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Project: Flood Risk Assessment (FRA)

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Site Location: Ruislip High School, Sidmouth Drive, Ruislip, London Borough of Hillingdon, HA4 0BY

Proposed Development: Construction of two new school blocks.

Consultant		Date	Signature
Author	Oliver Harvey	12/05/2017	
Document Check	Thea Powell	22/05/2017	
Authorisation	Daniel Cook	23/05/2017	

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Contact Us:

Ambiental Technical Solutions Ltd.
Science Park Square
Brighton, BN1 9SB
www.ambiental.co.uk
UK Office: +44 (0) 203 857 8540

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1. Summary

- 1.1 Ambiental Technical Solutions Limited has been appointed by Arcadis LLP to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the construction of a new school block.
- 1.2 The proposed development is located at Ruislip High School, Sidmouth Drive, Ruislip, London Borough of Hillingdon, HA4 0BY.
- 1.3 According to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA the site is partially located in Flood Zone 1 (Low Risk; less than 1 in 1000 annual probability of fluvial flooding (<0.1%)), partially located in Flood Zone 2 (Medium Risk; between 1 in 100 and 1 in 1000 annual probability of flooding from fluvial sources (1% - 0.1%)), with a small portion of the southern side of the site (currently playing fields) being located in Flood Zone 3 (High Risk; Greater than 1 in 100 annual probability of flooding from fluvial sources (>1%)). The existing and proposed development is considered to be "More Vulnerable".
- 1.4 The EA has provided records to confirm that an area in close proximity to the east of the site has not experienced any historical flooding, however an area to the south east of the railway line (adjacent to Bedford Road) was affected by flooding in 1959.
- 1.5 The EA Risk from Surface Water Flooding Map (Figure 6) has identified the site to be predominantly at 'Very Low' and 'Low' risk of flooding. The existing school and surrounding area has been shown to be a 'Very Low' risk while the playing fields to the south of the existing school have been shown to be mainly at 'Low' risk of flooding with small areas at 'Medium' risk.
- 1.6 Analysis of the calculated 1:100 year + 70% flood level across the site shows a flood level of 36.96m AOD. Comparison with topographic levels (between 36.12m AOD and 38.20m AOD) shows the site could experience flood depths of between 0 and 0.84m during this flood event.
- 1.7 Further Analysis of the calculated 1:100 year + 70% climate change flood level (36.96m AOD) shows that the existing school and proposed new school blocks are all located on land topographically higher (Figure 10).
- 1.8 As such, and given that:
 - the site lies within an existing developed area and is for the construction of an extension to an existing school;
 - the existing/proposed development are located on land topographically higher than the 1:100+CC (+35% increase in flow);
 - the site lies within an area with no history of flooding; and,
 - in terms of flood vulnerability, significant betterment can be achieved through the implementation of flood mitigation measures and flood warning procedures.

Following the guidelines contained within the NPPF, the proposed development is considered **to be suitable**, assuming appropriate mitigation can be maintained for the lifetime of the development.

Development Description	Existing	Proposed
Development Type:	Existing School	Construction of two new school blocks
(Number of Bedrooms):	N/A ¹	N/A ¹
EA Vulnerability Classification:	More Vulnerable	More Vulnerable; No Change
Ground Floor Level:	Ground topographic levels vary between 36.12mAOD and 38.20mAOD	No Change
Level of Sleeping Accommodation:	N/A ¹	N/A ¹
Impermeable Surface Area:	N/A ²	Increase post-development
Surface Water Drainage:	N/A ¹	It is understood surface water drainage is being considered as part of the application
Site Size:	N/A ¹	No change
Risk to Development	Summary	Comment
EA Flood Zone:	1, 2 and 3	Proposed development in Flood Zone 1, 2 and 3
Flood Source:	Fluvial	Yeading Brook
1 in 100yr flood level:	36.43mAOD	River Crane Mapping Study (Halcrow 2008)
1 in 100yr flood Level + 70% Climate Change:	36.96mAOD	
1 in 1000yr flood level:	37.36mAOD	
Recorded Flood Events in Area:	Yes	1959
Recorded Flood Events at Site:	None	
SFRA Available:	Yes	London Borough of Hillingdon Strategic Flood Risk Assessment (2008)
Management Measures	Summary	Comment
Ground floor level above extreme flood levels:	N/A ¹	Proposed new school block located outside of modelled flood extents
Safe Access/Egress Route:	Yes	Safe refuge on topographically higher parts of the site and in the existing school.
Flood Resilient Design:	N/A ¹	Proposed new school block located outside of modelled flood extents
Site Drainage Plan:	N/A ¹	It is understood surface water drainage is being considered as part of the application
Flood Warning & Evacuation Plan:	N/A ¹	
Offsite Impacts	Summary	Comment
Displacement of floodwater:	N/A ¹	Proposed development is located outside of the modelled flood extents
Increase in surface run-off generation:	None	It is understood surface water drainage is being considered as part of the application
Impact on hydraulic performance of channels:	None	Site is located in Flood Zone 1

Table 1: Summary of flood risks, impacts and proposed flood mitigation measures.

N/A¹ not required for this assessment; N/A² data not available.

2. Development Description and Site Area

Proposed Development and Location

- 2.1 The proposed development is located at Ruislip High School, Sidmouth Drive, Ruislip, London Borough of Hillingdon, HA4 0BY.
- 2.2 The proposed development is for the construction of two new school blocks to the existing school. The development will also incorporate a roof extension.
- 2.3 According to topographical data (Source: Topographic Survey), the topography generally slopes from a south east to north west direction. The existing playing field on the southern side of the site are topographic low points of the site (approximately 36.12mAOD) before sloping upwards towards the existing school building, with the highest topography recorded on the north site boundary (approximately 38.20mAOD). The existing school is located on land approximately 37.50mAOD.

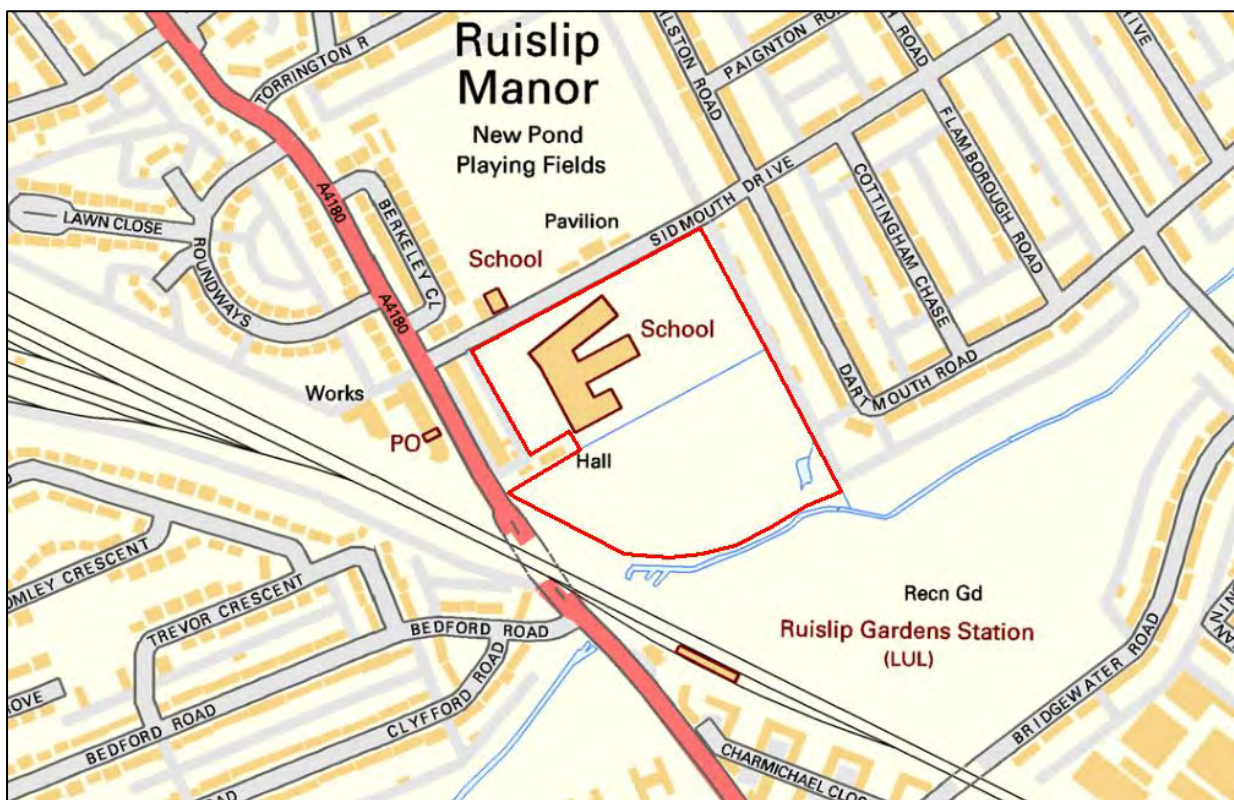


Figure 1: Site Location. Approximate Site Boundary is shown in red (Source: OS)



Figure 2: Wider view of site location, approximate site boundary outlined in red (Source: Google Earth)

Vulnerability classification

- 2.4 The existing development is considered 'More Vulnerable' under the NPPF. The proposed development is for the construction of two new school blocks and is considered to be an extension of the existing site. As such the development will remain being classified as 'More Vulnerable' under the NPPF.
- 2.5 According to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA the site is partially located in Flood Zone 1 (Low Risk; less than 1 in 1000 annual probability of fluvial flooding ($<0.1\%$)), partially located in Flood Zone 2 (Medium Risk; between 1 in 100 and 1 in 1000 annual probability of flooding from fluvial sources ($1\% - 0.1\%$)), with a small portion of the southern side of the site (currently playing fields) being located in Flood Zone 3 (High Risk; Greater than 1 in 100 annual probability of flooding from fluvial sources ($>1\%$)).



Figure 3: EA Flood Map for Planning (Source: EA)

Geology

- 2.6 The site's bedrock geology has been identified by the British Geological Survey's Online Geology of Britain mapping tool as the Lambeth Group comprised of clay, silt and sand. No superficial deposits have been recorded on site or in the surrounding area (Source: BGS).

3. Sequential Test/Exception Test

- 3.1 Under the NPPF, all new planning applications must undergo a *Sequential Test*. This test must be implemented by local planning authorities, with a view to locating particularly vulnerable new developments (e.g. residential, hospitals, mobile homes etc.) outside of the floodplain.
- 3.2 The test refers to the EA Flood Zones described in Table 5. For reference, the NPPF *Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table* is reproduced below:

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
	Zone 3b <i>Functional Floodplain</i>	Exception Test Required	✓	✗	✗	✗

Table 2: The Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table as specified by NPPF. Shaded cells denote the proposed re-development. Please note: ✓ means development is appropriate; ✗ means the development should not be permitted.

- 3.3 Using the principles of the Sequential Test outlined above, the proposed development is for the construction of two new school blocks. The proposed development is classified under the NPPF as "More Vulnerable" due to its educational use. As the site is located in partially within Flood Zone 1, 2 and 3 the development would need to apply the Exception Test.
- 3.4 As Table 2 demonstrates, the Exception Test would normally be required for this development. For the Exception Test to be passed, the proposed development would need to meet the following criteria:
- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh the flood risk, as informed by a Strategic Flood Risk Assessment;
 - a Flood Risk Assessment demonstrates that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

(Source: NPPF)

- 3.5 The planning application submitted by the client is required to be accompanied by a FRA which shows that the development can be achieved in a sustainable manner, with an overall reduction of flood risk to the site and surrounding area.

4. Site Flood Hazards

Sources of Flooding

- 4.1 As outlined in Figure 3, the proposed development is located within Flood Zone 1, 2 and 3 (Low, Medium and High Risk of flooding, respectively), and is considered to be “More Vulnerable” under the NPPF. Communication with the Environment Agency (EA) has identified the following potential sources of flooding to the site:

Source	Description
Fluvial	Yeading Brook
Surface	On Site
Groundwater	N/A
Sewer	N/A

Table 3: Summary of flood sources.

Mechanisms and History of Flooding

- 4.2 According to the low detail, national-scale flood mapping created on behalf of the EA the probability of fluvial flooding at the site is less than 1 in 1000 annual probability of fluvial flooding for areas in Flood Zone 1, between 1 in 1000 and 1 in 100 annual probability of fluvial flooding for areas in Flood Zone 2 and greater than 1 in 100 annual probability of fluvial flooding for area in Flood Zone 3. Figure 3 outlines only the potential floodplain; and the mitigating effects of flood defences currently in place are not considered.

Fluvial

- 4.3 The EA Flood Map for Planning (Figure 3) confirms that the proposed development lies within fluvial Flood Zone 1, 2 and 3 (Low, Medium and High Risk, respectively).
- 4.4 An unnamed drain runs parallel to the existing school through the centre of the site and along the eastern site boundary, the drain is connected to the Yeading Brook located on the southern boundary of the site. The Yeading Brook runs in an east to west direct and has been classified as an EA main river.
- 4.5 The EA have provided modelled in-channel flood data from the River Crane Mapping Study, completed in 2008. Node YW905 has been used in the analysis as it has been deemed the most representative upstream node and therefore provides a worst case scenario.

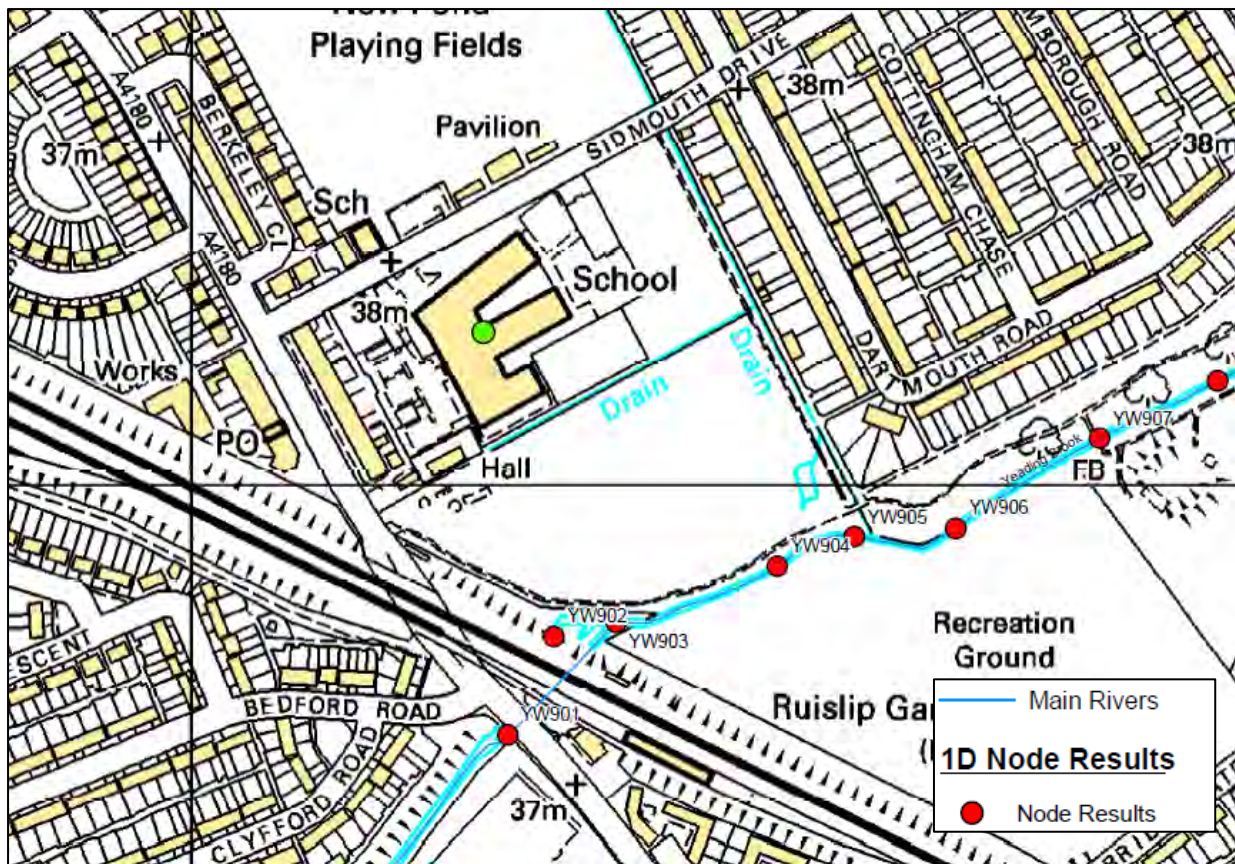


Figure 4: Node Location Map (Source: EA)

Modelled Defended Fluvial Floodplain Flood Level (mAOD)					
Node	5% AEP (1:20 year)	2% AEP (1:50 year)	1%AEP (1:100 year)	1%AEP + 20% (1:100 year+CC)	(0.1% AEP) (1:1000 year)
YW908	36.49	36.53	36.57	36.63	37.37
YW907	36.41	36.46	36.50	36.58	37.36
YW906	36.36	36.41	36.46	36.55	37.36
YW905	36.29	36.37	36.43	36.53	37.36
YW904	36.30	36.36	36.42	36.52	37.36
YW903	36.28	36.35	36.41	36.52	37.36
YW902	35.97	36.02	36.06	36.16	36.99
YW901	35.78	35.82	35.85	35.92	36.23

Table 4: Modelled Flood Level (Source: EA)

- 4.6 Analysis of the 1:20 year and 1:50 year flood events (36.29mAOD and 36.37mAOD) for node YW905 show that the site is partially inundated during these flood events, however flood extents are confined to the lower topographic areas on the existing playing fields towards the southern side of the site.
- 4.7 Comparison of the 1:100 year flood event (36.43mAOD) with topographic levels (between 36.12mAOD and 38.20mAOD) shows that the site would be partially inundated during this flood event, however flooding would be confined to the playing fields on the southern side of the site.
- 4.8 Comparison of the 1:1000 year flood event (37.36mAOD) shows the site would be partially inundated during this flood event, with the lower topography of the playing fields being affected

and part of the western side of the site (Figure 5). Possible flood depths could be anywhere between 0m and 1.24m.

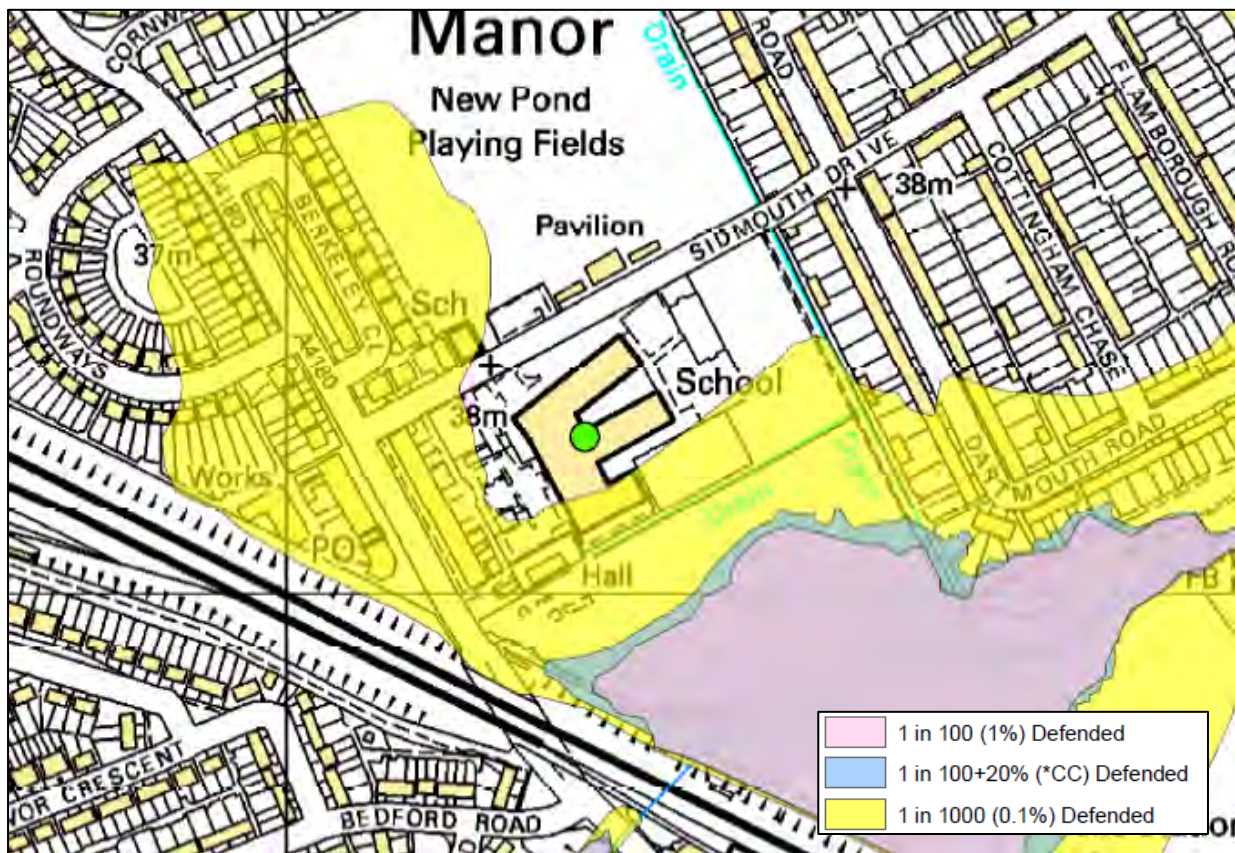


Figure 5: Node Location Map (Source: EA)

- 4.9 The EA has provided records to confirm that an area in close proximity to the east of the site has not experienced any historical flooding, however an area to the south east of the railway line (adjacent to Bedford Road) was affected by flooding in 1959.
- 4.10 As such the risk of flooding from this source is considered to be **relatively high**, however the risk of flooding to the existing/proposed development is considered to be **relatively low**.

Surface Water (Pluvial)

- 4.11 The EA Risk from Surface Water Flooding Map (Figure 6) has identified the site to be predominantly at 'Very Low' and 'Low' risk of flooding. The existing school and surrounding area has been shown to be a 'Very Low' risk while the playing fields to the south of the existing school have been shown to be mainly at 'Low' risk of flooding with small areas at 'Medium' risk.
- 4.12 Areas identified to be at 'Very Low' risk have a chance of flooding of less than 0.1% (1:1000) annually, areas identified to be at 'Low' risk have a chance of flooding between 0.1% (1:1000) and 1% (1:100) annually, and areas identified to be at 'Medium' risk have a chance of flooding between 1% (1:100) and 3.3% (1:30) annually.
- 4.13 The EA Surface Water Depth (Low Chance of Occurring) Map (Figure 7) shows that the existing school and surrounding area would be unaffected by flood depths during this flood event. The

playing fields could be affected by flood depths primarily between 300mm and 900mm, with small areas possibly being affected by greater than 900mm of flood depths.

- 4.14 The proposed new school blocks are to be constructed on land located in an area of “Very Low” risk of surface water flooding.
- 4.15 The London Borough of Hillingdon SFRA (2008) shows no record of surface water flooding at the site.
- 4.16 As such the risk of flooding from this source to the site is considered to be **relatively low**.

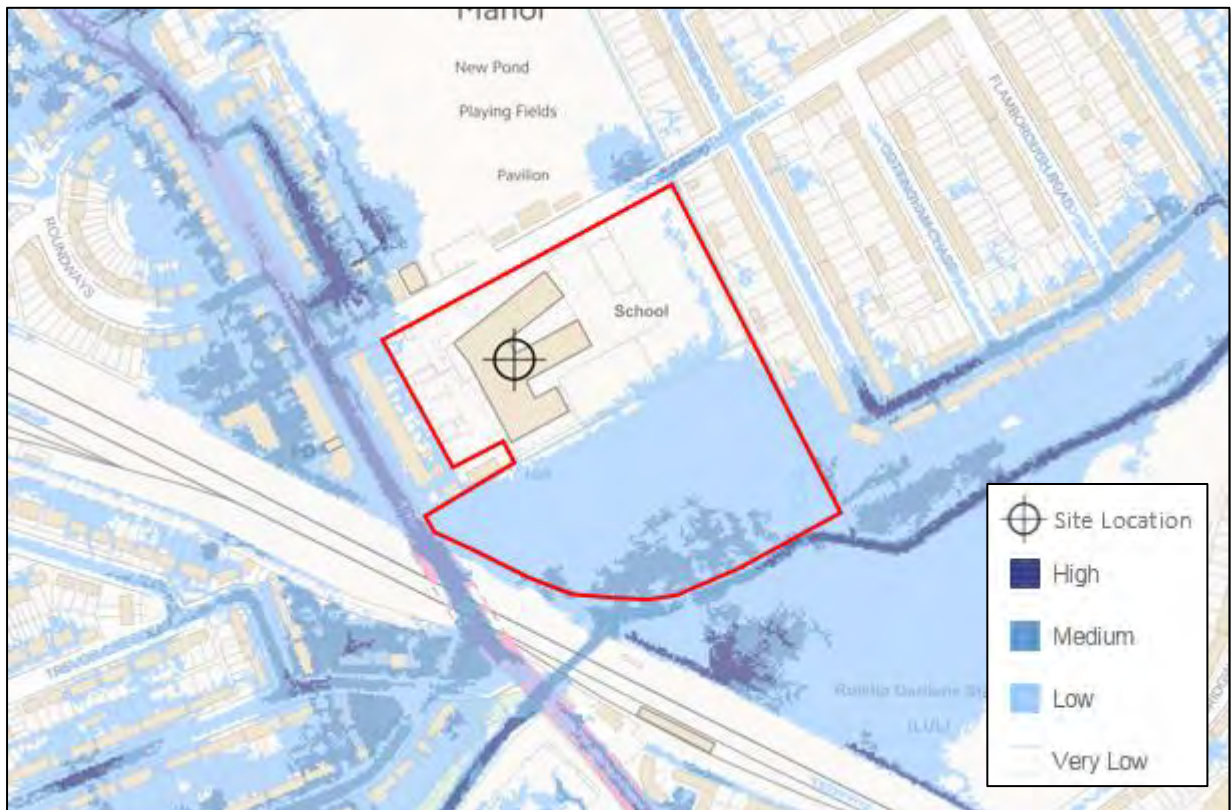


Figure 6: EA Risk of Flooding from Surface Water (Source: EA)

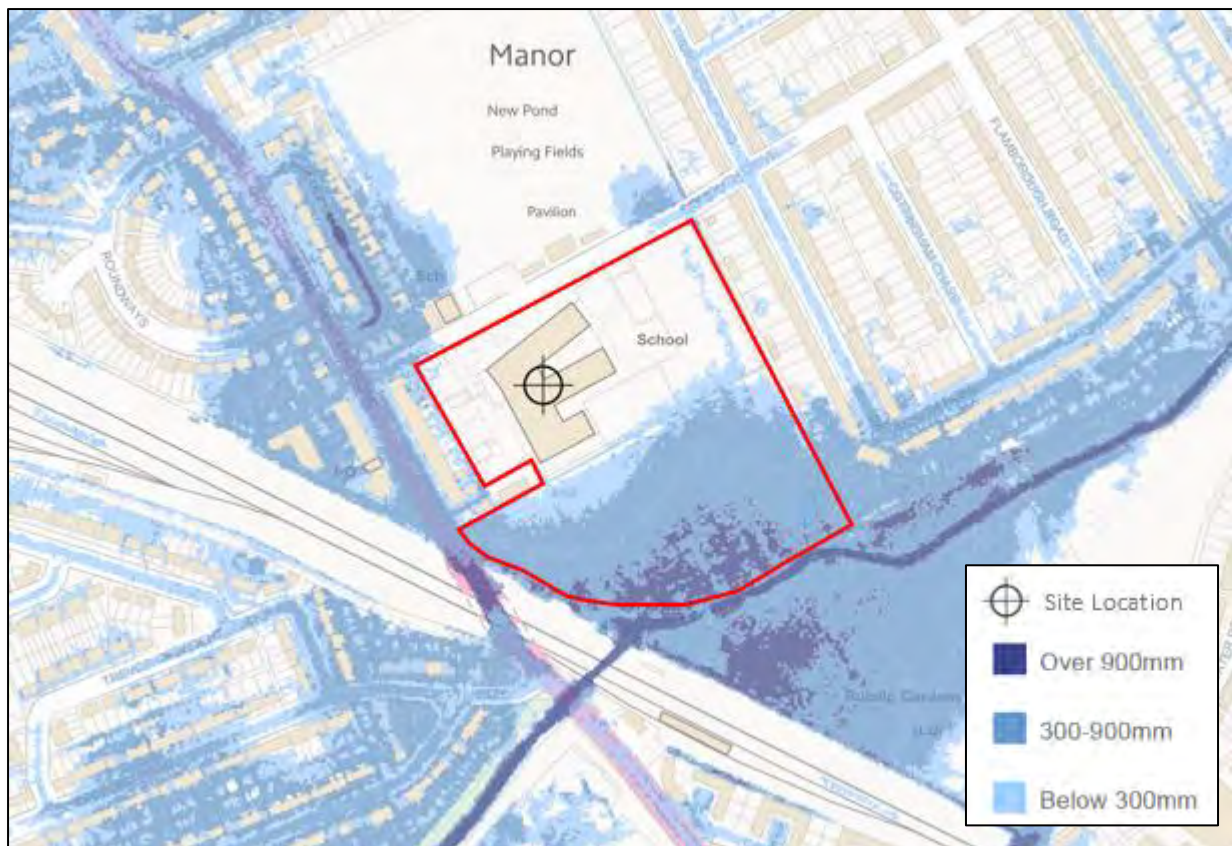


Figure 7: EA Low Chance of Occurring Surface Water Depths (Source: EA)

Groundwater

- 4.17 The EA has confirmed that the site is located outside of all groundwater source protection zones and groundwater vulnerability zones.
- 4.18 The London Borough of Hillingdon SFRA (2008) has not provided has shown the site to be located outside of any area to have experienced groundwater flooding previously.
- 4.19 Given the site has no history of flooding from this source, the risk of groundwater flooding in the vicinity of the site is therefore considered to be of **relatively low**.

Sewer

- 4.20 The London Borough of Hillingdon SFRA (2008) has stated that in the last 10 years (as of 2008), 11 properties were flooded due to overloaded sewers.
- 4.21 As such, the risk of flooding from this source can be considered to be **relatively low**.

Surface Water Drainage Strategy

- 4.22 Initial site investigations show that the pedestrian hardstanding areas around the school are constructed using permeable paving, while the tarmac car parking areas are constructed using a permeable macadam (Figure 8).



Figure 8: Permeable Paving and Permeable Macadam Around the existing School

- 4.23 Currently it is not known whether surface water is infiltrated into the surrounding soil or discharged to a surface water sewer/watercourse.
- 4.24 It was found, during a site visit, that there were isolated puddles of water on the existing permeable paving, it is recommended that the 'slots' between the permeable paving blocks are cleaned every 5-10 years, this will ensure that the permeable paving does not become clogged with debris.
- 4.25 The proposed school blocks are to be constructed on areas of permeable paving and playing fields, as such impermeable surfaces will increase as a result of the proposed development.
- 4.26 As such the proposed development should utilise SuDS in accordance with the Hillingdon Local Flood Risk Management Strategy and aim to provide at least a reduction in runoff volume/rate of 50% from the developed area, in accordance with the London Plan.

Records of Historical Flooding

- 4.27 The EA has provided records to confirm that an area in close proximity to the east of the site has not experienced any historical flooding, however an area to the south east of the railway line (adjacent to Bedford Road) was affected by flooding in 1959.

5. Probability of Flooding

- 5.1 As outlined in Figure 3, the proposed development is located within Flood Zone 1, 2 and 3, and is considered to be “More Vulnerable”. According to the low detail, national-scale flood mapping created on behalf of the EA the probability of the land assessed has a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
- 5.2 This information is supported by the EA Flood Map for Planning (Figure 3) which has been produced in part using JFLOW/HYDRO-F – a relatively coarse, national scale flood modelling strategy and in part by detailed modelling. These maps indicate the potential spatial extent of a fluvial flood event which has a magnitude that is, on average, likely to occur once in every one hundred years (i.e. the 1:100 year floodplain). It is important to note that only the *potential* floodplain is shown; *the mitigating effects of any flood defences currently in place are not considered*. For reference, the definition of the NPPF flood risk zones is included in Table 5.

Zone	Description
1	Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
2	Medium Probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
3a	High Probability. This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).

Table 5: Definition of the NPPF Flood Zones. Shaded cells denote the proposed development. (Source: EA)

Climate Change on Site

- 5.3 Climate change is likely to increase the flow in rivers, raise sea levels and increase storm intensity. The range of allowances in Table 6 is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it.
- The:

- central allowance is based on the 50th percentile,
- higher central is based on the 70th percentile,
- upper end is based on the 90th percentile.

- 5.4 So, if the central allowance is 30%, scientific evidence suggests that it is just as likely that the increase in peak river flow will be more than 30% as less than 30%.
- 5.5 At the higher central allowance 70% of the possible scenarios fall below this value. So, if the higher allowance is 40%, then current scientific evidence suggests that there is a 70% chance that peak flows will increase by less than this value, but there remains a 30% chance that peak flows will increase by more (*Source: EA*).
- 5.6 The risk of flooding to the site would therefore be expected to increase following the effects of climate change. The likely increases in peak rainfall intensity would also lead to an increased risk of surface water flooding. The increase in river flows for the Thames river basin district has been provided below in Table 7.

Flood Zone	Essential Infrastructure	Highly Vulnerable	More vulnerable	Less Vulnerable	Water Compatible
2	Higher Central and Upper End	Higher Central and Upper End	Central and Higher Central	Central	None of the allowances
3a	Upper End	Development should not be permitted	Higher Central and Upper End	Central and Higher	Central
3b	Upper End	Development should not be permitted	Development should not be permitted	Development should not be permitted	Central

Table 6: Allowance and Flood Zone Table. (*Source EA*)

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

Table 7: Peak river flow allowances by river basin district. (*Source EA*)

- 5.7 The proposed development is considered “More Vulnerable” under the NPPF and located within Flood Zones 1, 2 and 3. More vulnerable developments in Flood Zone 3 must use the higher central and upper end climate change allowances for their river basin district (Table 7). The allowances for the Thames basin are provided in Table 7. To provide a worst case scenario, the upper end (+70%) climate change allowance has been used in the analysis.
- 5.8 Analysis of the calculated 1:100 year + 70% flood level across the site shows a flood level of 36.96Maod (Figure 9). Comparison with topographic levels (between 36.12mAOD and

38.20mAOD) shows the site could experience flood depths of between 0 and 0.84m during this flood event.

- 5.9 Further analysis of the calculated 1:100 year + 70% climate change flood level (36.96mAOD) shows that the existing school and proposed new school blocks are all located on land topographically higher (Figure 10).

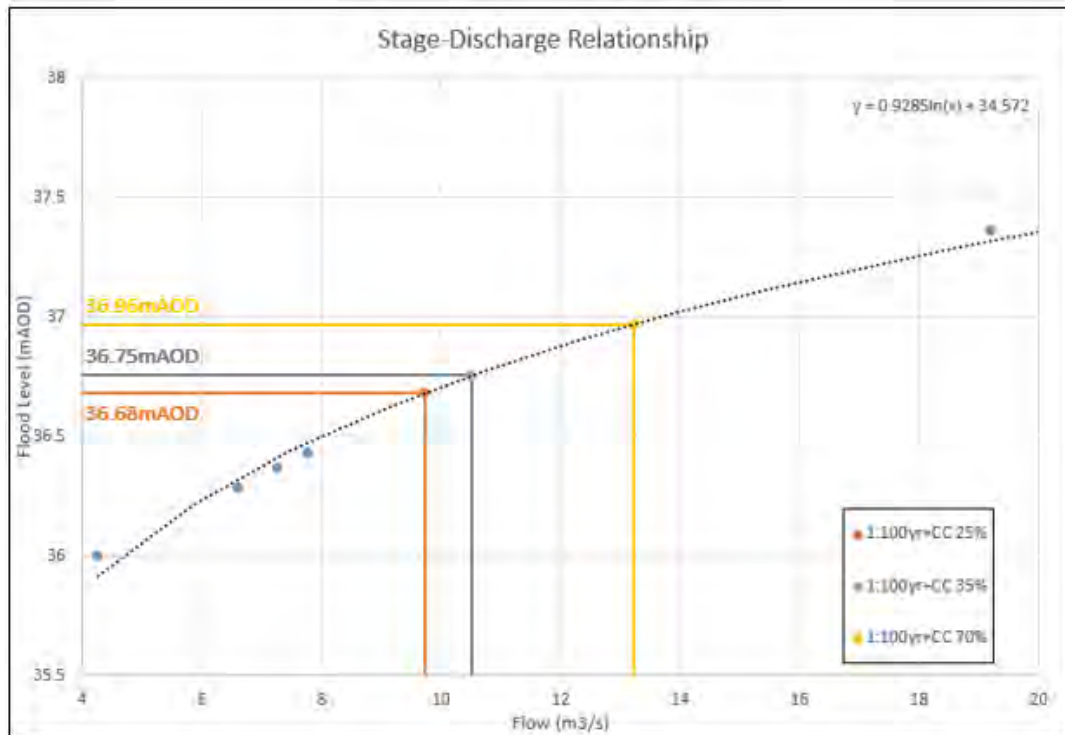


Figure 9: Stage-Discharge Relationship for modelled flows

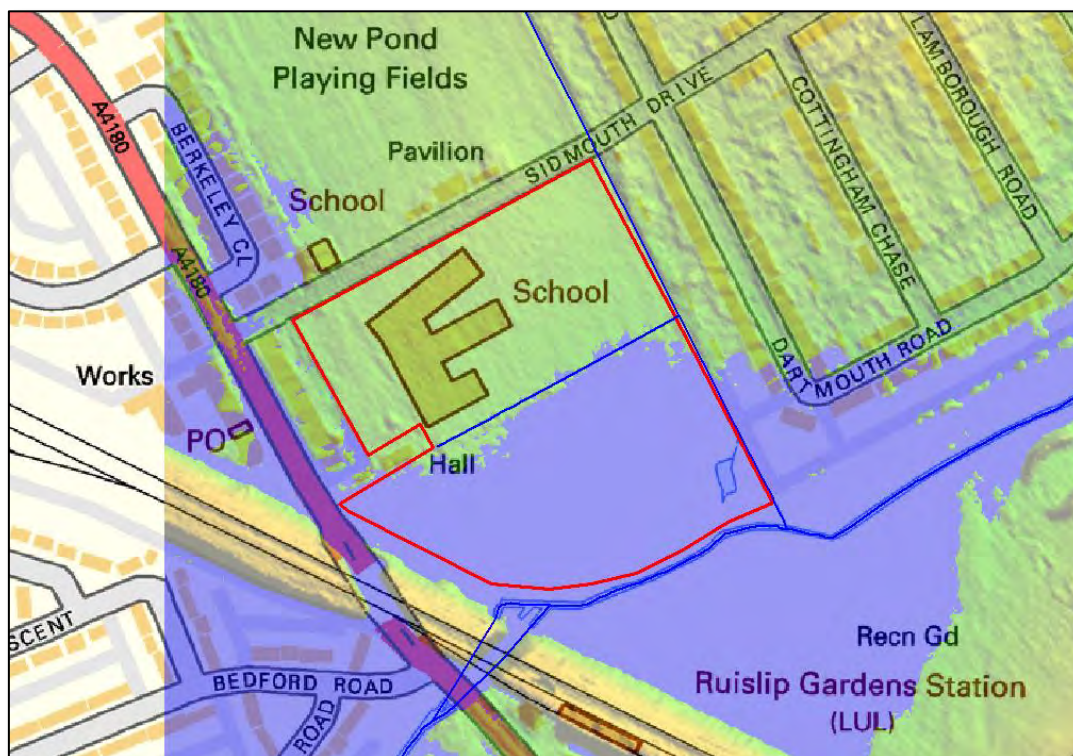


Figure 10: Calculated 1:100+70% flood extent overlain with topography (Source: OS, EA, LiDAR)

6. Flood Risk Management Measures

- 6.1 The site is partially located in Flood Zone 1, 2 and 3 and therefore the proposed development should incorporate mitigation measures. However it should be noted that the proposed school blocks are located completely in Flood Zone 1 (Figure 10).
- 6.2 It is recommended that the following mitigation measures are incorporated;
- solid (i.e. concrete floors) where possible on the ground floor with waterproof membrane;
 - finished floor levels/threshold levels raised at least 150mm above external ground levels to mitigate against extreme overland flows;
 - install back flow prevention on all new sewer connection on site;
 - the route of all electrical services will run from ceilings on the ground floor down towards sockets (where possible);
 - all plumbing insulation to be of closed-cell design;
 - anti-syphon fitted to all toilets, and;
 - if possible, site management and senior staff to sign up to EA Flood Warning/Alert Service and have an evacuation plan.

Access/Egress

- 6.3 Part of the site/building resides within Flood Zone 2 and as such, where available, it is recommended that the site owner and individual property owners subscribe to the EA's Flood Warning/Alert Service. The site owner should ensure that this service is made available to all occupants of the proposed development.
- 6.4 Safe refuge from flooding can be achieved via internal access to the upper floors of the existing school, moving to higher topographic areas of the site on the northern side, or by leaving the site and heading away from the source of flooding.
- 6.5 The EA operate a 5 day county-wide forecast in relation to flood risk. It is recommended that this service is regularly checked to ensure occupants/residents are aware of any possible risks: <https://flood-warning-information.service.gov.uk/5-day-flood-risk>.
- 6.6 The EA operate a Flood Information service which identifies whether any flood warnings or alerts have been issued for a specific postcode or place in England or Wales: <https://flood-warning-information.service.gov.uk/>.
- 6.7 The EA also operates a 24-hour telephone service on 0345 988 1188 that provides frequently updated flood warnings and associated floodplain information. It is important to note that the EA's flood warnings are only in relation to fluvial and tidal flooding, and do not cover other sources of flooding such as surface water or groundwater flooding.
- 6.8 The resident(s) will be required to register for this service (<https://www.gov.uk/sign-up-for-flood-warnings>). It is advised that all residents and site users also register for this service, as management

may not be on site at the time of a flood event. It is the responsibility of the management staff to make this service available to all site users.

- 6.9 Flood warnings will be issued by the EA no later than 2 hours before the tide reaches this area; however, it is expected that warnings will generally be issued about 6 hours in advance of high tide. The likely flood events in this flood warning area are going to be due to overtopping of defences or a breach in the defence line.
- 6.10 Further information can be found on www.environment-agency.gov.uk/floodline. Floodline Warnings Direct is a free service operated by the EA that provides flood warnings direct to occupants by telephone, mobile phone, fax or pager.

- On receipt of a **FLOOD ALERT**, the owners/occupiers of the property should:
 - Monitor the situation via local media;
 - Make themselves aware of forecast local weather conditions;
 - Alert others resident in the property of the situation;
 - Prepare to evacuate if necessary.
- On receipt of a **FLOOD WARNING**, the owners/occupiers of the property should:
 - Follow advice to “go in, stay in, and tune in”;
 - Be prepared to follow instruction from the Emergency Services.
- On receipt of a **SEVERE FLOOD WARNING**, the owners/occupiers of the properties should:
 - Follow advice to “go in, stay in, and tune in”;
 - Remain attentive to local media forecasts and news bulletins;
 - Do not evacuate unless instructed to do so by the Emergency Services;
 - Only when instructed to evacuate by the Emergency Services, leave the property and follow the agreed evacuation route – detailed previously.

- 6.11 If flooding has already occurred prior to evacuation, it is advised to remain on the higher topographic areas of the site and await instruction from the emergency services or until it is deemed safe to evacuate. Under no circumstances should site users enter the southern playing fields area. Site users should move via internal stairwells to the upper floors of the school or to the higher topographic areas on the northern side of the site so as to be located within an area of safe refuge. No evacuation should be sought if flood depths exceed 25cm, evacuation should only be sought with the assistance of the emergency services in these circumstances.

- 6.12 It is the responsibility of the site management to keep the evacuation route known to all site users.

7. Off Site Impacts

Impact to Flood Risk Elsewhere

- 7.1 The proposed school extensions are located outside of all modelled flood events, there is no offsetting flood storage, and thus; under the NPPF there is no requirement to provide compensatory flood storage.

Generation of Runoff

- 7.2 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.
- 7.3 In accordance with the provided plans for the proposed development, the proposed development will increase the impermeable surface cover to the site due to new school blocks on the permeable paving/playing fields. The runoff arising from the development will need to be managed in accordance with National Planning Policy Framework (NPPF) policy which, requires SuDS to be considered where appropriate for major developments.
- 7.4 Policy 5.13 – Sustainable Drainage of the London Borough of Hillingdon Local Flood Risk Management Strategy (February 2016) states:
- Development should utilise urban drainage systems (SUDS), unless there are practical reasons for not doing so, and should aim to achieve Greenfield runoff rates and ensure that surface water runoff is managed as close to its source as possible, in line with the following drainage hierarchy. Further requirements ensure that redevelopment in London aims to reduce surface water runoff to greenfield runoff rates. Sustainable Design and Construction Supplementary 4 Planning Guidance sets out a minimum target of a 50% reduction.*
- 7.5 As such the proposed development should utilise SuDS in accordance with the Hillingdon Local Flood Risk Management Strategy and aim to provide at least a reduction in runoff volume/rate of 50% from the developed area, in accordance with the London Plan.

8. Residual Risks

Identification of Residual Risks

- 8.1 Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:
- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
 - failure of a reservoir, or;
 - a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.
- 8.2 The proposed development has been shown to be located on land topographically higher than the modelled flood levels. The defences in the area have a design standard of protection of 1:5 years, as such there is a relatively low residual risk of defence failure.
- 8.3 Analysis of the EA's Risk of Flooding from Reservoirs map shows the site to be located outside of any maximum flood extents due to the failure of reservoirs.
- 8.4 As such, the only remaining residual risk to the site is that of drainage failure. A limited history of flooding due to sewers has been found as part of this flood risk assessment.

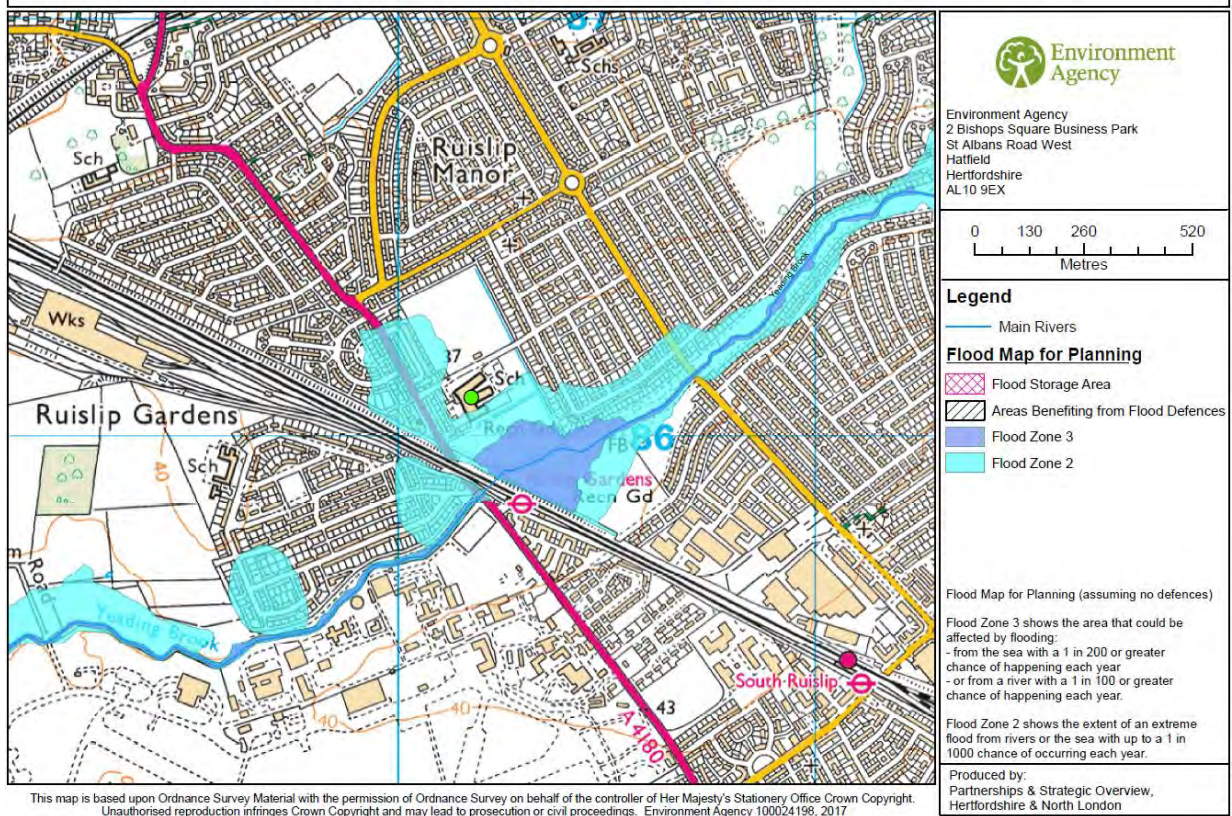
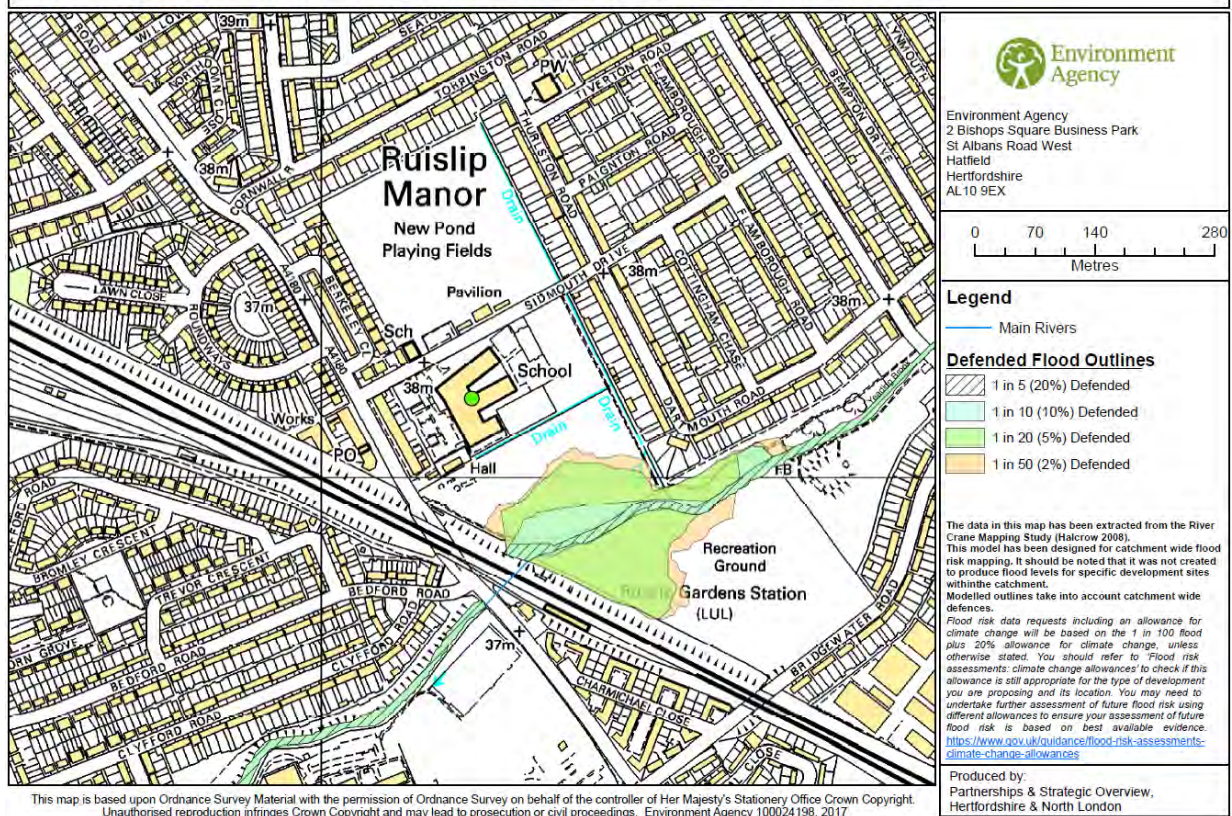
9. Conclusion

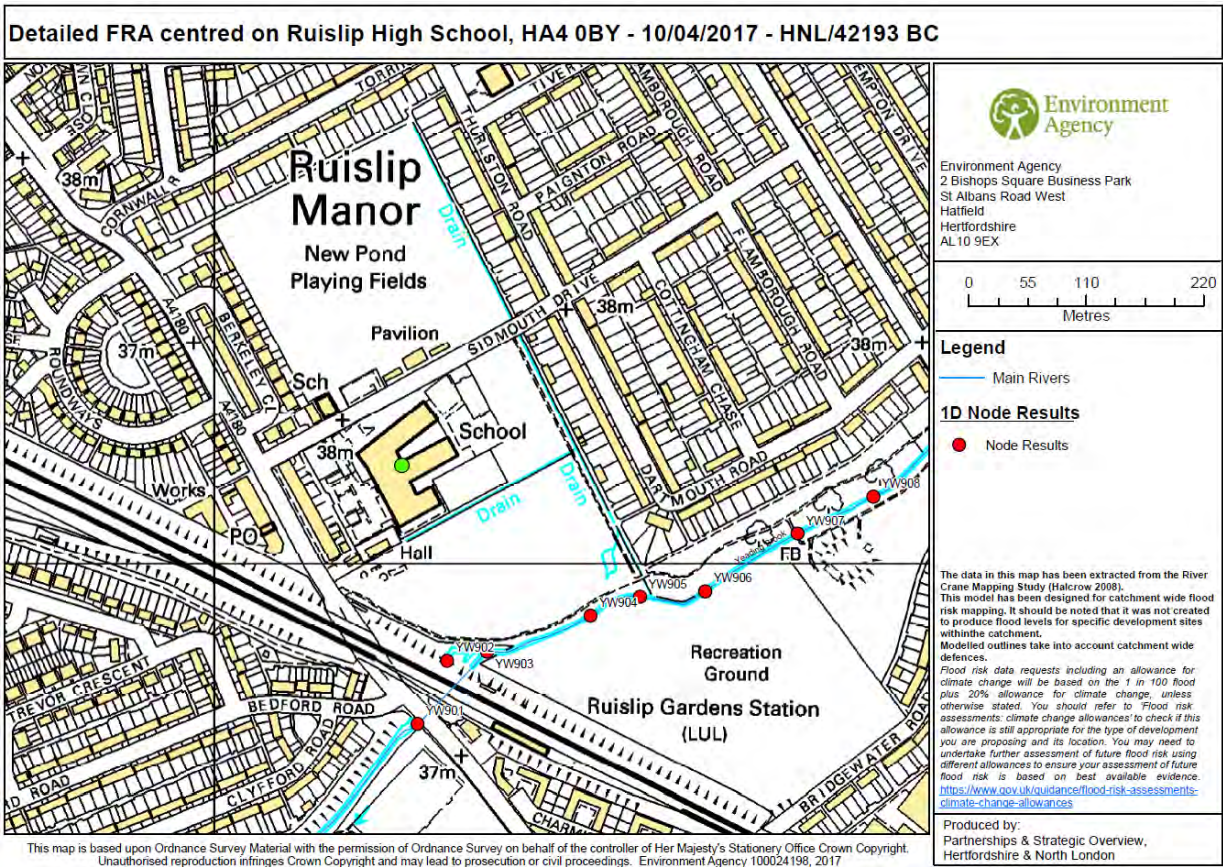
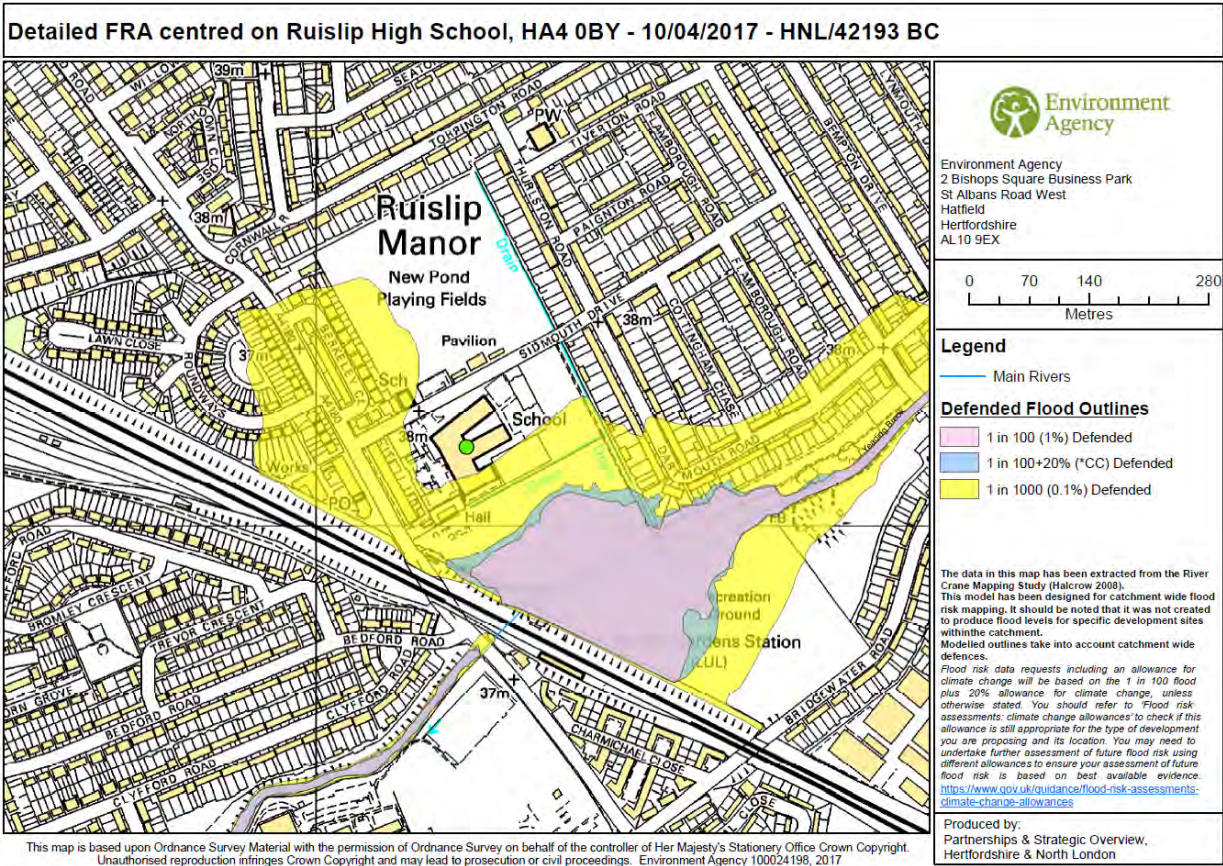
- 9.1 Ambiental Technical Solutions Limited has been appointed by Arcadis LLP to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the construction of a new school block.
- 9.2 The proposed development is located at Ruislip High School, Sidmouth Drive, Ruislip, London Borough of Hillingdon, HA4 0BY.
- 9.3 According to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA the site is partially located in Flood Zone 1 (Low Risk; less than 1 in 1000 annual probability of fluvial flooding (<0.1%)), partially located in Flood Zone 2 (Medium Risk; between 1 in 100 and 1 in 1000 annual probability of flooding from fluvial sources (1% - 0.1%)), with a small portion of the southern side of the site (currently playing fields) being located in Flood Zone 3 (High Risk; Greater than 1 in 100 annual probability of flooding from fluvial sources (>1%)). The existing and proposed development is considered to be “More Vulnerable”.
- 9.4 The EA has provided records to confirm that an area in close proximity to the east of the site has not experienced any historical flooding, however an area to the south east of the railway line (adjacent to Bedford Road) was affected by flooding in 1959.
- 9.5 The EA Risk from Surface Water Flooding Map (Figure 6) has identified the site to be predominantly at ‘Very Low’ and ‘Low’ risk of flooding. The existing school and surrounding area has been shown to be a ‘Very Low’ risk while the playing fields to the south of the existing school have been shown to be mainly at ‘Low’ risk of flooding with small areas at ‘Medium’ risk.
- 9.6 Analysis of the calculated 1:100 year + 70% flood level across the site shows a flood level of 36.96m AOD. Comparison with topographic levels (between 36.12m AOD and 38.20m AOD) shows the site could experience flood depths of between 0 and 0.84m during this flood event.
- 9.7 Further Analysis of the calculated 1:100 year + 70% climate change flood level (36.96m AOD) shows that the existing school and proposed new school blocks are all located on land topographically higher (Figure 10).
- 9.8 As such, and given that:
- the site lies within an existing developed area and is for the construction of an extension to an existing school;
 - the existing/proposed development are located on land topographically higher than the 1:100+CC (+35% increase in flow);
 - the site lies within an area with no history of flooding; and,
 - in terms of flood vulnerability, significant betterment can be achieved through the implementation of flood mitigation measures and flood warning procedures.

Following the guidelines contained within the NPPF, the proposed development is considered **to be suitable**, assuming appropriate mitigation can be maintained for the lifetime of the development.

Appendix A – Supporting Information

- EA Product 4 Dataset

Flood Map for Planning centred on Ruislip High School, HA4 0BY - 10/04/2017 - HNL/42193 BC**Detailed FRA centred on Ruislip High School, HA4 0BY - 10/04/2017 - HNL/42193 BC**



Environment Agency ref: HNL/42193/BC

The following information has been extracted from the River Crane Mapping Study (Halcrow 2008)

Flood risk data requests including an allowance for climate change will be based on the 1 in 100 flood plus 20% allowance for climate change, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

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

Caution:

The modelled flood levels and extents are appropriate for catchment wide strategic flood risk mapping. However, for more detailed flood risk assessment it is recommended that each of the underlying flood mapping, hydraulic modelling and hydrological assumptions are re-evaluated to determine the appropriateness in a more detailed analysis.

All flood levels are given in metres Above Ordnance Datum (mAOD)

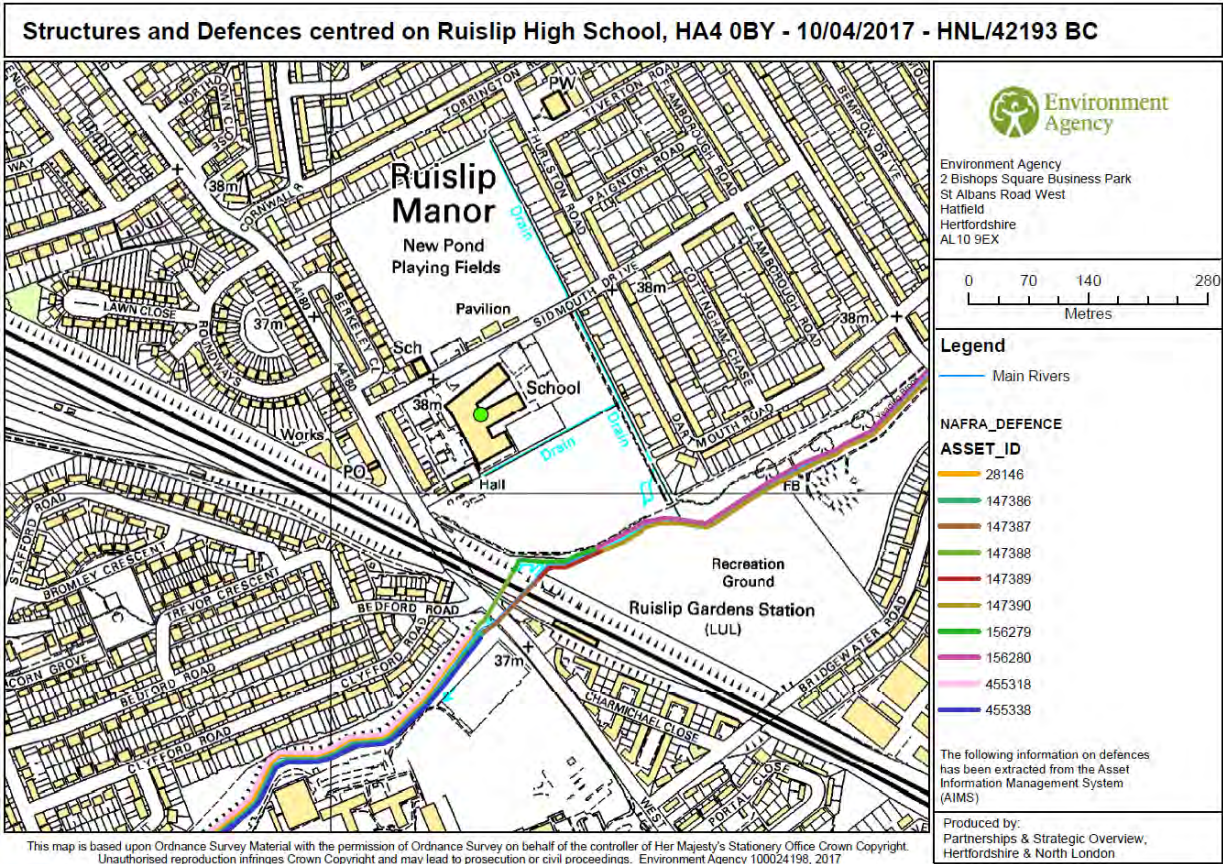
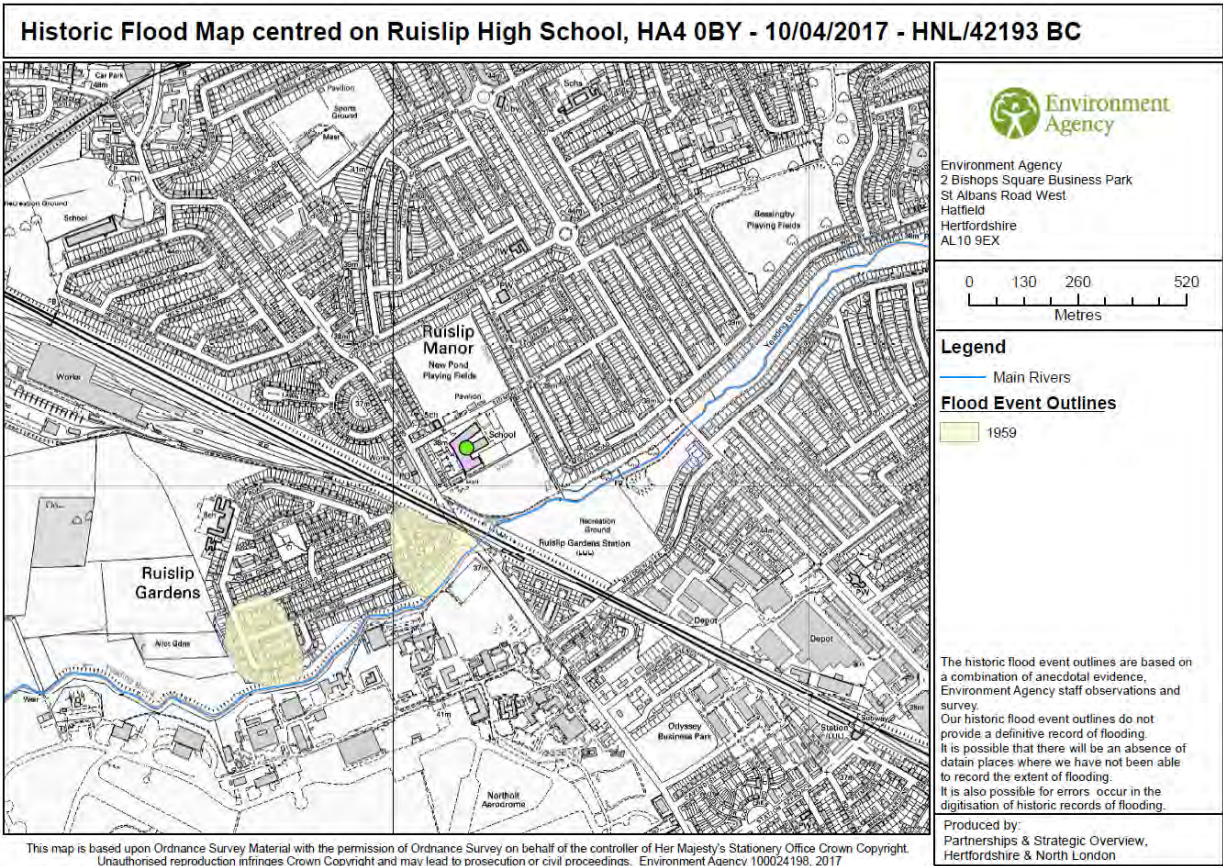
All flows are given in cubic metres per second (cumecs)

MODELLED FLOOD LEVEL

Node Label	Easting	Northing	Return Period					
			5 yr	20 yr	50 yr	100 yr	100yr + 20%	1000yr
YW908	510619	186061	36.24	36.49	36.53	36.57	36.63	37.37
YW907	510547	186028	36.15	36.41	36.46	36.50	36.58	37.36
YW906	510462	185972	36.06	36.36	36.41	36.46	36.55	37.36
YW905	510400	185965	36.00	36.29	36.37	36.43	36.53	37.36
YW904	510353	185951	35.96	36.30	36.36	36.42	36.52	37.36
YW903	510255	185914	35.92	36.28	36.35	36.41	36.52	37.36
YW902	510219	185909	35.72	35.97	36.02	36.06	36.16	36.99
YW901	510192	185849	35.58	35.78	35.82	35.85	35.92	36.23

MODELLED FLOWS

Node Label	Easting	Northing	Return Period					
			5 yr	20 yr	50 yr	100 yr	100yr + 20%	1000yr
YW908	510619	186061	4.27	6.71	7.44	8.02	9.16	21.47
YW907	510547	186028	4.27	6.70	7.43	8.01	9.13	21.00
YW906	510462	185972	4.26	6.66	7.36	7.93	8.99	20.04
YW905	510400	185965	4.26	6.61	7.27	7.78	8.78	19.18
YW904	510353	185951	4.26	6.52	7.11	7.59	8.54	18.53
YW903	510255	185914	4.26	6.35	6.89	7.36	8.27	17.82
YW902	510219	185909	4.26	6.37	6.91	7.38	8.29	17.80
YW901	510192	185849	4.26	6.38	6.92	7.38	8.30	17.80



Environment Agency ref: [HNL 42193 BC](#)

The following information on defences has been extracted from the Asset Information Management System (AIMS)

Defences

Asset ID	Asset Type	Asset Protection	Asset Comment	Asset Description	Design Standard of protection (years)	Downstream Crest Level	Upstream Crest Level	Condition of Defences (1=Good, 5 = Poor)
147390	high_ground	fluvial	Natural vegetated channel	Natural Bank	10	<Null>	37.43	3
28146	high_ground	fluvial	Natural Vegetated Bank	Natural Channel	10	34.08	36.98	3
147388	high_ground	fluvial	Poured concrete bank protection	Bank protection.	100	44.1	46.16	3
147387	high_ground	fluvial	Concrete block bank protection	Bank protection.	1000	44.13	46.29	3
147389	high_ground	fluvial	CONCRETE BLOCK BANK PROTECTION EXTENDING FROM CULVERT.	Bank protection.	75	<Null>	<Null>	3
147386	high_ground	fluvial	Natural Vegetated Channel	Natural Bank	5	34.11	36.59	3
455338	high_ground	fluvial	<Null>	Yeadon Brook.	<Null>	<Null>	<Null>	3
455318	high_ground	fluvial	<Null>	Yeadon Brook (main).	<Null>	<Null>	<Null>	3
156279	high_ground	fluvial	CONCRETE BLOCK BANK PROTECTION EXTENDING FROM CULVERT.	Bank protection.	100	36.23	36.18	3
156280	high_ground	fluvial	Natural vegetated channel	Natural Bank	5	<Null>	37.42	3

Appendix B – Information Relating To JFLOW

JFLOW and flood outlines (Source: EA)

Flood Zones have been produced using JFLOW, a nationally consistent model. JFLOW has been used to produce the 1% (1 in 100 year) and 0.1% (1 in 1000 year) flood outlines.

The flood outlines have been developed by applying flow and tide models to a 3D ground level map of England and Wales, known as a Digital Terrain Model (DTM). This is created by flying an aircraft over the whole of the country using radar to record and create a contoured model of the land. This DTM is used as the basis of a grid of cells which is used to estimate the extent of flooding in a flood of a given return period or probability.

The size of the flood event (1 in 100 or 1 in 1000 year) is determined by the inflows to the JFLOW model, which are calculated using statistical techniques from the Flood Estimation Handbook. The technique used is based upon catchment descriptors and data transfer, the details of these can be found in the Flood Estimation Handbook volume 3. The Flood Estimation Handbook provides a consistent technique for estimating inflows to the national model and its methods are widely accepted.

The methodology is a raster-based approach, driven by an underlying Digital Elevation Model (DEM).

- Each cell has a ground level and water depth
- Water can move to any of surrounding 8 cells where the water level is lower
- Water will pond in low spots until the water level is high enough to spill
- The velocity of movement depends on water surface slope and surface roughness

The above points describe the basic principles of the model. The two underlying principles are:

- Mass conservation within each cell
- Calculation of the fluxes between the cells

Each grid cell is treated as a small storage area. Mass conservation is applied to each grid cell. The flux between cells is calculated using a form of the generalised weir equation.

Efficient coding is achieved by keeping a list of all currently wet cells and a list of newly wet cells. This avoids having to search through each cell in the ground grid.

For whole catchment modelling, the hydrographs used as inflow boundary conditions represent the whole hydrograph at that inflow location and a simple conceptual method has been derived to account for the amount of flow within the channel banks. A simple solution was therefore sought which would approximately account for the proportion of flow contained within the channel without requiring further information about the channel.

The simple conceptual method used involves two assumptions:

1. That bankfull flow (Q_b) is equal to QMED as calculated by the Flood Estimation Handbook (FEH) methods. QMED has a return period of 2 years. This assumption derives from the concept of dominant discharge in fluvial geomorphology (Wolman and Leopold, 1957;

Wolman and Miller, 1960) where the cross-section shape is assumed to be formed by a discharge with a recurrence interval of 1-2years.

2. That the additional channel flow (Q_c) scales with both Q_b and depth above bankfull (d).

The basis of the current model is that each grid cell acts as a small flood cell and the links to each of the surrounding cells are automatically calculated. It is therefore capable of simulating the inundation extent at a level of detail equal to the underlying DEM. It is fundamentally volume conservative and so, in a given time period, will simulate the peak water levels across the floodplain depending on the volume of water that has entered the floodplain. This approach is a half-way house between the common 1D hydrodynamic models and a 2D hydrodynamic model.

Limitations

JFLOW was used to produce flood maps for the whole of England and Wales for all catchments greater than 3 sq-km in a consistent manner. The method is therefore very generalised and therefore cannot take account of information that may be very significant locally. This might include:

1. Effects of bridges and other structures including flood defences are not taken into account.
2. Errors in the DTM, caused by trees and buildings for example.
3. The effect of reservoirs and urban drainage and other man made influences on the flow regime can only be taken into account in a very general sense in JFLOW.
4. The channel is assumed to be able to take the 2 year flow. This may not be true especially in those modified by man.
5. Hydraulic roughness is assumed to be the same everywhere in JFLOW, but of course it is not.

For these and many other reasons, the flood outlines produced by JFLOW can only be taken as a rough guide, showing where more detailed flood risk assessments are essential. Flood risk assessments should also be undertaken near small watercourses whose catchments are too small to have been included in the JFLOW modelling.