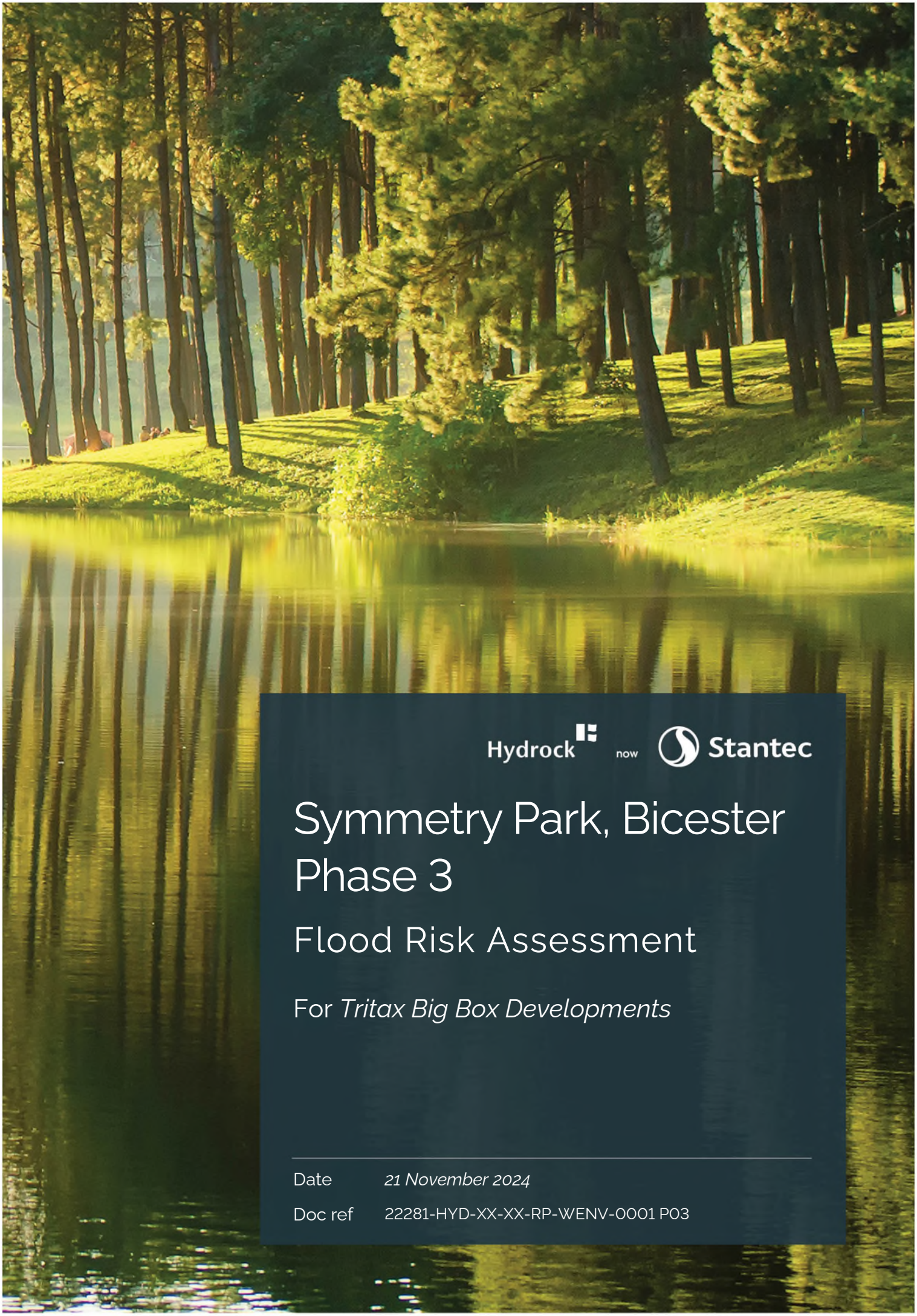

Hydrock now Stantec

Symmetry Park, Bicester Phase 3

Flood Risk Assessment

For *Tritax Big Box Developments*

Date	*21 November 2024*
Doc ref	22281-HYD-XX-XX-RP-WENV-0001 P03

Document control sheet

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P03	S2	21/11/2024	Final Issue for Planning

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1. Introduction

Hydrock Consultants Limited (Hydrock), now Stantec, have been commissioned by Savills on behalf of Tritax Big Box Developments (TBBD) to undertake a Flood Risk Assessment (FRA), to be submitted with a full planning application for a site known as Symmetry Park Bicester Phase 3, as part of the wider TBBD development.

This report has been completed in accordance with the National Planning Policy Framework (NPPF), updated December 2023, and its accompanying Planning Practice Guidance (PPG), updated February 2024. This report is an assessment of flood risk to the development, from on and off-site sources, and to off-site receptors arising from development at the site.

The report has been prepared to consider the requirements of the NPPF through:

- Assessing whether the proposed development is likely to be affected by flooding;
- Assessing whether the proposed development is appropriate in the suggested locations; and
- Detailing measures necessary to mitigate any flood risk identified, to ensure that the proposed development and occupants would be safe, and that flood risk would not be increased elsewhere.

2. Existing Site Conditions

2.1 Site Location

The site is located immediately adjacent to the existing Symmetry Park Bicester development.

The site is bound:

- To the north by undeveloped greenfield land;
- To the north-east by an industrial estate comprising a caravan dealer, metal recycling and car breakers yard;
- To the east by undeveloped greenfield land;
- To the south by the A41; and
- To the west by an 'Ordinary Watercourse', beyond which lies further commercial development associated with the existing Symmetry Park Bicester development.

The site currently comprises two larger and one smaller agricultural fields, with disused barns/agricultural buildings to the north-east. The site is located east of the existing Symmetry Park Bicester development (Bentley Designs, Medline and DPD).

The site address and Ordnance Survey information is available in **Table 1**, with the site location as **Figure 1.**

Table 1: Site Referencing Information

Site Referencing Information	
Site Address	Aylesbury Road, Oxfordshire, OX26 6WH
Grid Reference	SP 60649 20608 460649 , 220608

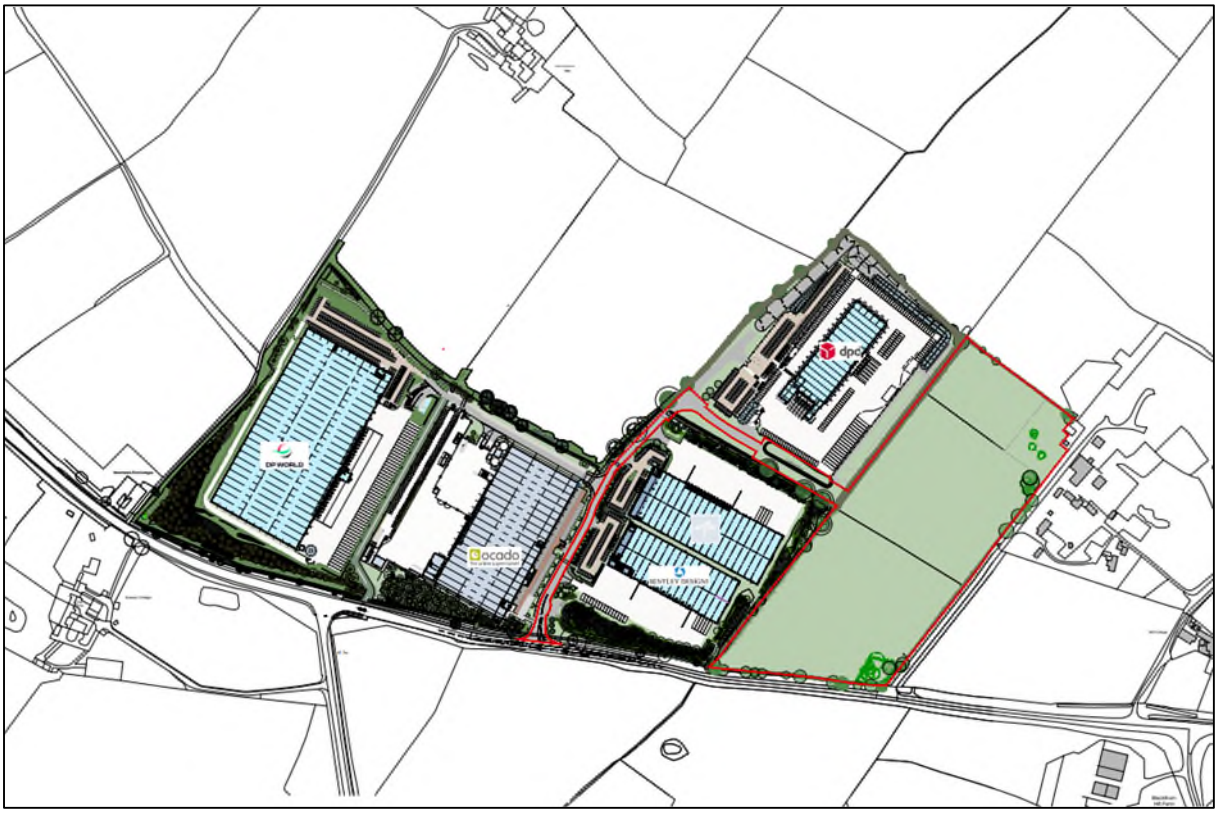


Figure 1: Site Location

2.2 Topography

A topographical survey of the site was undertaken by Greenhatch on behalf of TBBD (**Appendix A**) in 2024. The survey shows the site is relatively flat, sloping gently from 66.6 metres Above Ordnance Datum (mAOD) in the north east, to 64.36m AOD in the south west.

2.3 Hydrology

An unnamed Ordinary Watercourse (under the jurisdiction of Cherwell District Council as the Lead Local Flood Authority (LLFA)) is located adjacent to the site on the western boundary, flowing in a general southerly direction. The watercourse is culverted to the south-west of the site beneath the A41, before daylighting and becoming open channel in the undeveloped greenfield land beyond the A41.

2.4 Geology

According to British Geological Survey (BGS) geology mapping[1] [accessed September 2024] the site is underlain predominantly by bedrock deposits described as Peterborough Member (Mudstone). There are no records of superficial deposits on site. A more detailed account of the ground conditions on site, is available within the Preliminary Ground Conditions Technical Note (REF:22281-HYD-XX-XX-RP-GE-1004-S2-P01).

[1] BGS Geology Viewer (BETA)

According to the BGS directory[2] of historical borehole records, there are no historical boreholes within the vicinity of the site or within a 200m radius.

According to the EA's Aquifer Designation data, obtained from MAGIC[3] Map [accessed September 2024] the site is not considered to be located within the region of an aquifer.

According to Soilscapes[4] mapping, the site is located in 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with impeded drainage.

[2] GeoIndex - British Geological Survey (bgs.ac.uk)
[3] MAGIC (defra.gov.uk)
[4] LandIS - Land Information System - Soilscapes soil types viewer

3. Proposed Development

The proposed development comprises two distribution centres, with ancillary offices and associated hard standing, attenuation storage and landscaping. An access road is also proposed to cross the Ordinary Watercourse. The proposed site layout plan is presented in **Appendix B.**

The proposed site falls under the vulnerability classification of 'less vulnerable', in accordance with *Annex 3: Flood Risk Vulnerability Classification* of the PPG.

4. Planning Policy

4.1 National Planning Policy Framework (NPPF) (Updated December 2023)

The National Planning Policy Framework (NPPF) sets out the Government's planning policies, and how these policies should be applied. Planning Practice Guidance (PPG) is available online and provides additional guidance to the NPPF, as well as providing links to relevant detailed documents. Section 4.2 provides further detail on the PPG.

Paragraph 165 of the NPPF states "inappropriate development in areas at risk of flooding should be avoided by directing development away from areas of highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."

Paragraph 167 of the NPPF states "All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

- Applying the sequential test and then, if necessary, the exception test as set out below;
- Safeguarding land from development that is required, or likely to be required, for current or future flood management;
- Using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and
- Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

Paragraph 173 of the NPPF states "when determining planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location.
- The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.
- It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate.
- Any residual risk can be safely managed, and
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan."

In accordance with the NPPF, a site-specific FRA is required for sites within the following categories:

In Flood Zone 1, all proposals involving:

- Sites of one hectare or more.

- Land which has been identified by the EA as having critical drainage problems.
- Land identified in a strategic flood risk assessment (SFRA) as being at increased flood risk in the future.
- Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.
- All proposals for development in Flood Zone 2 and 3.

4.2 Planning Practice Guidance (PPG) (Updated February 2024)

The PPG provides additional direction to the NPPF, with details provided in each section of the document on how to conform to the NPPF.

All land in England is classified as falling into one of three main flood zones, with the zones referring to the probability of river or sea flooding, ignoring the existence of defences. The PPG identifies and describes the EA flood zones as:

- Flood Zone 1: Low probability – land assessed as having less than a 1 in 1,000 annual probability of river or sea flooding (<0.1% Annual Exceedance Probability (AEP)).
- Flood Zone 2: Medium probability – land assessed as having between a 1 in 100 and 1 in 1,000 annual probabilities of river or sea flooding (1% - 0.1% AEP).
- Flood Zone 3: High probability – land assessed as having a 1 in 100 or greater annual probability of river flooding (≥1% AEP), or a 1 in 200 or greater annual probability of sea flooding (≥0.5% AEP).
- Flood Zone 3b: The Functional Floodplain – land where water has to flow or be stored in times of flood (as identified by the LPAs in the SFRA).

The PPG requires drainage systems for new development to treat surface water at source using SuDS where practicable, to mimic natural conditions.

The current PPG sets out the following drainage hierarchy that the discharge of surface water runoff should adhere to:

- Into the ground (infiltration).
- To a surface water body.
- To a surface water sewer, highway drain, or another drainage system.
- To a combined sewer.

4.3 Cherwell District Council Local Plan (2011-2031)

The local plan[5] was prepared following a detailed examination of the needs and challenges facing the towns, villages and rural areas in the Cherwell district. It aimed to provide a proactive, positive set of policies "to help our places thrive, to deliver essential and longer-term infrastructure and achieve development that will improve the quality of life in the district".

The most relevant policy to this report is 'Policy ESD 6 - Sustainable Flood Risk Management'.

[5] The Cherwell Local Plan 2011-2031. Cherwell District Council. July 2015.

4.3.1.1 *Policy ESD6 Sustainable Flood Risk Management*

This policy states that "*The Council will manage and reduce flood risk in the District through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary, the exceptions test as set out in the NPPF and NPPG.*"

4.4 Cherwell Local Plan Review 2042

The Site is identified in the Cherwell Local Plan Review 2042 (Regulation 19) Proposed Submission Plan, which was published on 4th November 2024, and is due to go out for public consultation in December 2024. The Site is identified as a preferred employment site allocation and an extension to the successful Symmetry Park Phases 1 and 2. The allocation is for employment uses E(g)(i)/(ii)/(iii)/B2/B8 floorspace (Site Reference BIC 5).

4.5 Cherwell District Council Level 1 Strategic Flood Risk Assessment

The CDC Level 1 SFRA has been reviewed, produced by Wallingford HydroSolutions Ltd in November 2022. The site is listed as a preferred employment site, reference LPR21B - Land adjacent to Symmetry Park. Within this document, it is stated that the site should be suitable for all development types, with "more vulnerable" development in areas at lowest risk and "less vulnerable" development within areas at higher risk where necessary.

5. Sources of Flood Risk

The NPPF requires flood risk from the following sources to be assessed:

- Tidal and fluvial sources (sea and river flooding);
- Pluvial sources (flooding resulting from overland flows);
- Groundwater sources;
- Sewer flooding; and
- Artificial sources, canals, reservoirs etc.

Each of these sources are addressed separately below.

5.1 Tidal Flood Risk

Due to the site's distance from a tidal waterbody and its ground elevation of approximately 64m AOD, the risk of tidal flooding is considered 'negligible'.

5.2 Fluvial Flood Risk

According to the Environment Agency's (EA) Flood Map for Planning (**Figure 2**), the site is entirely located within Flood Zone 1 (Low Probability). The CDC Level 1 SFRA claims that the fluvial risk of flooding to the site is low.

An unnamed Ordinary Watercourse (under the jurisdiction of the LLFA, Cherwell district council) is located adjacent to the site on the western boundary, flowing in a general southerly direction. The watercourse is culverted to the south-west of the site beneath the A41, before daylighting and becoming open channel in the undeveloped greenfield land beyond the A41. This is represented on the Flood Map for Surface Water held by the EA and is therefore discussed further in the following section.

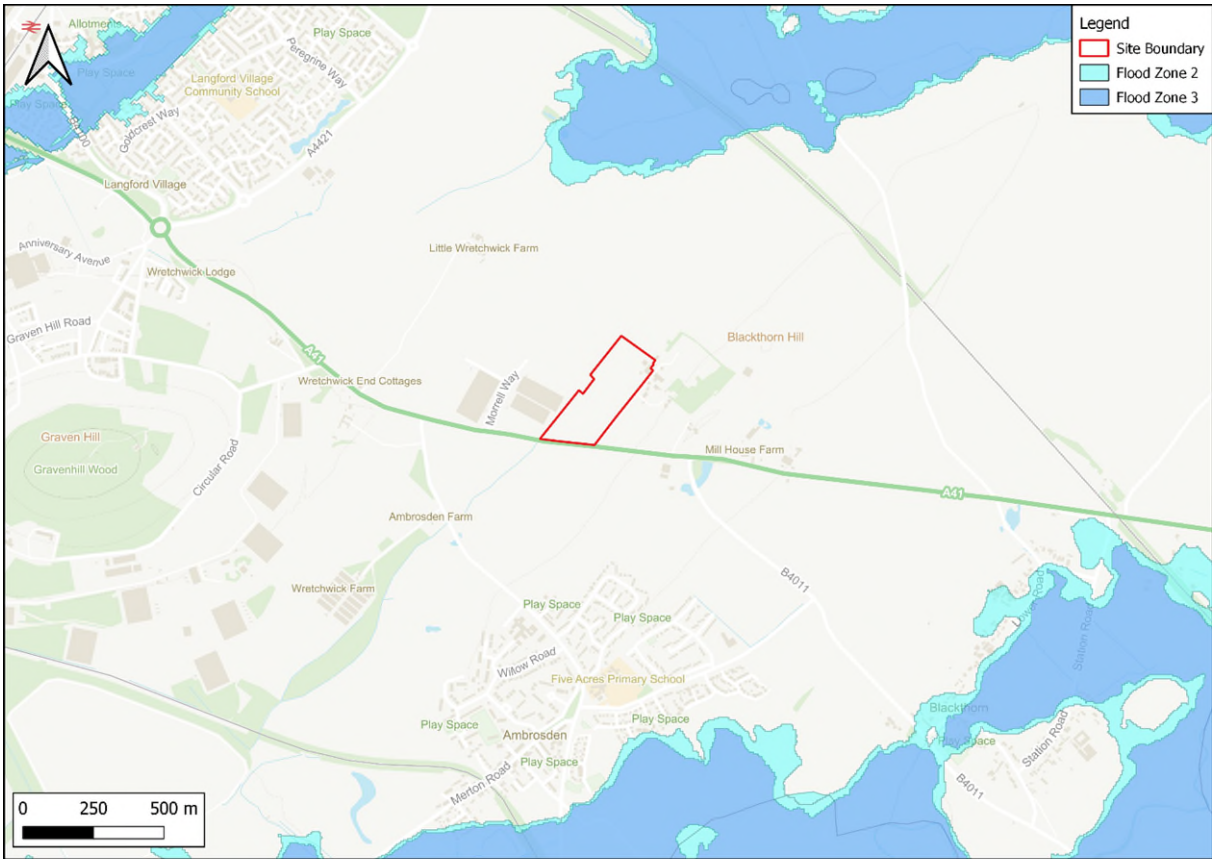


Figure 2: Flood Map for Planning

5.3 Surface Water Flood Risk

Surface water (pluvial) flooding is caused by rainfall levels exceeding the natural infiltration properties of the surrounding soils. Flooding can also occur owing to the absence of a natural method of drainage such as watercourses or ditches, or where soil infiltration rates are low. Flooding often results in ponding of water at low points or when surface water flow routes are blocked by an obstruction.

The EA's Surface Water Flood mapping (Figure 3) shows the western and south western extents of the site as being at 'low' to 'high' risk of surface water flooding.

Most of the flood extents are categorised as 'Low' risk (0.1-1% annual probability), with the south western portion of the site indicated as being at 'Medium' (1-3.3% annual probability) to 'High' (>3.3% annual probability) risk of flooding from this source.

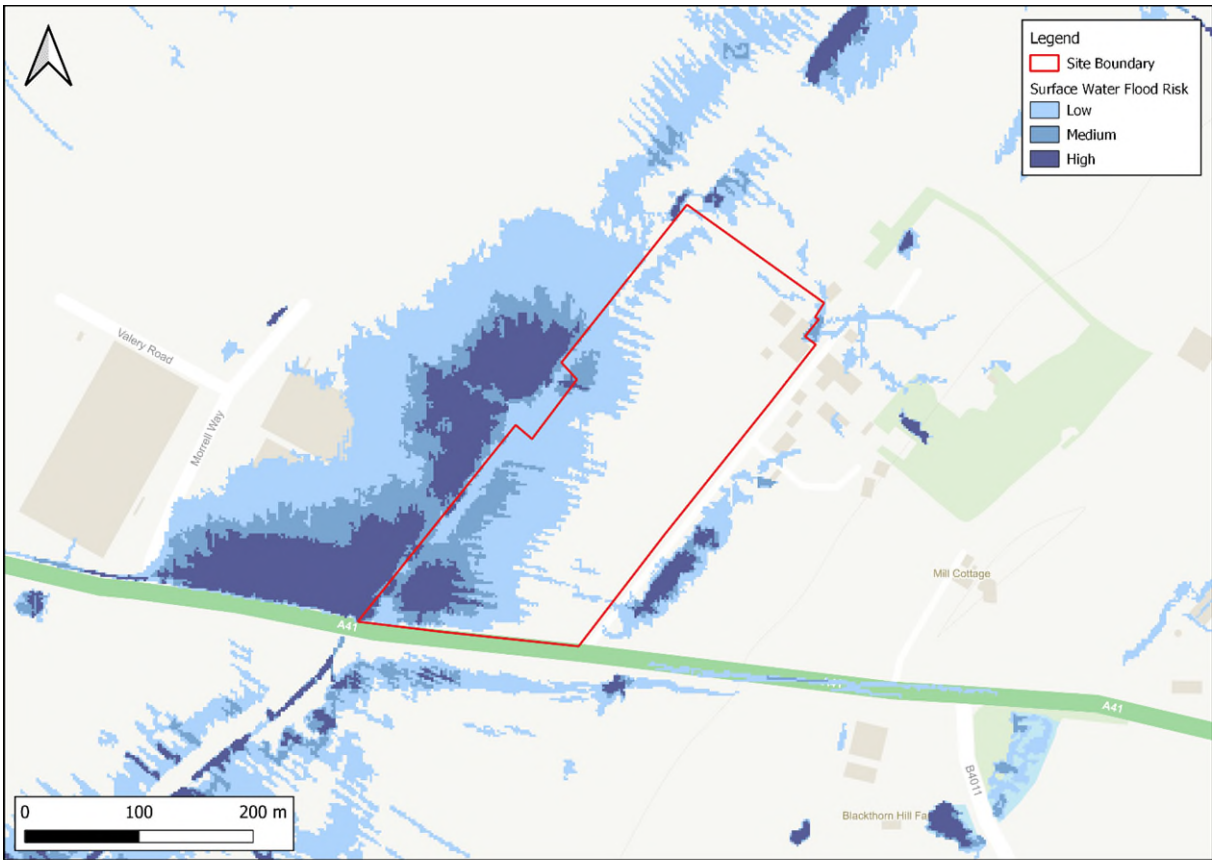


Figure 3: Surface Water Flood Map

It is considered that these flood extents are associated with the Ordinary Watercourse on the western boundary of the site. This was also identified and highlighted in the FRA previously produced by Hydrock in 2020 for the neighbouring 'DPD' site (REF:10942-HYD-XXX-XXX-RP-FR-0002), where a detailed hydraulic modelling study was undertaken to confirm the site-specific flood extents and depths and support planning application reference 19/02714/SO.

The 2020 hydraulic model has been reviewed and updated for this site to inform the FRA. A separate Hydraulic Modelling Technical Note covering the updates can be found as **Appendix C**.

5.3.1 Hydraulic Modelling Summary (2024)

5.3.1.1 Baseline

An updated 1D-2D TUFLOW-ESTRY hydraulic model has been produced covering the site, as an update to the previously produced hydraulic model in 2020.

The flood events modelled are as follows:

- 1 in 30 year (3.3% AEP)
- 1 in 100 year (1% AEP)
- 1 in 100 year + 15% Climate Change (CC) Allowance (1% AEP + CC)
- 1 in 1000 year (0.1% AEP)

As shown in Figure 4, the site is predominantly outside of flooding in the north and eastern sections.

The updated modelling results indicate that the south west of the site is at 'medium' (1% AEP) to 'low' (0.1% AEP) risk. Notably, it shows no areas of "high" risk (3.3% AEP) at the site, with the "low" (0.1% AEP) risk area smaller than that shown on EA mapping, particularly in the north and west of the site.

Figure 4: Modelled Flood Extents (Baseline Scenario)

The maximum modelled flood levels and their associated on site flood depths, at three locations (Figure 5), are shown in **Table 2** for the events modelled.

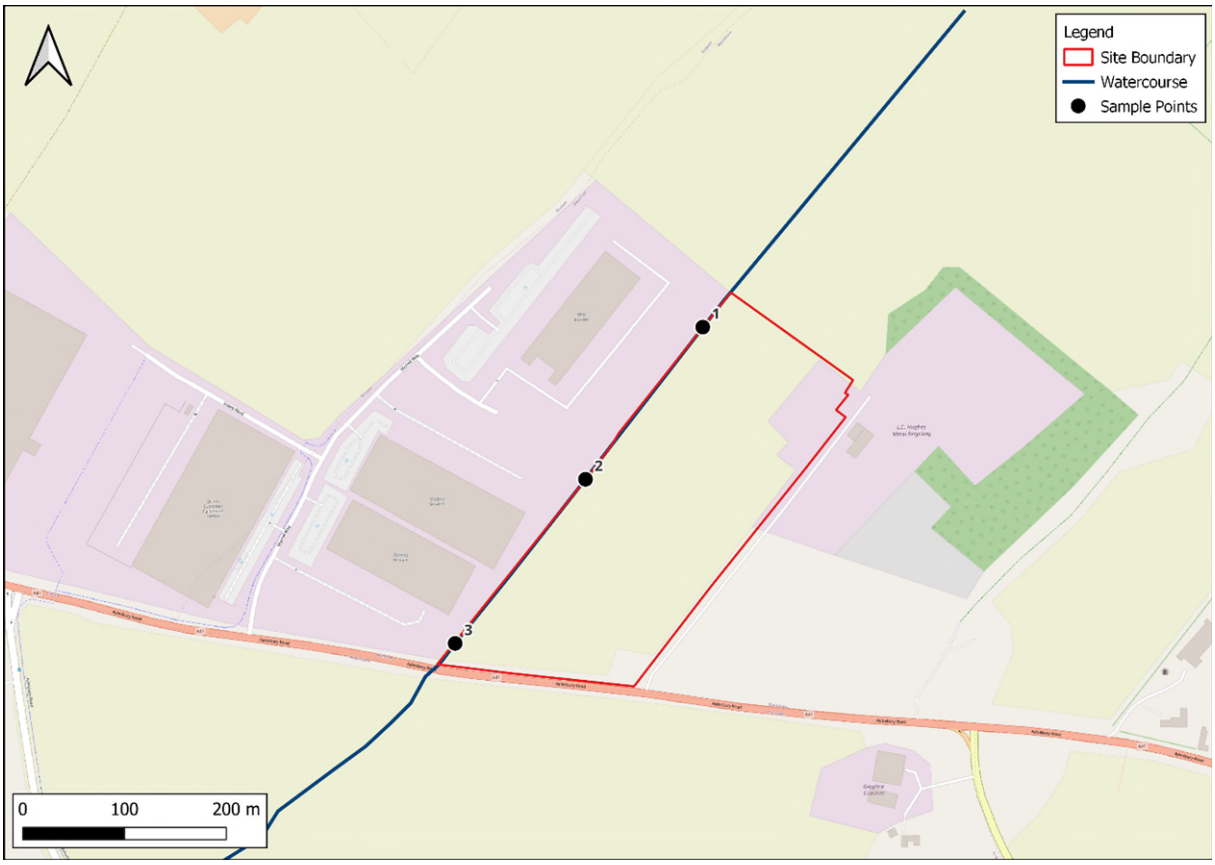


Figure 5: Sample point locations

Table 2: Maximum Modelled Flood Levels on site (baseline Scenario)

Return Period	Maximum Flood Level (m AOD)			Maximum Associated Flood Depth on site (m)
	Sample Point			
	1	2	3	
3.3% AEP	64.92	64.64	64.54	N/A (in channel)
1% AEP	64.98	64.73	64.70	0.30
1% AEP + 15% CC	65.00	64.78	64.76	0.36
0.1% AEP	65.07	64.87	64.86	0.46

5.3.1.2 *Proposed Scheme*

To reduce the risk of flooding to the proposals, it is recommended to raise the Finished Floor Levels (FFLs) and some external areas of the site to form a development plateau. Guidance suggests that commercial units should be a minimum of 600mm above the flood level for the 1% AEP + 15% CC event. In this instance, FFLs for Unit F (south) and Unit E (north) will be raised to 65.50m AOD and 66.10m AOD, respectively. This information is displayed in Table 3 below.

Table 3: Freeboards

Unit	Adjacent Design Flood Level (m AOD)	FFL (m AOD)	Freeboard (mm)
F (south)	64.78 (sample point 2)	65.50	720
E (north)	65.00 (sample point 1)	66.10	1100

Based on the information above, the units will be safe for the anticipated lifetime of the development, including the impacts of climate change. Further information on proposed ground levels can be found within the drainage strategy report (REF:22281-HYD-XX-XX-RE-C-0001).

Further features of the proposed scheme to note comprise the following items:

- 6 no. bunds ranging from 3m to 1.5m high along the south west, east and north side of the site;
- A 1.2m wide by 1m high rectangular culvert to carry the Ordinary Watercourse beneath the proposed access road. This has been sized to accommodate the design event flow (1% AEP +15%CC); and
- Lowering ground levels to the north of the bund by 950mm, creating a 1,217 m3 mitigation basin connected to the watercourse via a swale. This has been incorporated into the scheme to ensure there are no impacts to flood risk offsite.

The proposed ground raising/bunds, access road culvert and lowering of levels have been represented in a "post-development" model. The "proposed" flood extent for the 1% AEP + 15% CC design event is shown in Figure 6.

Figure 6: Post development 1% AEP+15%cc flood extent

A review of the post-development modelling results confirms that the proposed mitigation strategy is effective in containing flooding within the designated mitigation areas. The proposed industrial units are not at risk of flooding, and the proposed rectangular culvert is shown to accommodate the design event flow (1% AEP +15%CC - 0.89m3/s).

In order to quantify the impact of the proposals on flood risk off site, the baseline model results have been compared to the "proposed" scheme model results in terms of changes in flood level. As shown in Figure 7 overleaf, the development does not result in any detrimental impact on flooding outside of the site boundary. The proposed scheme also results in slightly reduced flood extents and a 20mm reduction in flood level to the service yard on the adjacent Bentley site.

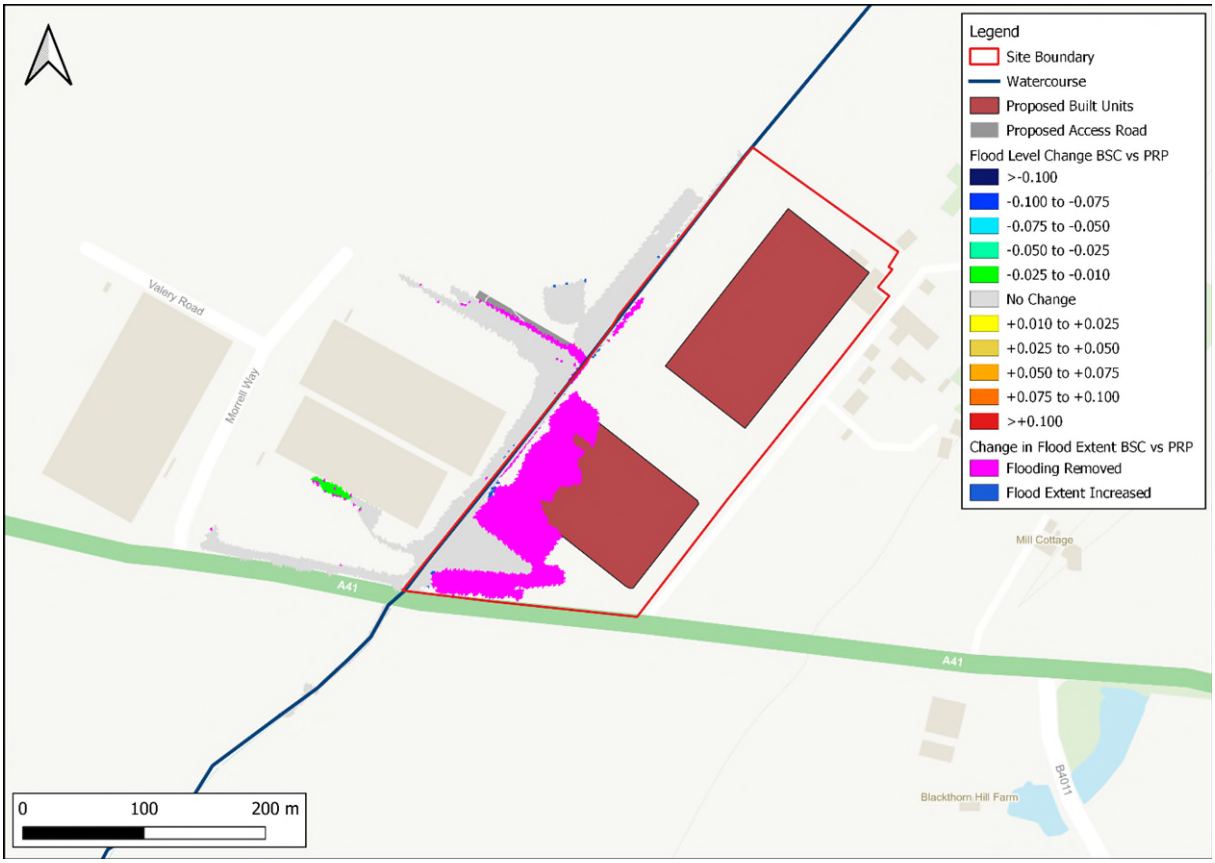


Figure 7: Change in flood level (baseline vs proposed) - 1% AEP+15%cc event

The majority of the proposed development is situated outside of the existing flood risk area in order to follow a sequential approach to mitigating flood risk at the site, whereby flood risk is first avoided. There are however some limited areas of the proposed development (less vulnerable and water compatible uses) that would fall within the existing flood risk area. The modelling demonstrates that raising the less vulnerable development to a safe level, and providing a flood mitigation area to the south, result in no detrimental impact on flood risk.

With the implementation of the above mitigation measures, the site is considered to be at low risk from surface water flooding.

5.4 Groundwater Flood Risk

Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Periods of prolonged rainfall may also be a cause of groundwater flooding, with aquifers and soils becoming saturated.

The CDC Level 1 SFRA indicates that the risk of groundwater flooding to the site is low. The Ground Conditions Technical Note ref 22281-HYD-XX-XX-RP-GE-1004 provides a summary table of groundwater levels over the monitoring period of August 2024. This shows a minimum depth to groundwater of 4m.

Overall, the risk of groundwater flooding is considered low. Any residual risk would be mitigated by the raising of levels specified in the site wide earthworks strategy, the risk of flooding from groundwater to the developed areas of the site is anticipated to be low.

5.5 Sewer Flood Risk

Flooding can occur owing to the failure of existing foul or surface water drainage infrastructure. If flows within the drainage system exceed the designed capacity or foreign matter causes blockages, overflow to the surface can occur, leading to flooding.

Thames Water were consulted during the production of the 2020 FRA and confirmed that there had been no reported incidents of sewer failure due to lack of hydraulic capacity within the public sewer networks in this area. Confirmation of this has been requested and a response is awaited.

There are existing sewer systems within the vicinity of the site, however these serve the adjacent sites beyond the watercourse within Symmetry Park. Therefore, the site is deemed to be outside of the immediate extents of this risk owing to the design criteria of the adjacent sewer systems and the presence of the Ordinary Watercourse that would intercept flows in the event of surcharge.

Therefore, the site is considered to be at low risk of flooding from sewer flooding.

5.6 Artificial Sources of Flood Risk

Failure and overtopping of reservoirs and navigable water bodies, and failure of water mains, constitute the primary means of flooding from artificial sources.

The EA Reservoir Failure Extent mapping **(Appendix D)** shows the site to lie outside of the extents of potential reservoir flooding.

There are also no canals located at the site or in the surrounding areas. Therefore, the site is not considered to be at risk from artificial sources of flood risk.

5.7 Flood Risk Summary

The updated modelling indicates that the south western section and far west of the site is at risk of flooding from a 1% AEP event - no development is proposed in these areas.

FFLs for the proposed buildings, as well as some external areas, have been raised above design flood levels. The smallest freeboard amount is 720mm (unit F).

A 1.2m wide by 1m high rectangular culvert is proposed to take the proposed access road over the Ordinary Watercourse. This has been designed to accommodate the design event flow and analysis of the hydraulic modelling results shows that it does not cause an increase to flood risk off site.

The mitigation strategy includes a lowered area to the south west of the site that can accommodate a volume of 1,217m3, which ensures that there is no increased risk of flooding offsite. A small reduction in flood risk to the service yard of the Bentley site is noted as a result.

Additionally, external ground levels have been designed to slope away from buildings, and to ensure, where applicable, overland surface water flow routes are directed away from and around buildings and entrances.

Access and egress to the site is proposed via a new connection to Morell Way in the west. The connection route is raised above the design flood level following incorporation of the access road and culvert into the model. Therefore, safe access/egress can be achieved.

With the implementation of the proposed mitigation measures, the site is considered to be at low risk of flooding from fluvial, tidal, surface water, groundwater, sewer and artificial sources.

6. The Sequential and Exception Test

6.1 Sequential Test

The NPPF requires that a sequential, risk-based approach is followed to steer new developments to areas with the lowest probability of flooding (i.e. Flood Zone 1, then 2, then 3). The site is shown to lie entirely in Flood Zone 1 according to the EA FMfP.

Part of the development plateau lies within the baseline flood extent for the design event. However, the proposed mitigation measures demonstrate that flood risk can be managed to an acceptable level without increasing flood risk elsewhere, providing some betterment to the neighbouring site.

The site is identified in the CDC Consultation Draft Local Plan as a Preferred Employment Site Allocation for 6.3 hectares of Employment Land as an extension to the successful Symmetry Park Phase Bicester. The draft allocation is for employment uses E(g)(i)/(ii)/(iii)/B2/B8 floorspace (Site Reference LPR21B).

The CDC Level 1 SFRA also highlights the site to be preferred for employment use, stating that the site is suitable for all development types and that "less vulnerable" development can be considered in areas at higher risk where necessary. The site will also assist in contributing to key employment objectives in the emerging CDC Local Plan, namely Bicester Core Policy 70.

Considering the mitigation strategy, all built development will be located outside of areas at risk of flooding. Therefore, the site is considered to meet the requirements of the Sequential Test in this case.

6.2 Exception Test

The Exception Test is used where no suitable development areas can be found in low-risk areas, the risk of flooding is clearly outweighed by other sustainability factors, and the development will be safe for its lifetime, taking climate change into account. Paragraph 170 of the NPPF states that for the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh the flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Given that the proposed industrial units are classed as 'less vulnerable' uses, the Exception Test is not considered to be required in this instance. Notwithstanding this, the updated modelling has confirmed that flood risk will not be increased elsewhere, and that there will actually be a slight betterment on the service yard associated with the neighbouring Bentley development.

7. Conclusions

Hydrock, now Stantec, have been commissioned by TBBD to undertake a Flood Risk Assessment to be submitted with a planning application for the site at Symmetry Park Bicester.

The site is entirely located within Flood Zone 1 (Low Probability) according to the EA FMfP. The site is shown to be at largely very low risk of surface water flooding, with some areas of 'low', 'medium' and 'high' risk in the west and south west, as shown by the EA's Long Term Flood Risk map (Surface Water). An Ordinary Watercourse is present along the western boundary.

A hydraulic modelling study of the Ordinary Watercourse was undertaken and updated from a previous version of the model in 2020. This confirmed the south west and west of the site to be partially at-risk during events modelled from a 1% AEP event and above.

The proposed scheme includes the raising of a development plateau and FFLs, a rectangular culvert to take the proposed access road over the watercourse, and a lowered mitigation area in the south west of the site to ensure there are no impacts to flood risk off site. The minimum freeboard offered is 720mm (unit F). Analysis of the post development model confirms there to be no increase in flood levels off site as a result of the scheme, with a slight betterment recorded on the service yard associated with the neighbouring Bentley development.

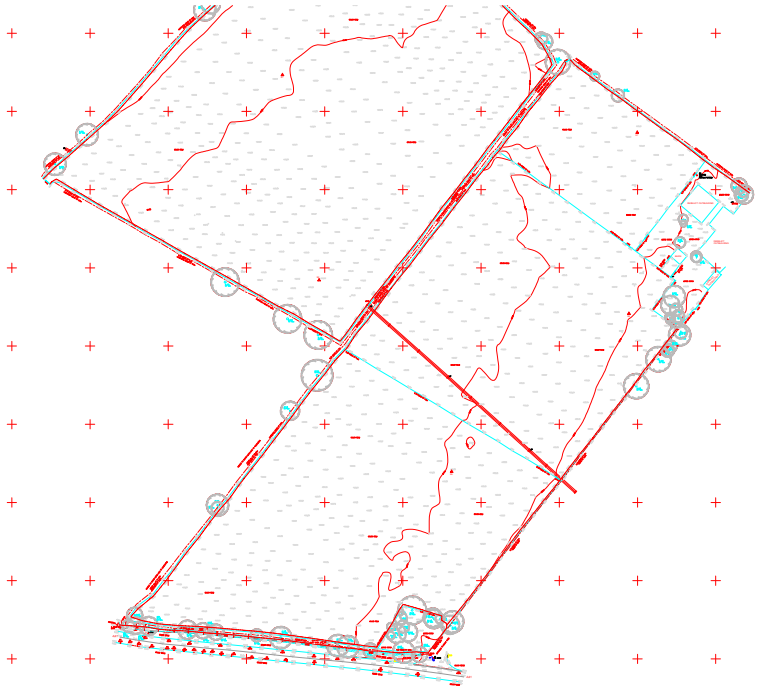
With the implementation of the overall mitigation strategy, it is concluded that the site is at a 'low' risk of flooding from all sources assessed within this report.

This report therefore demonstrates that, in respect to flood risk, the proposed development:

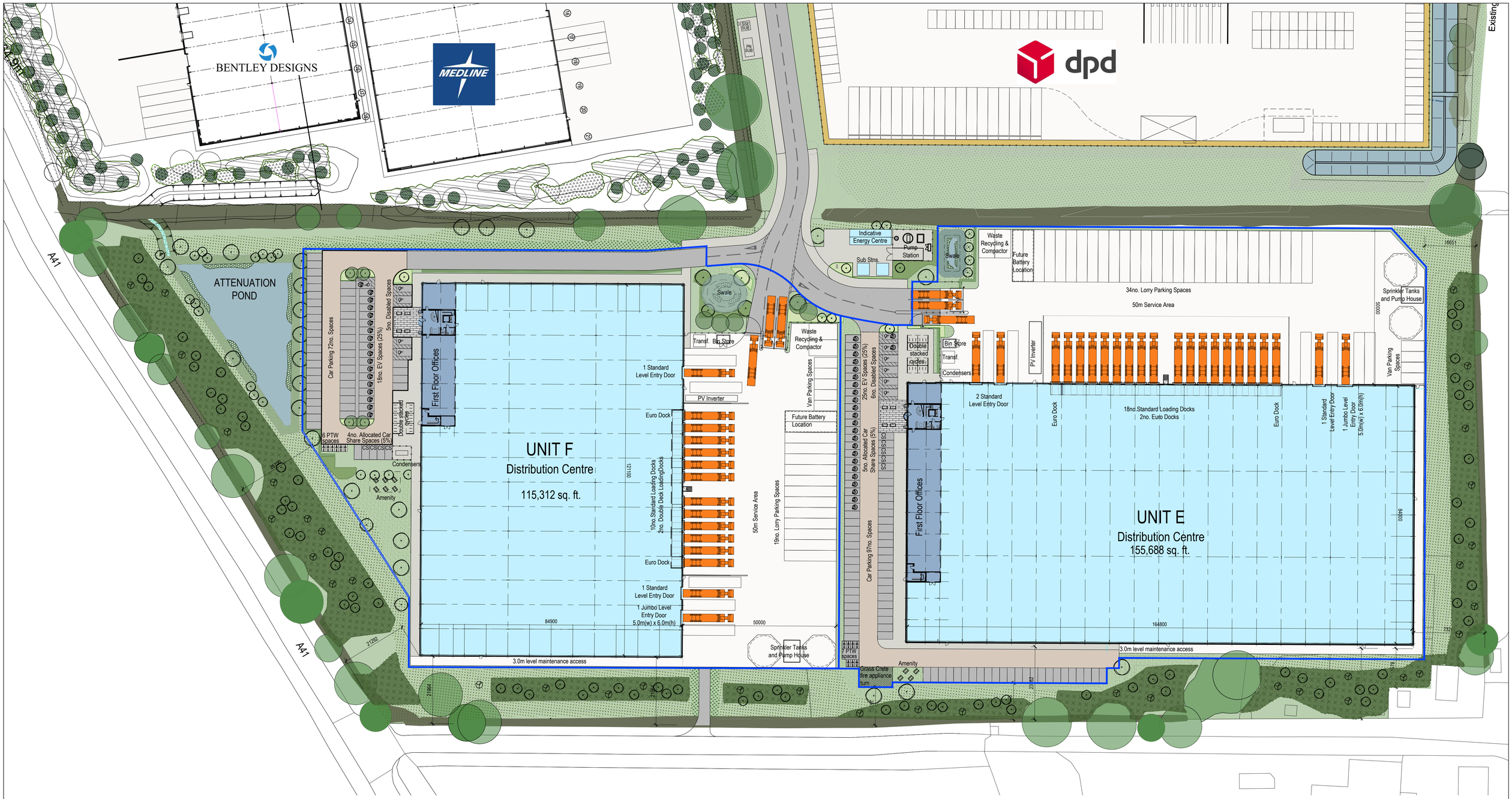
- Is suitable in the location proposed;
- Will be adequately flood resistant and resilient;
- Will not place additional persons at risk of flooding;
- Will not increase flood risk elsewhere as a result of the proposed development through the loss of floodplain storage or impedance of flood flows; and
- Will put in place measures to ensure surface water is appropriately managed.

This report concludes that in flood risk context, the proposals are safe and appropriate and do not increase flood risk.

Appendix A Topographic Survey



Appendix B Proposed Site Layout



Schedule of Accommodation											
All areas are Gross Internal											
	Distribution	Offices	Total	Site Areas	Loading Docks	Level Access	HGV Parking	Van Parking	Car Parking	Cycles	PTW
Unit E	147,680 sq. ft.	8,008 sq. ft.	155,688 sq. ft.	6.59 acres	16 2 euro docks	4 1 jumbo door	34	4	97 25% EV 6% accessible	85	7
	13,720sq.m.	744 sq.m.	14,464 sq.m.	2.67 hectares							
Unit F	109,382 sq. ft.	5,930 sq. ft.	115,312 sq. ft.	5.37 acres	10 2 euro docks	3 1 jumbo door	19	5	72 25% EV 6% accessible	71	6
	10,162 sq.m.	551 sq.m.	10,713 sq.m.	2.17 hectares							

Total Development	271,000 sq. ft.	11.96 acres
	25,177 sq.m.	4.84 hectares

Gross External Areas	Unit 06	14,836 sq.m. / 159,693 sq. ft.	
	Unit 07	11,020 sq.m. / 118,618 sq. ft.	
Gross Development Area			16.51 acres
			6.68 hectares

Key

Delineation of individual net plots

TRITAX BIG BOX

Rev		Date/Checked
PL01: Planning Issue. WE.		19.11.24. RM.

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WAREHOUSE DEVELOPMENT
LAND ADJACENT TO SYMMETRY PARK
BICESTER - PHASE 3

PROPOSED SITE LAYOUT

Issue Purpose:	PLANNING
Drawn by: MU	Checked by: SH
Scale @ A1: 1:600	Date: OCTOBER 2021
CAD ref: 4036-X3-001	Dwg no.: 4036-X3-SK030 Rev: PL01

Appendix C Hydraulic Modelling Technical Note

Hydraulic Model Technical Note

Project name	Symmetry Park, Bicester Phase 3		
Design note title	Hydraulic Modelling Technical Note		
Document reference	22281-HYD-XX-XX-TN-WENV-0001		
Author	Bethan Williams BSc (Hons) GradCIWEM		
Revision	P01		
Date	20 November 2024	Approved	✓

1. Introduction

This Technical Note has been prepared by Hydrock, now Stantec, on behalf of Tritax Big Box Developments (TBBD) to undertake hydraulic modelling for Phase 3, Symmetry Park, Bicester (hereon after referred to as 'the site').

The site is located entirely within Flood Zone 1 (Low risk) according to the Environment Agency's (EA) Flood Map for Planning and is shown to largely be at 'low' to 'high' risk of surface water flooding. Most of the flood extents are categorised as 'Low' risk (0.1-1% annual probability), with the south western portion of the site indicated as being at 'Medium' (1-3.3% annual probability) to 'High' (>3.3% annual probability) risk of flooding from this source. This is assumed to be associated with an unnamed watercourse located on the western boundary of the site that had not previously been hydraulicly modelled.

It is understood that this Technical Note will support the site-specific Flood Risk Assessment ((FRA) REF:22281-HYD-XX-XX-RP-WENV-0002), to be submitted with a full planning application. The proposed development will comprise two distribution centres, with ancillary offers and associated hard standing, attenuation storage and areas of public open space (POS).

1.1 Model History

Hydrock, now Stantec has previously undertaken hydraulic modelling for the adjacent site (known as DPD) in 2020 (Planning Ref: 20/00530/F) in which a Flood Risk Assessment (FRA) was produced and subsequently approved for the development (Report ref: 10942-HYD-XX-XX-RP-FR-0002). As such, this study aimed to update and convert the existing Hydraulic Model from the Flood Modeller format into the ESTRY format.

1.2 Aims

The aims of this study were identified as:

- Estimate updated peak flows for the study catchment for a variety of storm events;
- Further develop the model of the 1D domain (channel and in line hydraulic structures) using site-specific topographic and channel survey;
- Update the 2D domain of the floodplain to include the topography of the surrounding parcels of land (now developed);
- Hydrodynamically link the channel to the floodplain;
- Run the model for a range of storm events, from the 1 in 30yr event to the 1 in 1000yr event, including the latest climate change allowance where appropriate;
- Review the model results and compare to existing flood risk datasets;
- Undertake sensitivity analysis on key model assumptions such as roughness and structure blockages; and

» Run the model for a post development scenario.

In order to achieve these aims, a 1D/2D hydraulic model of the unnamed watercourse was converted to ESTRY/TUFLOW software. The model was based on the existing hydraulic model and watercourse survey (2020), with some further updates made to represent current topography. An update was also made to the peak flows to include the latest software versions and guidance.

1.3 Data Sources

The following sources of data were used to develop the hydraulic model:

» Environment Agency (EA) Flood Map for Planning (FMfP);
» EA Surface Water Flood Map;
» EA Recorded Flood Outlines Dataset;
» Site-Specific Topographic Survey (Greenhatch, 2024);
» Watercourse Survey (Hydrock, 2020);
» Topographic Survey for the "as built" DPD site (Hydrock);
» Topographic Survey for units A1/A2 (Hydrock, 2017);
» EA Fluvial Climate Change Allowances;
» LiDAR Composite Digital Terrain Model (dated 2022) at 1m resolution; and
» Topographic Surveys, Built Ground Levels and Proposed Ground Levels.

2. Hydrology

The hydrology was calculated by scaling the ReFH2 hydrographs to the peaks provided by the FEH statistical method. The FEH statistical method benefits from up-to-date peak flow data for hydrologically similar catchments. Climate change has been applied by using the central allowance for the 2080s, as the site sits within the Thames River Basin District and Cherwell and Ray Management Catchment (15%).

The overall catchment peak flows can be found below in Table 1. The peak flows were applied in their entirety to the upstream end of the modelled reach. As shown, the peak flows have increased since the 2020 version of the model due to the updated software versions and additional years of peak flow data.

Table 1: Catchment Peak Flows

Return Period	2020 Model Catchment Peak Flow (m3/s)	Updated Catchment Peak Flow (m3/s)
1 in 30yr	0.38*	0.59
1 in 100yr	0.51	0.82
1 in 1000yr	0.99	1.33
1 in 100yr + 15% climate change	0.68**	0.94

*Only 1 in 20yr available

**A higher climate change allowance was previously used (35%)

3. Baseline Hydraulic Model

TUFLOW's Heavily Parallelise Compute (HPC) Solver was used (version 2023-03-AC) which uses an adaptive timestep to solve the equations, with single precision chosen, the most common for HPC models. TUFLOW's built in 1D component, ESTRY, was used to model the 1D domain.

3.1 1D Domain

A summary of the key 1D model elements/updates can be found below:

- The 1D domain totals 0.6km in length, which matches the extent of the existing watercourse survey
- Manning's n (Chow, 1959) was used to define the hydraulic roughness, with river channel and structures given a value based on survey photographs. The most dominant channel type was open channel. Engineering judgment was used to input an appropriate value, with values ranging from 0.015 to 0.04 ; however, this has been sensitivity tested (see **section 3.5**).
- Boundaries were applied to the 1D domain as both flow-time (QT) and head-time (HT) points. The QT boundary was read into the upstream end of the model as a point inflow, with the HT boundary read into the downstream end of the model. The downstream boundary was based on a constant bank full level which has been sensitivity tested (see **section 3.5**).
- A total of 2 structures were included within the baseline model: a 0.55m circular pipe to carry the flow underneath the A41 and another a 0.61m circular to carry the flow beneath a small access crossing downstream of the A41. Invert levels were taken from the watercourse survey.

3.2 1D/2D Links

The domains were linked by using 'HX' links, which transfer the water level from the channel into the floodplain, providing that the levels of the cell they fall within is lower than the predicted flood level. The levels along the HX link were dictated by LiDAR and supplements with survey information, using a 2d_Zline THICK feature. Cross sections were trimmed in the 1D domain at these levels (where the top of bank is located).

3.3 2D Domain

The selected grid size of 2m provided a fine resolution across the site whilst achieving a good balance between resolution and model runtimes/output file sizes. The grid was orientated using a location line that was digitised in the predominant direction of flow.

Floodplain topography was based on a combination of a site-specific topographic survey, as built drawings for the Bentley and DPD site, which sit west of the site and watercourse, and a LiDAR Composite Digital Terrain Model (dated 2022) at 1m resolution.

Roughness in the floodplain was defined by the Mannings n coefficient, based on land use within the model active area. **Table 2** displays the values used within the TUFLOW Materials Files (TMF).

Table 2: Mannings n values

Land Use	Mannings n value
Natural land/long grass	0.045
Buildings	0.3
Woodland	0.07
Road, tracks and paths	0.022
Paved areas e.g., car parks	0.022

There were number of assumptions made during the amendment of the hydraulic model, there are as follows:

- The modelling exercise has made use of the available data and represents the floodplain and channel conditions at the time of the survey. In some areas, this would have been the 2020 dataset.
- The model contains no formal representation of the conveyance within minor watercourses or ditches other than that captures by the model grid and within the 1D model domain.
- The 2m resolution of the model may negate any small-scale topographic features, although all the significant features are believed to have been captured.
- The baseline floodplain levels are derived from a topographic survey, site specific existing ground levels and LiDAR Composite Digital Terrain Model (dated 2022)
- This further modelling exercise has been undertaken to produce a good representation of flood risk mechanisms in and around the study site. It has not been designed to accurately map flooding in the wider catchment.
- Generally, buildings have been modelled with a high roughness value in accordance with best practice, rather than by uniformly raising slab levels. However, the known slab level for the DPD site and Bentley site have been manually added to reflect current conditions.

3.4 Model Stability

The HPC solver used an adaptive timestep to solve the equations to find a balance between model stability and run time. A timestep that is required to drop below 1/10th of the model grid size (in this instance 0.2s) would be indicative of poor model stability.

As shown in the below figure, the timestep remained relatively steady over the whole duration of the simulation, indicative of good model stability. Nu, Nc and Nd values were also checked and shown to remain in the appropriate range. Flow and stage time series were checked throughout the model to ensure continuity of flow and smooth hydrographs, with no issues observed that would compromise results.

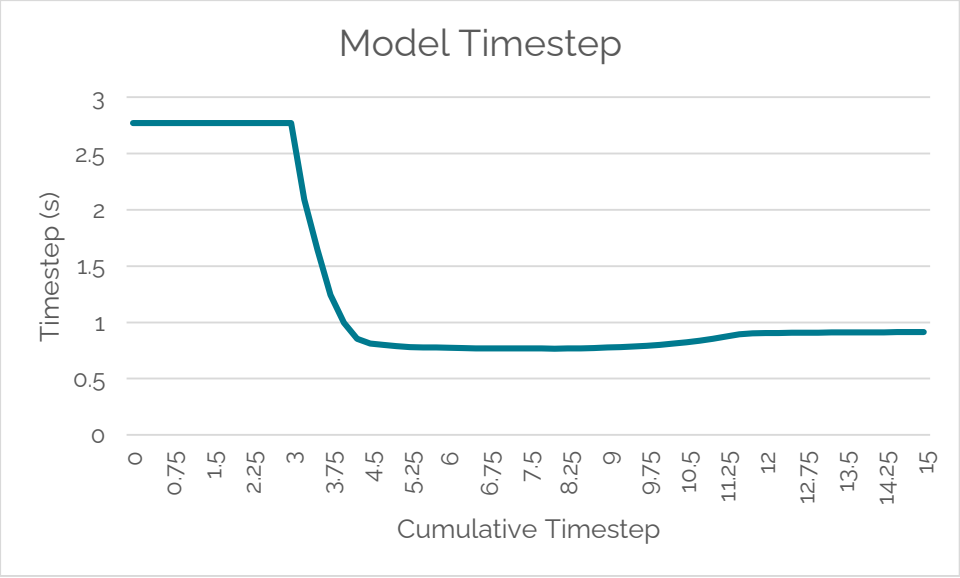


Figure 1: Model timestep over the 100yr+15% simulation

3.5 Sensitivity Tests

A number of sensitivity tests were carried out on the 1 in 100 year + 15% CC event to understand how the model results would be impacted in the event that several of the assumptions/parameters are altered. These are each described in more detail within their associated section.

3.5.1 Manning's N Roughness Coefficient

-20% Mannings n

The hydraulic roughness in both the channel and floodplain was reduced to provide an indication of the impact of winter seasonal conditions or if a flood event were to occur following channel maintenance i.e., where vegetation coverage was sparser. Greatest impact was evidenced within the south west of the site where flood levels reduced from 64.76m AOD to 64.73m AOD.

+20% Mannings n

The hydraulic roughness in both the channel and floodplain was increased to provide an indication of the impact of summer seasonal conditions or if a flood event were to occur following a period where the channel was not maintained i.e., where vegetation coverage was increased. Greatest impact was evidence within the central extents of the site where due to an increase in water levels, an area of floodplain upstream was susceptible to change (wider by 120m). Additionally, the south west of the site evidenced and increase in flood levels from 64.76m AOD to 64.78m AOD,

3.5.2 Structure Blockage

A structure blockage of 50% on the existing culvert beneath the A41 was tested in the model.

This blockage resulted in an increase in flood extents evidence within the site boundary, particularly within the south western extents. Flood levels showed an increase from 64.76m AOD to 64.85m AOD.

3.5.3 Downstream Boundary

The downstream boundary water level was increased by 0.3m to understand if the model results were sensitive to changes in downstream boundary conditions and what the potential backwater effect could be. The results confirm that the backwater effects remain downstream of the A41 and therefore remote from the site.

3.6 Baseline Results

The baseline flood extents are presented in **Figure 1** and peak flood levels for the modelled events at three locations are presented in **Table 3.**

Figure 2: Baseline Floodplain Extents

Table 3: Maximum Modelled Flood Levels on site (baseline Scenario)

Return Period	Maximum Flood Level (m AOD)			Maximum Associated Flood Depth on site (m)
	Sample Point			
	1	2	3	
1in30yr (3.3% AEP)	64.92	64.64	64.54	N/A (in channel)
1in100yr (1% AEP)	64.98	64.73	64.70	0.30
1in100yr+CC (1% AEP + 15% CC)	65.00	64.78	64.76	0.36
1in1000yr (0.1% AEP)	65.07	64.87	64.86	0.46

The baseline modelling results indicate that the south west of the site is at a 'medium' (1% AEP) to 'low' (0.1% AEP) risk. Notably, it shows no areas of 'high' risk (3.3% AEP) on the site during any of the return periods modelled in this study. Additionally, the 'low' (0.1% AEP) risk area is shown to be smaller than that of the EA surface water mapping. Particularly in the north and west of the site.

4. Post Development Modelling

4.1 Approach

Post development modelling was conducted for a proposed scheme on site, inclusive of the flood mitigation strategy.

Features of this proposed scheme to note comprise the following items:

- 6 no. bunds ranging from 3m to 1.5m high along the south west, east and north side of the site included as 2d_zsh layers;
- A 1.2m wide by 1m high rectangular culvert to carry the Ordinary Watercourse beneath the proposed access road;
- Lowering of ground levels to the north of the southern bund by 950mm, creating a 1,217m3 mitigation basin connected to the watercourse via a swale; and
- The raising of the site's ground levels and two built units proposed Finished Floor Levels (FFLs).

4.2 Post Development Modelling Results

The "proposed" flood extents for the 1% AEP + 15% CC design event are displayed in **Figure 2**.

The post development modelling results for the design event (**Figure 2**) confirm that the proposed mitigation strategy is effective in containing flooding within the designated mitigation areas.

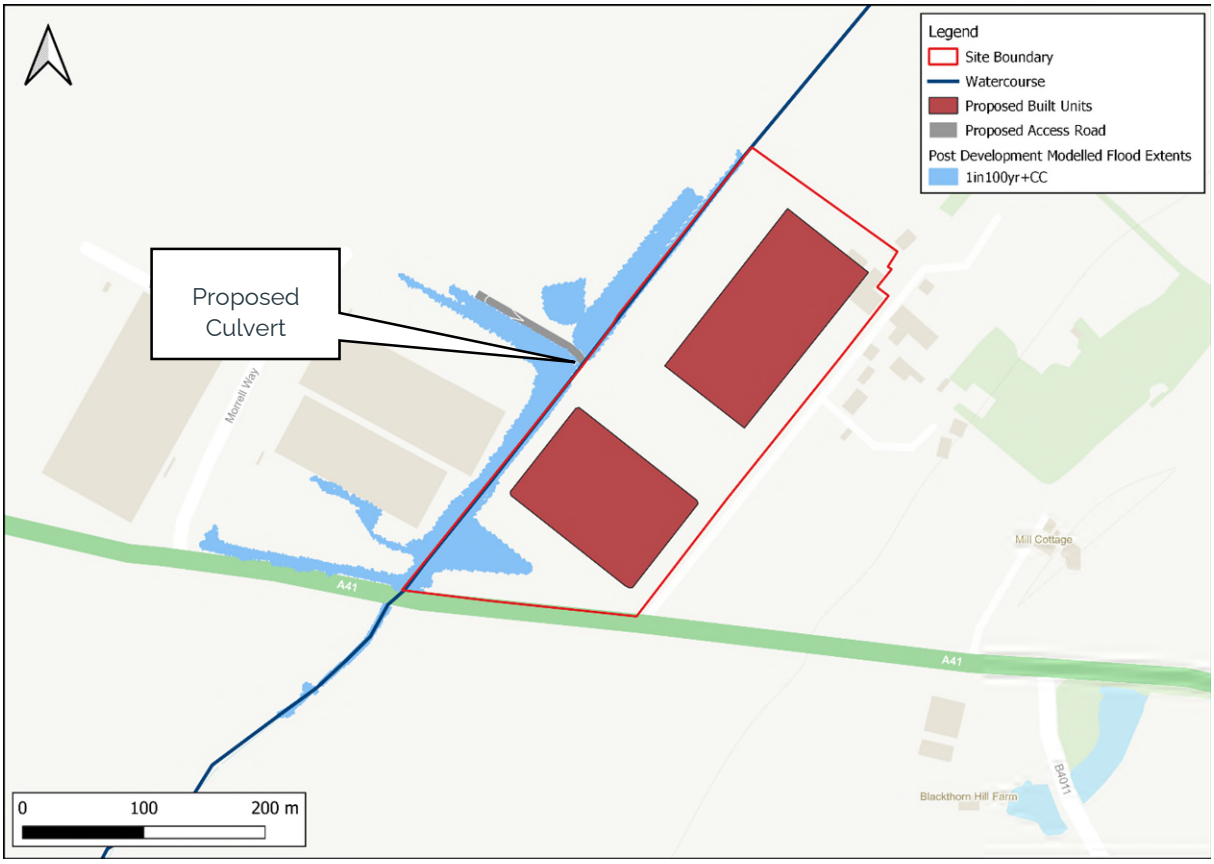


Figure 3: Proposed Floodplain Extents

4.3 Post Development vs Baseline

In order to quantify the impact of the proposals on flood risk off site, the baseline model results have been compared to the "proposed" scheme model results in terms of changes in flood level. As shown in **Figure 3**, the development does not result in any detrimental impact on flooding outside of the site boundary. The proposed scheme also results in slightly recued flood extents and a 20mm reduction in flood level to the service yard on the adjacent Bentley site.

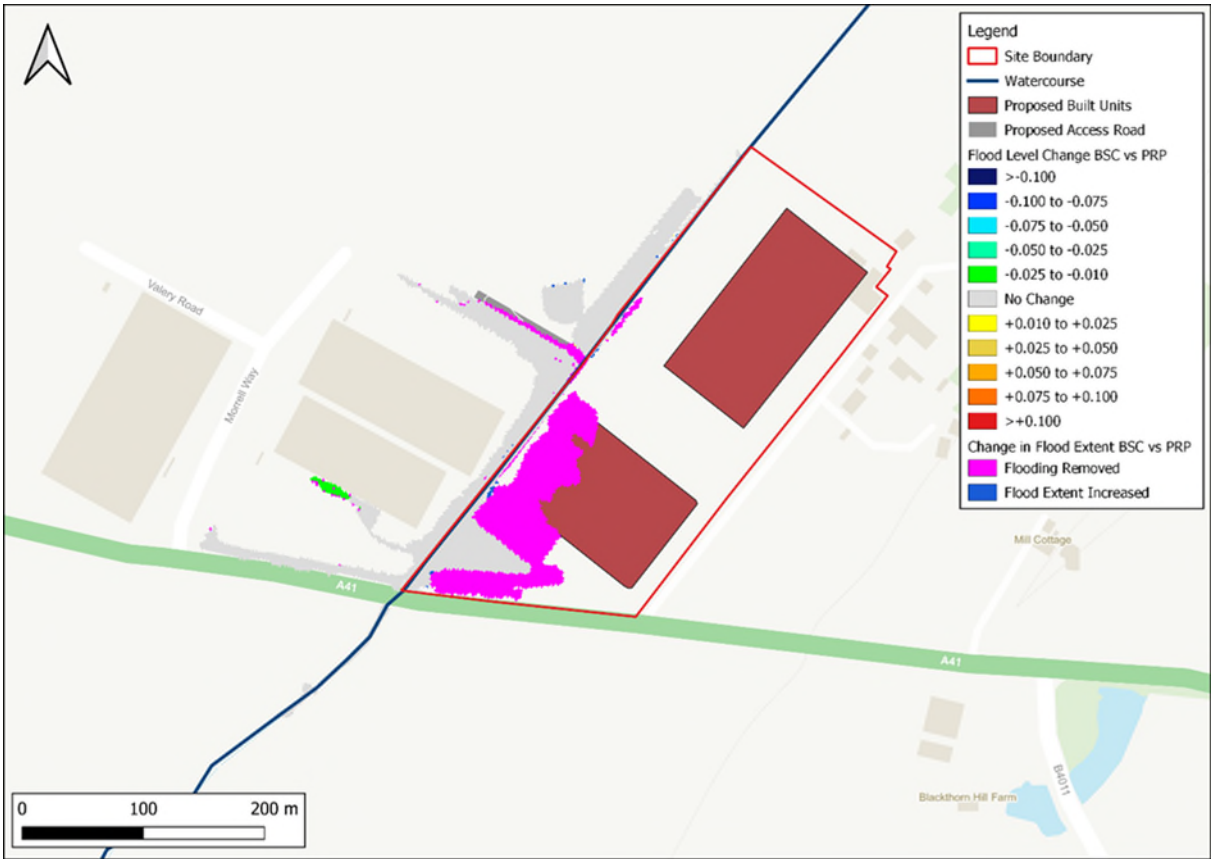


Figure 4: Change in flood level (baseline vs proposed) - 1% AEP+15%cc event

The majority of the proposed development is situated outside of the existing flood risk area in order to follow a sequential approach to mitigating flood risk at the site, whereby flood risk is first avoided. There are however some limited areas of the proposed development (less vulnerable and water compatible uses) that would fall within the existing flood risk area. The modelling demonstrates that raising the less vulnerable development to a safe level, and providing a flood mitigation area to the south, result in no detrimental impact on flood risk.

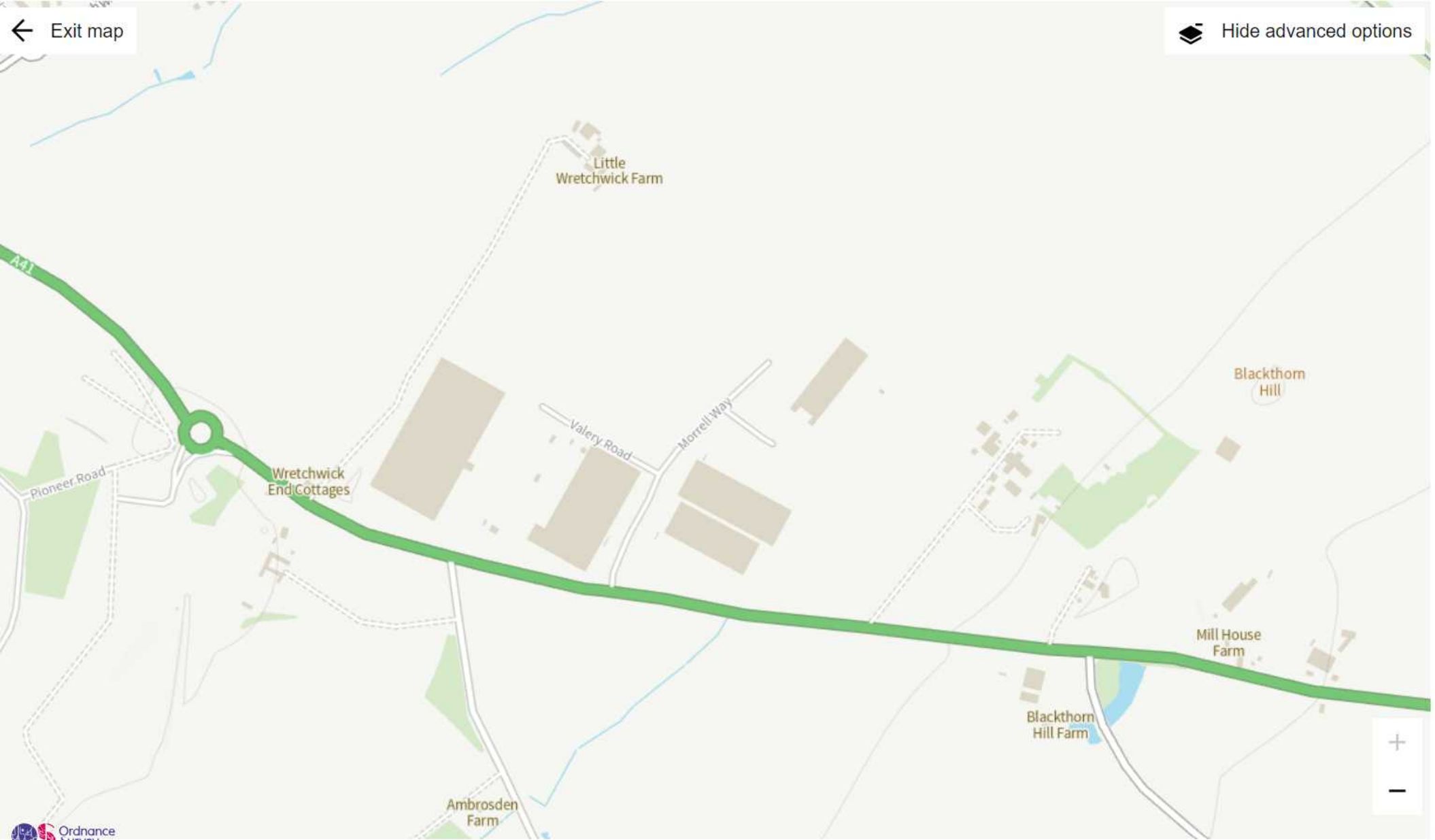
5. Conclusions

Hydrock, now Stantec, have been commissioned to undertake further detailed hydraulic modelling of an unnamed watercourse located within the proximity of the Phase 3, Symmetry Park site. The watercourse flows north to south, and exits the site boundary to the south west where it becomes culverted under the A41. This Technical Note described the updates made to the model and supports the Flood Risk Assessment ref: 22281-HYD-XX-XX-RP-WENV-0002.

When considering the aims and objectives set out in Section 1, the following conclusions can be made:

- A 1D/2D model has been updated based on an existing watercourse survey, new topographic data and as built information for the surrounding completed parcels of land (DPD and Bentley sites).
- The model has been run for a range of events from 1 in 30yr through to 1 in 1000yr, with the latest climate change included on the 1 in 100yr event (15%).
- The baseline model results show a reduction in flood extents when compared to surface water mapping. This is expected given the increased resolution and detail provided by the site-specific model e.g., geometry of the channel and hydraulic structures.
- Following a range of sensitivity analysis, the results are not overly sensitive to the change in parameters for Mannings n, blockages and increase in the downstream boundary water level.
- The post development model results show that the proposed mitigation strategy is effective in containing flooding and does not increase flood risk offsite.

Appendix D EA Reservoir Failure Extents



Key

Extent

Depth

Velocity

Rivers and the sea

Extent

Reservoirs

Extent

When river levels are normal

When there is also flooding from rivers

Map details

Show flooding

Selected address

Pause to updates of flood risk data

We have paused updates to information about flood risk from rivers and the sea and surface water while we get ready for new data.