Consultee	Key Theme	Consultee Comments/ Considerations
	Design Flood Event (DFE)	• The EA confirmed that it is appropriate to treat the 1 in100 with 26% allowance for climate change as the Design Flood Event (DFE) for the Site based on the 'More vulnerable' uses for the site. • Consideration needs to be given on whether the infrastructure on site is classified as 'Essential Infrastructure'. This should be considered as any infrastructure that is required to function during a flood and which serves a wider network other than the Site itself. The DFE for 'Essential Infrastructure' would be the 1 in 100 with 41% allowance for climate change.
	Finished Floor Levels (FFLs)	• EA confirmed a 300mm freeboard should be applied on top of the DFE level if permittable development located in Flood zone 2 or 3. • If development is in Flood Zone 1, a freeboard is not required to be applied. Although it was suggested to include this 300mm freeboard above the DFE level.
	Safe Access and Egress	• EA noted that this is often a critical matter on development sites and that features crossing the watercourses should be carefully considered. Bridge soffit levels would need to be designed to be above the DFE level with the addition of an appropriate freeboard. • EA noted that any land raising in the floodplain required to facilitate these crossings will need to demonstrate that the proposals do not increase flood risk and any solutions are feasible. • Once the flood extents have been defined, the impact of bridges and associated earthworks will need to be assessed.
OCC	Historic Flooding	• Information on historic flooding has been requested, OCC not aware of any records of flood risk in the vicinity of the site.
	8m easement	• Confirmation has been requested as to the LLFA's guidance on the requirement of an 8m easement from top of bank on the ordinary watercourses of the Site and what would be required as part of obtaining consent for works along these ditches. At the time of publishing this report, no response had been received on this matter.
	Surface Water Drainage Strategy	• At the time of publishing this report, the meetings to date have been used to present the overarching principles and the key engineering constraints to the SWD strategy. The LLFA confirmed the approach to restrict discharge rates from the Site to QBAR runoff rates. • Further liaisons will be had with the LLFA as the project develops to ensure that local guidelines and design requirements are met.

Consultee	Key Theme	Consultee Comments/ Considerations
CRT	Oxford Canal	• Confirmation that there are no current outfalls/ discharge points between Lock 42 and 44 (Information included in Appendix C). • Control levels given for the pounds above Lock 43 and 44, in the vicinity of the site. • Information on historic flooding has been requested multiple times, no response has been received at time of issue.

It is noted that as of the end of July 2023, Buro Happold have received no comment from the EA on the Hydraulic Modelling Strategy Technical Note.

3 Appraisal of Existing Flood Risk

3.1 Overview

This section evaluates the sources of flood risk to the existing Site. In this section the following sources of flood risk are evaluated:

- Historic Flooding
- Flooding from rivers (fluvial);
- Flooding from the sea (tidal);
- Flooding from surface water runoff (pluvial) and sewer surcharge;
- Flooding from groundwater; and
- Flooding from artificial sources.

3.2 National Planning Policy Framework

3.2.1 Flood Risk Zone Classification

The EA 'Flood Map for Planning (Rivers and Sea)' indicates that the Site lies within the three Flood Zones as shown in Figure 7, as follows:

- The majority of the Site sits within Flood Zone 1;
- Areas either side of the Rowel Brook across the north of the Site are in Flood Zone 2 and Flood Zone 3a;
- A large proportion of the east of The Site are in Flood Zone 2 and Flood Zone 3a.

There is no risk of tidal flooding at the Site.

The Environment Agency flood maps do not include an allowance for climate change and it is noted in the Level 2 SFRA that the drainage ditch at the south of the Site is unlikely to have been hydraulically modelled if its catchment area is <3km^2. This drainage ditch is culverted underneath the A44. There is a potential risk that if this culvert became blocked or the capacity was exceeded, that water could back up onto The Site and create localised flooding.

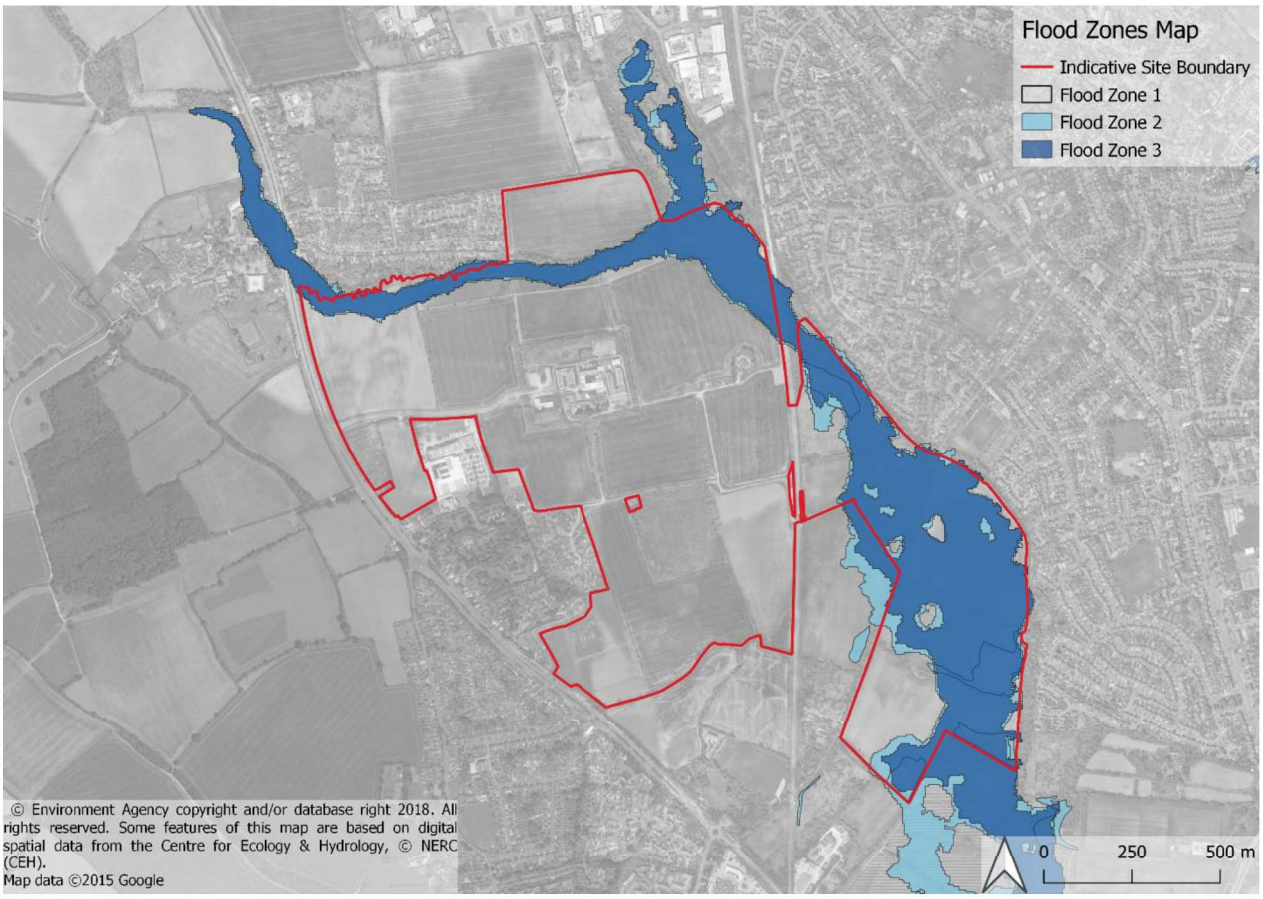

Figure 7 EA flood maps for planning shows present day flood zones

3.3 Historic Flooding

The EA Historical Flood Map illustrates small areas to the east of the railway line that have experienced historical flooding (Figure 8). The Level 2 SFRA Addendum identifies that this is as a result of fluvial flooding. The mapping also indicates that there have been a further four reported incidents of fluvial flooding, from ordinary watercourses, within 200 m of the Site.

The Level 2 SFRA Historic Flooding Incidents Map for the Site records 6 flooding incidents reported to the LLFA regarding drainage issues, however all of which are outside of the Site boundary.

Further consultation has been had with the EA, LLFA, CRT and Thames Water, with all parties sharing no further known historic flooding events in or in the locality of the Site.

Yarnton Flood Group have been engaged with as part of wider consultation for the Proposed Development. Discussions have been held with the Yarnton Flood Group and Begbroke Parish Council by OUD in order to understand both historical and current flooding issues observed in the local community. Local mapping was provided by Yarnton Flood Group which indicates that numerous sources of flood risk coupled with hydraulic capacity issues in the local drainage network combine to cause flooding to the community.

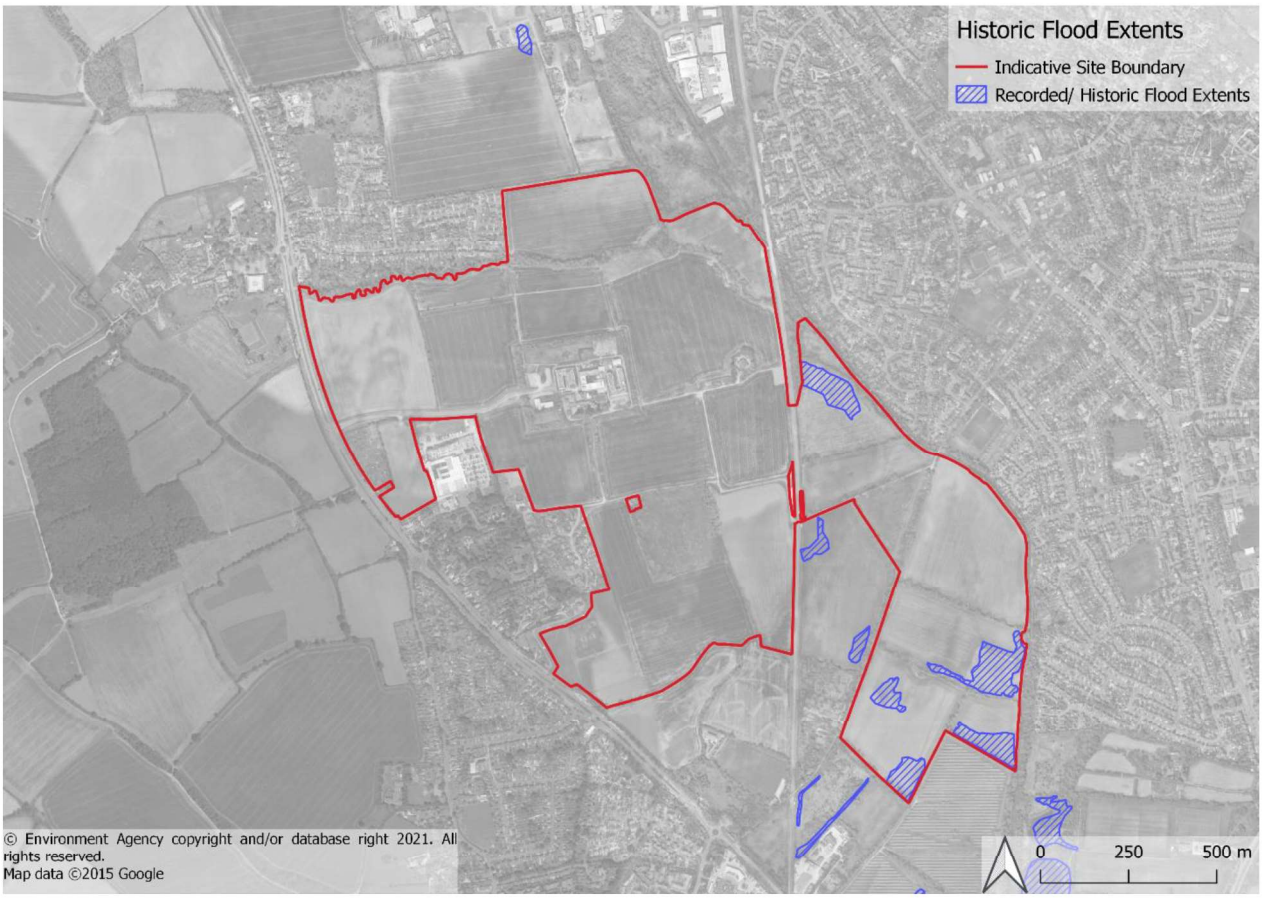

Figure 8 EA flood map showing historic flood event

3.4 Flood Risk to the Development Site

3.4.1 Fluvial and Tidal Flooding

Tidal flooding occurs when particularly high tides coincide with storm surges driven by low atmospheric pressure events causing localised raising of sea levels. It is noted from the EA flood maps and the SFRAs that the Site is not at risk of tidal flooding.

Fluvial flooding occurs when sustained or intense rainfall events increase the flow in rivers causing the water level to rise above the level of the banks and into the surrounding areas. The watercourses on site and their flow direction are noted in the Site description.

As advised by the EA, detailed hydraulic modelling has been undertaken to define the flood extents for the following key design events, with the 1 in 100-year event representing the Flood Zone 3 extent and the 1 in 1000-year event representing the Flood Zone 2 extent:

Table 5 Fluvial events simulated in the Baseline Modelling

Fluvial Events	AEP	Epoch	Scenario	Uplift
1 in 30 year	3.33%	Present		0%
1 in 100 year	1%	Present		0%

Fluvial Events	AEP	Epoch	Scenario	Uplift
1 in 100 year + CC	1%	2080s	Central	26%
1 in 100 year + CC	1%	2080s	Higher	41%
1 in 1000 year	0.1%	Present		0%

Full details of the modelling undertaken can be found in Appendix D. The baseline flood extents are shown in Figures 9-12 for the fluvial events noted above in Table 5. The baseline flood depth maps are provided for all fluvial events within Appendix D.

The modelling indicates that the majority of the Site is outside of all flood events.

The key areas at flood risk in all return events are:

- Sections of the Site along the length of Rowel Brook; and
- The parcel of land immediately to the west of the Oxford Canal.

In the higher order events, flood risk is also present:

- In the North-West of the Site, owing to water overtopping Woodstock Road and flowing in a north-easterly direction to Rowel Brook;
- Around the Southern drainage ditch due to a capacity issue within the ditch; and
- To the east of the site, close to Oxford Canal. This flooding is believed to be due to capacity issues in the Eastern drainage ditches. Much of the surface water from the Site is routed through these, however they do not appear to have the capacity to convey the flows in the more extreme events considered.

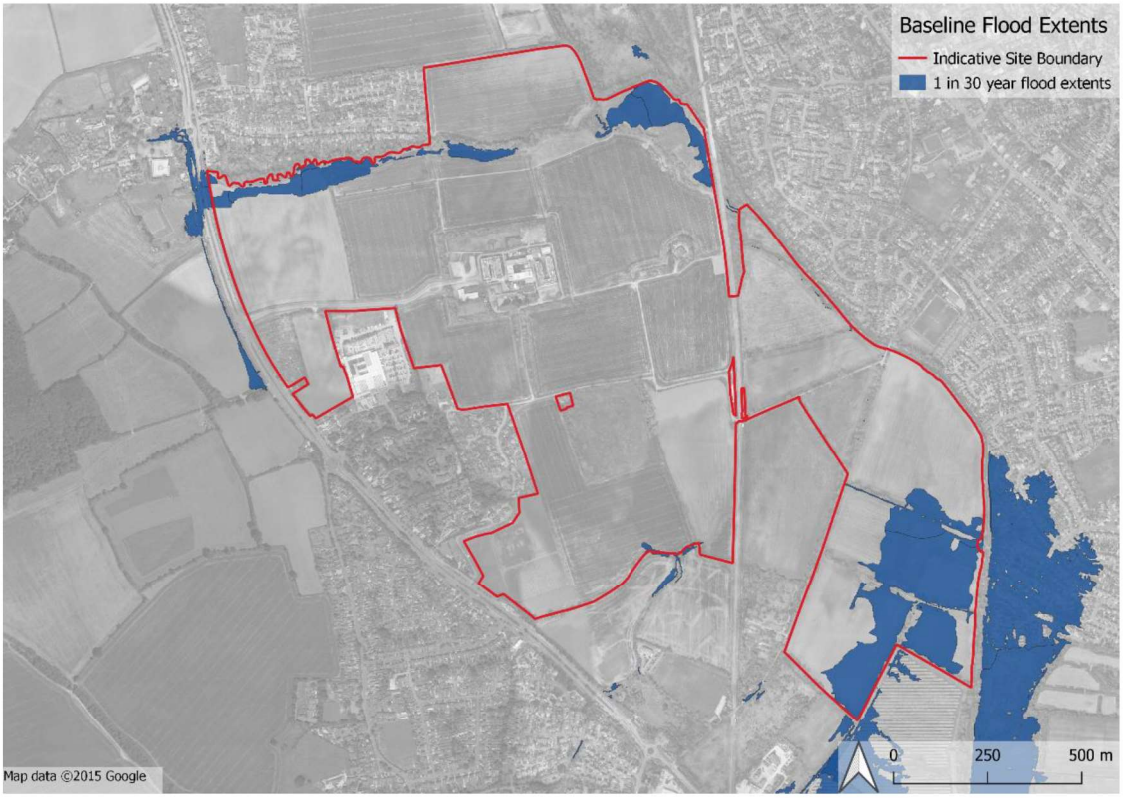

Figure 9 Baseline Fluvial Modelling Results – 1 in 30 year flood extents

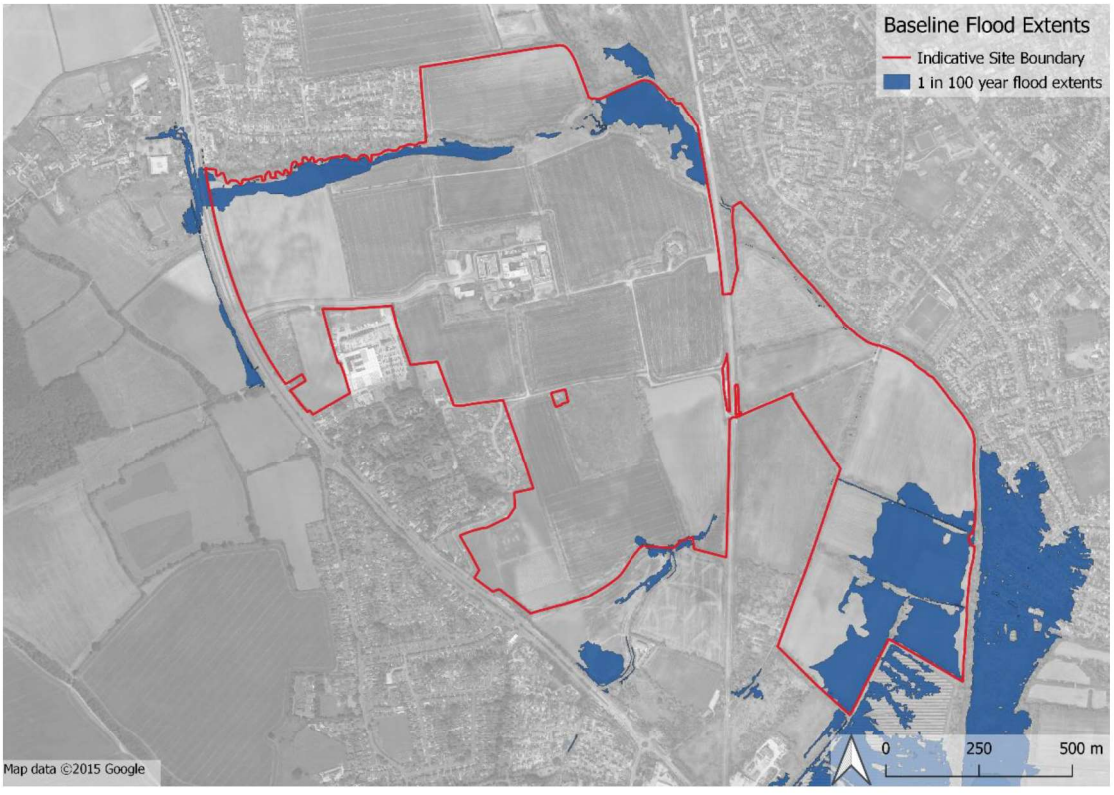

Figure 10 Baseline Fluvial Modelling Results – 1 in 100 year flood extents

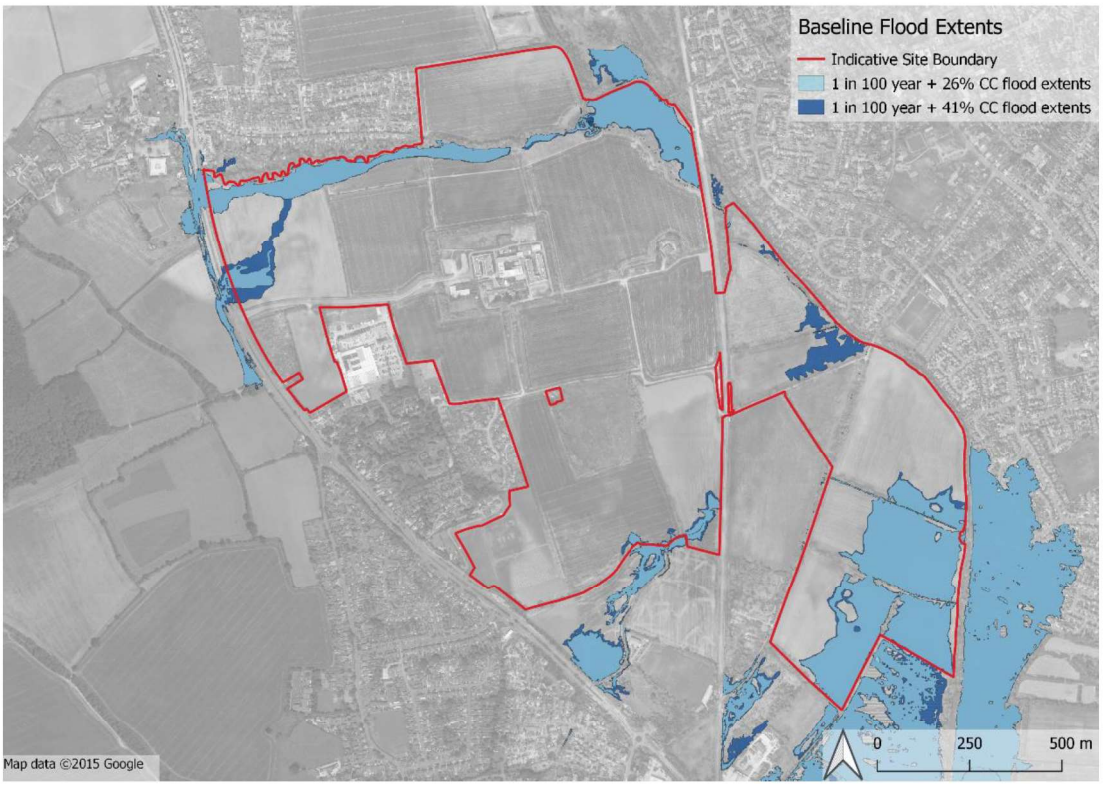

Figure 11 Baseline Fluvial Modelling Results – 1 in 100 year + 26% and 41% CC flood extents

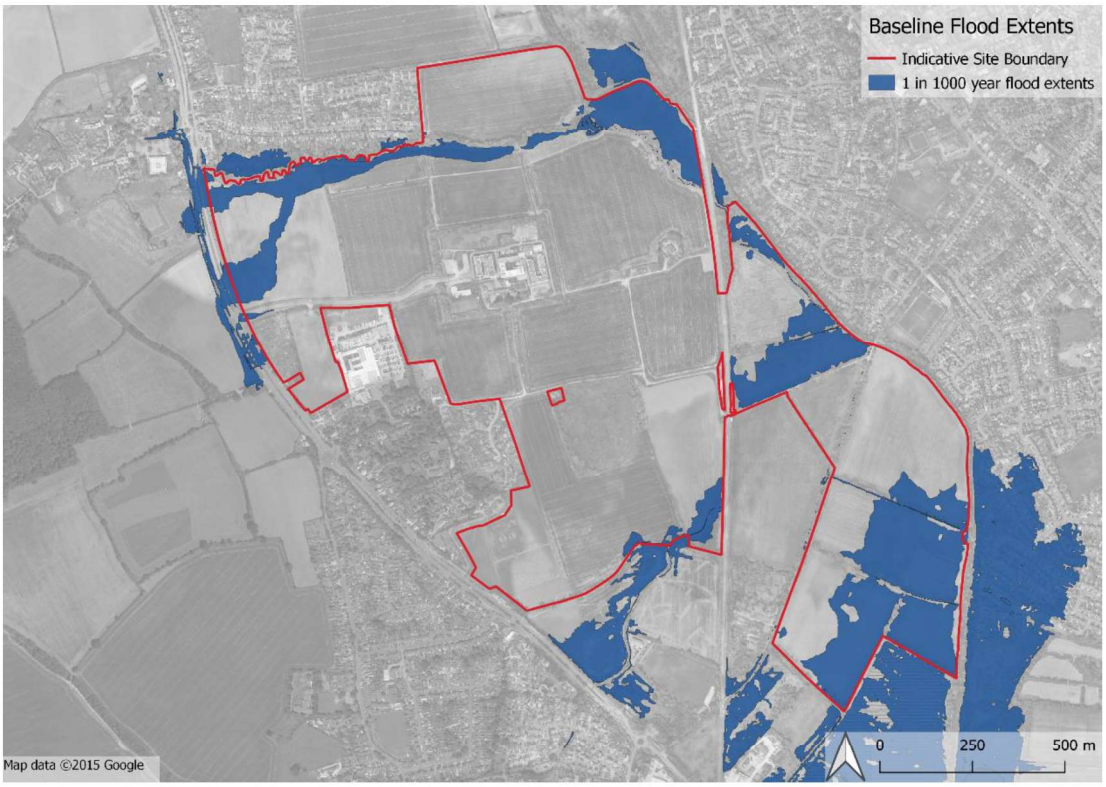

Figure 12 Baseline Fluvial Modelling Results – 1 in 1000 year flood extents

3.4.2 Surface Water Flooding

Surface water flooding occurs when intense rainfall is unable to naturally soak into the ground due to impermeable ground covering such as concrete or tarmac, or due to low permeability ground conditions preventing infiltration. This excess surface water can flow through built-up areas and open space and pond in lower-lying areas causing localised flooding.

The EA Surface Water Flood Maps show that most of the Site is subject to Very Low (between 0.1% and 1% AEP) surface water flood risk. There are localised areas of ponding on the Site, which are classified as having Medium (between 1% and 3.3% AEP) to High Risk (>3.3% AEP) of surface water flooding. These occur around the drainage channels to the south, around the east and southeast of the Site and also on the land adjacent to the Rowel Brook.

It is noted that no climate change allowance is considered in the below surface water flood mapping. Climate change will however be considered in the design of the surface water drainage strategy.

The baseline surface water flood risk to the Site is classified as medium. The map below shows some overlap between the risk of stormwater flooding and the baseline flood extents identified by the hydraulic modelling. However, development of the Site and the proposed surface water drainage strategy will mitigate any further risk of surface water flooding as a result of on-site rainfall in the design flood event.

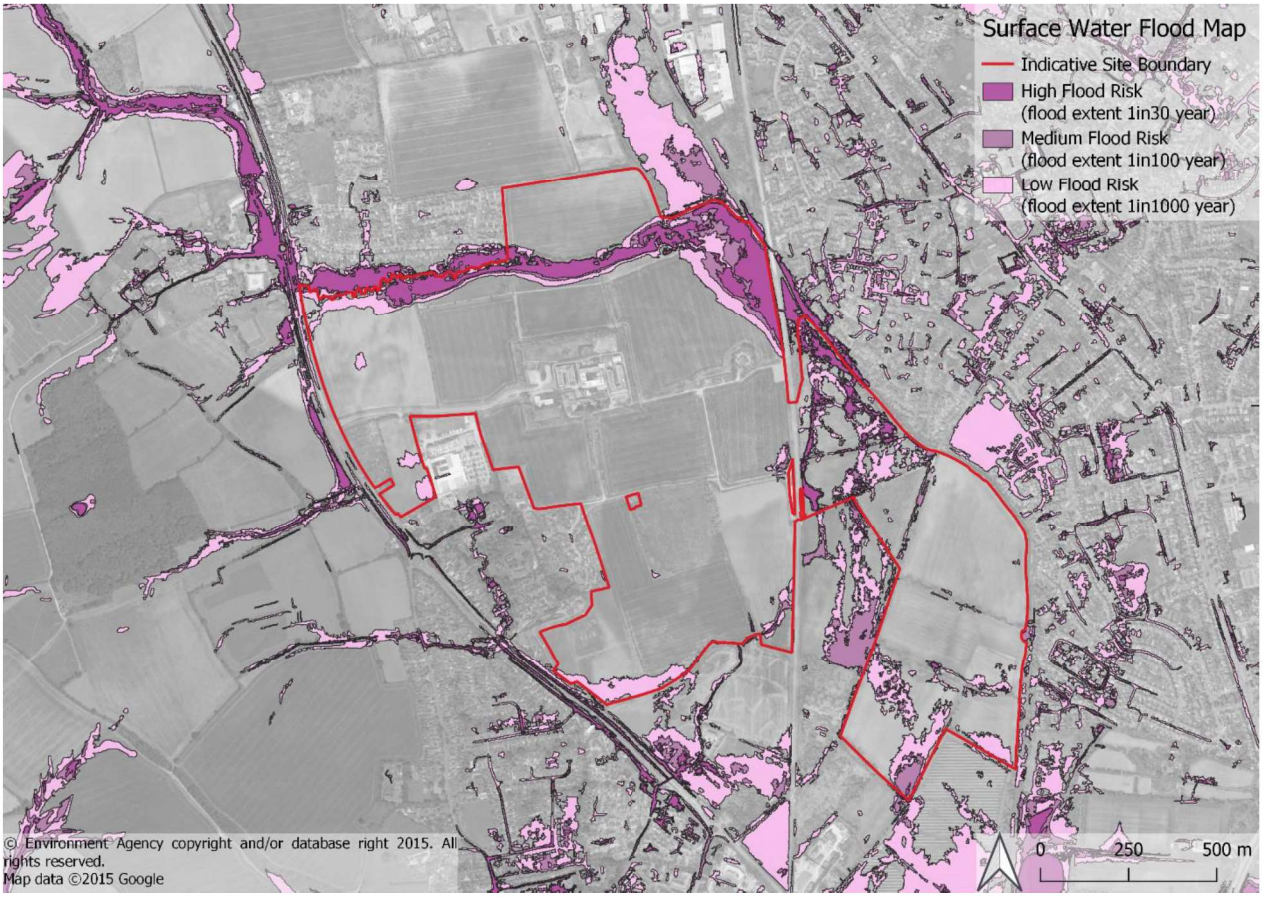

Figure 13 Surface water flood risk map

3.4.3 Flooding from Sewers

Flooding from combined sewers may occur during periods of intense rainfall when:

- The rainfall event exceeds the capacity of the sewer system;
- The system becomes blocked by debris or sediment; and,
- The system surcharges due to high water levels in receiving watercourses.

The Level 2 SFRA Addendum notes that the Thames Water (TW) DG5 register identifies 20-25 recorded incidents of sewer flooding within the post code area (OX5) covering the Site between 2006 and 2016.

The Level 2 SFRA records two flooding incidents in Kidlington in 2016 because of limited capacity.

According to Thames Water's asset plan, the existing sewer network includes five active and two abandoned Thames Water sewers which cross the site. These have been flagged for diversion, further details of these proposed diversion routes being developed in collaboration with TW can be found in the Surface Water Drainage Strategy (Appendix E).

Thames Water have confirmed that there is capacity within the sewer infrastructure for connection.

3.4.4 Groundwater Flooding

Groundwater flooding generally occurs in low-lying areas above permeable rock aquifers where the water table meets, and rises above, the ground surface.

The EA Areas Susceptible to Groundwater Flooding map (as shown in Figure 14) is a coarse data set but illustrates that the western half of The Site lies within 1 km grid squares of which between 50% and 75% of their area is considered to be susceptible to groundwater emergence. This area is classified as having a medium susceptibility to groundwater flooding. The eastern half lies within 1km grid squares of which >75% of their area is considered to be susceptible to groundwater emergence. This area is classified as being highly vulnerable to groundwater flooding. A small area north of Rowel Brook has low vulnerability to groundwater flooding (SFRA Level 2 Addendum, 2018).

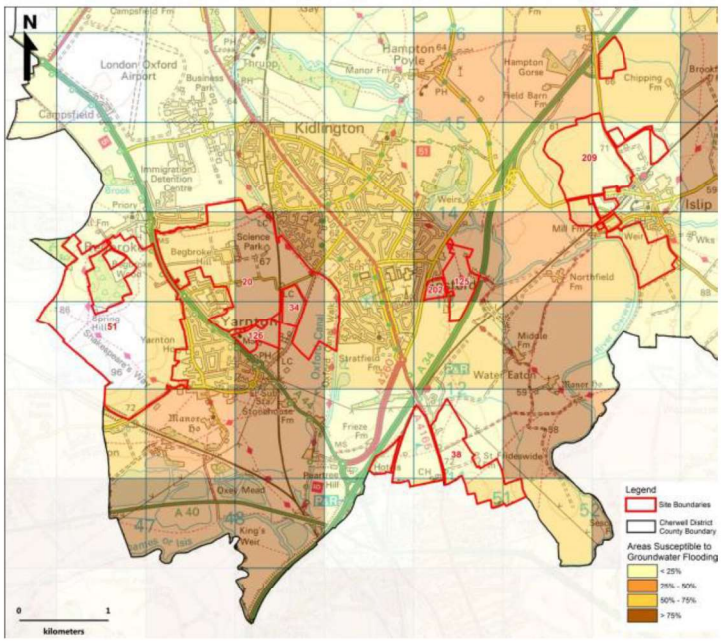

Figure 14 Areas susceptible to groundwater flooding Map (SFRA Level 2 Addendum, 2018).

A number of Ground Investigation (GI) studies have been undertaken by Hydrock to understand the geology and groundwater on the Site to inform measures which may be required as the design is developed. These include soil infiltration rate test pits, trial pits, dug pits and boreholes. The latest report which summarises the outcomes of this GI is Desk study review and GI report (Doc ref: 19114-HYD-XX-XX-RP-GE-1002).

From this information, the key points from a groundwater flooding perspective are summarised below:

- GW was encountered between 0.03m bgl and 5.83mbgl during the monitoring period which commenced in August 2022. The monitoring is being undertaken for a 12-month period.
- Based on the hydraulic gradient, within superficial deposits, the shallow groundwater flow is from the west of the site, from the topographic high, to the east and south-east, although in the north of the Site groundwater flow is locally towards Rowel Brook (from the north and the south). In the far east of the Site(in the floodplain), groundwater flows are to the south and at a shallower hydraulic gradient, but potentially influenced by the Oxford Canal which borders the east of the site. Groundwater levels and flow directions are shown in Figure 15.
- In general, groundwater was encountered within the River Terrace Deposits towards the base of the stratum with the groundwater encountered shallower in the topographic lows of the site.
- It should be noted that the ground slopes to the north-east and south and the presence of underlying relatively impermeable soils at shallow depth (Kellaways Clay Member and Oxford Clay Member) will need to be considered, as groundwater will track along the interface of these impermeable units and the overlying River Terrace Deposits.

Hydrock have confirmed that through a review of the geology encountered on the Site during the investigation works, the areas where potential springs may occur is in the north-east area of the site; north-east of Rowel Brook.

It is considered that the potential for groundwater flooding to occur is more likely to be a risk in the lower lying areas around the perimeter of the Site.

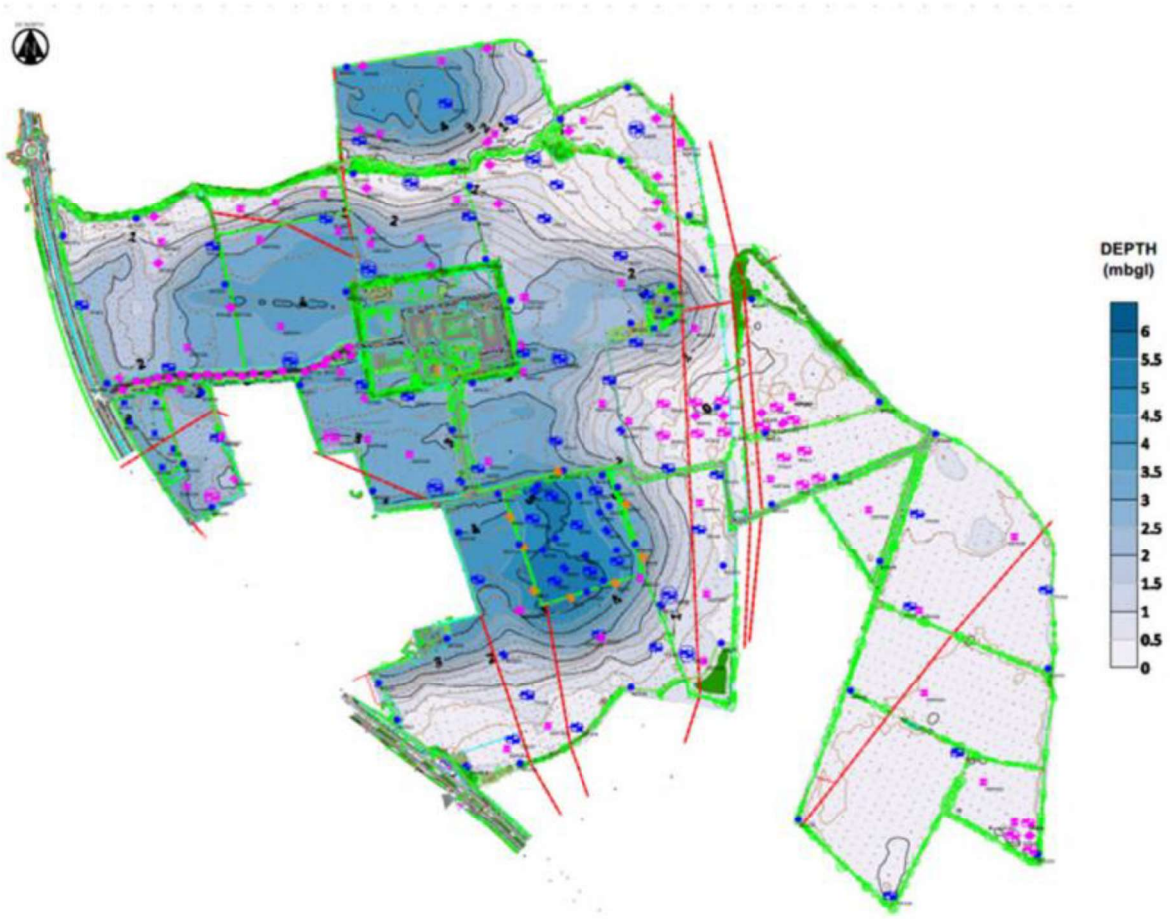

Figure 15 Groundwater depths (m bgl) (Doc ref: 19114-HYD-XX-XX-RP-GE-1002)

3.4.5 Flooding from Lakes, Reservoirs and Artificial Sources

There are several non-natural sources of flood risk including flooding from canals, reservoirs, and man-made lakes. These sources of flooding can occur when the facility is overwhelmed by high rainfall or when a dam or bank fails. Flooding from such sources can happen suddenly and can cause significant damage and danger to life. However, the likelihood of such a failure occurring is extremely low given that these are controlled water bodies.

According to the risk of flooding shown on the EA Reservoirs Map (Figure 16), a portion of the Site, mainly to the east/ south-east, is located within the maximum extent of flooding from reservoirs. This is for the scenario when there is also flooding from rivers. The Site is not at risk of reservoir flooding if the water levels within the rivers are at normal level. This flood risk is from Banbury Flood Alleviation Scheme, which is located upstream of Banbury. However, as noted above flood risk to the development from reservoirs is classed as being low.

The Oxford Canal runs through the east of the Site and is at similar ground levels to the Site. It is noted in the Level 2 SFRA Addendum that the only recorded flooding incident from the Oxford Canal in the vicinity of the Site was in January 2003 along the east side and the southernmost part of the Site due to the capacity of the canal being exceeded and overtopping. Details on the locality and extent of flooding have not been provided. However, the report identifies a residual risk of flooding to the Site from overtopping of the canal.

The water levels in the canal are controlled by a series of locks and overflow weirs which look to divert any excess flows into the river Cherwell. It is noted in the Level 1 SFRA that there is a residual risk in Cherwell of overtopping or breach failure of the Oxford Canal. There were breach failures during the 2007 summer floods, however none of these incidents were located in the vicinity of any of the Level 2 SFRA sites.

The residual risk of canal embankment failure is managed by the Canal and River Trust (CRT) who perform monthly towpath side inspections. The overall flood risk from artificial sources is Low and no further mitigation is required. It is noted that once the water overtops the canal in a more extreme event, this will have been captured in the fluvial flood modelling and therefore risk mitigated against if required for the development.

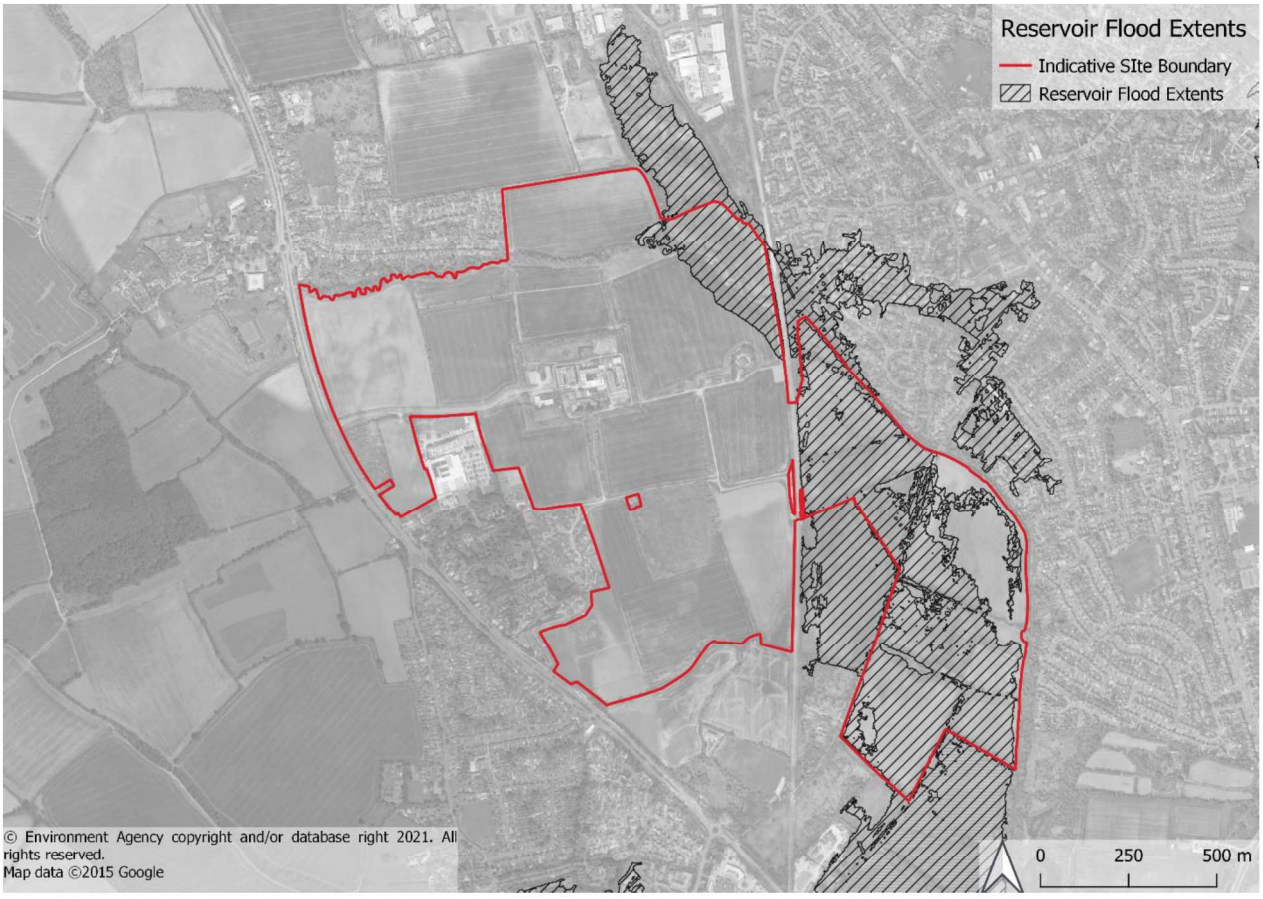

Figure 16 Reservoir flood extents map

4 Proposed Development Flood Risk

This section outlines the flood risk to the Proposed Development and any mitigation measures required to remove flood risk to the development.

4.1 Fluvial

Considering the baseline fluvial flood modelling results, as seen in Figure 17 below, the majority of Proposed Development is located outside of the key design events noted in Table 5. There are two locations where the Proposed Masterplan is within the modelled flood extents and therefore potentially at risk of flooding without further mitigation, these locations are:

- NW of the Site
    - Affecting commercial and residential assets
- South of the Site
    - Affecting the playing fields and grounds of the fields of the Secondary School

The following sections note the proposed mitigation to manage the fluvial flood risk to the development.

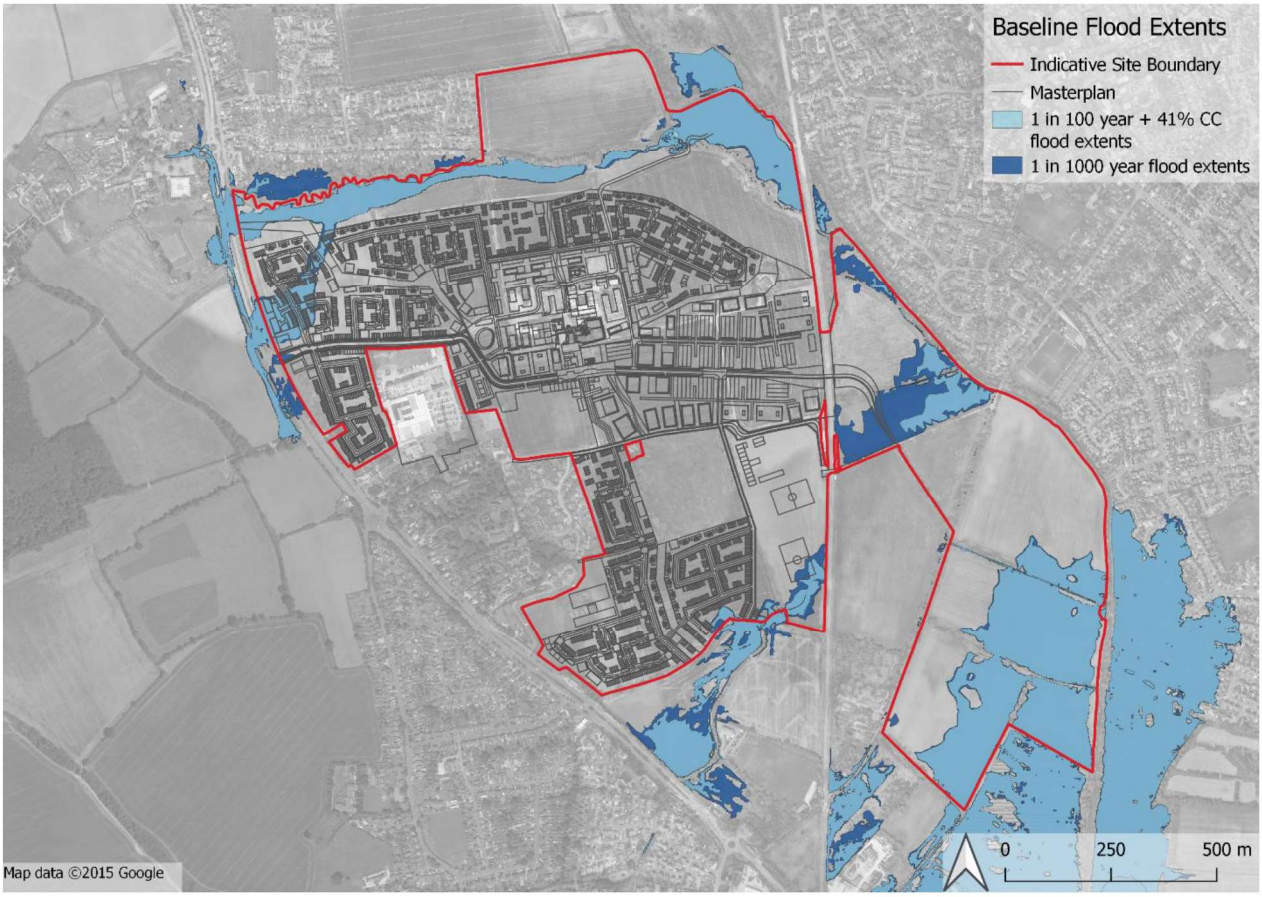

Figure 17 Baseline Fluvial Modelling Results with illustrative masterplan overlaid for the 1 in 100 year + 41% CC and the 1 in 1000 year flood extents

4.1.1 NW Area – Proposed Swale

To mitigate the flood risk to the masterplan in this location, a swale is proposed within the Site boundary along Woodstock Road which will act re-route the flood water along this designated corridor before overtopping and flowing north into Rowel Brook (concept showflon in Figure 18).

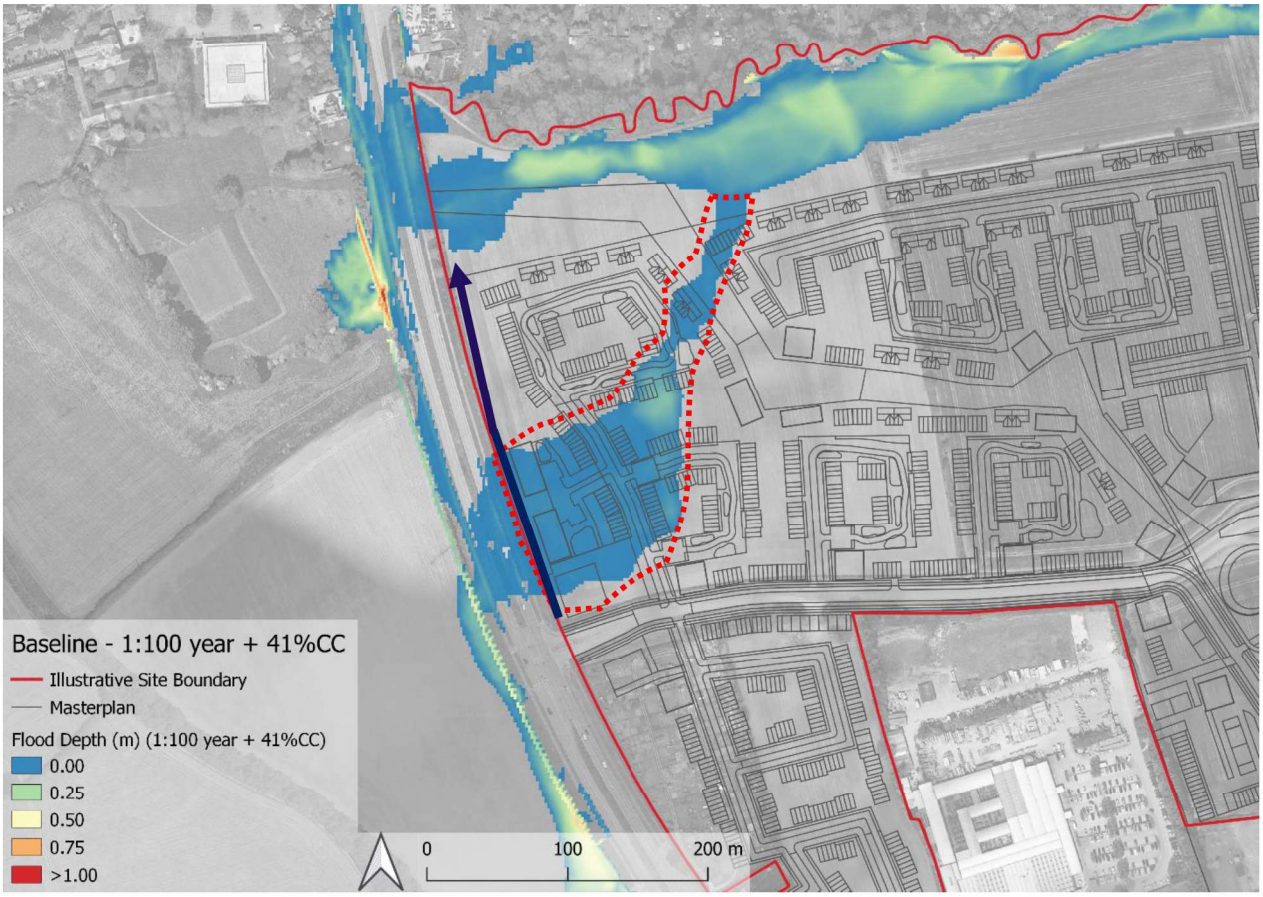

Figure 18 Concept showing proposed mitigation to remove flood risk to the illustrative masterplan in the NW area (red dashed extent shows flood extent to be removed and blue arrow shows approximate location of the swale)

The swale has been tested within an indicative scenario of the detailed hydraulic model as a 7m wide (top-of-bank), 0.5m deep channel with a 1:2 side slope, as shown in the cross illustrative section below. It has been designed to convey flows for the 1:100 year + 41% CC event with a 300mm allowance for freeboard. This design also has sufficient capacity to convey flows in the 1:1000 year event. A 300mm bund/ barrier is proposed on the bank of the swale to the east between the swale and the development. This will assist with routing the water towards the end of the ditch to the north, where it will overtop and then discharge into Rowel Brook. This area will act as a flood storage area which is an important aspect as it provides attenuation; delaying the floodwater reaching the Rowel Brook. Further detail on the modelling of this mitigation strategy is detailed within Appendix D where maximum depth and flood level differences are shown for both the 1:100 year + 41% CC event and the 1:1000 year event for an 11 hour storm duration.

Parameter Plan 01 – Development Zones includes a 10m set back from the A44 north of Begbroke Hill. This would allow for a swale of the above dimensions alongside any potential noise mitigation barrier, if required.

With this mitigation in place, water is captured and diverted around the Proposed Development layout. The flood risk associated with the overland flow route is removed for the Proposed Development in this location. This mitigation measure does not create any disbenefit along Rowel Brook, i.e. there are no increases in flood level or extent downstream of this point. This is because the proposed swale is designed in a way to capture and convey the floodwater, whilst at the same time attenuating and delaying the floodwater reaching the Rowel Brook.

Figure 19 Illustrative cross section of proposed swale

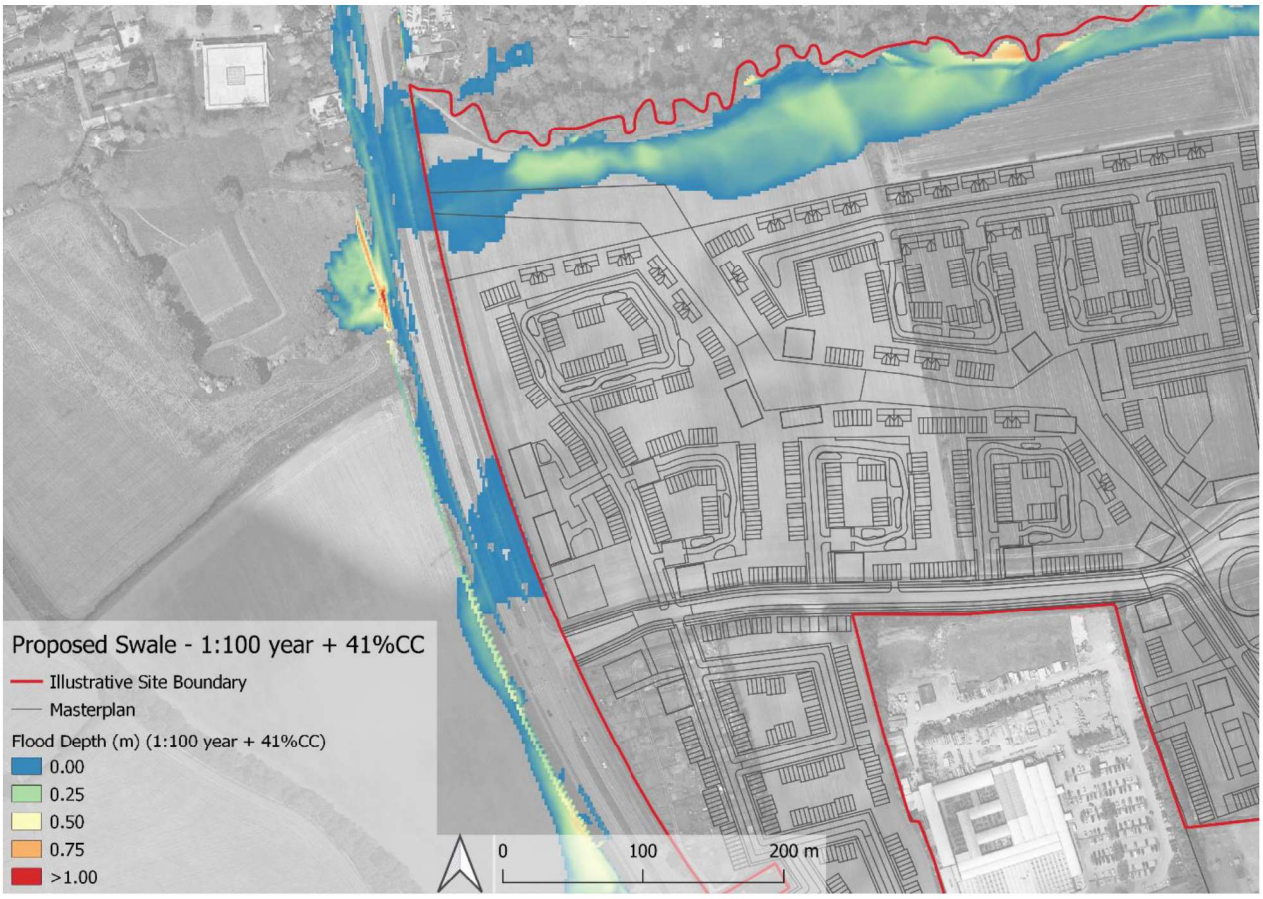

Figure 20 Modelled results showing flood extents and depths for the 1:100 year + 41% CC with the proposed swale in place.

4.1.2 Secondary School Site

Following the OCC Design Criteria for Secondary Schools outlined in Section 2.5, no part of the proposed Secondary School should be located in an area of Flood Zone 2 or 3, or have any ditches on the site. To remove any flood extents from the Secondary School Site in all events up to and including the 1:1000 year event, it is proposed to re-grade the land within the school site so that the flood risk from outside of the school site is removed.

Hydraulic modelling has been undertaken to assess the impacts associated with re-grading the school site. Mitigation measures have then been designed to manage the consequent change in flood risk on site, within the red line boundary. The purpose of the mitigation measures is to ensure that there is no increase in flood extent or flood depth outside the red line boundary and that no proposed buildings within the development are at flood risk.

The proposed land-raising across the school site would necessitate the filling-in of an existing tributary reach of the southern drainage ditch across the southwest corner of the site. So as to not limit connectivity between the ditch to the west of the school site and the southern drainage ditch, a replacement channel is proposed along the boundary of, but outside of the school site to maintain the connectivity of the southern drainage ditch. The schematisation of this proposed condition as well as the maximum depth and flood level difference plots are shown for the 1:100 year + 41%CC event and 1:1000 year event in the Technical Note in Appendix F. This shows that the school site is flood free in all events up to the 1 in 1000 year event.

The 1:100year+ 41%CC event flood extents are shown in Figure 21. Without further mitigation, it can be seen that a substantial amount of floodwater will be displaced from the school site. To offset the increase in flood volume arising from reprofiling the school site, a flood storage area has been considered within the red line boundary to the west of the school site to provide effective mitigation on a volume-for-volume basis.

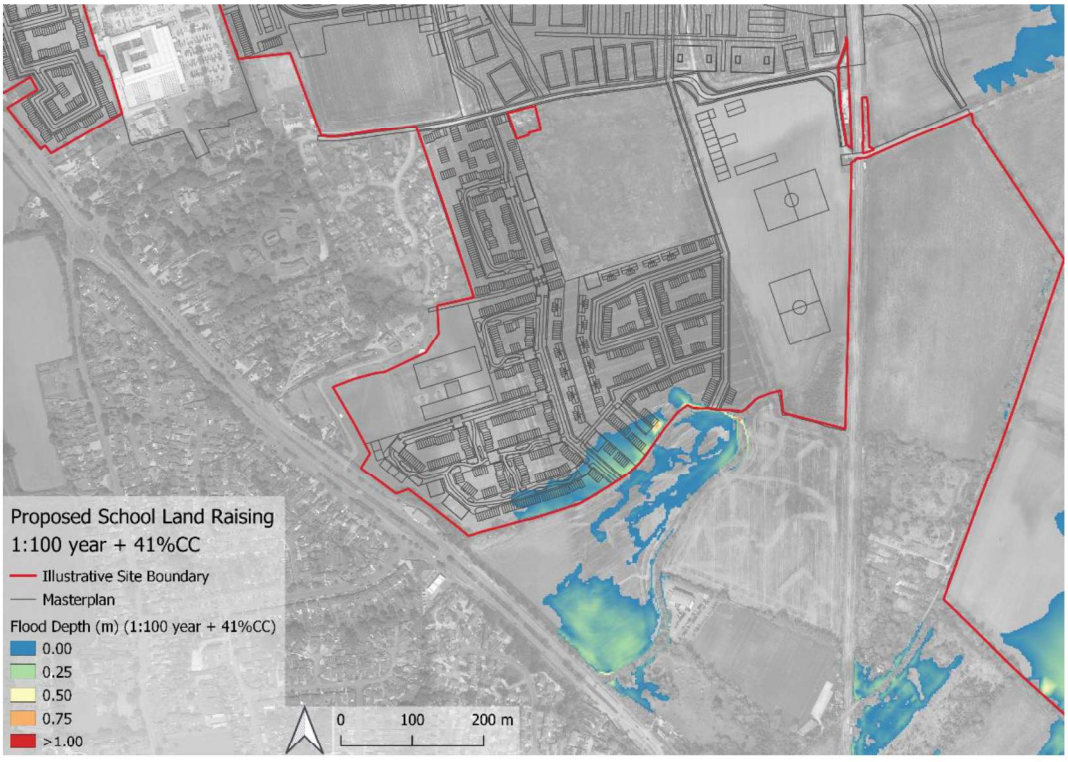

Figure 21 Flood depths shown for the 1:100 year + 41%CC event with the proposed mitigation of raising the levels in the Secondary School site implemented.

All increases in flood extents and flood depths as a result of the re-grading of the school can be accommodated within the red line boundary. It is proposed that the design of this flood storage area should store the water contributing to any observed increases in flood extent and flood depth for both the 1:100 year + 41%CC and the 1:1000 year event.

A flood storage area with plan area of 2,960m^2, with graded side slopes down to a depth of 1m, has been proposed. This can be accommodated in the area shown with the black line in Figure 22. It is proposed that in addition to the 1m depth of water, a 300mm allowance for freeboard is provided.

Review of the flood storage area shown shows that there is sufficient space to include the 300mm freeboard allowance with a 1:3 slope without any adverse impact on the adjacent building blocks.

It is recognised that the masterplan is illustrative at this stage and as part of the further development of the masterplan the area, depth and layout of this storage area will need to be developed. The proposed updates to the storage area will need to be tested through hydraulic modelling to maintain the goal of achieving no increase in flood risk off site.

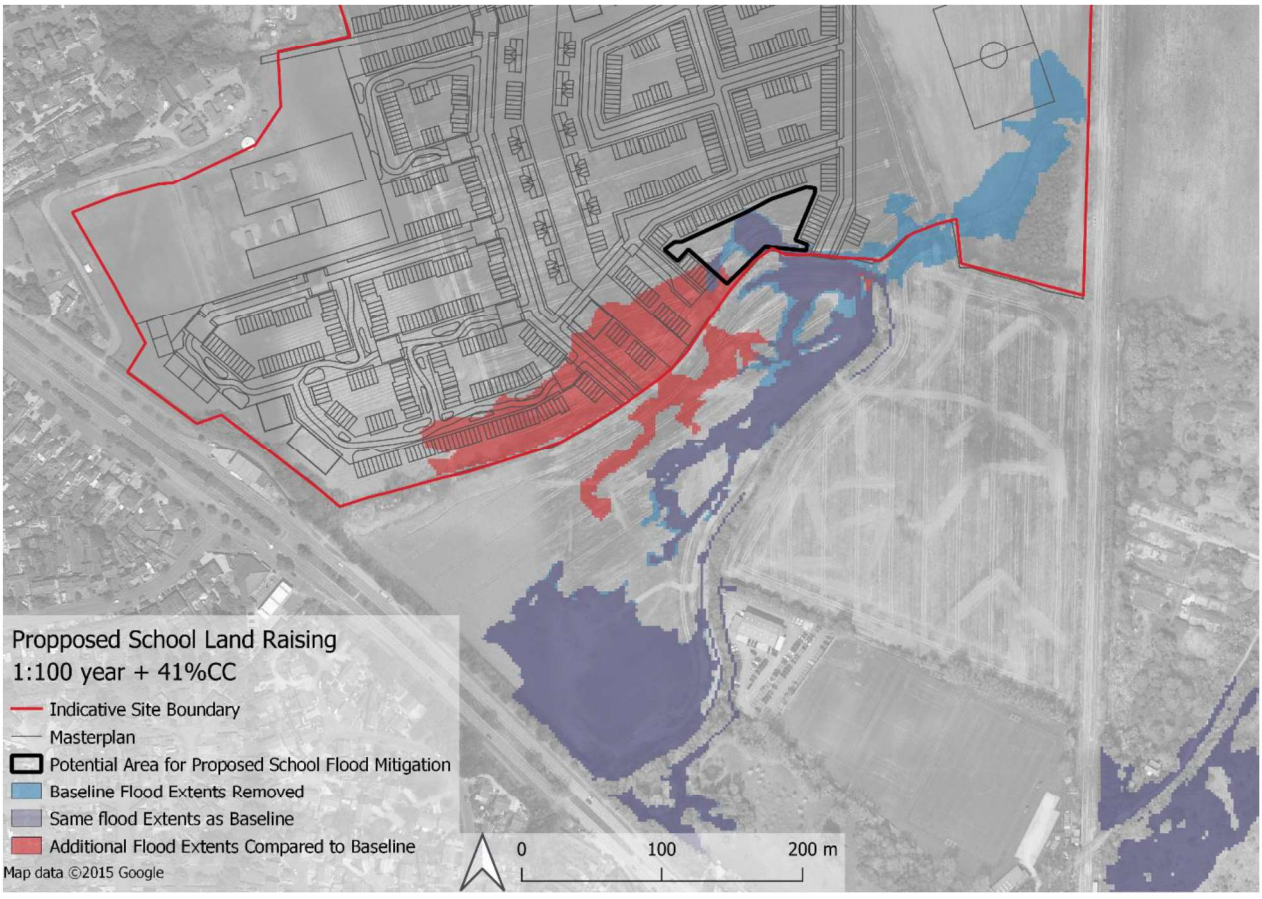

Figure 22 Potential location for flood storage area shown. This has been sized to mitigate any increase in flood extents and flood depths resulting from the proposed land raising on the Secondary School site

4.1.3 Stratfield bridge