Resilience and Flood Risk

9 Kingsmans Farm Road, Hullbridge

FLOOD RISK ASSESSMENT

10th February 2015
Draft 1.0
RAB: 1011B

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Resilience and Flood Risk

Revision history

Version	Date	Amendments	Issued to
Draft 1.0	February 2015		Mr Kevin Curtis

Quality control

Action	Signature	Date
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Checked	Ray Pickering DipCE CEng MCIWEM C.WEM MCGI MEPS	10/02/2015
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Resilience and Flood Risk

Executive Summary

RAB Consultants was appointed by Mr Richard Bailey on behalf of Mr Kevin Curtis to undertake this flood risk assessment (FRA) in support of a planning application to extend an existing residential property at 9 Kingsmans Farm Road, Hullbridge, Essex.

The site is located within Flood Zone 3a (high probability flooding) as described in Table 1 of the Planning Practice Guidance to the National Planning Policy Framework. Tidal flood defences offer protection and the south part of the site is within a formal 'Area that Benefits from Defences'.

The existing understanding of tidal flood risk at the site is based on the Environment Agency modelling data of the adjacent River Crouch, which can be found in Appendix B and referred to throughout this report. A topographic survey of the site enabled an assessment of existing ground and property floor levels at the site against the modelled flood levels. The assessment shows that based on the measured crest of the flood defences, the site is protected against overtopping of the defences to a standard of protection of 1 in 200 years (0.5%). When climate change is considered over the lifetime of the development, the site would be at risk during the 1 in 100 year (1%) flood.

An outline assessment of the residual risk of flooding from a breach in the tidal defences was undertaken and this report makes recommendations to mitigate that risk including flood resistant and resilient design, raising finished floor levels as high as practicable, signing up to the Environment Agency flood warning service and implementing a safe evacuation route.

The risk of flooding from all sources was deemed to be low. Surface water risk however, was shown to be high. The surface water flood map at this location is more representative of fluvial risk from the adjacent Kingsman Farm Ditch which flows from south to north 20m from the site. The dominant risk is tidal.

The proposals propose an increase in impermeable area, therefore there will be some increase in surface water run-off rates or volumes. There is scope to implement simple SuDS techniques to reduce surface water run-off as outlined in this report.

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Abbreviations

Abbreviation	Definition
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FSR	Flood Studies Report
IDB	Internal Drainage Board
m AOD	metres Above Ordnance Datum
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SuDS	Sustainable Drainage Systems

Resilience and Flood Risk

1.0 Introduction

1.1. Terms of Reference

RAB Consultants was appointed by Mr Kevin Curtis to undertake this Flood Risk Assessment (FRA) in support of a proposed residential development at 9 Kingsmans Farm Road, Hullbridge, Essex, SS5 6QB. The National Planning Policy Framework requires a Flood Risk Assessment to be carried out to ensure flood risk to the proposed development is considered as well as the impact the development will have elsewhere on people and property.

This FRA has been prepared in accordance with the Environment Agency's Flood Risk Assessment (FRA) Guidance Note 3 (All development in Flood Zones 2 and 3 where standing advice does not apply).

1.2. FRA Requirements

It is a requirement for development applications to consider the potential risk of flooding to a proposed development over its expected lifetime and any possible impacts on flood risk elsewhere, in terms of its effects on flood flows and runoff.

Where appropriate, the following aspects of flood risk should be addressed in all planning applications in flood risk areas:

- The area liable to flooding.
- The probability of flooding occurring now and over time.
- The extent and standard of existing flood defences and their effectiveness over time.
- The likely depth of flooding.
- The rates of flow likely to be involved.
- The likelihood of impacts to other areas, properties and habitats.
- The effects of climate change.
- The nature and currently expected lifetime of the development proposed and the extent to which it is designed to deal with flood risk.

This FRA follows government guidance on development and flood risk (National Planning Policy Framework).

1.3. Site Details

Figure 1 - Summary of site details

Site name	9 Kingsmans Farm Road, Hullbridge, Essex, SS5 6QB
Site footprint	Approximately 1,780m²
Existing land-use	Residential
Purpose of development	Residential
Estimated lifespan	100 years
OS NGR	594593 206016
Country	England (NPPF applies)
Local planning authority	Essex County Council
Other authorities	Environment Agency

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1.4. Site Description

The proposed site is the existing property at 9 Kingsmans Farm Road, Hullbridge, Essex, SS5 6QB and is currently the site of a residential property. Vehicular and pedestrian access to the site leads directly off Kingsmans Farm Road. The existing impermeable area is approximately $100m^2$.

1.5. Development Proposals

It is proposed to extend the existing property by $62m^2$. The proposed development site will occupy an approximate total impermeable area of $162m^2$.

1.6. Existing Drainage Network

Surface water is currently managed by water butts, while the excessive volume of runoff drains to the existing garden. In addition, foul water is managed by existing foul water pipes which drain to the public sewer.

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2.0 Site Layout – January 2015

2.1. General Site Observations

The existing site is relatively flat with a downward slope at the rear garden, and is comprised of a house and a large garden area. The surrounding area has been recently developed with modern residential properties. Access to the site can be gained directly from Kingsmans Farm Road. Figure 2 and Figure 3 show the access paved road and front view of the property, respectively. The proposed development is to take place at the front and rear of the existing property. Figure 4 and Figure 5 show the west and east facing elevation of where the proposed extension is to take place, respectively. Figure 6 shows the rear elevation of the existing property. A large garden area exists at the rear of the property (Figure 7). The existing property actively manages foul water via the public sewer (Figure 8, Figure 9). The developer will incorporate the installation of greywater systems to improve the existing situation. In addition, the proposed development will improve the management of surface water run-off by employing relevant techniques. Note that currently rainwater is directed to water butts (Figure 10) and the existing greenfield area. Finally it should be highlighted that the existing site benefits from flood defences (Figure 11).

Figure 2 – Access road to the site and front garden

Figure 3 – Front view of the site

Figure 4 – West facing view of the proposed extension site

Figure 5 – East facing view of the proposed extension site

Figure 6 – Rear elevation of the existing property

Figure 7 - Garden located at the rear of the property

Figure 8 – Existing foul water sewer

Figure 9 – Existing foul water inspection chamber

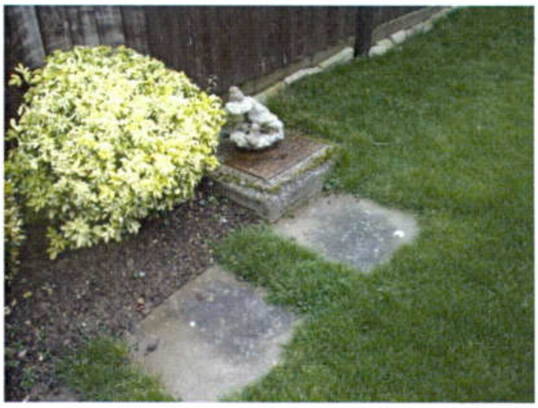


Figure 10 – Existing water butt

Figure 11 – Flood defences protecting the site

3.0 Development and Flood Risk Policy

3.1. Planning Context

3.1.1. Applicable Planning Policy

National Planning Policy Framework (NPPF) was issued by the Department for Communities and Local Government in March 2012. NPPF deals specifically with development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency Flood Map. The main study requirement is to identify the Flood Zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

3.1.2. Flood Zones

The Environment Agency has developed a Flood Map that shows the risk of flooding in England and Wales for different return period events. It should be noted that the Environment Agency's Flood Map is based on broad scale hydraulic modelling and is an indication of the potential flood risk to a site and the actual risk may differ. The Flood Zone Maps (without climate change) provide the information required by NPPF for planning purposes, as described in Section 3.2. The Flood Zones do not take account of the effect of flood defences.

The site lies within Flood Zone 3 as described in Table 1 of the Planning Practice Guidance to the National Planning Policy Framework, on 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. The proposed development is categorised as a 'more vulnerable' development in accordance with Table 3 of the Planning Practice Guidance to the National Planning Policy Framework. The site is within an area that benefits from defences.

3.1.3. Sequential Test

The Sequential Test should be applied when choosing the location of new development and the layout of the development site. The Sequential Test aims to promote development in areas with low flood risk. The Sequential Test is not applicable for this site as it is a residential extension (<250m^2).

3.1.4. Exception Test

The Exception Test is used where no suitable development areas can be found in low risk areas, the risk of flooding is clearly outweighed by other sustainability factors, and the development will be safe for its lifetime, taking climate change into account. The development must fulfil two conditions to pass the Exception Test:

1. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared;

2. A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Despite the fact the Exception Test does not apply for this site it is good practice to ensure that the second condition is demonstrated.

3.2. NPPF Flood Zones

Table 1 shows how the Flood Zones relate to a sequential planning process.

Table 1 - NPPF Flood Zones and Requirements

Zone 1: Low Probability	
Land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).	**Appropriate uses** All uses of land are appropriate in this zone. **FRA requirements** For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 2: Medium Probability	
Land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%) in any year.	**Appropriate uses** The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table2-2 are appropriate in this zone. Highly vulnerable uses in Table 2-2 are only appropriate in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 3a: High Probability	
Land assessed as having a 1 in 100 or greater annual probability of river flooding	**Appropriate uses** The water-compatible and less vulnerable uses of land in Table 2-2 are appropriate in this zone.

(<1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	The highly vulnerable uses (Table 2-2) should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2-2 should only be permitted in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding; • create space for flooding to occur by allocating and safeguarding open space for flood storage.
Zone 3b: Functional Floodplain	
Land where water has to flow or be stored in times of flood. (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 local planning authority and the Environment Agency, including water conveyance routes).	**Appropriate uses** Only the water-compatible uses and the essential infrastructure listed in Table 2-2 that has to be there should be permitted. It should be designed and constructed to: • remain operational and safe for users in times of flood; • result in no net loss of floodplain storage; • not impede water flows; • not increase flood risk elsewhere. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** In this zone, developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding.

Source: NPPF Planning Practice Guidance Table 1

Table 2 - Flood Risk Vulnerability Classification

Essential Infrastructure	Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	Hospitals, residential institutions such as residential care homes, children's homes, Social services homes, prisons and hostels. Buildings used for: dwelling houses, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping. Non–residential uses for health services, nurseries and education. Landfill and waste management facilities for hazardous waste.
Less Vulnerable	Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities), minerals working and processing (except for sand and gravel). Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	Flood control infrastructure, water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel workings. Docks, marinas and wharves, navigation facilities. MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

Source: NPPF Planning Practice Guidance Table 2

Table 3 - Flood Risk Vulnerability and Flood Zone 'compatibility'

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

Source: NPPF Planning Practice Guidance Table 3

Key:

✓ Development is appropriate

✗ Development should not be permitted

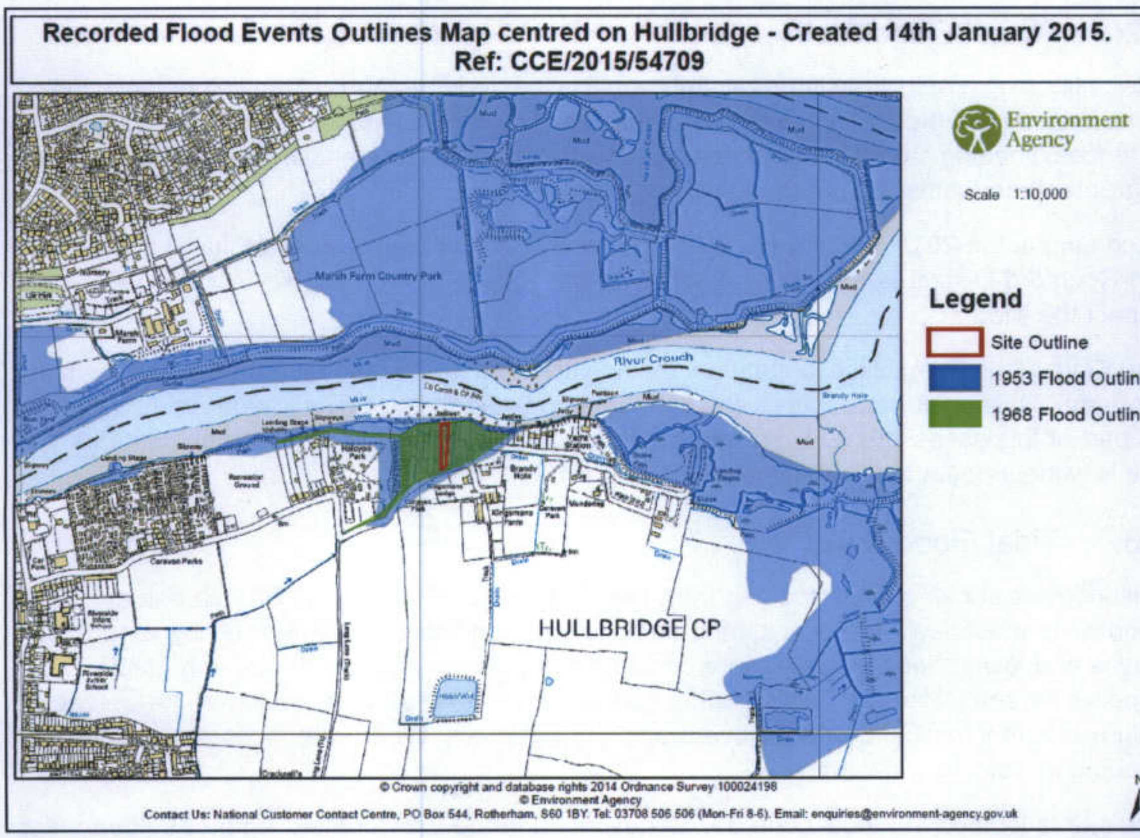
4.0 Assessment of Flood Risk

4.1. Previous Flood History

According to the 2011 Essex County Council Preliminary Flood Risk Assessment, the 2011 Rochford District Council Strategic Flood Risk Assessment, and the 2012 South Essex Surface Water Management Plan (SWMP), there are a number of main rivers draining Rochford District Council, mainly the tributaries of the Tidal River Roach and the Tidal River Crouch. As a result, a large proportion of the district falls within the Environment Agency's fluvial and tidal flood zones 2 and 3.

The Environment Agency (EA) has provided a historic flood map (Figure 12). As can be seen from Figure 12, the site has been affected by flooding events which occurred in 1953 and 1968. These records show flooding to the land and do not necessarily indicate that properties within the historic flood events were flooded internally. It is also possible that the pattern of flooding in this area has changed and that this area would now flood under different circumstances.

Figure 12 - Environment Agency Historic Flood Map



The 1953 East Coast flood was a tidal surge event that caused widespread disruption along the East Coast of England, Scotland and in the low lying areas of Belgium and the Netherlands. Following this flood there was major investment in flood defences, flood warning and forecasting and the construction of the Thames Tidal Defences including the Thames Barrier.

In 1968 exceptionally heavy rainfall led to extensive flooding within the Rochford District from tributaries of the River Roach including the Eastwood Brook and Prittle Brook. Rochford Golf Course was flooded to a depth of nine foot and up to 50 properties in Glenwood Avenue, to the south of Hockley, were affected. 78 properties were flooded in Rochford, located on Ashingdon Road, Church Street, St Andrews Road, Oak Road, Hall Road, Newlyn Lane and South Street. In September 1958, 76mm of rainfall fell in two hours leading to flooding of properties in Rawreth and the evacuation of a number of families by boat. Similar conditions of heavy rainfall in February 2001 were combined with high tides which led to tide locks on several Essex Rivers. Three properties were flooded in Rochford and 5 in Rawreth during these high water levels. Following the event of 1968, several structural flood mitigation measures were undertaken along the channels of the River Roach tributaries to improve the standard of protection against flooding.

Moreover, the historical flood records suggest that the recorded surface water flooding incidences were mainly due to inundation of the surface water drainage systems and under capacity of ordinary watercourses during high intensity rainfall events.

4.2. Fluvial Flood Risk

Fluvial flooding results from large rainfall events in the upper reaches of the catchment causing flows in excess of the carrying capacity of the channel. Where land is protected by fluvial flood defences, flooding can occur as a result of overtopping of the defences when the flood event is greater than that which the defences are designed for.

According to the 2011 Rochford District Council SFRA, the main source of fluvial flood risk in the Rochford District is the upper reaches of the River Roach. The River Roach does not impact the site.

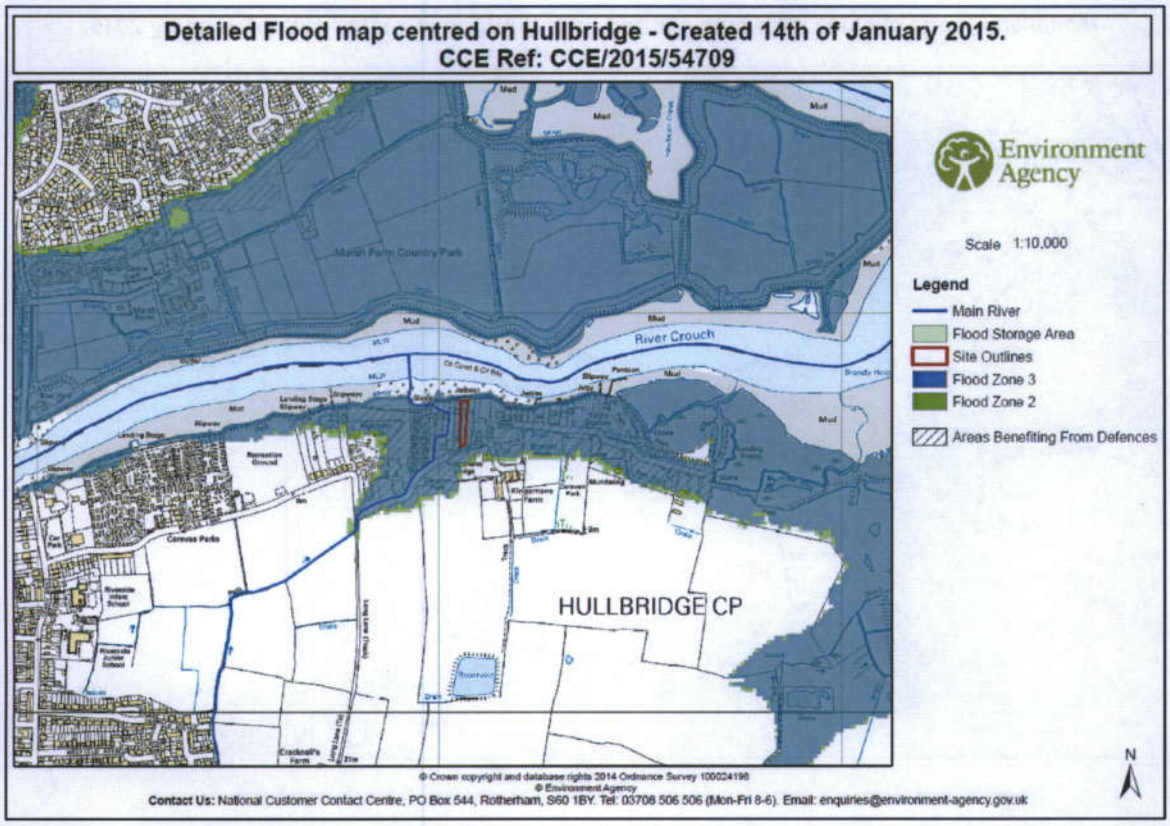
The Kingsmans Farm Ditch, a statutory main river, flows from south to north within 30m of the property. This small watercourse has not been modelled by the Environment Agency and not as part of this assessment. However, based on tidal levels of the River Crouch estuary, the risk is without doubt tidally dominated.

4.3. Tidal Flood Risk

Hullbridge is at risk of tidal flooding from the North Sea and the River Crouch estuary. Tidal flooding is most likely to occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. In areas protected from flooding by sea defences, tidal flooding can occur as a result of a breach in the defences, failure of a mechanical barrier or overtopping of defences. Where defences are not present, flooding is typically widespread.

The site is located in Flood Zone 3a, as described in the Environment Agency's flood maps (Figure 13). This means that the site has a chance of tidal flooding of greater than 1 in 200 (0.5%). It is however, shown to be within an area benefiting from flood defences; which the Flood Zones do not take account of.

Figure 13 - Detailed Flood Map



The EA has provided modelled flood levels in respect of the site (Figure 14).

Figure 14 – Modelled Data Node Points

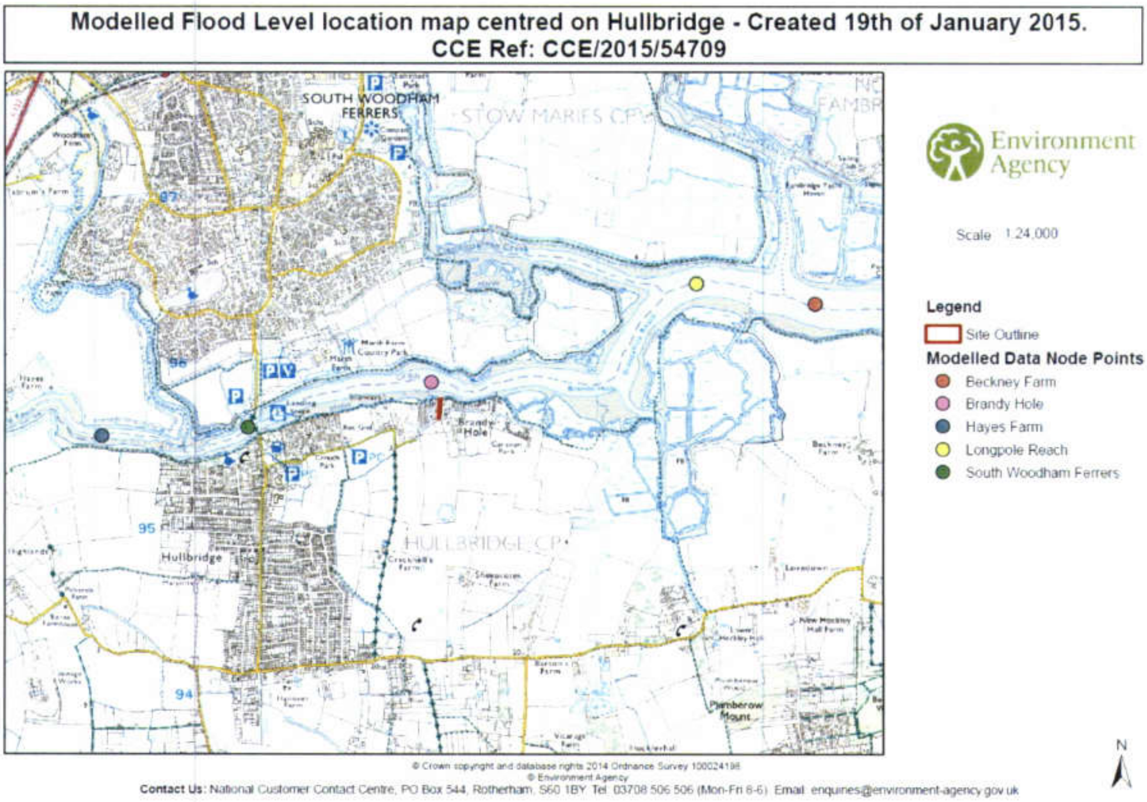


Table 4 and Table 5 show the modelled defended and undefended flood levels (respectively) concerning the site (EA data – Appendix B). These levels relate to the nodes relevant to the site. The node closest to the site is the purple node – Brandy Hole.

Table 4 –Undefended Tidal Flood Levels (mAOD) for the Brandy Hole node

5% (1 in 20)	1% (1 in 100)	1% + CC (1 in 100+CC)	0.5% (1 in 200)	0.5% (1 in 200+CC)	0.1% (1 in 1000+CC)
3.72	4.03	5.12	4.17	5.26	5.55

CC=Climate Change

Table 5 - Defended Tidal Flood Levels (mAOD) for the Brandy Hole node

5% (1 in 20)	1% (1 in 100)	1% +CC (1 in 100+CC)	0.5% (1 in 200)	0.5% (1 in 200+CC)	0.1% (1 in 1000+CC)
4.44	4.59	4.93	4.63	4.95	4.97

CC=Climate Change; N/A=event modelled but water did not reach node point

On the basis of the above data and in combination with the topographic survey of the site, several observations can be made in respect of flood risk. The present day modelled defended flood levels of the 1 in 100 (1%) and the 1 in 200 (0.5%) storm events (4.59 and 4.63m AOD, respectively) are higher compared to the lowest site level (2.20m AOD). This suggests that the site will flood during these particular storm events. As can be seen from Table 5, the undefended flood levels are higher compared to the defended levels for return periods equal to the 1 in 100 year (1%) plus Climate Change and less. However, the site is protected by a flood defences adjacent to the existing property.

The Essex and South Suffolk Shoreline Management Plan2 (October 2010) states that the policy for the shoreline at Hullbridge is to 'hold the line' from now until 2105. The current line will be held throughout all epochs. The standard of protection will be maintained or upgraded. The site will continue to benefit from defences over the lifetime of the development.

4.4. Flood Defence Breach and Overtopping Risk

The flood defences present in the Rochford District study area are typically earth embankments fronted by areas of intertidal mudflats or salt marsh habitats. The embankments work to protect an area from flooding by providing a mass of earth, which raises the surrounding land level and prevents inundation from a specific direction. Bunds may be reinforced with piles, concrete retaining wall structures or sheet pile walls driven through the crest to provide structural stability, additional resistance to breaching and to raise the level of protection. Where these reinforcements are absent, the earth embankment may be more susceptible to breaching, particularly in circumstances when the crest is overtopped by floodwaters.

The EA holds a database of flood defences and their condition. The EA has classified the overall condition grade of the embankments as good (2) and the condition of the clay sea-wall as very poor (5). **Error! Reference source not found.** shows the condition grade in respect of the structural integrity of flood defences. Defence condition is rated based on the National Flood and Coastal Defence Database categories. This suggests that the defences protecting the site have severe defects and could result in complete performance failure. The risk of a breach in the defences must be considered as high if this is the case. The property owner, however, stated that the defences were completely rebuilt in 2002 and at that time were promised a 50 year life span. Photographic evidence (Figure 7 and Figure 11) shows that the flood defences at the rear of the property do not appear in very poor condition, evidenced by the clean, rust free steel sheet piling. The client also reports that works are ongoing to the east of the property and along the tidal wall. In summary, this suggests that the EA flood defence asset assessment is not up to date with recent and ongoing works and the present condition adjacent to the site.

Table 6 – Overall Condition Grade

Grade	Rating	Description
1	Very Good	Cosmetic defects that have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce performance of the asset.

4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation.
5	Very Poor	Severe defects resulting in complete performance failure.

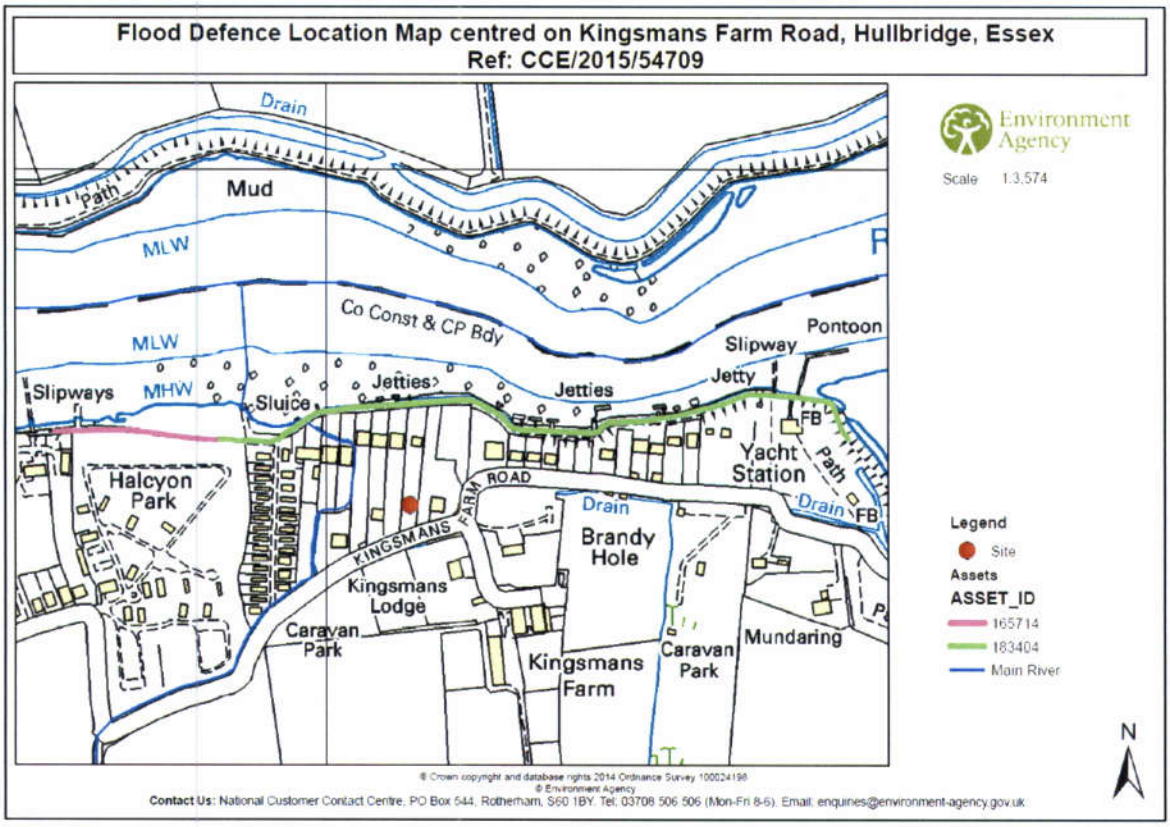
4.4.1. Overtopping Risk

According to the Environment Agency data provided, the flood defences protecting the site are a coastal embankment and a clay sea-wall (Figure 15) with crest levels of 5.194m AOD (Asset Reference-165714) and 4.100m AOD (Asset Reference-183404). The site sits behind the flood defences which are at 4.100m AOD. However, the topographic survey suggests that the top of the sheet piling is at a level of 4.83m AOD. This adds further weight to the suggestion that the flood defence data provided by the EA is out of date.

Based on the crest level of the defences (sheet piles at 4.83m AOD) and the present day modelled defended flood levels, the defences provide a standard of protection slightly better than 1 in 200 year (0.5%). They would overtop during an extreme 1 in 1,000 year (0.1%) flood.

When climate change is taken into consideration, the defences would overtop during the 1 in 100 plus climate change and 1in 200 plus climate change scenarios (4.93m AOD, 4.95m AOD, respectively).

Figure 15 - Flood Defences Outline



4.4.2. Breach Risk

The EA has not provided modelled flood extents with respect to any potential breach scenarios for the flood defences (River Crouch) close to the site. Consequently, this report considers the worst case scenario (water level at crest) in terms of a potential flood defences breach. Flood risk behind defences is related to the probability of flooding and the magnitude of the consequence, this is often expressed as follows:

Risk = probability x consequence

The probability of the flood at the property is dependent on the earth embankments failing by breaching, which in turn is dependent on the following:

- Height of defence;
- Structure of defence;
- Condition of defence;
- Length of time water will be at a high level.

In line with the Defra/Environment Agency FD2320 Flood Risk Assessment Guidance for New Development document, this flood risk assessment considers the consequences of a flood to be based on the danger to people. This approach is adopted, as in the FD2320 document, because the most serious risk associated with development behind defences is the risk to people, including entering and leaving properties during the flood. Danger to people is assessed using flood hazard, which can be expressed as a combination of flood depth and velocity.

A simple assessment of the flood risk behind defences has been carried out in accordance with the FD2320 document. The simple approach uses information on the danger to people from flooding in defended areas, particularly how flood depths for a particular breach scenario can be interpreted as danger to people. The results of this type of modelling have been used to create generic lookup tables provided within the FD2320 document which relate the level of danger to people to the distance from the defence during a breach scenario, where the hazard is related to the water level above the floodplain. Table 2 within the FD2320 document has been provided below in Table 7. This table has been generated for a breach of 100m wide, breaching onto a flat floodplain. There may be greater spatial variation in the hazard on complex floodplains and for different sized breaches.

Our breach assessment is based on a flood defence breach occurring during the peak of a 1 in 200 year tidal flood event. The site lies approximately 20m from the River Crouch defences. The difference in level (head) between the base of the defences (2.55m AOD) and the defended modelled 1 in 200 year (0.5%) tidal flood level (4.63m AOD) is 2.08m. According to Table 7, the site is in an area where there is danger for all (red area of table).

Table 7 – Danger to people from breaching relative to distance from defence

Distance from breach (m)	Head above floodplain (m)						
	0.5	1	2	3	4	5	6
100							
250							
500							
1,000							
1500							
2000							

Key:

Danger for some	
Danger for most	
Danger for all	

4.5. Canal Flood Risk

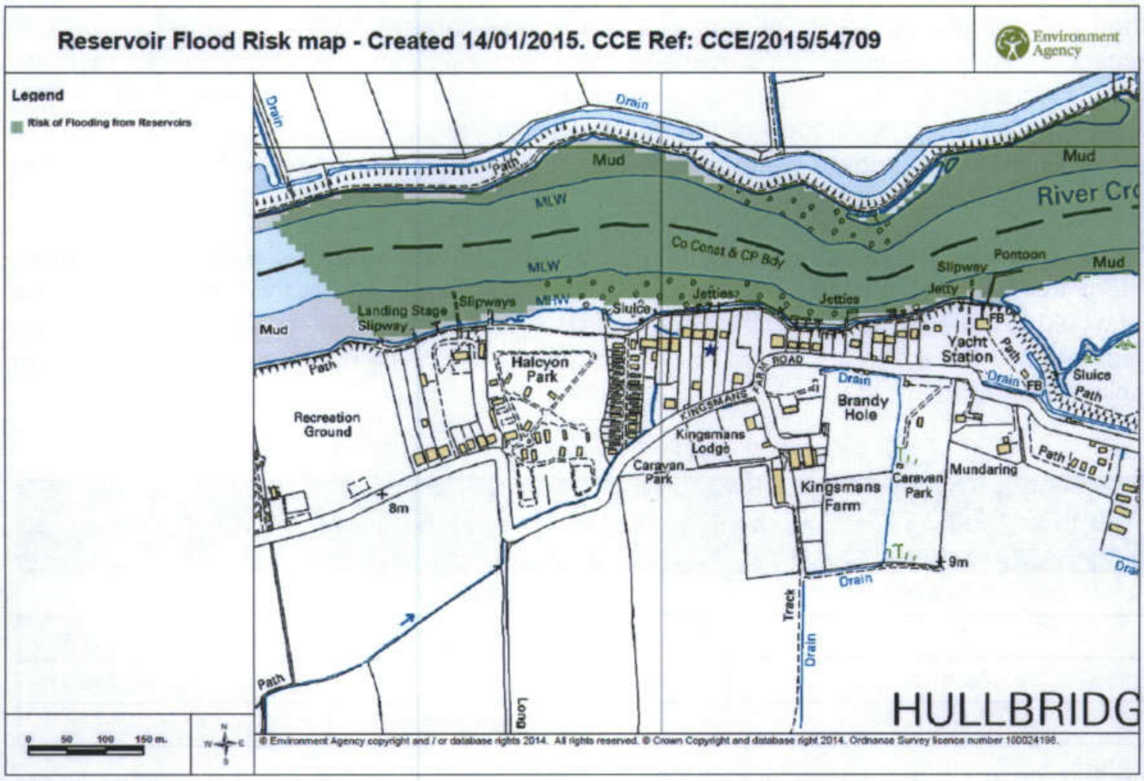
The 2011 Essex County Council Preliminary Flood Risk Assessment (PFRA) reported that there is no available information on risk of flooding from this source. Additionally, the proposed development is located at a considerable distance from a canal and consequently there is no risk of flooding from this source.

4.6. Reservoir Flood Risk

The site is not identified as being at risk of reservoir flooding according to the EA reservoir flood map (Figure 16).

The reservoir flood map provided by the Environment Agency is a worst case scenario and in reality reservoir flooding is extremely unlikely with no loss of life attributed to dam failure in the UK since 1925, which was prior to reservoir safety legislation being introduced to ensure high standards in reservoir maintenance.

Figure 16 – Reservoir Flood Map



4.7. Groundwater/Geology

British Geological Survey (BGS) records indicate that the proposed development site overlays London Clay Formation – clay, silt, sand, overlain by beach and tidal flat deposits (undifferentiated) – clay, silt, and sand. Due to the soil present at the site there could be a potential for swelling clays (ground may be susceptible to shrink-well ground movement) in extreme rainfall events. These findings are in agreement with the findings of the 2011 Rochford District Council SFRA. The risk of groundwater flooding is considered to be greatest where areas area underlain by permeable rocks that form major aquifers. The predominance of clay and deep loam to clay soils lead to a relatively impermeable surface where rapid runoff of surface water can be expected. This results in a greater risk of surface water flooding and causes local watercourses to respond rapidly to rainfall. However, the presence of such geology and soils also create an impermeable barrier to prevent groundwater rising to the surface and reduces the risk of flooding from groundwater.

Groundwater flooding usually occurs following a prolonged period of low intensity rainfall and although there are no records of significant groundwater flooding in the region, it is still a possibility. The future risk from this source is more uncertain than surface water as the climate change predictions indicate that although sea levels will rise, thus possibly raising groundwater levels, overall summer rainfall will decrease, therefore having a long-term effect of lowering the groundwater levels. However, long periods of wet weather, such as those experienced in the autumn and winter of 2000/01 are predicted to increase: these are the type of weather patterns that can cause groundwater flooding to occur.

4.8. Surface Water Flood Risk

When the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded, excess rainwater flows overland; this water will collect in topographic depressions and at obstructions, and can inundate development downslope. The severity of the rainfall event, the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use all contribute to and affect the severity of overland flow.

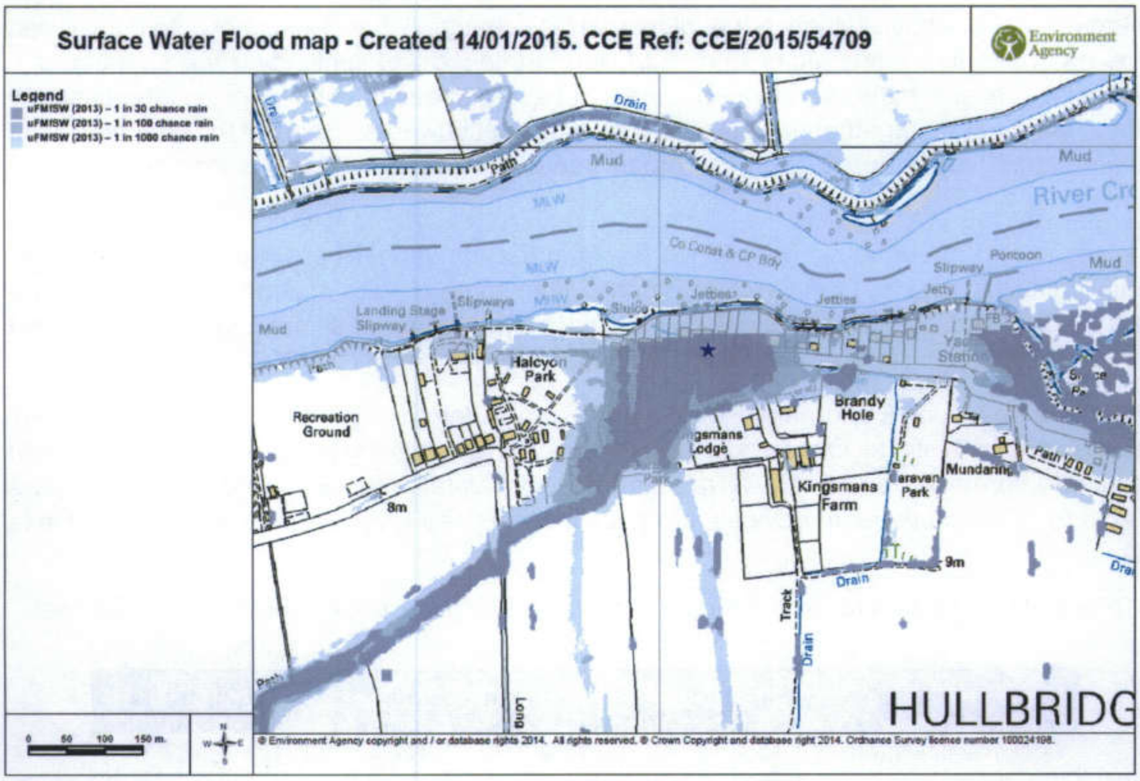
The Environment Agency most recent flood map for surface water published in December 2013 is freely available online at their website and can be used to see the approximate areas that would experience surface water flooding from a variety of rainfall return periods. The risk is categorised based on annual probability of occurrence. The different risk categories are displayed below in Table 8.

Table 8 - Environment Agency Surface Water Risk Categories

Environment Agency Surface Water Risk Category	Surface water flooding annual probability of occurrence
Very Low	Less than 0.1% (1 in 1,000 years)
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1,000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	Greater than 3.3% (1 in 30 years)

The surface water maps identify that the site has a high risk of flooding from surface water (Figure 17). The risk appears to be associated with the small fluvial watercourse, the Kingsmans Farm Ditch and is more representative of the fluvial risk from this watercourse as opposed to surface water flooding from overwhelmed drains or overland flow from excessive rainfall. This type of flooding can be difficult to predict as it is hard to forecast where or how much rain will fall in any storm. The Environment Agency's flood map is based on the best information available to them, such as ground levels and drainage assumptions.

Figure 17 - Surface Water Flood Risk Map



However, according to the 2012 South Essex County Council SWMP, there are no recorded incidents of surface water flooding at the site.

4.9. Drainage and Sewage Infrastructure

Flooding is often caused by excess surface water entering the drainage network causing sewers to surcharge. Anglian Water, who are responsible for the management of urban drainage and sewerage within the District, maintain a DG5 register of sites affected by sewer flood incidents on a post code by post code basis.

For the ten years preceding production of the 2012 SWMP, Anglian Water have provided this data which details locations of surface water and foul water drainage infrastructure flooding. Due to policy within Anglian Water it is not possible to provide detailed locations of identified flooding areas at a street level. There are no records of sewer flooding in respect of the proposed site. It should be noted, however, that there has been one incident of sewer related flooding close to the site in the area of Hullbridge (South Essex SWMP, 2012).

It is important to note that previous sewer flood incidents or the lack thereof do not indicate the current or future risk to the site as upgrade work could have been carried out to alleviate any issues or conversely in areas that have not experienced sewer flooding incidents the local drainage infrastructure could deteriorate leading to future flooding.

4.10. Climate Change

There is clear scientific evidence that global climate change is happening now. In the UK sea level has risen and more winter rain has fallen in intense wet spells over the past century. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

Looking ahead, greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

The Department for Environment, Food and Rural Affairs FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts (October 2006) provided information on sensitivity ranges for peak rainfall intensities and peak river flows (Table 9). This report also provides information on net sea level rise relative to 1990 (Table 10)

Table 9 - Defra national precautionary sensitivity ranges for peak rainfall intensities and peak river flows

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		

On a more localised scale, if emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 14% (very likely to be between 3 and 31%);
- Precipitation on the wettest day in winter up by around 14% (very unlikely to be more than 29%);
- Peak river flows in a typical catchment likely to increase between 8 and 16%.

Table 10 – Defra recommended national precautionary sensitivity ranges for net sea level rises

	Net sea level rise (mm per year) relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, east midlands, London, south-east England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South-west England	3.5	8.0	11.5	14.5
North-west England, north-east England (north of Flamborough Head)	2.5	7.0	10.0	13.0

The impacts of climate change have been considered in this report and included within the modelled data provided by the EA.

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability. Wetter winters and more of this rain falling in wet spells may increase river flooding. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected. Drainage systems in the district have been modified to manage water levels and could help in adapting locally to some impacts of future climate on flooding, but may also need to be managed differently. Rising sea or river levels may also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses. Even small rises in sea level could add to very high tides so as to affect places a long way inland.

It is now fairly widely accepted that one of the main effects of climate change in the South East will be a higher intensity rainfall and more frequent winter storms, which will increase the risk of flooding from surface water (2011 Essex PFRA).

The effect of climate change on future groundwater flood risk is more uncertain. Climate change predictions indicate that although sea levels will rise, thus possibly raising groundwater levels, overall summer rainfall will decrease, therefore having a long-term effect of lowering the groundwater levels. However, long periods of wet weather are predicted to increase: these are the type of weather patterns that can cause groundwater flooding to occur (2011 PFRA).

Resilience and Flood Risk

5.0 Mitigation Measures

5.1. Recommended Finished Floor Levels

In order to afford a level of protection against flooding it is normally recommended that finished floor levels are set a nominal 300mm above the 1 in 100 year annual probability fluvial flood (1%) or 1 in 200 year annual probability tidal flood (0.5%) in any year (including an allowance for climate change), depending which is higher. Raising finished floor levels above ground level would in normal circumstances also reduce the risk of flooding from other sources such as drainage infrastructure flooding. Using this guidance, finished floor levels of the property extension should be set no lower than 5.25m AOD. This of course is impracticable for a domestic extension given the existing floor levels are some 2m lower. It should be noted that the finished floor level of the proposed design should be as high as possible, given the circumstances and the practicalities.

5.2. Flood Resistance and Resilience

Flood resistance and resilience measures must be incorporated into the final design. It is recommended that the developer refer to the Department for Communities and Local Government Publication "Improving the Flood Performance of New Buildings, Flood Resilient Construction, May 2007 (**https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings**). Examples given below:

5.2.1. Flood Resistance Measures

Flood resistant products should conform to BS PAS 1188-1. They should be designed to resist flood depths up to 600mm, after which a water entry strategy should be adopted so as not to affect the structural integrity of the building.

- Waterproof construction techniques to the foundations, floor slab and walls.
- Flood resistant doors and windows.
- Airbrick covers / auto-closing airbricks.
- Install moveable flood protection barriers doorways, low level windows and other openings.
- Installation of non-return valves on foul drain pipes and foul inspection chambers.

5.2.2. Flood Resilience Measures

Flood resilience measures are designed to minimise the damage caused once flood water enters a property.

- Use of flood resistant material within walls and/or floors.
- Ground floor ring main should be installed at first floor level with drop down cables to ground floor sockets (if applicable).
- Locate electrical sockets at a height above flood level (if possible).

- Locate consumer unit above flood level.
- Locate electricity/gas meters above flood level.
- Locate boilers and associated pumps and controls above flood level.
- Pipe insulation below expected flood level should be replaced with closed cell insulation.
- Flood proof flooring, e.g. tiles, stone.

5.3. Flood Warning and Evacuation

5.3.1. Floodline Warnings Direct

The Environment Agency operates a free flood warning service called Floodline Warnings Direct (FWD) which can give advance notice of when tidal flooding is likely to happen and time to prepare for a flood event. Property owners on the proposed development site will be able to sign up to FWD online using the following channels:

Table 11 – FWD sign up channels

Channel	Details
Online	https://fwd.environment-agency.gov.uk/app/olr/register
Telephone	0845 988 1188
Typetalk	0845 602 6340

5.3.2. Flood Warning Service

The Flood Warning Service throughout England and Wales in areas at risk of flooding from rivers or the sea. This is provided using up to date rainfall, river level and sea condition monitoring 24 hours a day to forecast the possibility of flooding. If flooding is forecast, the Environment Agency will issue warnings using a set of three different warning types (Table 12). Many areas of England are covered by the full four stages of the Environment Agency Flood Warning Service, including Hullbridge. The Environment Agency Flood Warning target lead time (the time between a flood warning being issued and the onset of flooding) is approximately two hours. Providing the Environment Agency can meet their target Flood Warning lead time, the occupants of the proposed development will have two hours to ensure that property is relocated to minimise risk and evacuation to safe locations can be carried out.

Table 12 – Environment Agency Flood Warning Types

Flood Warning Code	What it Means	What To Do
	Flooding is possible. Be prepared.	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.

FLOOD WARNING	Flooding is expected. Immediate action required.	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.
SEVERE FLOOD WARNING	Severe flooding. Danger to life.	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.
Warnings no longer in force	No further flooding is currently expected in your area.	Be careful. Flood water may still be around for several days. If you've been flooded, ring your insurance company as soon as possible.

5.3.3. Hullbridge Flood Warning Service

Table 13 - Hullbridge flood warning service details

Location	Hullbridge waterside properties
Region	Anglian
Floodline	Call Floodline on 0845 988 1188, select option 1 and enter Quickdial number 111114 to get more information

5.4. Safe Access and Exit

Safe pedestrian and vehicular access to and from the site will be provided by using the Kingsmans Farm Road towards the west and heading to Pooles Lane, which is in Flood Zone 1. This route will be the safest and lowest hazard route from the property as it is a defended route. Figure 18 shows the evacuation route from the site in the event of extreme flooding.

There is an opportunity for the application of SuDS techniques:

Table 15 - Feasible SuDS techniques for the site

Technique	Issues	Feasible? Y/N
Prevention Good site design and housekeeping/rainwater harvesting/infiltration devices/education.	• The proposed development could utilise water butts or rainwater harvesting tanks for rainwater harvesting to reduce runoff. • Education to prospective homeowners about how to manage flood risk could be implemented.	Y Y
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	• Ground testing has not been conducted at the site and consequently the potential for infiltration SuDS is unknown.	?
Site and Regional Control Infiltration/detention basins/ balancing ponds/ wetlands/swales/retention ponds.	• Ground testing has not been conducted at the site and consequently the potential for infiltration SuDS is unknown. • There is sufficient room at the site for an attenuation pond/tank to be accommodated.	? Y

6.0 Recommendations

- The ground floor of the proposed residential extension should be set as high as feasibly possible.
- Flood resistance and resilience techniques should be integral to the design of the extension as outlined in Chapter 5.2.
- The future residents should register to the Environment Agency Flood Warning Service as the site is located within a Flood Warning Area.
- The site design should consider the use of Sustainable Drainage techniques (SuDS) as outlined in Chapter 5.5.

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Appendix A Development Proposals

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Appendix B Environment Agency Data

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Appendix C Topographic Survey