

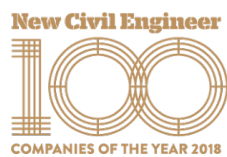


Highgate School MSC 4-Phase

Flood Risk Assessment

Revision F
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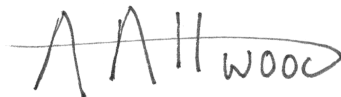
Written by



23 January 2023

Juliette Pout

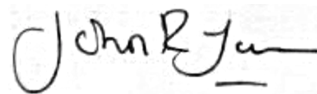
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Glossary of Terms

- +CC - Return period inclusive for the predicted effects of Climate Change
- 1D - One-Dimensional
- 2D - Two-Dimensional
- AMAX - A series containing the peak flows recorded at a gauge from each year
- AOD - Above Ordnance Datum (0m sea level, Newlyn, UK)
- Channel Cross Section - profile view of a river channel, normally obtained by surveying a line across the watercourse
- Critical Storm - A storm that produces peak run off in the watershed
- Culvert - A device used to channel water, similar to a pipe though may be larger
- Defended - A scenario in which river defences are used
- FEH - Flood Estimation Handbook
- Fluvial - Referring to the processes associated with rivers and streams
- FRA - Flood Risk Assessment
- GIS - Geographic Information System
- Hydraulic Model - The mathematical process of analysing the interaction of water and the connected environment
- Hydrology - The calculation of catchment based flow rates
- Inflow - Source of water within a modelled domain
- FMP Software - One-Dimensional hydraulic model – Representation of watercourses
- FMP-TUFLOW - Hydraulic program that dynamically links FMP and TUFLOW (1D-2D)
- LiDAR - Light Detection And Ranging, remote sensing technology to measure distance typically used to obtain topographic data over a large area
- Outflow - The method by which water may leave a modelled area
- Overtopping - Where water has passed over a feature that might ordinarily prevent flow
- f100 - 1% annual probability fluvial event
- f1000 - 0.1% annual probability fluvial event
- f100CC - 1% annual probability fluvial event with an allowance for the predicted effects of climate change
- QMED - The median of the set of annual maximum flow data (AMAX)
- TUFLOW Software - Two-Dimensional hydraulic model – Representation of floodplain
- Undefined - A scenario in which river defences are ignored

1 Introduction

1.1 General

Edenvale Young Associates Ltd. were commissioned by Capital Projects to undertake a Flood Risk Assessment (FRA) in order to support the planning application relating to the Mallinson Sports Centre development.

This flood risk assessment is a desk based study which mainly uses information from;

- The 'Haringey Council Strategic Flood Risk Assessment' (Level 2) (SFRA), 2015, JBA consulting
- 'London Borough of Haringey surface water management plan (SWMP)', 2011, Capita Symonds
- Flood map for planning online¹.

Other sources, when used, are referenced appropriately.

1.2 Site Details

There are no watercourses in the immediate vicinity of the site. The existing site layout and proposed development are shown in detail in Figure 1.2 and Figure 1.3. The proposed works consist of various refurbishments to existing structures as well as a new sports hall replacing building at the northern end of the site and extension to the existing one, for detailed description of the proposed development refer to the Planning Statement.

1.3 Local Geology, Hydrology and Hydrogeological details

British Geological Survey (BGS) mapping² has recorded no superficial deposits.

The bedrock comprises "Claygate Member - Clay, silt and sand. Sedimentary bedrock formed between 56 and 47.8 million years ago during the Palaeogene period".

¹<https://flood-map-for-planning.service.gov.uk/>

²<http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html?>



Figure 1.1: Location

1.4 Existing surface water drainage

On the basis of the existing topographic survey (See Appendix A) and the existing site cover, it is assumed that surface water on the site flows across the site in north-westerly direction towards Broadlands Road. Further details of surface water flood risk are found in Section 2.1.3.

1.5 Site Drainage

The site drainage strategy including consideration of SuDs is considered separately to this document.

1.6 Appendices

The FRA should be read in conjunction with the following Appendices:

- Appendix A – Topographic Survey
- Appendix B - SWMP 1 in 100 year event + climate change flood depth map
- Appendix C - Mapping from the SWMP showing sewer flooding incidents in Haringey.
- Appendix D - Mapping from the SWMP showing groundwater flooding incidents in Haringey.
- Appendix E - Highgate Surface Water Modelling Report RevC

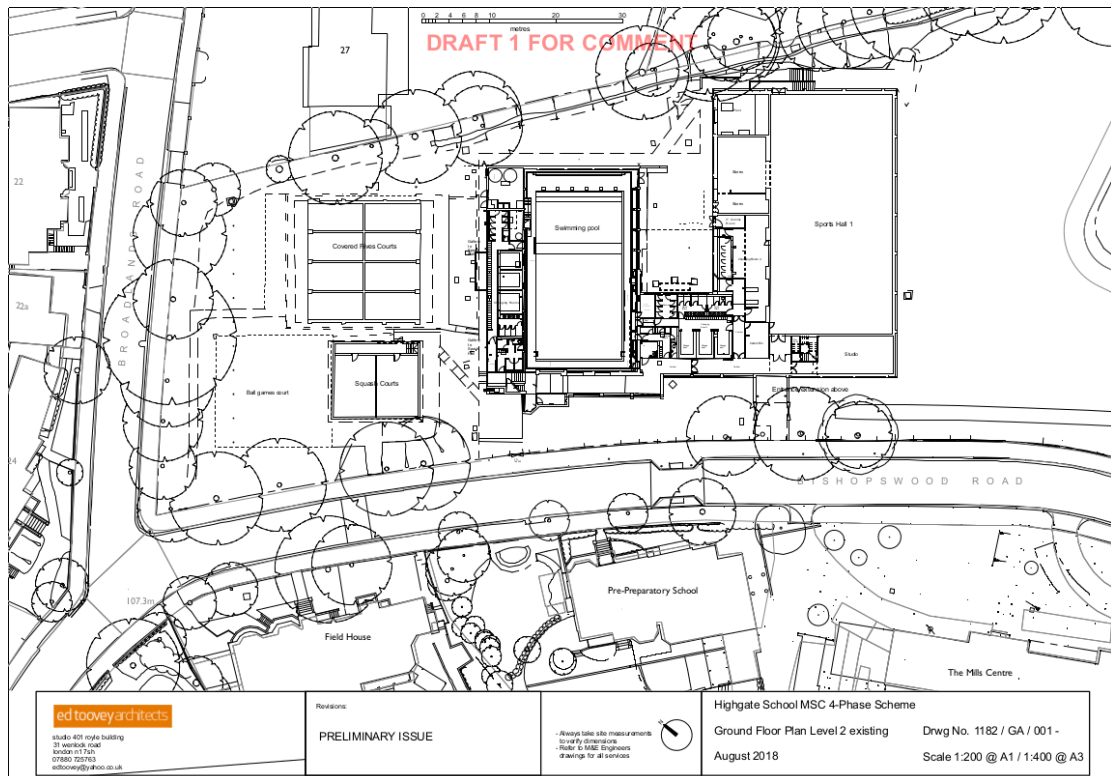


Figure 1.2: Existing Site Layout

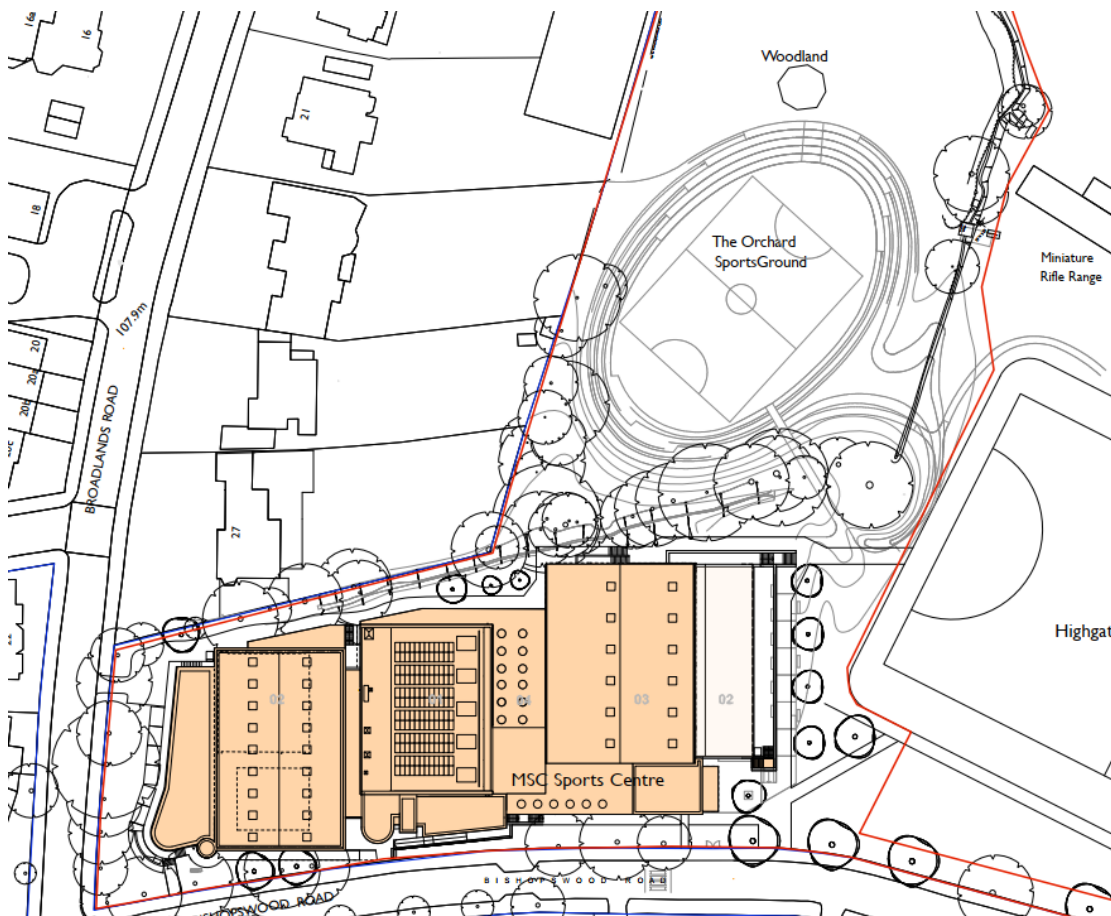


Figure 1.3: Proposed Site Layout

2 Published Information

2.1 Environment Agency Flood Risk Mapping

2.1.1 Flood Zone Classification

Figure 2.1 show the flood zone classification for the . The mapping has been extracted from the UK Government's flood map for planning¹ and confirms that the development is within Flood Zone 1.



Figure 2.1: Flood Risk for Planning

2.1.2 Rivers and Seas

A copy of the “long term flood risk mapping” shown on the UK government website² is shown in Figure 2.2. This shows the extent of flooding on the - adjacent to the site. The development is deemed to be at a High risk of fluvial flooding (greater 1% AEP).

¹ <https://flood-map-for-planning.service.gov.uk/>

² <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>

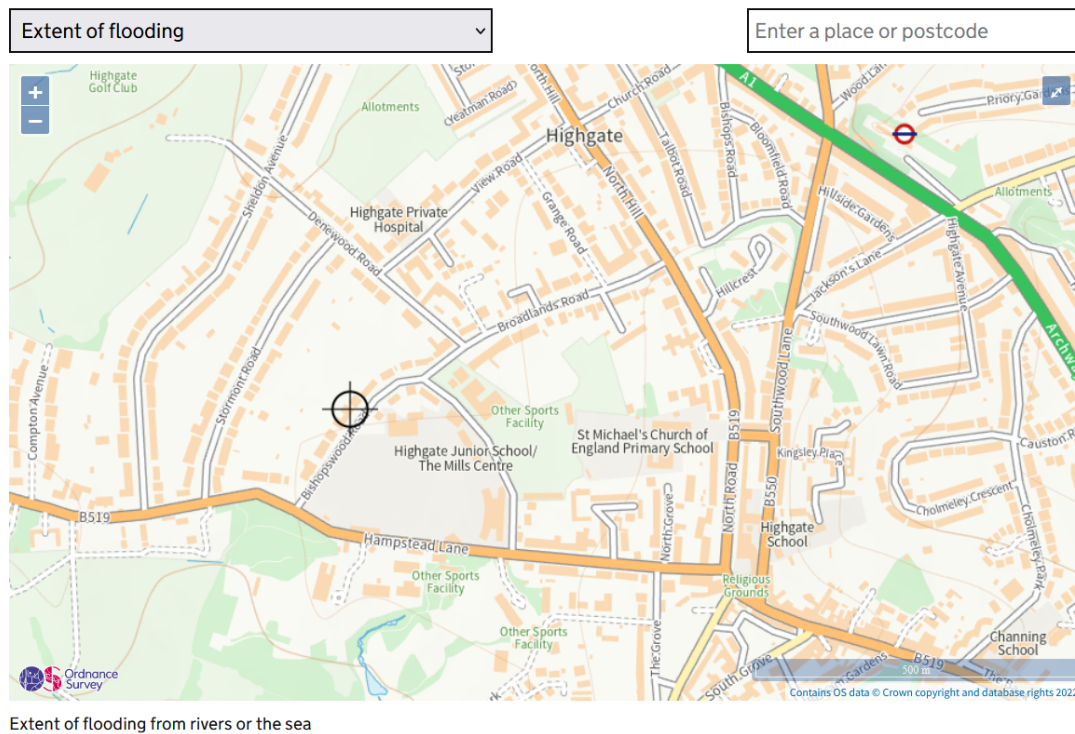


Figure 2.2: Long Term Flood Risk

2.1.3 Surface Water Flood Risk

Surface water flooding occurs following intense rainfall events, when water is unable to infiltrate the ground or cannot discharge to a watercourse. The Environment Agency mapping shows that the site is not at significant risk of surface water flooding. Accordingly it is considered that surface water flood risk is not an issue. It should also be noted that the drainage design for the development is reported elsewhere.

Figures 2.3 to 2.5 show the surface water flood risk to the site which have been downloaded from the UK Government website (<https://flood-warning-information.service.gov.uk/long-term-flood-risk>). The mapping gives flood depths on the site for high, medium and low risks which are quantified in Table 2.1. Importantly it should be recognised that the depths shown on the figures reflect the existing surface water flood risk and not surface water flood risk to the proposed sports facilities. The predicted depth of surface water is considered to present a flood risk to the sports facilities which will be raised above the maximum surface water level.

The low risk scenario shows a clear flood route from the south east flowing across the site, where water then appears to pond behind Broadlands Road before spilling over. This mapping does not take into account culverts under the road which is the reason why water builds up behind the road causing the flooding shown on the figures.

The surface water flood maps presented are very broad scale and it is considered that they do not represent the true nature of flooding to the site. Accordingly site specific modelling has been undertaken to determine more accurate flood depths and extents. The model build and results are discussed in detail in the report "EVY0753

Highgate SW modelling. A brief summary is given later in the report.

Risk	Depth
Low Risk	over 900mmm
Medium Risk	over 900mmm
High Risk	over 900mmm

Table 2.1: Surface Water Flood Depths

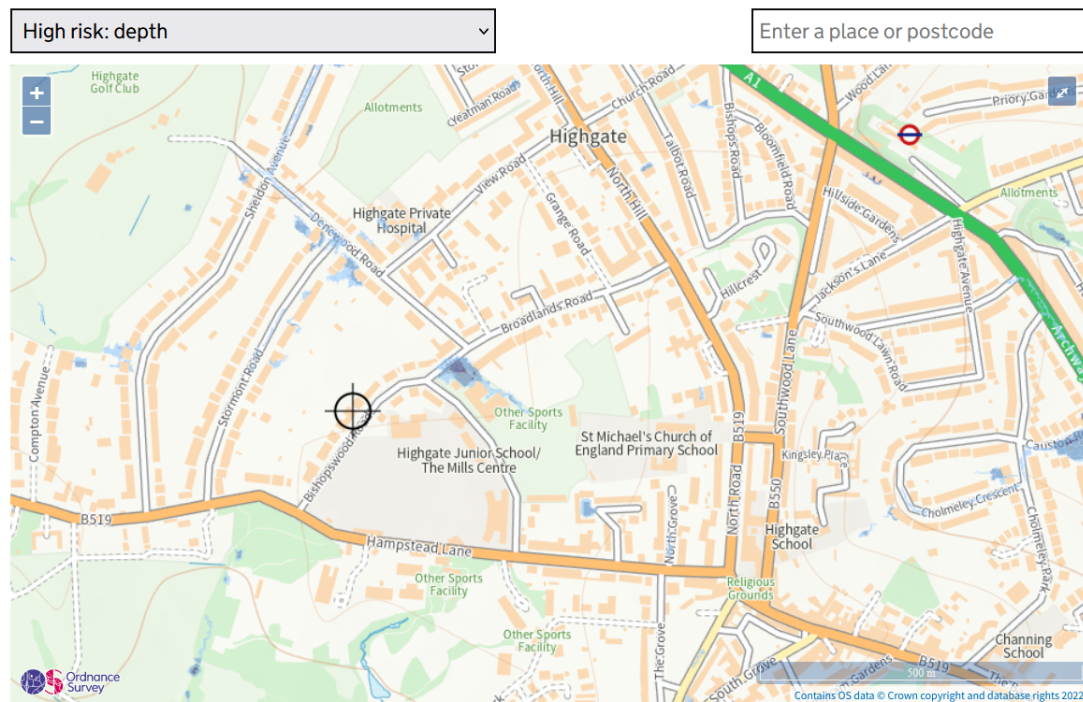
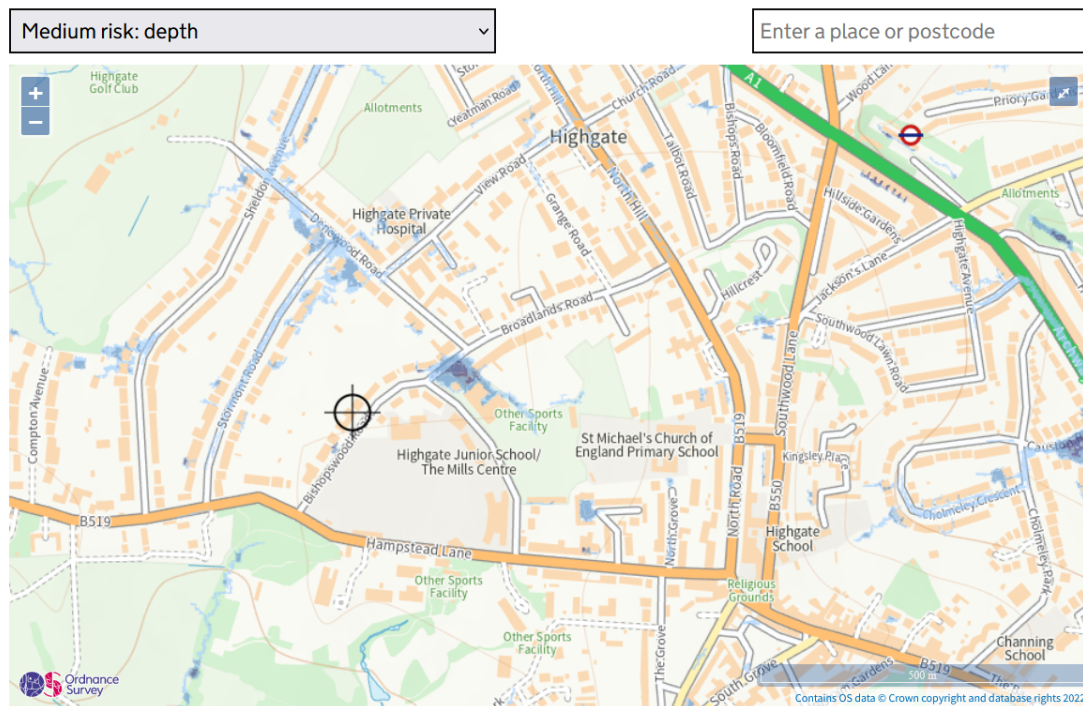


Figure 2.3: Surface Water Flood Risk (High <3.3%)

2.1.4 Reservoirs

A copy of the Reservoir Inundation mapping is shown in Figure 2.6. There are no issues associated with reservoir inundation.



Surface water flood risk: water depth in a medium risk scenario

Figure 2.4: Surface Water Flood Risk (Medium 3.3% to 1%)

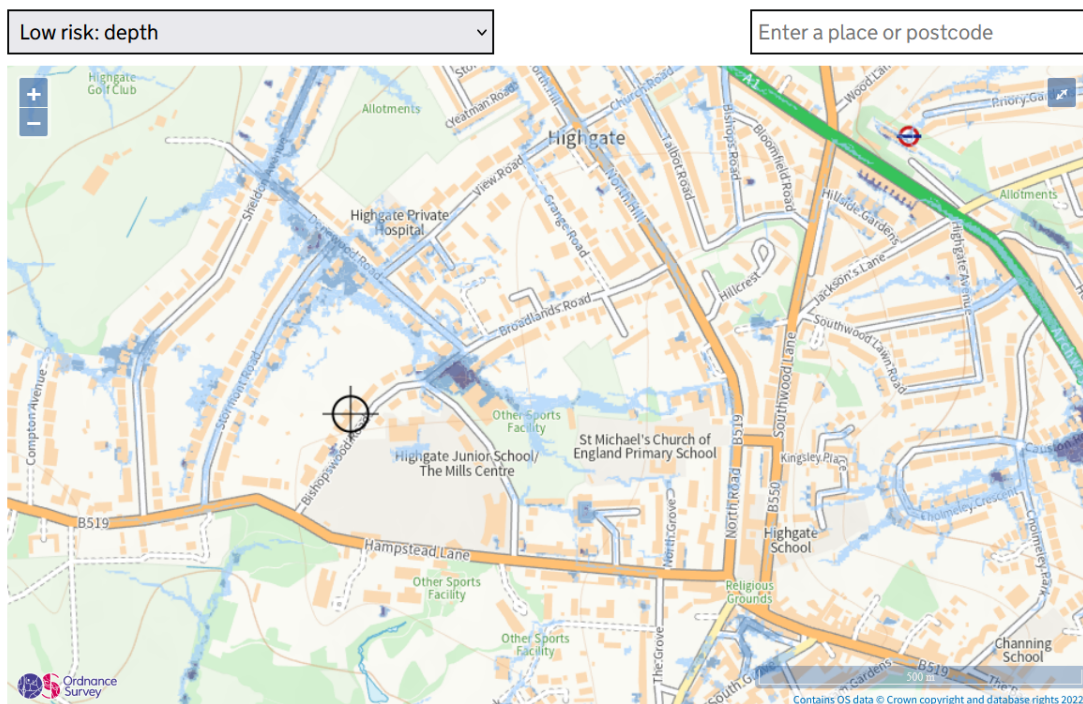


Figure 2.5: Surface Water Flood Risk (Low 0.1% to 1%)

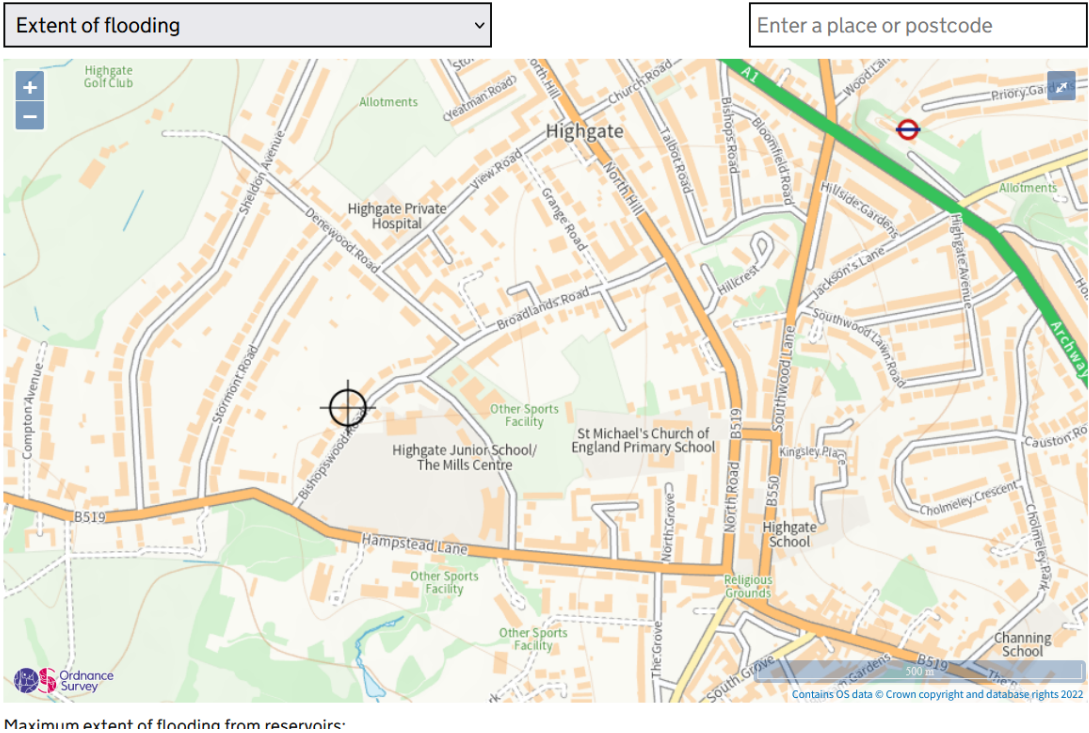


Figure 2.6: Reservoir Inundation

2.2 Strategic Flood Risk Assessment

2.2.1 Overview

A Level 2 Strategic Flood Risk Assessment (SFRA) for Haringey Council was completed in February 2015, to refine information of the probability of flooding, taking other various sources of flooding and the impacts of climate change into account.

The over-arching principles (Section 9.1), that all proposed developments should follow according to the SFRA are outlined below:

- *“In line with the NPPF guidance and evidence from the LB of Haringey Level 2 SFRA development proposals should:*
- *show development not at risk of flooding or is compatible with the residual risk;*
- *not increase flood risk elsewhere, taking into account the impacts of climate change;*
- *not increase surface water peak flow rates or runoff volumes above green field levels including an allowance for climate change, as this would result in an increased flood risk to the receiving catchments;*
- *not increase the risk of groundwater flooding elsewhere or change the hydrogeological regime of the area;*
- *the location of basement development should be carefully considered within the LB of Haringey and attention should be paid to all sources of flood risk early within the planning process for new development (including the impact of potential future subterranean works that fall under permitted development);*
- *wherever possible use the opportunities offered by new development to reduce flood risk within the site and elsewhere; and*
- *ensure that where new development is necessary in areas of flood risk (in exceptional circumstances); it is made safe from flooding for the lifetime of the development, taking into account the impacts of climate change. This includes consideration of the potential effect of residual risks.”*

2.2.2 Finished Floor Levels

There are no recommendations for finished floor levels in either the SFRA or SWMP. As discussed above 3, surface water flooding is the governing flood risk to the site. However, as guidelines for surface water are not mentioned in the standing advice, finished levels have been based on providing freeboard to the 1 in 100 year + 40% climate change.

2.2.3 Sustainable Drainage Systems (SuDS)

Further requirements are that:

- Surface water discharge from proposed development sites should mimic that of a present day green field site, up to and including a 1:100 AEP critical storm event including an allowance for climate change. Green field runoff rates should be maintained irrespective of whether the site falls within an area designated as being effected by flood risk from any source.
- It is critical that the onsite drainage models should demonstrate that there is no increased flood risk to third parties.
- Use SuDS measures wherever practical and achieve 50% attenuation of undeveloped site's surface water runoff at peak times.

The SFRA also contains suggestions for Highgate School in the form of "Green infrastructure", which would be covered by suitable SuDS measures Figure 2.7.

HDA01	Highgate School, Highgate Wood, St Luke's Hospital	• Green Infrastructure at Highgate School • Habitat creation in Highgate Wood • Green Infrastructure at St Lukes Hospital, green roofs
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Figure 2.7: SFRA Recommendation for Highgate School

2.2.4 Sewer Flooding

The SWMP mapping (Appendix C) has not identified a specific sewer flooding issue in the vicinity of the site. The area 'N6 4', which the site is located within is recorded as having '1 to 5' sewer flooding records. Other areas within the borough are recorded as having between '21 to 50' sewer flooding records so sewer flooding incidents at our site can be considered low.

However, as the SFRA mapping is very broad scale, it does not offer strong conclusions regarding risk of flooding from sewers.

2.2.5 Groundwater Flooding

There is limited information on flood risk from groundwater. The EA website shows no information on groundwater flooding for the site.

The British Geological Survey (BGS) possesses a record of boreholes within the UK. According to this record, boreholes (TQ28NE4111, TQ28NE412 and TQ28NE413) are available in the vicinity of the site, approx. 250m away, to the East on Bishopswood Road. The Borehole logs, from 2006, indicate the ground is all clay and remarks include 'water seepages throughout'. Groundwater flooding usually occurs in more permeable strata such as chalk, so the risk for groundwater flooding in clay is considered low.

The SWMP mapping (Appendix D) shows two potential incidents have occurred near to the site. However the disclaimer states that *"Incident records shown are generally unconfirmed and may include issues such as water main bursts or non-groundwater related problems."*

The proposed new sports hall is partly below ground level, however with suitable tanking and an entrance threshold level above the potential surface water flood level, this should mitigate some risk of development.

Given the points raised in this section, groundwater flooding at the site is considered a low risk and will not be considered further.

3 National Planning Policy

3.1 Introduction

The National Planning Policy Framework (NPPF) clauses 159 to 169 details the policy associated with flooding with clause 161 giving the sequential, risk-based approach for managing flood risk. This includes:

- Sequential Testing - Clause 162
- Exception Testing - Clauses 163 to 165

These issues are discussed in more detail in subsequent sections.

3.2 The Sequential Test

The NPPF Sequential Test is used to, where possible, steer development to sites at a lesser risk of flooding. Given that the development site is located in the current EA flood zone 1, it does not apply to this development.

3.3 The Exception Test

Table 3 of the Flood Risk and Coastal Change Guidance (reproduced as Table 3.1) shows whether a particular type of development (i.e vulnerability) is compatible with the flood zone in which it is located. As noted above, the is located in Flood Zone 1 and considered to be ". Table 3 confirms that:

- development is appropriate development in Flood Zone 1.
- There is no requirement for an Exception Test.

Flood Zone	Essential Infrastruct	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Comp Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Exception Test	Yes	Yes	Yes
Zone 3a	Exception Test	No	Exception Test	Yes	Yes
Zone 3b	Exception Test*	No	No	No	Yes*

Table 3.1: Flood Zone and Vulnerability Compatibility

3.3.1 Climate Change

Table 1 of the The Technical Guidance for Flood Risk Assessments - Climate Change Allowances gives the rainfall climate change allowances applicable to the development. Table 3.2 gives the climate change allowances for rainfall:

Climate Change Allowance	Percentage
Central 2070s	25%
Upper End 2070s	40%

Table 3.2: Climate Change Allowances for Rainfall

4 Hydraulic Modelling Surface Water Flood Risk

Please see report E for full details of the model build and results discussion.

A hydraulic model has been constructed of the Highgate school catchment using industry standard ESTRY TUFLOW software to assess surface water flooding at the existing sports facilities and for the proposed sports facilities.

As part of the new sports facility development, various flood mitigation options have been proposed, which include:

- An amphitheatre which doubles as a flood storage attenuation area with ground levels set to 107.5mAOD at the lowest level.
- A bund set to 110mAOD surrounding the southerly sports facility buildings to protect them from surface water run-off.
- Ground levels around the most northerly buildings are set to 106.00mAOD as indicated by the plans. There is a proposed extra gully to help drain this area.
- An existing swale has been diverted through the proposed all weather sports pitch area.
- The north block has two entrances, at east and west ends. The interior FFL at the entrances is set at 107.00m AOD. In each entry lobby the users will then step down [or use lift access] to a main floor level set at 106.150.
- All window cills will be set at at least 107.000 m AOD datum.
- the proposal is to effectively tank all the walls from lower basement right up to the 107.0m AOD datum, so that flood water cannot enter below this level
- The tanking will be concealed by the outer skin of brickwork of the insulated cavity construction

The latest modelling has demonstrated that:

- The modelled flood options are effective at mitigating internal flooding to the school up to and including the 1 in 100 year design event + 40% climate change (Figure 4.1). They also provide a benefit for those downstream of the school, with a reduction in flood level of up to 100mm.
- The flood level for the 1 in 100 year design event + 40% climate change is 106.62mAOD at the northern end of the site. This gives a freeboard of 0.38m to the interior FFL at the entrances to the building.
- There is no adverse impact off site with flood levels reduced by 100mm at the northern end of the site Figure 4.3.

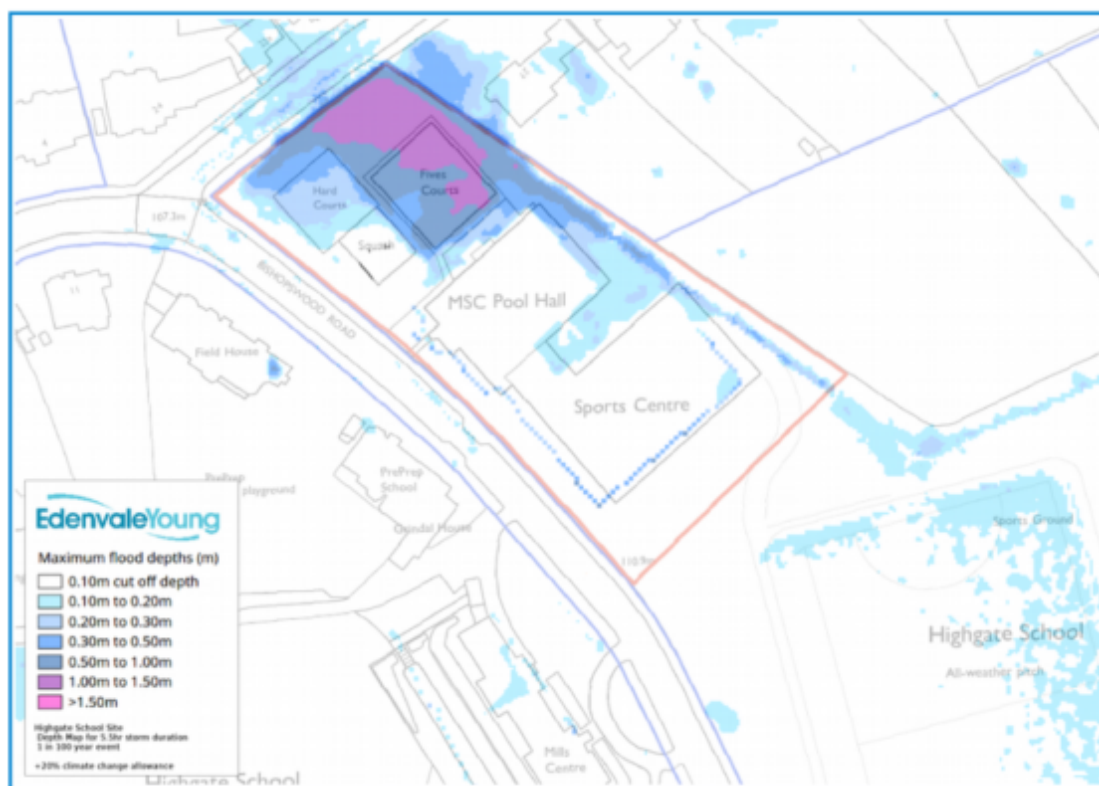


Figure 4.1: Baseline case, maximum flood depths: 1 in 100 year design event + 20% climate change allowance

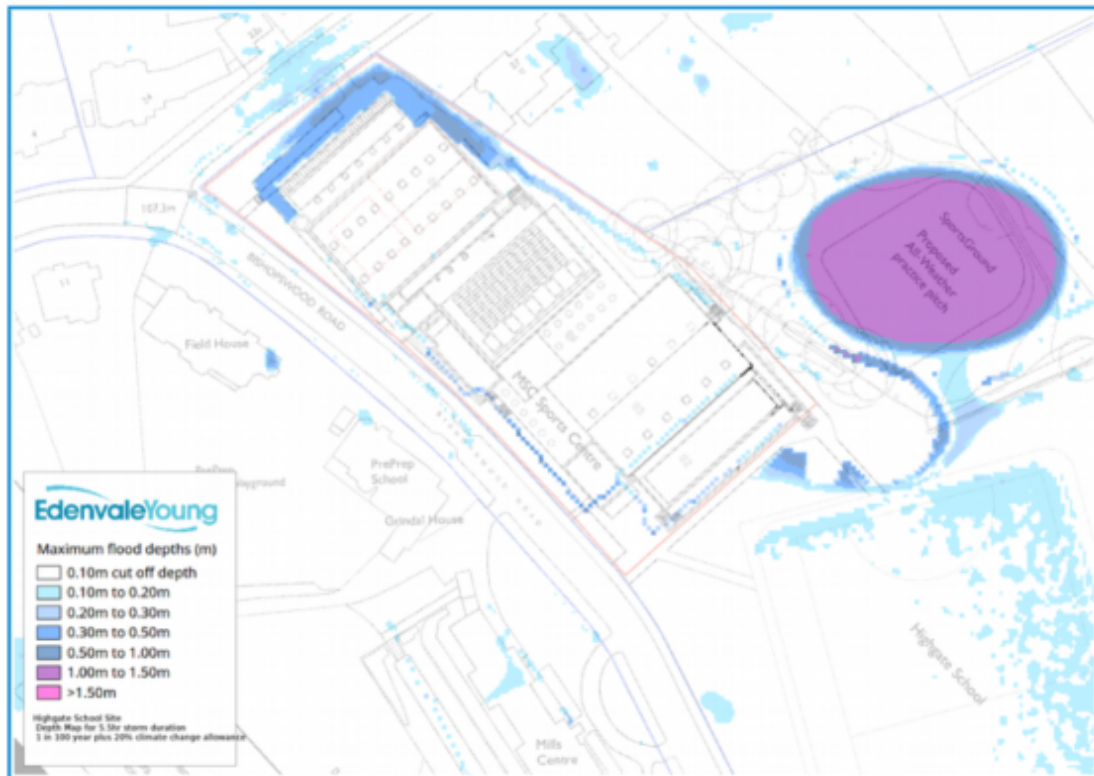


Figure 4.2: Post development scenario, maximum food depths: 1 in 100 year design event + 20% climate change allowance

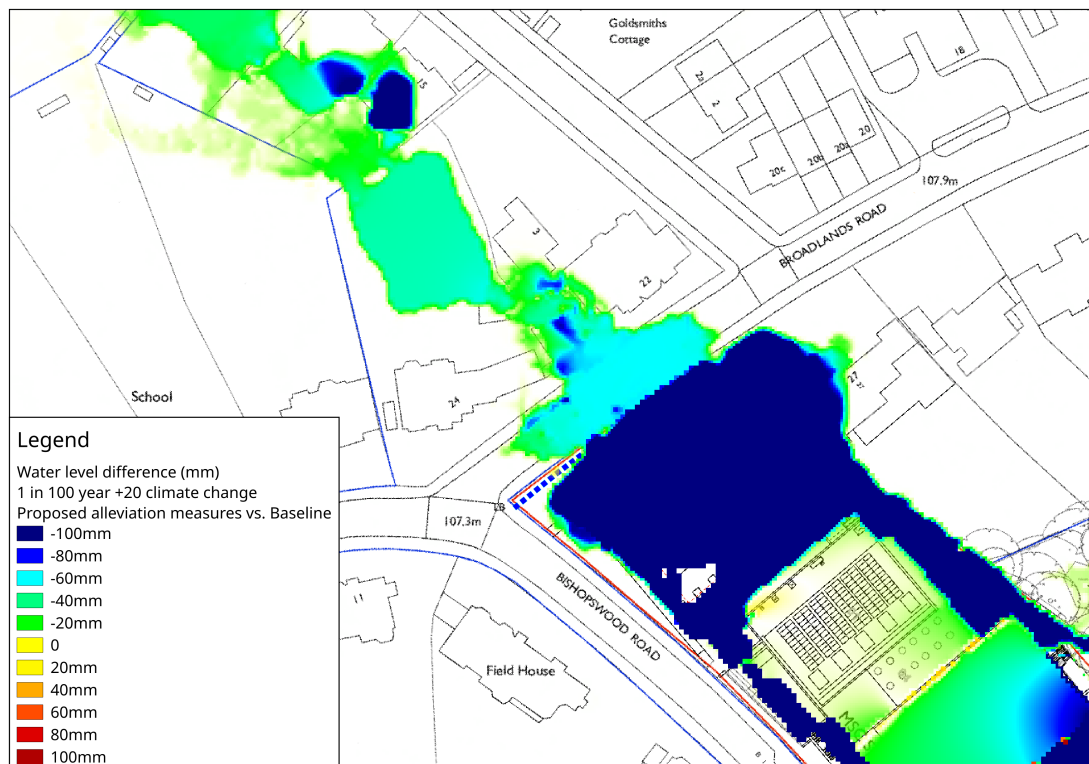


Figure 4.3: Water level difference mapping between the proposed post development scenario and existing case

5 Conclusions and Recommendations

5.1 Conclusions

The following conclusions are made from the Flood Risk Assessment undertaken to assess the risk of flooding to the Mallinson Sports Centre redevelopment at Highgate school

- The proposed development lies in Flood Zone 1.
- The main flood risk posed to the site is surface water flooding.
- Other sources of flooding such as infrastructure flooding, surface water flooding and groundwater flooding have been reviewed but are considered low risk.
- Site specific hydraulic modelling has been undertaken as well as modelling of proposed flood mitigation measures.
- The modelled flood mitigation options are effective at preventing internal flooding to the school up to and including the 1 in 100 year design event + 40% climate change. They also provide a benefit for those downstream of the school, with a reduction in flood level of up to 100mm.
- The flood level for the 1 in 100 year design event + 40% climate change is 106.62mAOD at the northern end of the site. This gives a freeboard of 0.38m to the interior FFL at the entrances to the building.

5.2 Recommendations

It is recommended that:

- Suitable SuDS measures should still be considered on site to control surface water run-off.
- Flood resilience measures should be adopted as part of the sports hall design, it is recommended that;
 - All new build below ground level should be tanked.
 - One-way valves should be installed in foul pipework to prevent sewage backing up into the development.

- Suitable flood doors shall be installed at the entrance to the buildings to mitigate the risk of internal flooding in a 1 in 100 year event with a climate change allowance of 40% on rainfall plus a freeboard of 0.3m.

A Topographic Survey

B SWMP 1 in 100 year event + climate change flood depth map

C Mapping from the SWMP showing sewer flooding incidents in Haringey

D Mapping from the SWMP showing groundwater flooding incidents in Haringey

E Highgate Surface Water Modelling Report RevC

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