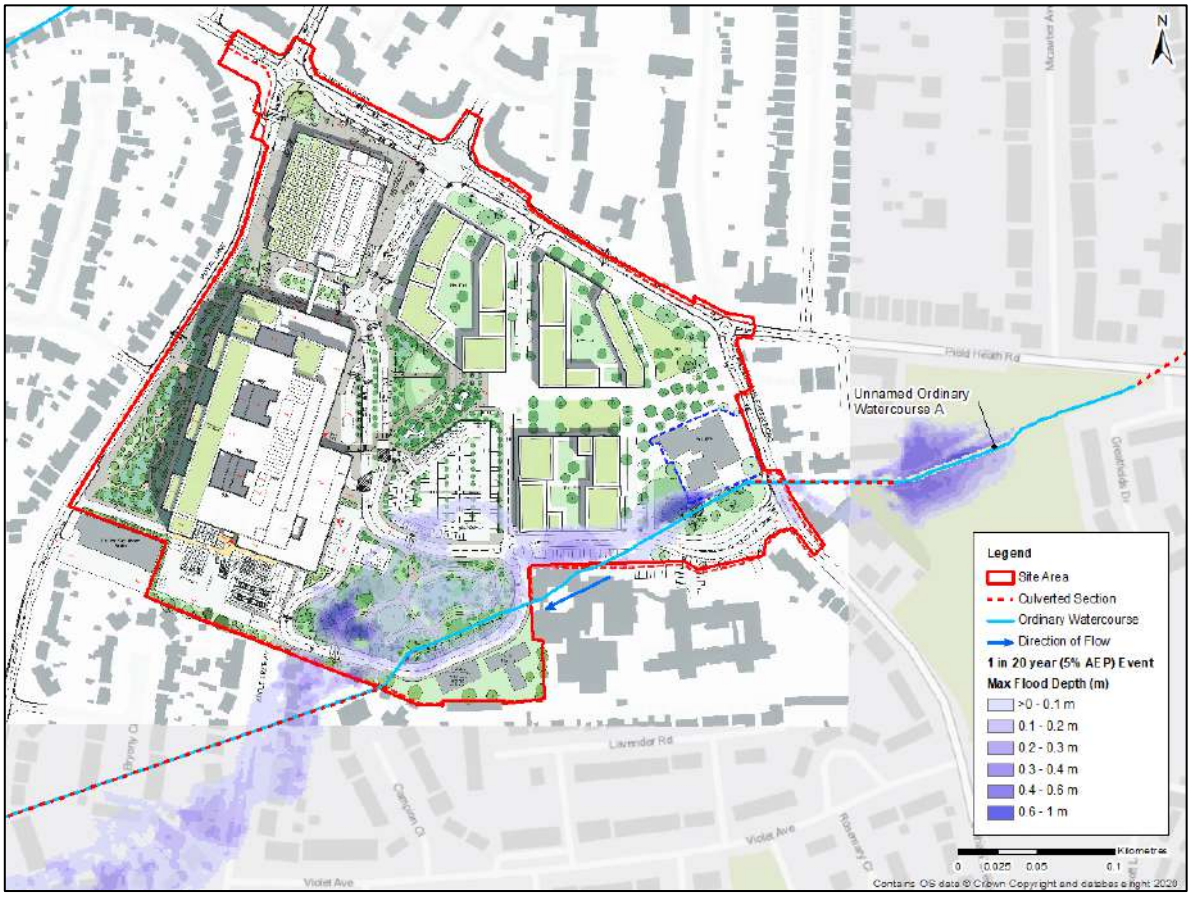

Figure 4-14 –Phase 1c and Phase 2 Flood Extents and Depths - 1 in 20 year event

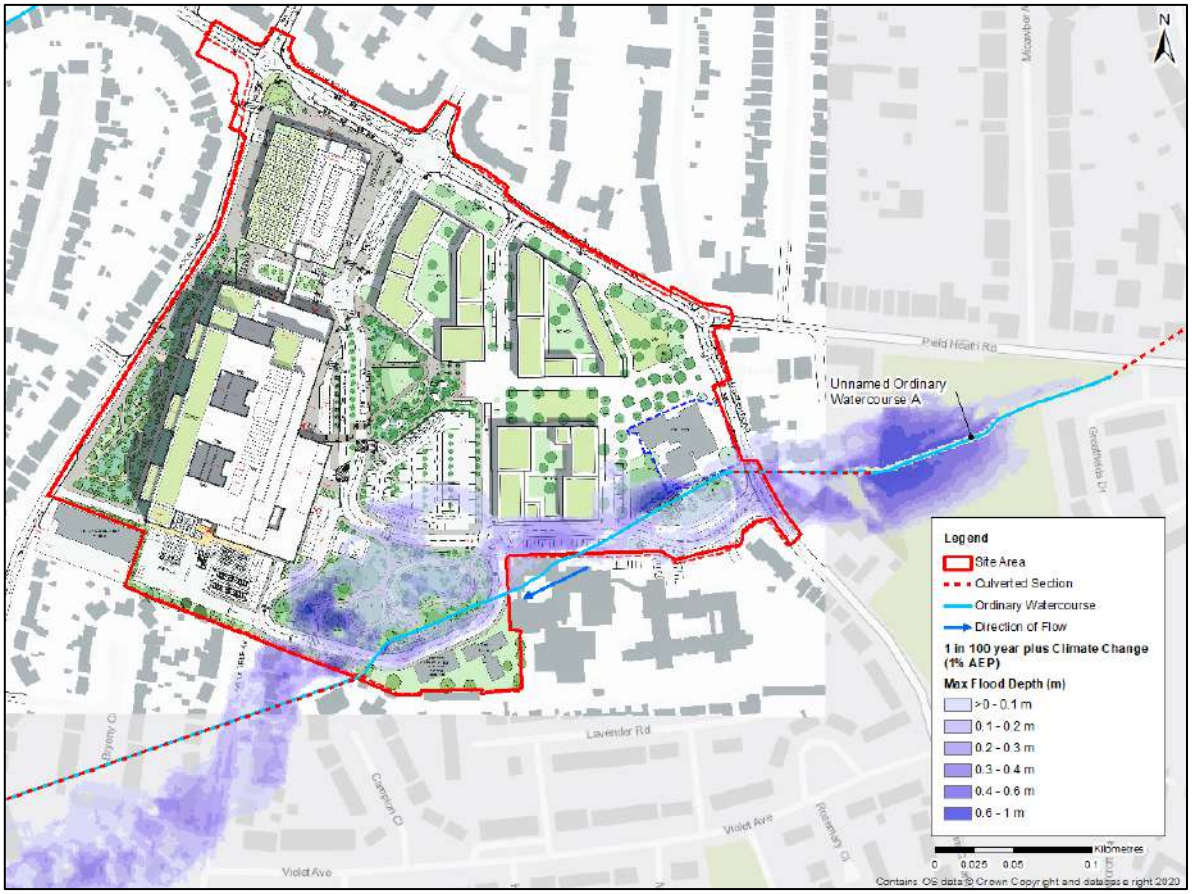

Figure 4-15 – Phase 1c and Phase 2 Flood Extents and Depths - 1 in 100 year plus 21% CC event

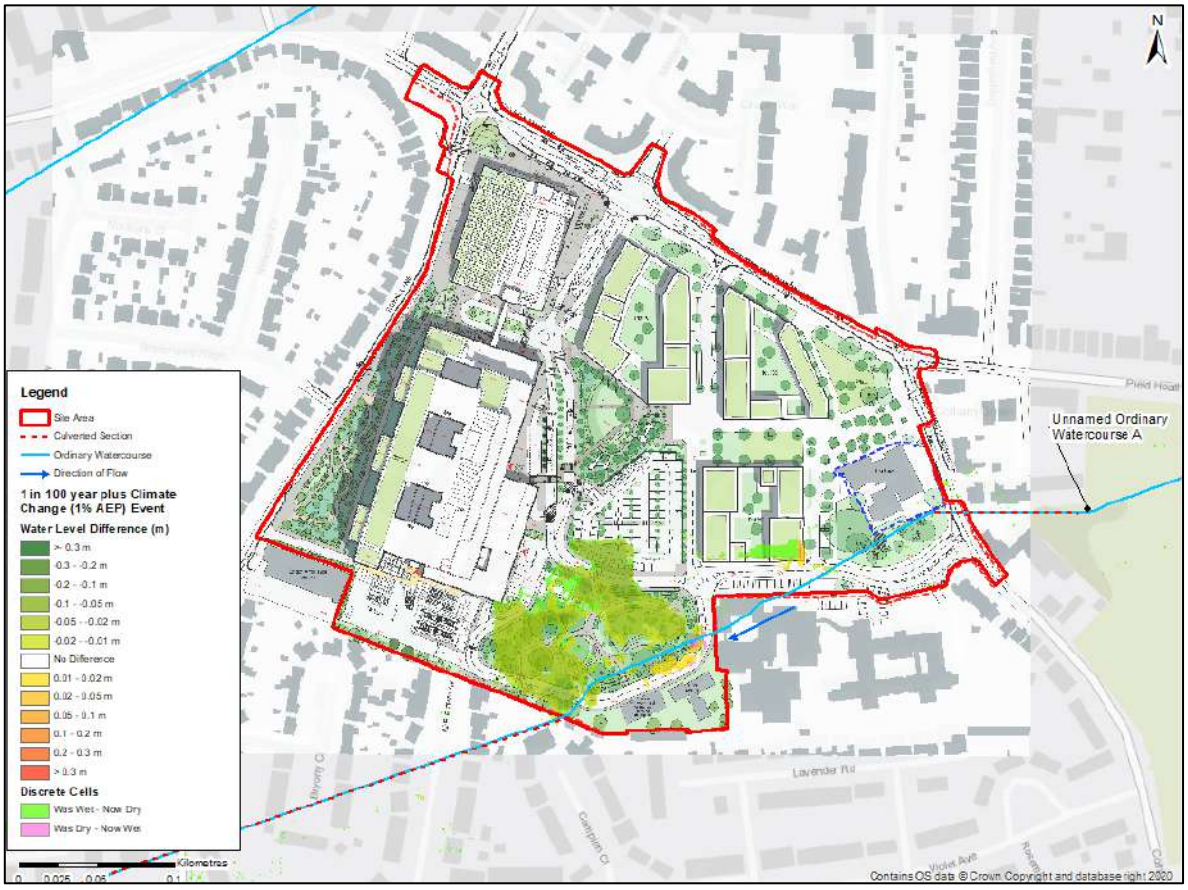

Figure 4-16 – 1 in 100 year plus 21% CC Water Level Difference Map (Phase 1c and Phase 2 Proposed Scenario vs Baseline)

Whilst Plot P03 is outside of the flood extents up to and including the 1 in 100 year plus 21% CC event, the flood extents for Phase 1c and Phase 2 are still shown to encroach upon the access road, green space and surface car park. As such, the fluvial flood risk to the Proposed Development is considered **medium**.

The Flood Hazard Map for the 1 in 100 year plus 21% CC, refer to

Figure 4-17, shows that the site is mostly classified as 'Low Hazard', however there are localised areas classified as 'Danger for Most', however this has not changed from the baseline scenario.

It is recognised where possible, **additional mitigation measures** should be explored with the objective to reduce flood extents and flood depths within the site boundary to provide additional betterment, specifically along the southern access road in the lower return periods. Two options; Options 1 and 2, have been hydraulic modelled to understand the concept and principles of whether additional on-site flood risk mitigation measures are effective in minimising fluvial flood risk on site.

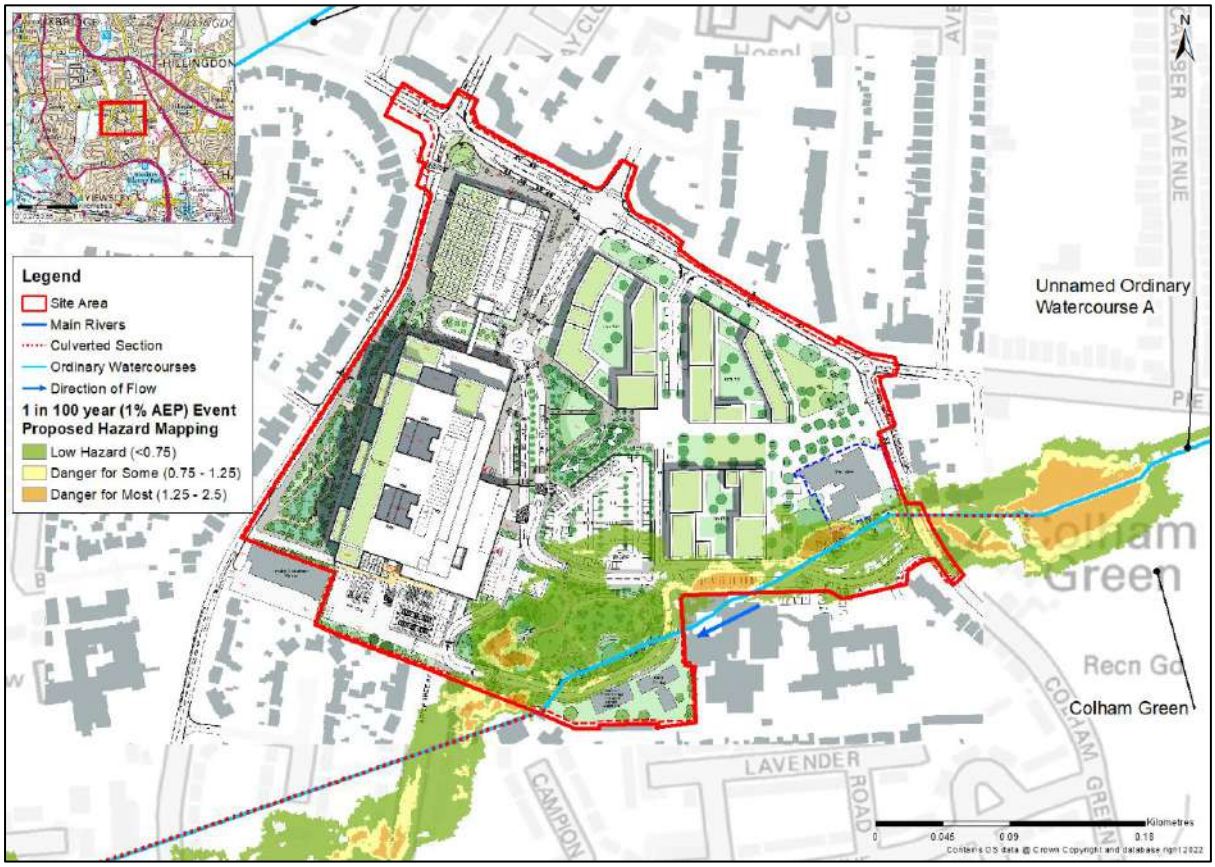

Figure 4-17 – Flood Hazard Map – Proposed Scenario Phase 1c and Phase 2 – 1 in 100 year plus 21% CC Event

4.4.1 Phase 1c and Phase 2 – Option 1 Onsite Mitigation

Option 1 includes the concept of increasing the capacity of an existing 0.9 m culvert to a 1 m diameter culvert situated immediately south of the Furze building, where the Ordinary Watercourse A is conveyed beneath the southern access road. In addition, an offtake channel to a proposed fluvial basin situated within the southern green space is also included. The concept of this option is shown in **Figure 4-18.**

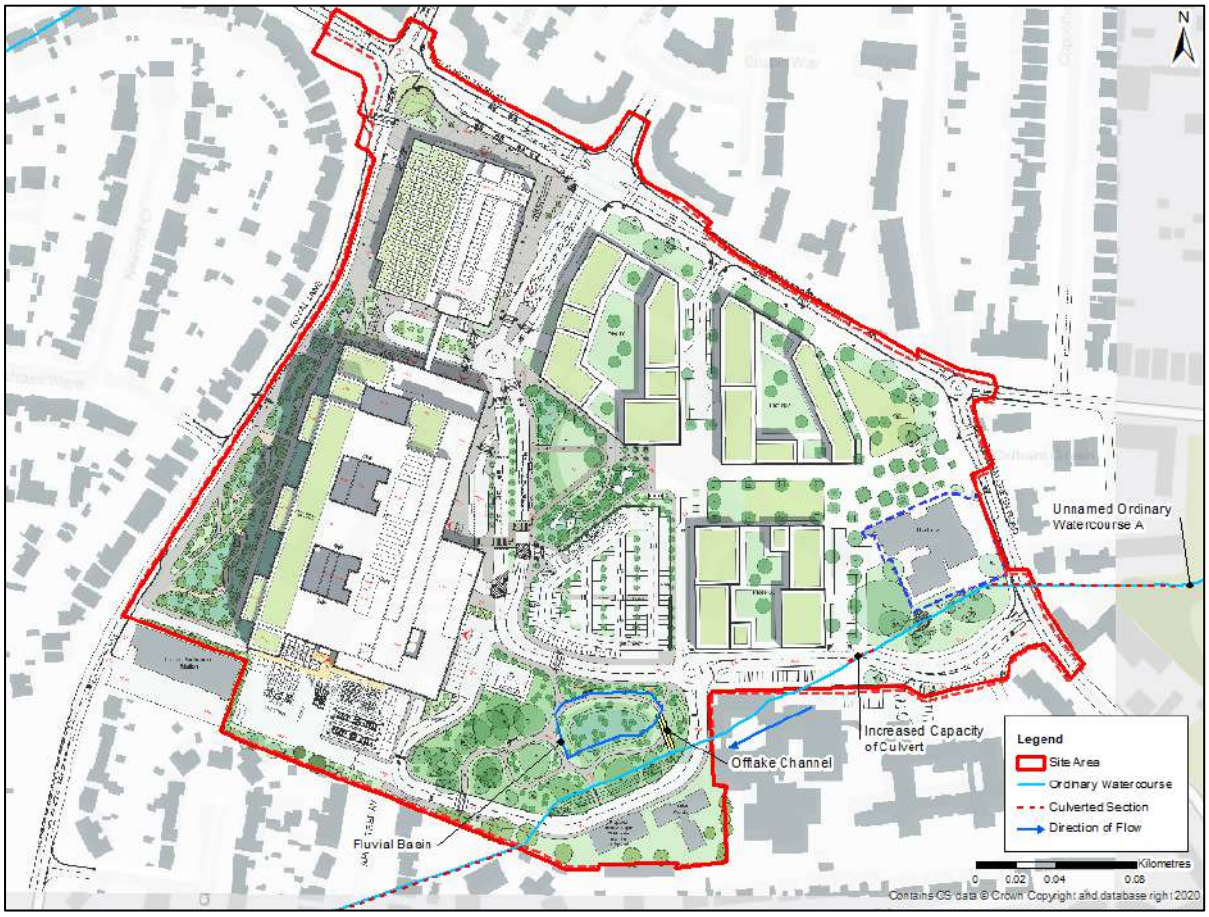

Figure 4-18 – Phase 1c and Phase 2 – Option 1 – Site Location Plan

The proposed fluvial basin has an invert level of 35 m AOD and has been modelled to allow the attenuation up to and including the 1 in 100 year plus 21% CC event. **Table 4-2** shows the maximum modelled flood depths within the fluvial basin for the 1 in 5 year, 1 in 20 year and 1 in 100 year plus 21% CC event.

Table 4-2 – Option 1 – Maximum Modelled Flood Depths in Fluvial Basin

Return Period	Maximum Water Level in Basin (m)
1 in 5 year	0.66
1 in 20 year	1.12
1 in 100 year plus 21% CC	1.39

The offtake channel connects from Ordinary Watercourse A, where the invert level of the channel falls from 35.6 m AOD to 35.4 m AOD, before connecting to the fluvial basin. It should be noted no outflow pipe from the basin has been modelled, however it is assumed during the detailed design an outflow pipe with a restricted outflow will be incorporated to ensure there is no increase in flows downstream of the site. For the purposes of the FRA, the fluvial basin is represented within the hydraulic model to operate when water levels in Watercourse A allow. Once the basin is full, fluvial flows will continue downstream with the channel of Watercourse A which has an invert level of 34.5 m AOD, as such, an outflow pipe from the fluvial basin will be able to discharge to the watercourse via gravity.

As shown in **Figure 4-19,** the flood extents during the 1 in 5 year flood event are reduced with no modelled flood extents predicted along the access road. Similarly, up to and including the 1 in 100 year plus 21% CC event, whilst flooding is still shown along the access road, the flood depths are shown to reduce by an average of approximately 0.07 m, refer to **Figure 4-20** and **Figure 4-21**.

Localised areas within the southern green space are also no longer shown to flood within this return period. A marginal detriment of flood depths localised along the southern access road however is shown in the 1 in 100 year plus 21% CC event by an increase of approximately 0.03 m, likely associated from increasing flows at the unnamed Ordinary Watercourse A.

The fluvial flood risk posed to the Proposed Development for Phase 2 which includes the concept of Option 1 is considered to be **medium**.

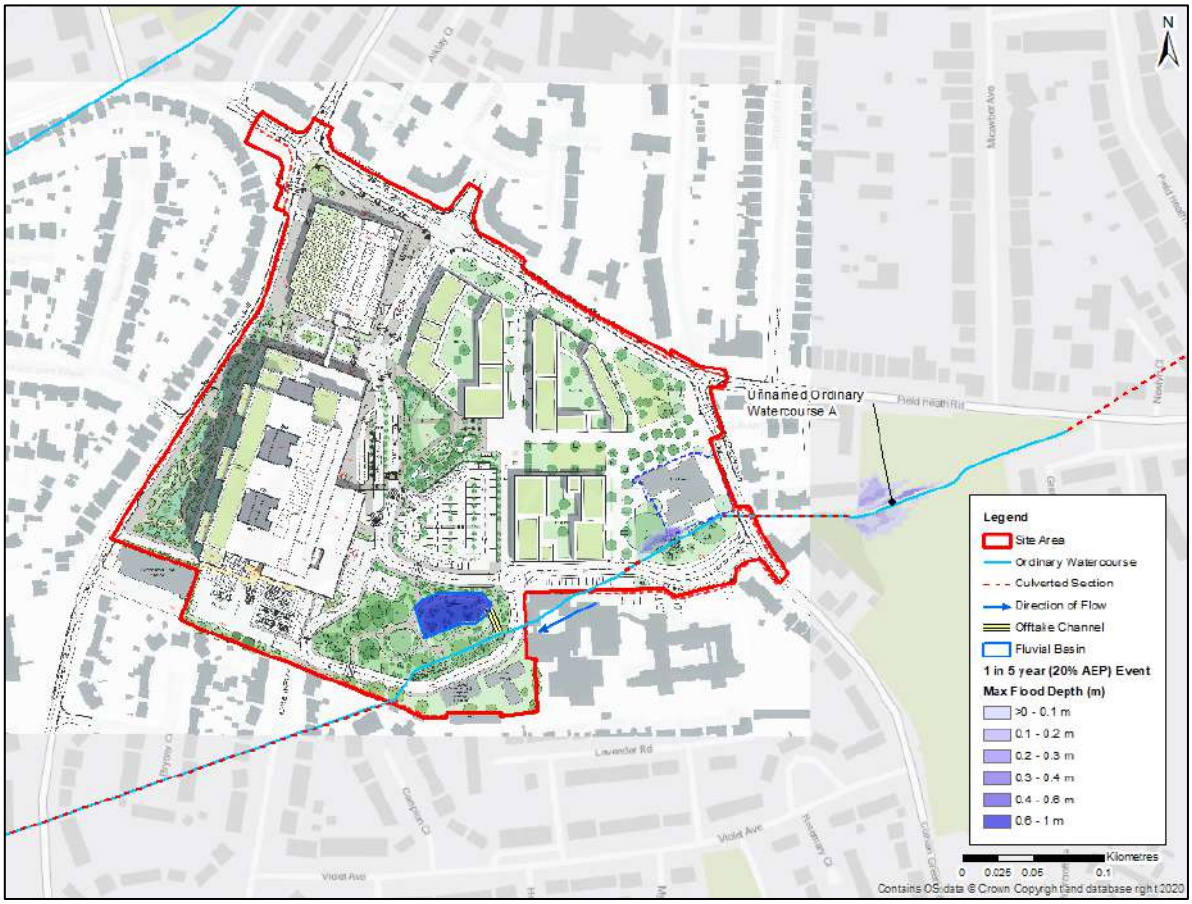

Figure 4-19 - 1 in 5 year flood extents – Phase 1c and Phase 2 – Option 1

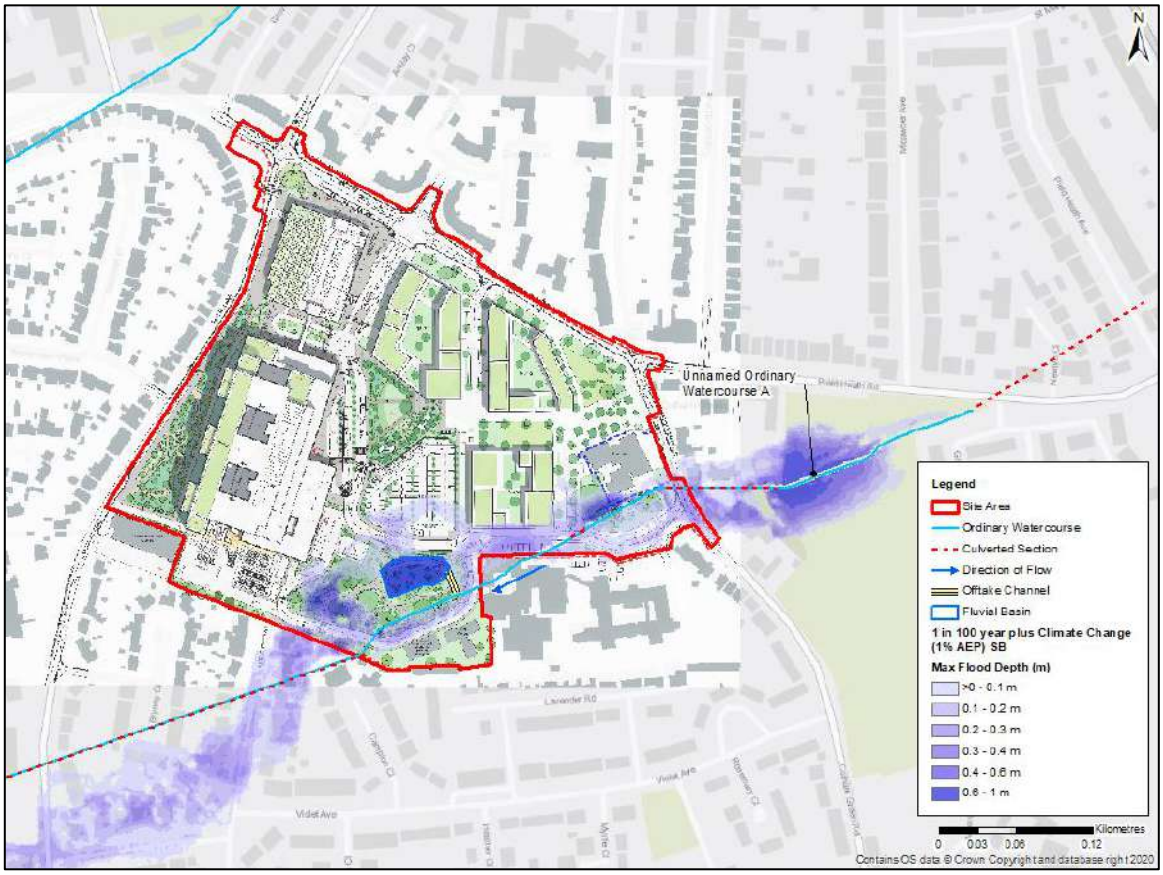

Figure 4-20- 1 in 100 year plus 21% CC flood extents – Phase 1c and Phase 2 – Option 1

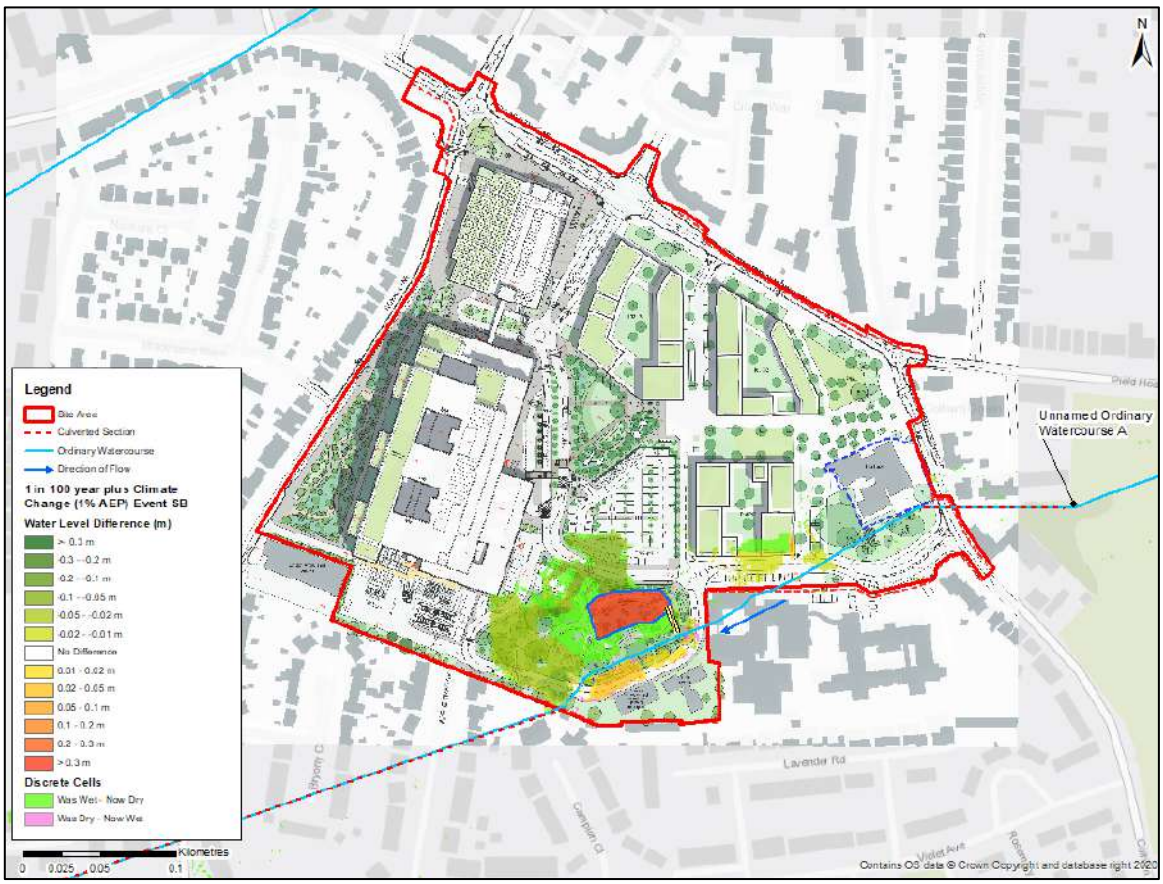

Figure 4-21 – 1 in 100 year plus 21% CC event – Water Depth Difference (Option 1 vs Baseline)

4.4.2 Phase 1c and Phase 2 – Option 2 Onsite Mitigation

Option 2 includes the concept of implementing a proposed flood relief culvert situated south of the Furze where exceedance flows are conveyed beneath the southern access road and directly connected to the proposed fluvial basin at the southern green space for attenuation. As such, no changes to the existing culvert situated south of the Furze are proposed. The circular flood relief culvert is approximately 125 m in length and has an internal diameter of 375 mm. The upstream invert level of the flood relief culvert is 37 m AOD and falls to 35 m AOD which achieves a gradient of 1:62. To prevent the ingress of water at the outlet of the flood relief culvert, it is recommended that a flapped valve is installed. The dimensions of the fluvial basin are innkeeping with those outlined in Option 1 and similarly no outflow pipe from the basin has been modelled. As such, a restricted outflow pipe will need to be developed during the detailed design stage. The concept of this option is shown in **Figure 4-22.**

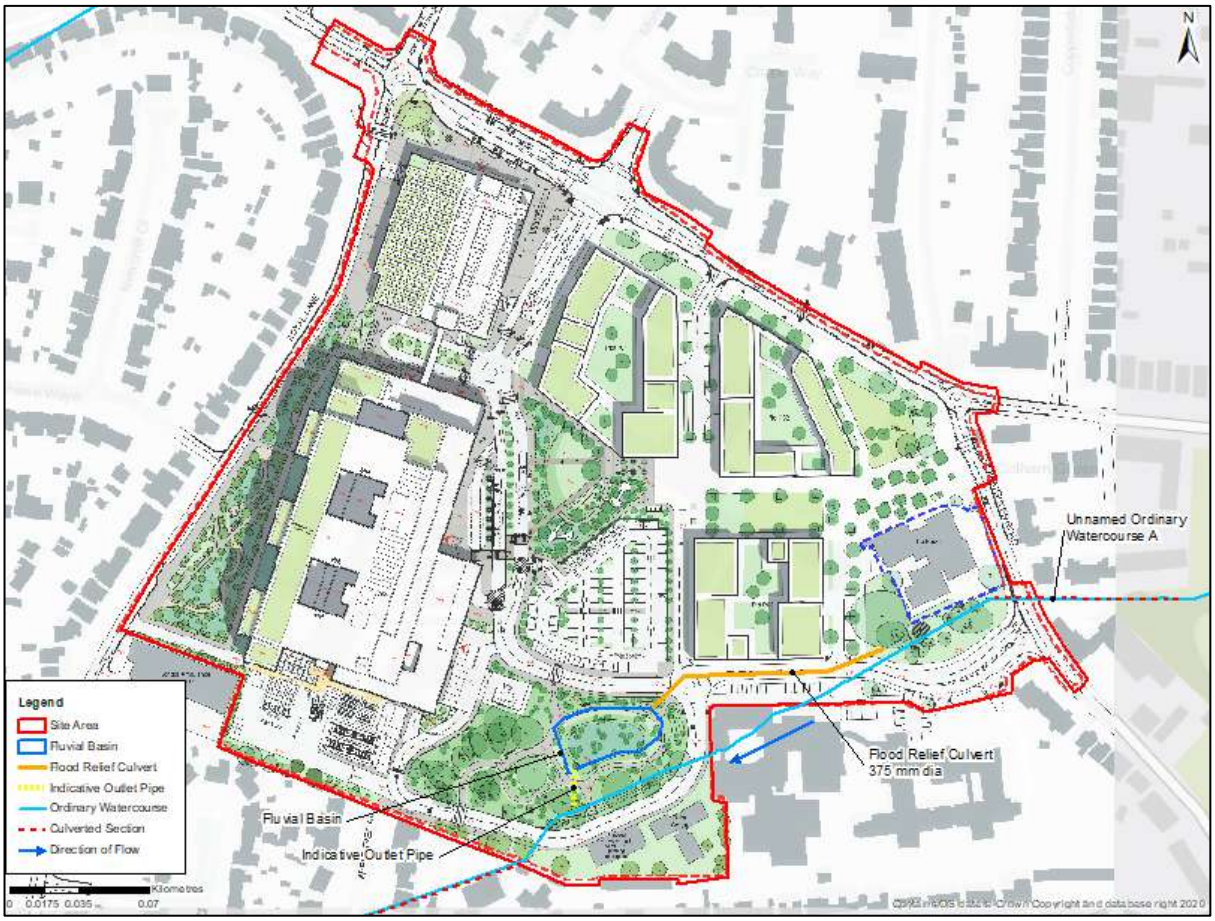

Figure 4-22 - Phase 1c and Phase 2 – Option 2 – Site Location Plan

As shown in **Figure 4-23, Figure 4-24** and **Figure 4-25**, a reduction of flood depths during all flood events up to and including the 1 in 100 year plus CC across the Proposed Development site are shown. In the 1 in 5 year event, the southern access road remains dry as a result of exceedance flows being conveyed through the flood relief culvert as opposed to overland. As such, the flood depths have been reduced by approximately 110 mm in comparison to the baseline scenario.

In the 1 in 20 year, whilst flows are also conveyed through the flood relief culvert, flows do begin to surcharge the existing culvert immediately south of the Furze. As such, fluvial flooding is conveyed overland, however flood depths remain shallow at the most southerly section of the access road with flood depths ranging between 0.07 m and 0.14 m. Maximum flood depths at a localised area immediately south of Plot P03 is shown at 0.2 m.

In the 1 in 100 year plus 21% CC event, whilst fluvial flooding is shown along the access road, flood depths have been reduced by approximately 0.03 m to 0.09 m, refer to **Figure 4-26**. In comparison to Option 1, a localised area along the southern access road is no longer showing a detriment to flood depths, likely a result of channelling flows along a flood relief culvert, rather than allowing the increase of flows downstream before being attenuated within the fluvial basin.

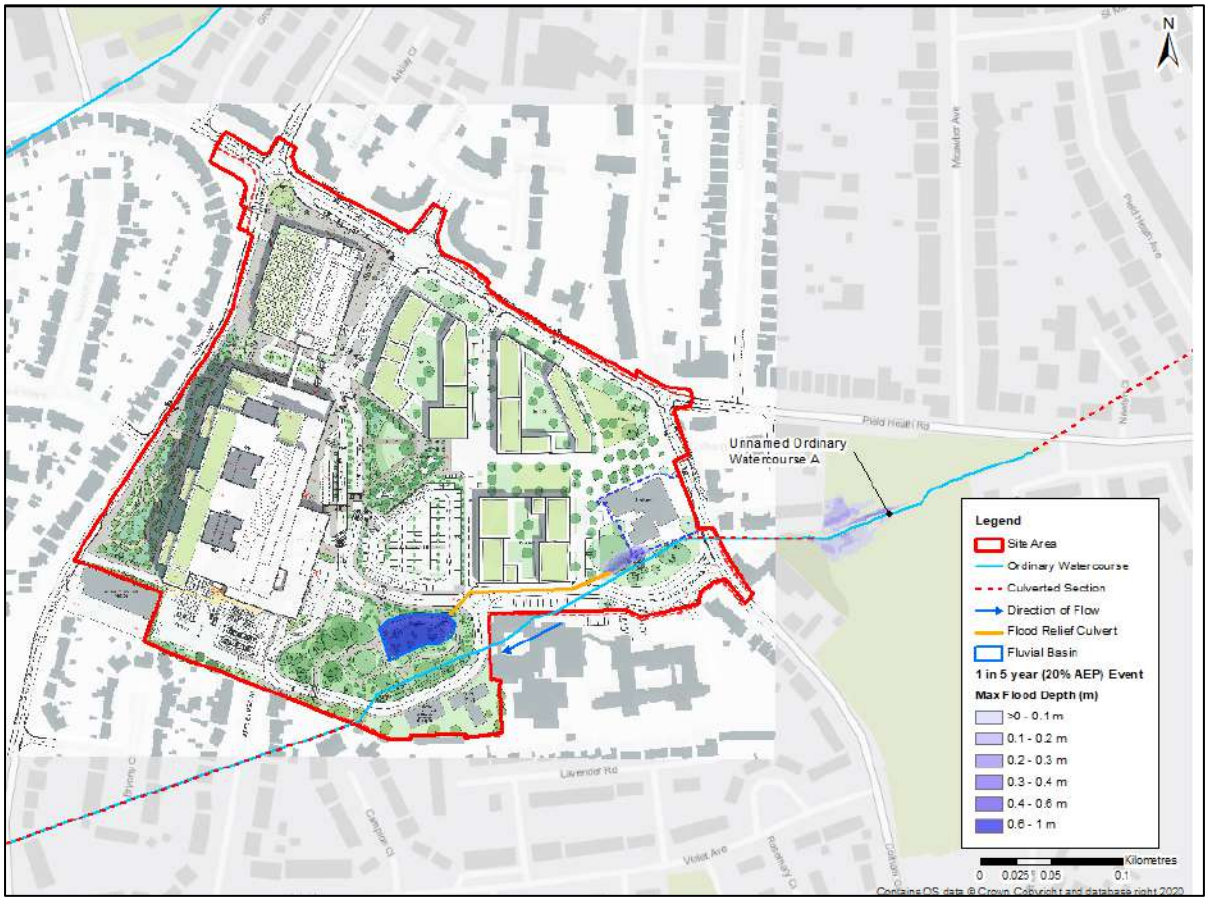

Figure 4-23 - Phase 1c and Phase 2 – Option 2 - 1 in 5 year Flood Extents

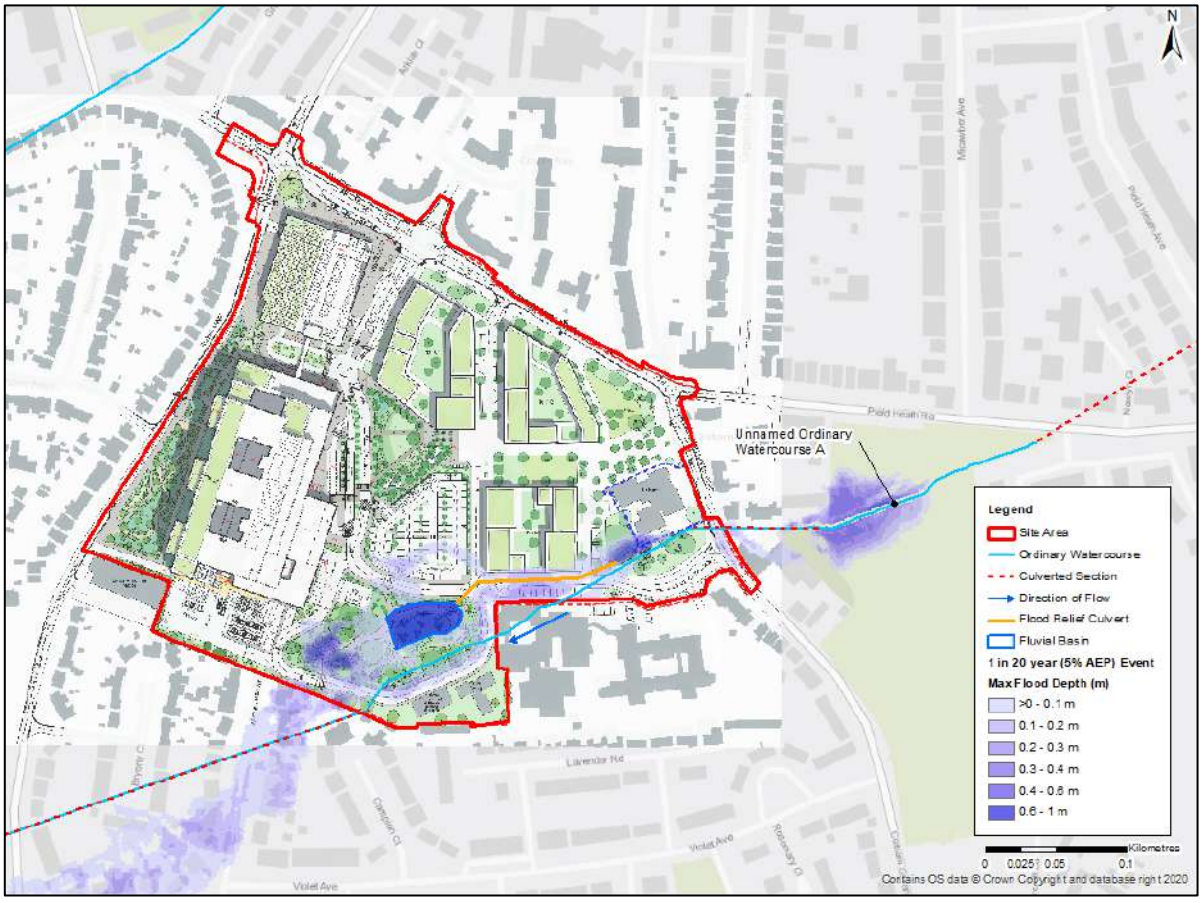

Figure 4-24 - Phase 1c and Phase 2 – Option 2 - 1 in 20 year Flood Extents

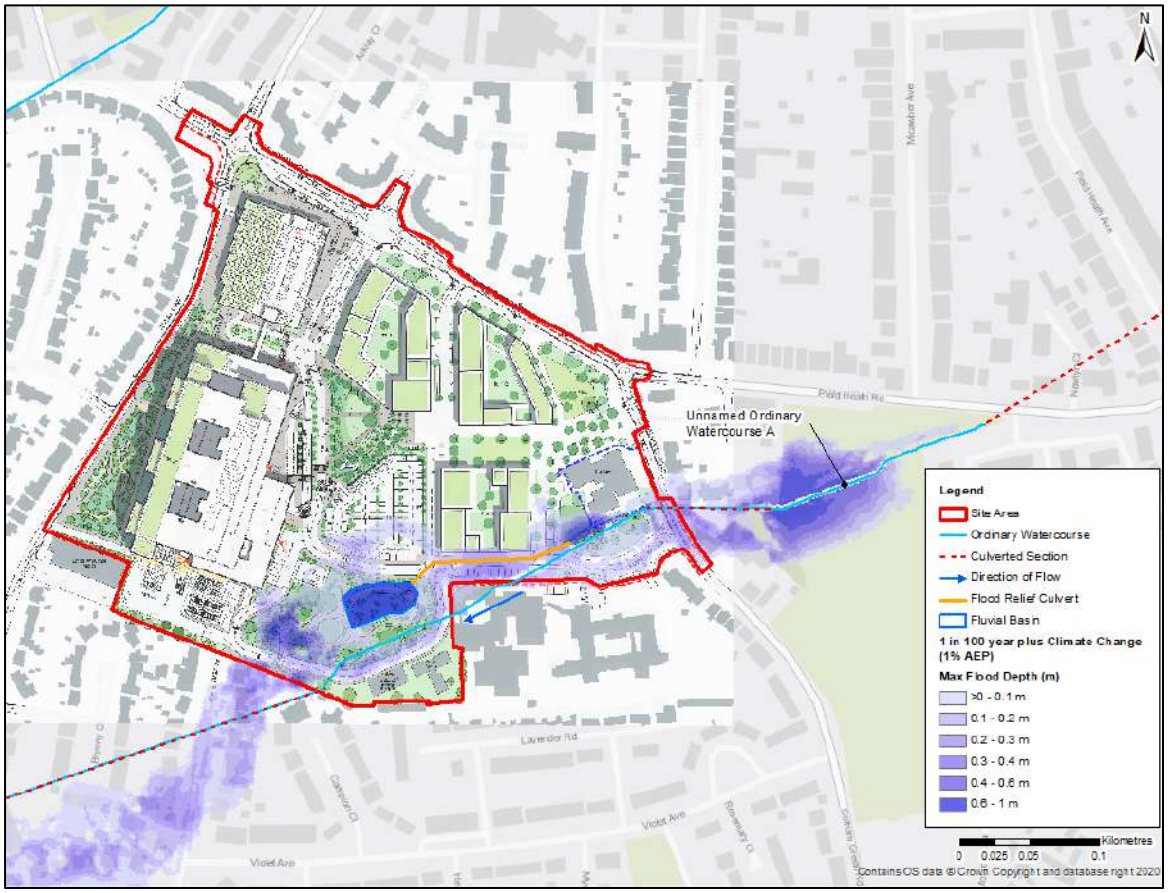

Figure 4-25- Phase 1c and Phase 2 – Option 2 - 1 in 100 year plus 21% CC Flood Extents

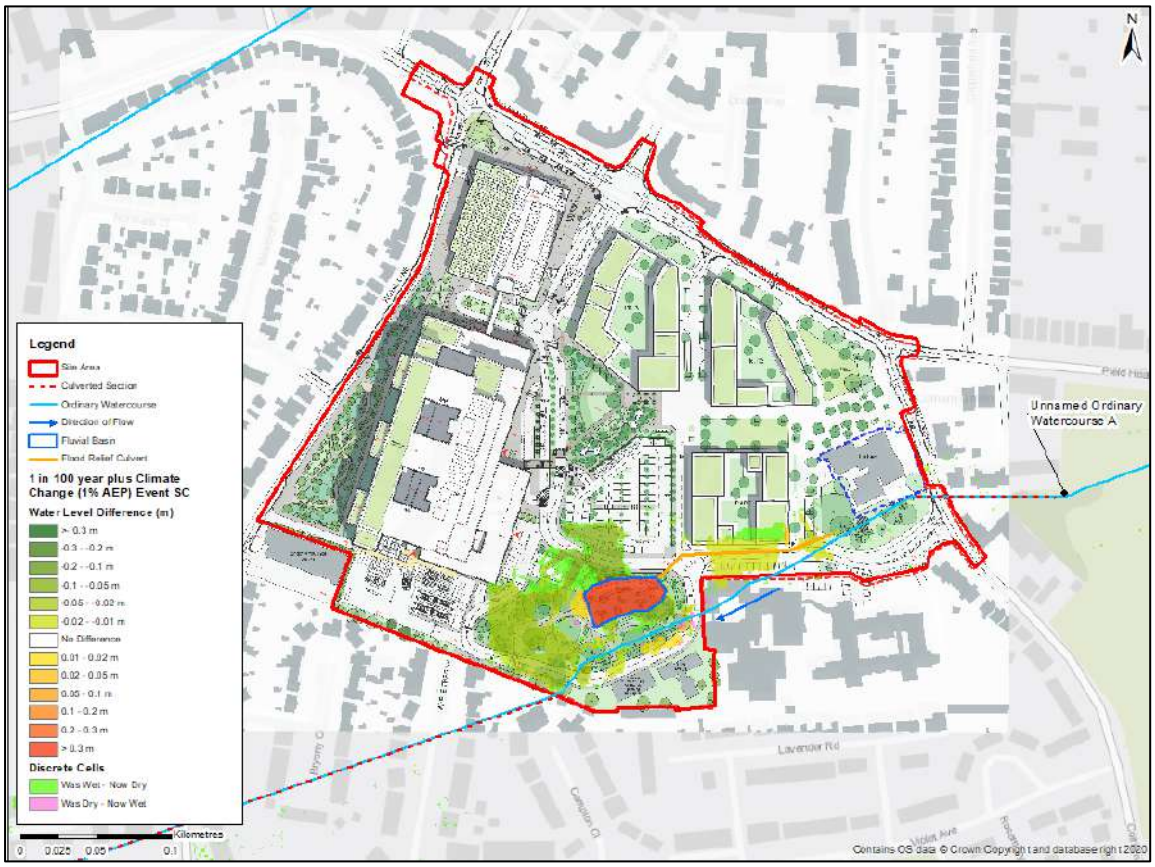

Figure 4-26 - 1 in 100 year plus 21% CC event – Water Depth Difference (Option 2 vs Baseline)

Flood Hazard Maps have also been produced for the 1 in 5 year, 1 in 20 year and the 1 in 100 year plus 21% CC event, refer to **Figure 4-27, Figure 4-28** and **Figure 4-29** respectively. In the 1 in 5 year event, given the access road remains dry during this fluvial flood event, the hazard rating has been classified as 'No Hazard', an improvement compared to the baseline scenario. The fluvial basin which has been classified as 'Danger for Most' given flood depths of 1.08 m and an appropriate risk assessment should be undertake during the detailed design stage to identify appropriate safety measures.

In the 1 in 20 year event, with the exception of the fluvial basin and adjacent to Ordinary Watercourse A immediately south of the Furze, the site is classified as 'Low Hazard'.

In the 1 in 100 year plus 21% CC event, despite fluvial flood risk posed to the access road and surface car park, the site is predominately classified as 'Low Hazard'. A localised area shown to infringe upon a car park adjacent to the access road immediately south of Plot P03 however is shown as 'Danger for Most'. Whilst this is not increasing the flood hazard compared the baseline scenario, it is recommended that a Flood Management Plan is prepared advising users of alternative car parking during the larger fluvial flood events.

Option 2 provides a reduction in flood depths and flood extents within the site boundary and fundamentally allows the site to remain dry during the 1 in 5 year event. As such, Option 2 is the preferred option in reducing the risk of fluvial flooding.

As such, the fluvial flood risk to the Proposed Site, in the lower return periods; 1 in 5 year and the 1 in 20 year is considered **low**. In the modelled 1 in 100 year plus 21% CC event, the fluvial flood risk is considered **medium**. A summary of the proposed fluvial mitigation is provided in **Section 4.5.**

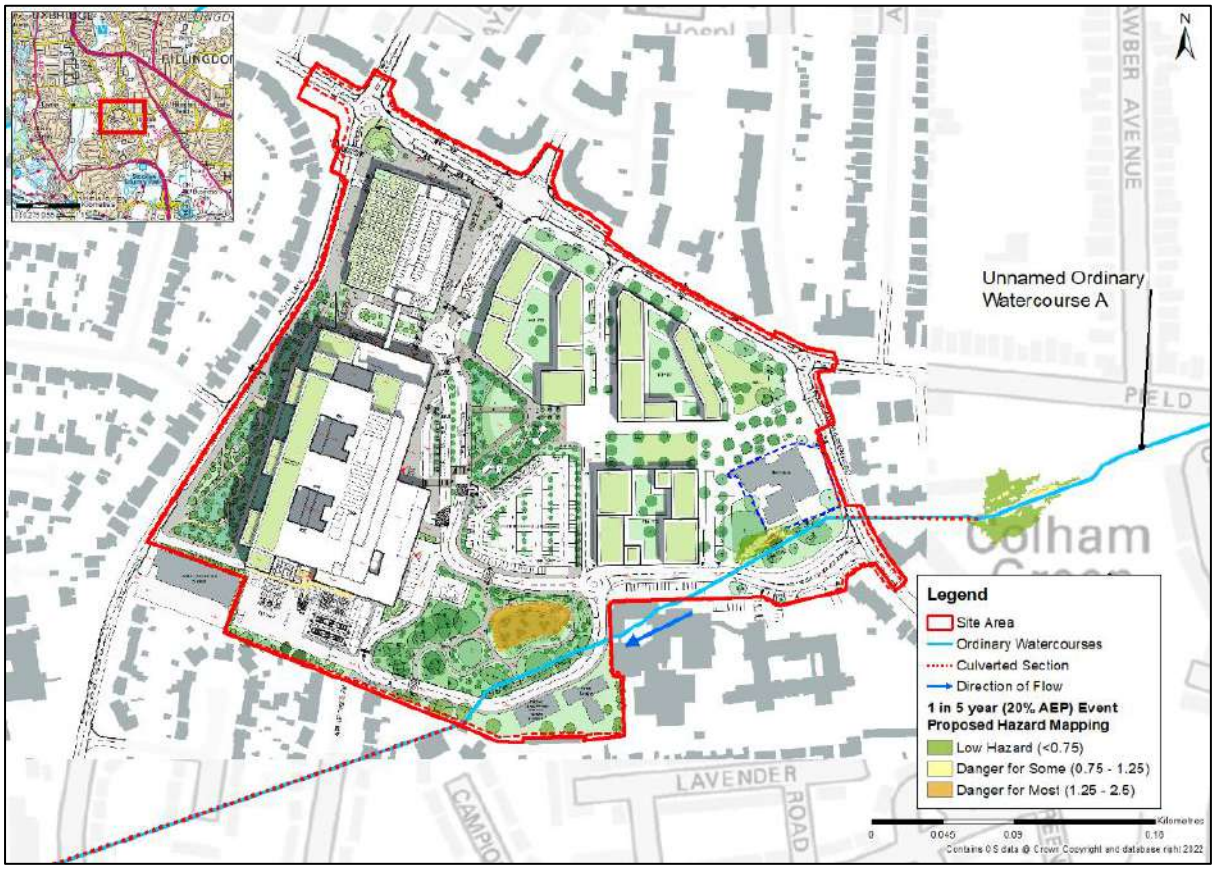

Figure 4-27 – Flood Hazard Map – Phase 1c and Phase 2 – Option 2 - 1 in 5 year

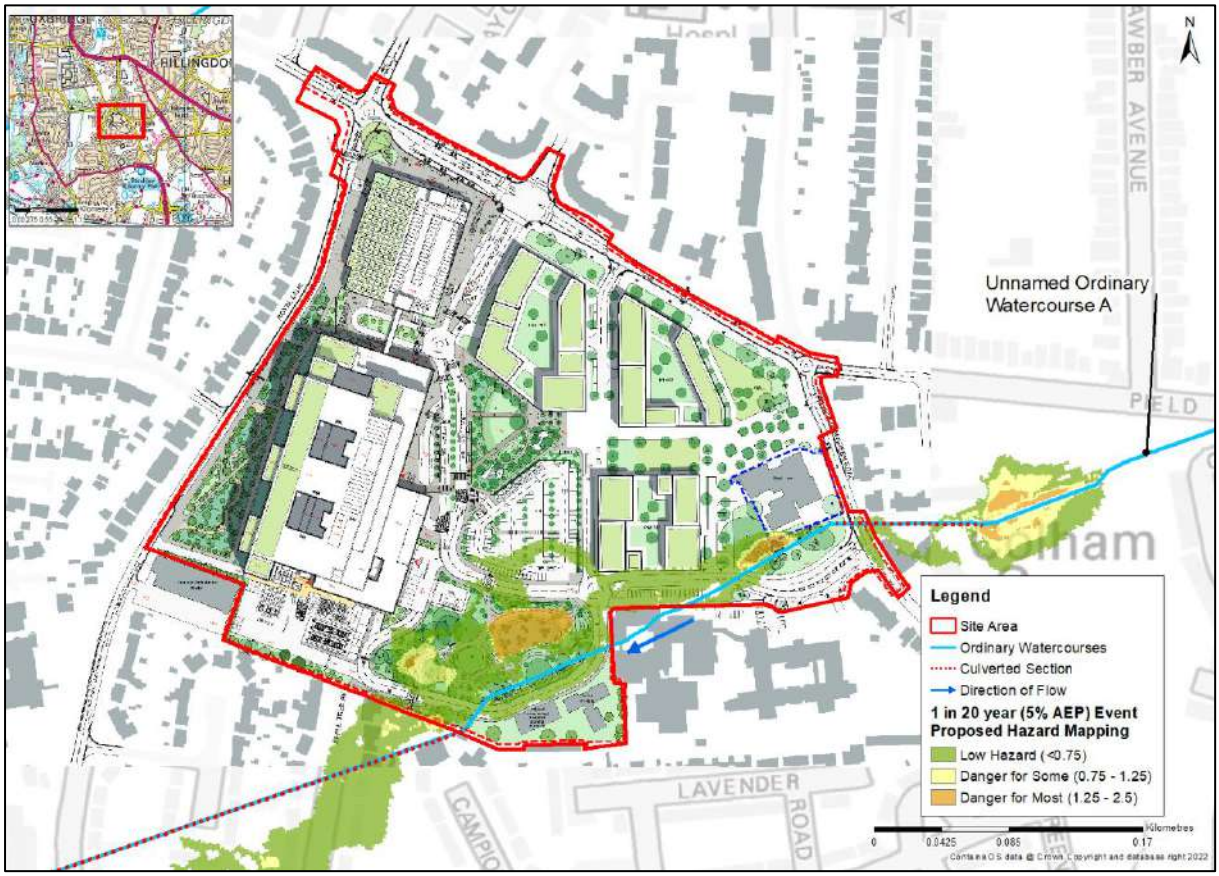

Figure 4-28 – Flood Hazard Map – Phase 1c and Phase 2 – Option 2 – 1 in 20 year

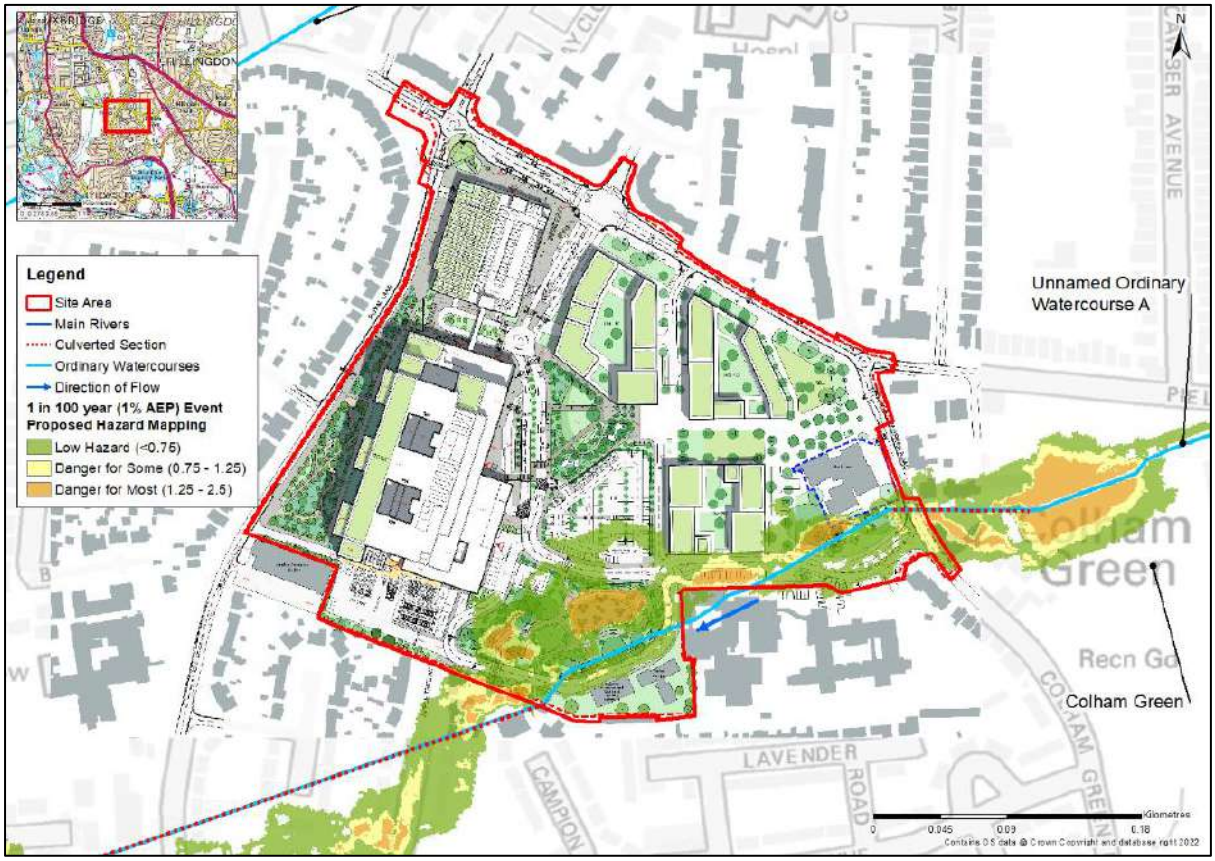

Figure 4-29 – Flood Hazard Map – Phase 1c and Phase 2 – Option 2 - 1 in 100 year plus 21% CC

4.4.3 Safe Access and Egress

Whilst the risk of flooding to the southern access road is to be reduced post development, some discrete areas are identified as a 'Risk to Some' in the 1 in 100 year plus 21% CC hazard mapping (as discussed in **Section 4.4.2**). To provide further resilience, an alternative access route (shown in **Figure 4-30**) will be provided from the north at Pield Heath Road. This will ensure vehicular access, including emergency vehicles, to the hospital can be achieved during an extreme flood event. A second access route is shown to ensure safe access to the residential areas. Signage advising users the road is liable to flooding is recommended.

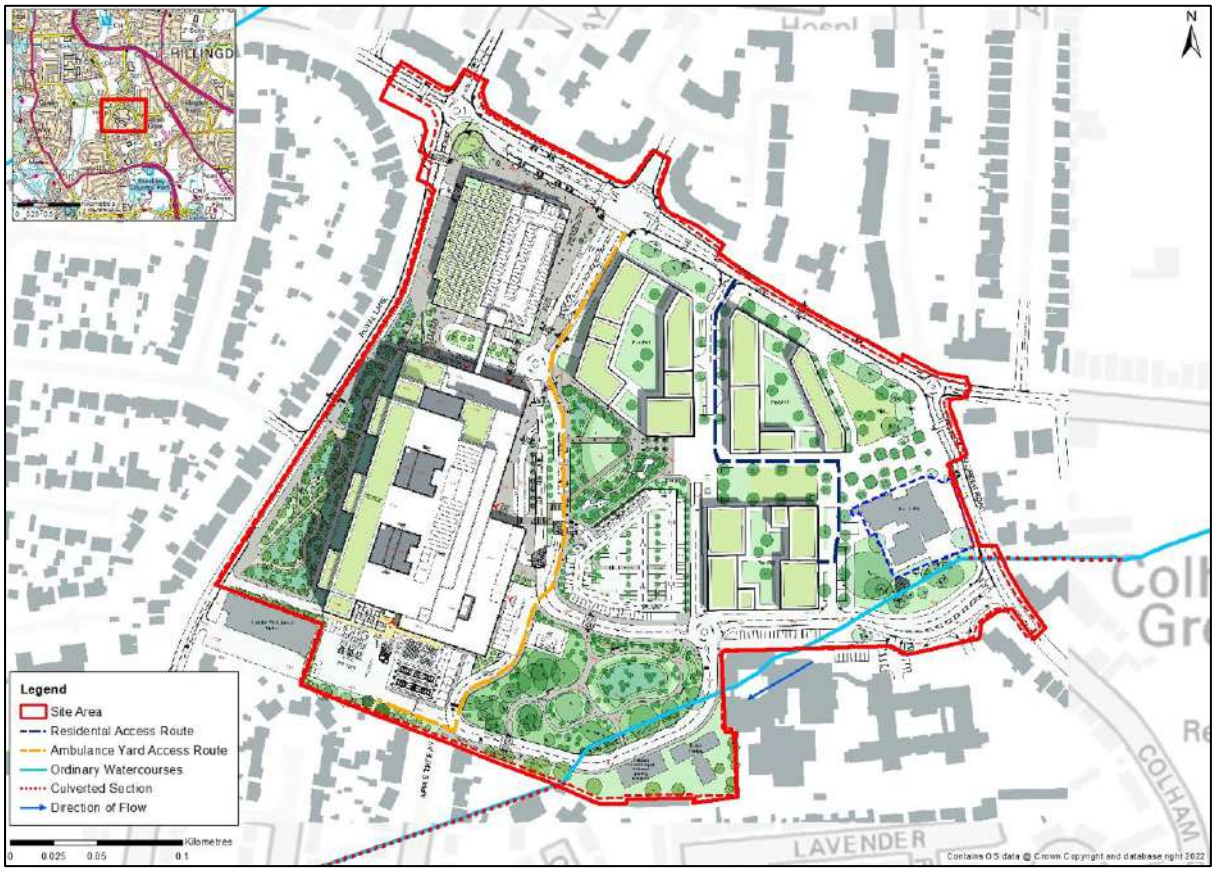

Figure 4-30- Safe Access and Egress Alternative Route Plan

4.5 Summary of Fluvial Flood Risk Mitigation Measures

In conclusion, the Proposed Development site is shown to be at risk of fluvial flooding in the baseline scenario, especially in the lower return periods, where the existing southern access road floods from the 1 in 5 year event. All vulnerable receptors associated from the Proposed Development for Phase 1a, Phase 1b, Phase 1c and Phase 2 are shown outside the flood extents up to and including the 1 in 100 year plus 21% CC event. However, it is recognised that the southern access road is predicted to flood in the lower return periods, so a variety of options have been hydraulic modelled to minimise flood depths along this road. Whilst the flood extents and flood depths are no greater in comparison to the baseline scenario, opportunities to reduce the risk of flooding have been explored and discussed.

As discussed in **Section 4.4.2,** Option 2 provides a reduction in flood depths and flood extents within the site and fundamentally allows the site to remain dry during the 1 in 5 year event. **Table 4-3** shows a comparison of the flood depths at two locations within the site boundary for each of the phases. The location of the spot levels is presented in **Figure 4-31.** It is noted that the Phase 1 Off-site mitigation at Colham Green has not been included/ taken forward? due to the negligible flood risk benefit and therefore financial contribution to a catchment wide management scheme may be more a beneficial solution.

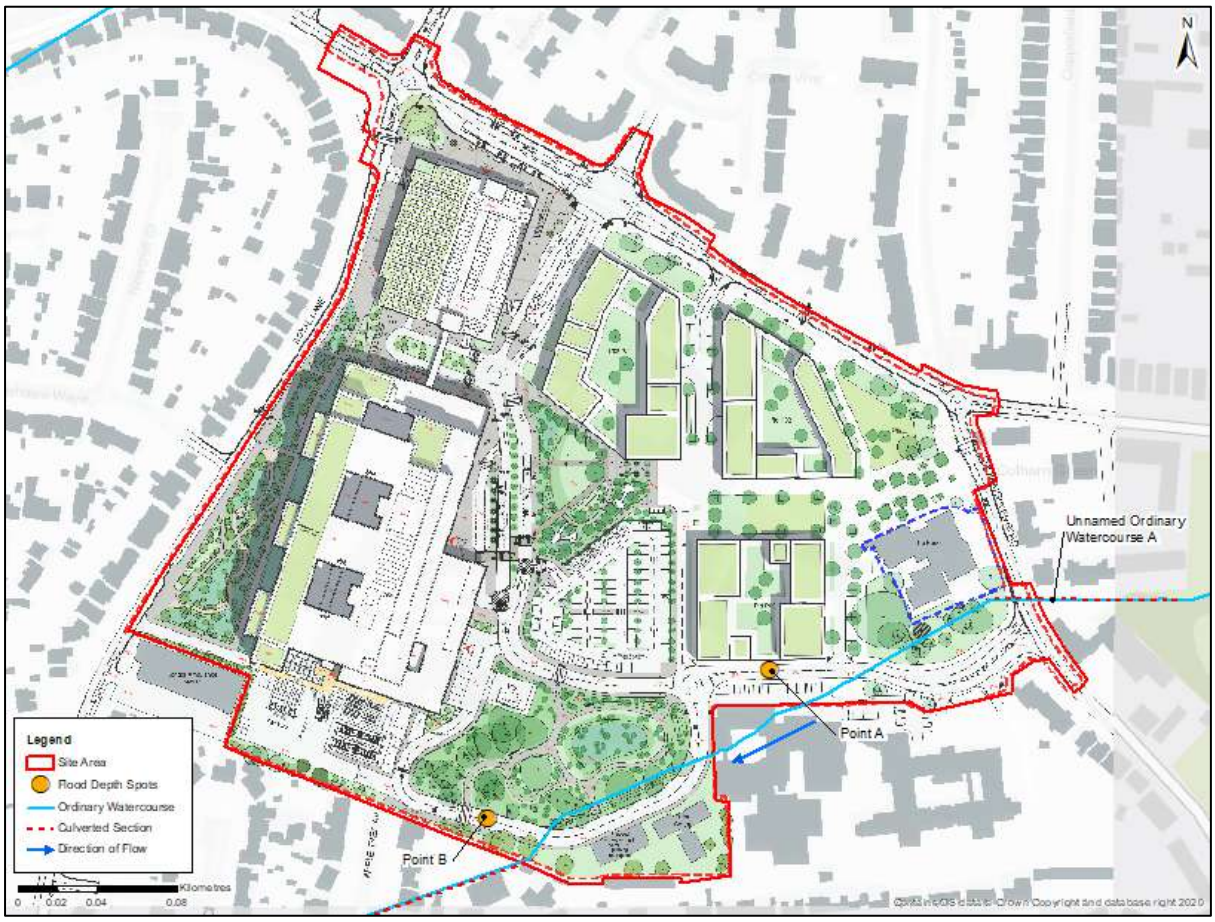

Figure 4-31 – Flood Depth Spots

As shown in **Table 4-3,** the flood depths at these two locations are shown to marginally decrease during the Proposed Scenarios for each Phase. The greatest reduction in flood depths is observed in the lower return periods including the 1 in 5 year and 1 in 20 year flood events. Option 2 in Phase 1c and Phase 2 shows the greatest betterment in flood depths in comparison to the other scenarios, and as such is the preferred option in reducing the risk of fluvial flooding.

Table 4-3: Comparison of Flood Depths amongst the Phases

Return Period	Existing Baseline Flood Depths		Phase 1a & Phase 1b Proposed Flood Depths		Phase 1a & Phase 1b On-Site Mitigation Flood Depths		Phase 1c & Phase 2 Proposed Flood Depths		Phase 1c & Phase 2 Option 1 Mitigation Flood Depths		Phase 1c & Phase 2 Option 2 Mitigation Flood Depths	
	Point A	Point B	Point A	Point B	Point A	Point B	Point A	Point B	Point A	Point B	Point A	Point B
1 in 5 year	0.11 m	0.03 m	0.09 m	0.03 m	0.04 m	0.01 m	0.07 m	0.007 m	0 m	0 m	0 m	0 m
1 in 20 year	0.2 m	0.11m	0.17	0.09 m	0.17 m	0.1 m	0.16 m	0.11 m	0.15 m	0.1 m	0.14 m	0.08 m
1 in 100 year + 21% CC	0.29 m	0.21 m	0.28 m	0.2 m	0.28 m	0.21 m	0.26 m	0.18 m	0.26 m	0.17 m	0.24 m	0.17 m

A summary of the following mitigation measures required for each Phase are detailed below.

Phase 1a and Phase 1b

- 300 mm heighted flood bund near the proposed hospital entrance.
- Raising the Oxygen Tanks on a 150 mm platform.
- Road Signage advising the southern access road is liable to flooding.
- Develop an emergency flood action plan which details the safe access and egress routes.

Phase 1c

- Option 2 is the preferred on-site flood risk mitigation option including a new flood relief culvert and fluvial basin. (Subject to detailed design).

Phase 2

- Raising the FFLs at the residential properties at Plot P03 by 300 mm above the 1 in 100 year plus 21% CC flood level. The minimum FFL required is 38.213 m AOD. A 500 mm heighted wall which is dry-proofed is required along the southern perimeter of Plot P03. (Subject to detailed design).
- Prepare a Flood Risk Management Plan in collaboration with LBH.

4.6 Flood Risk from Tidal Sources

Tidal flooding occurs during extreme high tide and / or storm surge events which may cause wave overtopping or the unlikely event of a breaching scenario of existing tidal defences. High water levels within tidally influenced estuaries and rivers may also contribute to tidal flooding. As a consequence of climate change, sea level rises and increased storm surges are predicted, increasing the probability of flooding from overtopping or breach on tidal watercourses and at the coast.

The Proposed Development is located approximately 80 km west of the North Sea and is situated outside the extent of tidally influenced rivers. As such the Proposed Development is considered to be at very low risk from tidal flooding.

4.6.1 Impact of Climate Change on Fluvial and Tidal Flooding

The Proposed Development will include a surface water drainage network which will be sized to attenuate up to and including the 1 in 100 year plus 40% CC event. The Proposed Site will be divided among three drainage catchments including the southern access road which will be discharged to the unnamed Ordinary Watercourse A, restricted to the greenfield runoff rate. As such, climate change will not significantly increase the risk of fluvial flooding from the site.

As a result of climate change, the frequency and intensity of storm events are likely to increase in future which could lead to elevated water levels along the unnamed Ordinary Watercourse A. The supporting Hydraulic Modelling Study has modelled the 1 in 100 year plus 21% CC event which shows that there is no increase to flood risk in or outside the site boundary as a result of the Proposed Development.

4.7 Flood Risk from Surface Water

Surface water runoff is defined as water flowing over the ground that has not yet entered a drainage channel or similar. An intense period of rainfall which exceeds the infiltration capacity of the ground usually results in surface water runoff, and it can also occur when the capacity of the sewer or drainage network is exceeded. Typically, runoff occurs on sloping land or where the ground surface is relatively impermeable. The ground can be impermeable, either naturally through the soil type or geology, or unnaturally due to development, which places large areas of impervious material over the ground surface (e.g., paving and roads).

As defined by the EA, levels of surface water flood risk can be classified as follows:

- High Risk – the area has an annual chance of flooding of greater than 1 in 30 (3.33% AEP).
- Medium Risk – the area has an annual chance of flooding of between 1 in 100 (1% AEP) and 1 in 30 (3.33% AEP).
- Low Risk – the area has an annual chance of flooding of between 1 in 1000 (0.1% AEP) and 1 in 100 (1% AEP).
- Very Low Risk – the area has an annual chance of flooding less than 1 in 1000 (0.1% AEP).

A review of the EA RoFfSW (**Figure 4-32** and **Figure 4-33**) dataset predicts a prominent surface water flow path from the 1 in 30 year event alongside the southern perimeter of the site boundary. In the 1 in 100 year event and 1 in 1000 year event, the flood extent of surface water flooding is predicted to increase further on site. Surface water ponding is also predicted during the 1 in 30 year event in areas of green space including the southern green space within the site. Given a low topographical depression is situated within this space, fluvial and surface water flooding is likely to pond with flood depths predicted to reach between 300 and 900 mm. Given these areas of predicted surface water flooding is likely associated from fluvial sources, this risk of flooding to the site is best described in **Section 4.3.6** and subsequent mitigation measures identified.

In addition, a surface water flow route is shown to originate off-site, entering the site boundary near the north-eastern corner, before flowing in a southerly direction and likely entering the unnamed Ordinary Watercourse A. Surface water flooding is also predicted along Pield Heath Road along the north-western site boundary in the 1 in 100 and 1 in 1,000 year events, although flood depths are predicted below 300 mm. The centre of the site where a car park is proposed as part of Phase 1c construction is also shown to be at medium risk from surface water flooding.

The Proposed Development for Phase 1 and Phase 2 will involve the construction of a drainage system capable of attenuating surface water up to and including the 1 in 100 year + 40% CC event and will restrict run off to the greenfield rate. The new drainage system designed for Phase 1 includes incorporating Sustainable Drainage Systems (SuDS) such as wetlands and swales situated to the west of the proposed hospital. Surface water in the western catchment will be attenuated on site, before being discharged to an existing Thames Water surface water sewer network. The eastern catchment of the site which includes the southern access road will incorporate permeable paving and restrict flows to greenfield at the existing outfall to the unnamed Ordinary Watercourse A. The Drainage Strategy for Phase 2 utilises below attenuation tanks and SuDS to attenuate a volume of 3650 m^3, where flows will be restricted at a greenfield runoff rate to an existing outfall at the Ordinary Watercourse A immediately south of Plot P03. To mitigate for the offsite surface water flow route in the north-eastern corner, a cut off filter drain is proposed along the eastern boundary of the site. As such, flows will be conveyed to the Ordinary Watercourse A to mimic the existing situation, whilst mitigating surface water flood risk to the Proposed Development.

As such, any surface water which would have ponded within the Proposed Development site are likely to be captured by the proposed drainage network. Therefore, the risk to the Proposed Development is considered to be low and no further mitigation is required.

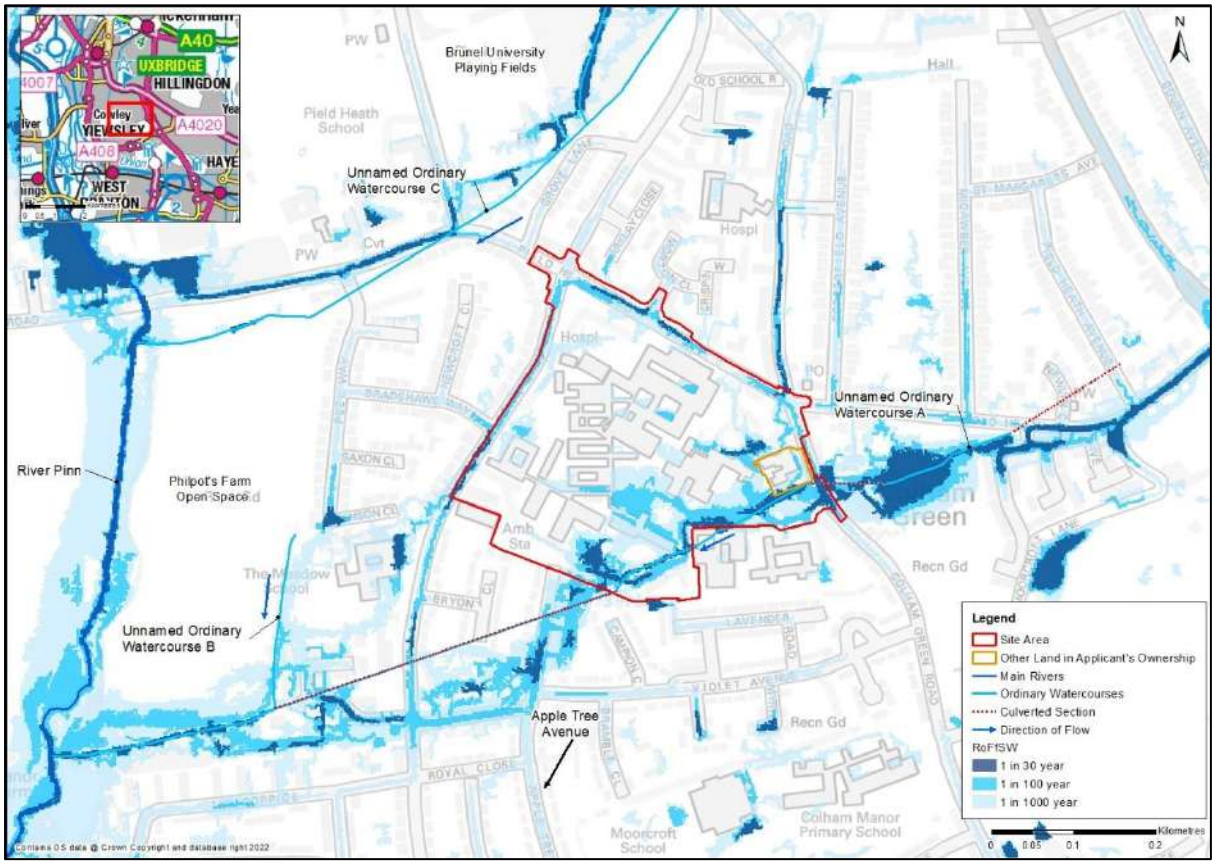

Figure 4-32 - Risk of Flooding from Surface Water Flood Map

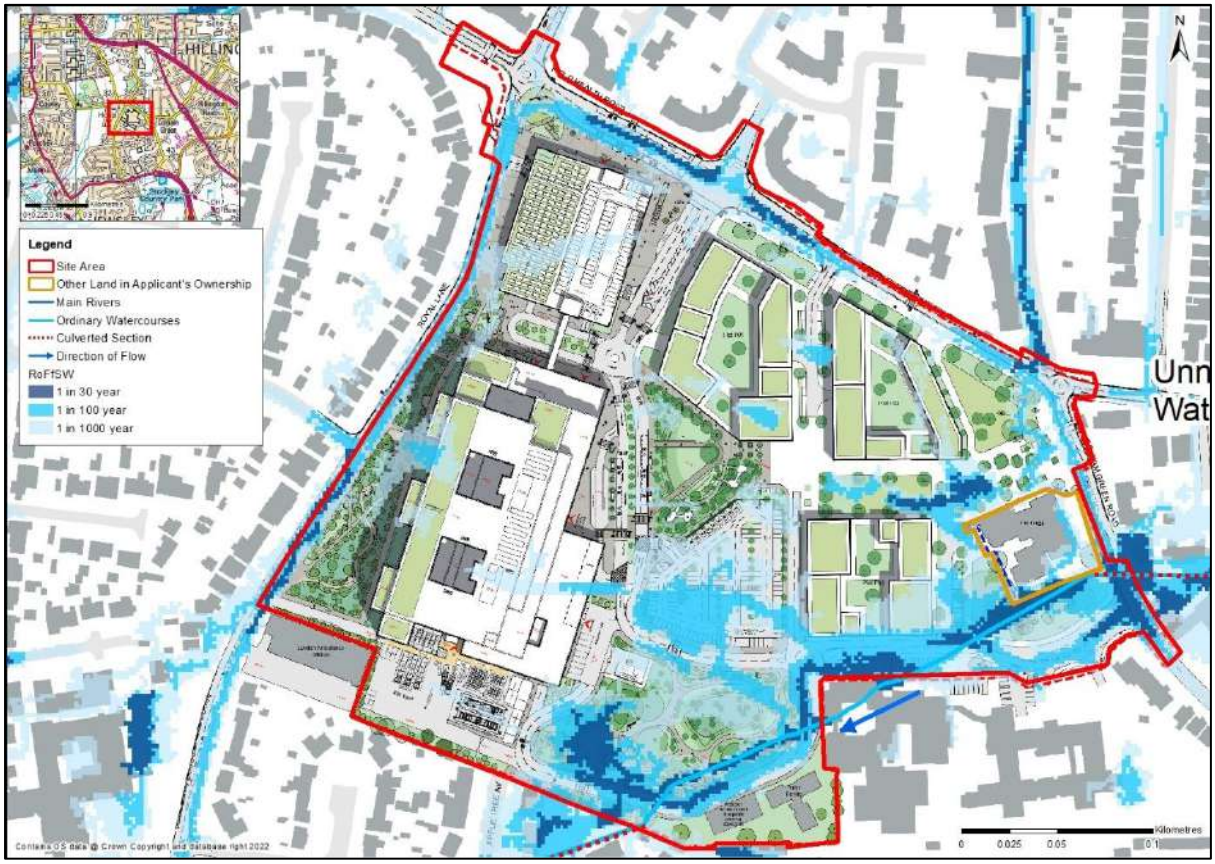

Figure 4-33 - Risk of Flooding from Surface Water Flood Map

4.7.1 Impact of Climate Change on Surface Water

The predicted increase in the frequency and intensity of storm events could increase the volumes of surface water on the site. As discussed in **Section 4.7** the proposed surface water drainage network will attenuate surface water generated by the Proposed Development up to and including the 1 in 100 year plus 40% CC event. Therefore, despite the anticipated increase in rainfall intensity, climate change will unlikely increase the risk of surface water flooding to and from the site.

4.8 Flood Risk from Groundwater

Groundwater flooding occurs when the natural level of water stored within the ground rises above local ground level. This can result in deep and long-lasting flooding of low lying or below ground areas such as underpasses and basements. It tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is most likely to occur in areas underlain by major aquifers, although it is also associated with more localised floodplain sands and gravels.

British Geological Survey (BGS)[17] suggests that the geology below the site is located within a region of London Clay formation comprising clay, silt and sand with superficial deposits of Boyn Hill Gravel Member. Whilst clay is typically characterised by low permeability, sand and gravel are typically characterised by higher permeability.

In accordance with the EA Aquifer Designation Map[18] the site is underlain by an Unproductive Aquifer in the bedrock suggesting this area is of negligible significance for water supply and is characterised by low permeability. However, the site is underlain by a Secondary A aquifer in the Superficial Drift which suggests there are permeable layers close to the surface that are capable of supporting water supplies. The presence of this aquifer could be indicative of elevated groundwater levels within the surrounding area. In addition, the BGS Groundwater Vulnerability Map shows the site to be at low to unproductive risk from groundwater flooding. A BGS borehole record[19] which is located at the centre of the Proposed Development site includes a description of the strata for thirty feet[20]. The borehole record indicates a sandy and gravel layer in the top five feet followed by an eleven-foot layer of clay. The northern part of the Proposed Development site is located within Source Protection Zone (SPZ) 1 (Inner Protection Zone) and SPZ 2 (Outer Protection Zone) suggesting there is a greater risk of groundwater contamination in this area.

The Proposed Development involves the construction of a basement below a partial area in the south western section of the new hospital ward footprint. The proposed FFL is anticipated to be +32.125 m OD which is expected to extend beneath the water table surface. GI work and boreholes suggest that allowing for seasonal variation, a groundwater level of 37.25 m OD has been assumed. The Basement Impact Assessment Ref: THHR_01_ACM_ZZ-XX-RP-Y-9002 should be read in conjunction with the FRA. Given the elevated groundwater table within the vicinity, mitigation measures are required. To prevent the 'floatation' of sub-surface elements as a consequence of increased groundwater levels, all below ground elements must be designed to prevent water ingress and withstand hydrostatic groundwater pressures. Furthermore, the proposed drainage strategy involves the construction of a below ground foul and surface water drainage network including pumping stations and below ground attenuation tanks which may be vulnerable to groundwater ingress.

Assuming all below ground elements are designed to prevent groundwater ingress, the risk to the Proposed Development from groundwater flooding is considered low and no further mitigation is required.

4.8.1 Impact of Climate Change on Groundwater

The direct impact of climate change on groundwater resources is dictated by the changes in rainfall intensity and soil infiltration. During drier seasons, there may be reductions in groundwater recharge that may cause a long-term decline in groundwater storage. Alternatively, groundwater recharge may be stabilised or even increased by frequent and prolonged periods of rainfall. As a precautionary measure, all below ground elements associated with the Proposed Development should be designed in such a way as to withstand any upward hydraulic pressure, in the event groundwater levels rise as a result of climate change. Assuming this is the case, any anticipated increase in groundwater levels, as a result of climate change will unlikely increase the risk of groundwater flooding to the Development.

[17] British Geological Survey (2019) Geology of Britain Viewer. [Online] http://mapapps.bgs.ac.uk/geologyofbritain/home.html Accessed 05/10/2021.
[18] BGS/EA Aquifer Designation Map https://magic.defra.gov.uk/MagicMap.aspx Accessed 05/10/2021.
[19] BGS Borehole Record Map [Online] http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes&_ga=2.159911421.1568061181.1643820059-1244610453.1626794978 Accessed 02/02/2022
[20] Hillingdon Hospital Colham Green Borehole Record [Online] http://scans.bgs.ac.uk/sobi_scans/boreholes/576334/images/12193521.html Accessed 02/02/2022

4.9 Flood Risk from Sewer and Water Supply Infrastructure

Given potable water mains are pressurised systems, significant flooding could occur in the event of a pipe burst scenario. Sewer and surface water flooding are often interconnected especially in combined sewer systems; insufficient drainage capacity in the sewer network can result in surface water flooding and, by the same rationale, large volumes of surface water can overload the public sewers, causing the sewer network to back up, surcharge and ultimately cause flooding above ground level.

4.9.1 Water Supply Infrastructure

Given potable water mains are pressurised systems, significant flooding could occur in the event of a pipe burst scenario. A review of a Utility Survey, as shown in **Appendix G**, shows that there are several water mains located within the site boundary and along the roads which surround the Proposed Development site, including Pield Heath Road, Colham Green Road and Royal Lane. Records from Thames Water indicate a 600 mm surface water sewer located in Royal Lane to the west of the proposed site. Following a review of the site topography, there is a plausible flow route from this infrastructure towards the proposed site buildings. Given the potable water main is a pressurised system, this infrastructure could pose a residual risk in the event of a pipe burst scenario.

However, Affinity Water have a legislative responsibility to undertake adequate maintenance and inspection regimes of the public water mains within the vicinity of the Proposed Site, such that the risk of pipe breach is considered low. As such, the risk of flooding from water supply has been considered as a residual risk and no mitigation is required.

4.9.2 Sewer Infrastructure

Following a review of the available Thames Water asset location search, as shown in **Appendix H**, there are several foul sewerage and surface water networks within close proximity to the Proposed Development, along Pield Heath Road, Colham Green Road and Royal Lane which surround the Proposed Development site. Following a review of the topography, in the event of a sewer surcharge, there are plausible flow routes from this sewer infrastructure along Pield Heath Road towards the Proposed Development given the topography gradually falls to the south. The existing sewer infrastructure along Pield Heath Road has a 225 mm internal diameter and is located at the beginning of the respective drainage networks, as such, the ability of these systems to generate large volumes of flow is considered unlikely. In the event that exceedance flows from this infrastructure did enter the site, these would likely be intercepted by the Proposed Drainage network and as such, would not pose a risk to the site. In addition, Thames Water, have a legislative responsibility to undertake adequate maintenance and inspection regimes, such that the risk of pipe surcharge is considered low.

As such, the risk of flooding to the site from the failure of sewer infrastructure is considered to be low.

4.9.3 Impact of Climate Change on Sewer and Water Supply Infrastructure

As discussed in **Section 4.9**, a review of Thames Water Drainage Plans (**Appendix H**), in the event of a sewer surcharge, there are plausible flow routes from this infrastructure along Pield Heath Road towards the Proposed Development due to a gradual slope in topography. Thames Water as a designated Risk Management Authority have a legislative responsibility to undertake adequate maintenance and inspection regimes and as such the risk of pipe surcharge is considered low. As such, the risk of increased sewer and water main flooding to the site as a result of climate change is considered to be low.

4.10 Flood Risk from Canal Systems

Canals do not pose a direct flood risk given they are regulated water bodies with controlled water levels; however, flooding can still occur through a breach or overtopping. Control structures such as weirs or locks could experience a blockage or failure resulting in rising water levels and overtopping. Structural failure could lead to a breach which can potentially be hazardous as they may involve the rapid release of large volumes of water at high velocity.

A review of the Canal and River Network Mapping[21] from the Canal and River Trust shows the Grand Union Canal as the nearest canal to the Proposed Development which is located approximately 1.5 km west of the site. The Grand Union Canal is not within close proximity to the Proposed Development and there are no likely plausible flow routes from this feature to the site as the canal is situated at a lower elevation to the site. Therefore, the risk of flooding from the canal system is considered to be low.

4.11 Flood Risk from Reservoirs

Reservoir failure can be particularly dangerous as it causes the release of large volumes of water at a high velocity, which can result in deep and widespread flooding. However, reservoir inspection and design procedures are very rigorous such that the probability of failure is generally regarded as extremely low.

In accordance with the EA's flood map showing 'Risk of Flooding from Reservoirs'[22], the Proposed Development is not located within the extent of potential reservoir flooding. The nearest extent of reservoir flooding is from Ruislip Lido Reservoir where flows are channelled along the River Pinn Main River, approximately 0.5 km west of the site.

Given the site is not located within the extent of potential reservoir flooding, the risk to the site is considered to be low and no mitigation is required.

4.12 Flood Risk from Flood Risk Management Infrastructure

The nearest flood risk management infrastructure includes the River Pinn which is protected by high ground[23] and acts as a natural flood defence to reduce the extent of fluvial flooding, approximately 0.5 km west of the Proposed Development. The site is not located within an area considered to benefit from defences. As such, the risk to the Proposed Development from flood risk management infrastructure is considered to be low and no mitigation is required.

[21] Canal and River Networking Map [Online] Canal Map UK | UK Canal Network | Canal & River Trust (canalrivertrust.org.uk) Accessed 07/01/22

[22] Risk of Flooding from Reservoirs [Online] Learn more about flood risk - GOV.UK (check-long-term-flood-risk.service.gov.uk) Accessed 07/01/22

[23] Environment Agency Asset Management Map [Online] https://environment.data.gov.uk/asset-management/index.html Accessed 09/02/2022

4.13 Summary of Flood Risks to the Proposed Development

Flood Risk	Summary of Risk to Development Site (High/Medium/Low)	Notes	Mitigation Required
Main Rivers	Low	A review of the EA FMfP suggests that the Proposed Development is located in Flood Zone 1 and approximately 0.5 km east of the closest Main River, the River Pinn. A review of the topography suggests that the site is located at higher elevation and therefore there is no likely plausible flow route between the River Pinn and the Proposed Development.	No
Ordinary Watercourses and Land Drainage Systems	Medium	Three Ordinary Watercourses are shown to flow in close proximity to the Proposed Development. The closest being unnamed Ordinary Watercourse A which flows along the south eastern boundary of the Proposed Development site. Due to the fall in topography, the fluvial flood risk posed from unnamed Ordinary Watercourse B and C to the Proposed Development are considered to be low. The baseline hydraulic modelling results indicate that the southern area of the Proposed Development site is at risk from the 1 in 5 year up to and including the 1 in 1000 year event.	Yes Phase 1a – 300 mm heighted flood bund near the proposed hospital entrance Phase 1a – Raising the Oxygen Tanks on a 150 mm platform Phase 1a – Road Signage advising the southern access road is liable to flooding and develop an emergency flood action plan which details the safe access and egress routes Phase 1c – Option 2 is the preferred on-site flood risk mitigation option including a new flood relief culvert and fluvial basin. (Subject to detailed design) Phase 2 – Raising the FFLs at the residential properties at Plot P03 by 300 mm above the 1 in 100 year plus 21% CC flood level. The minimum FFL required is 38.213 m AOD. A 500 mm heighted wall which is dry-proofed is required along the southern perimeter of Plot P03. (Subject to detailed design) Phase 2 – Preparation of a Flood Risk Management Plan in collaboration with LBH
Tidal Sources	Low	The Proposed Development is located approximately 80 km west of the North Sea.	No