The Sizewell C Project

5.7 Yoxford Roundabout and Other Highway Improvements Flood Risk Assessment

Revision: 1.0

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Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Contents

Tables

Plates

None provided.

Figures (provided separately)

Appendices

None provided.

Executive Summary

This Flood Risk Assessment (FRA) presents an assessment of existing flood risk from all sources of flooding to the proposed Yoxford roundabout and is submitted as part of the application for development consent for Sizewell C Project. The FRA also describes future flood risk to the site taking account of climate change and considers possible changes in flood risk to off-site receptors as a result of the proposed development. It also presents mechanisms for managing residual risk.

The site is mainly in Flood Zone 1 (low probability of flooding from river or sea) with a small area along the river indicated to be in Flood Zone 2 (medium probability of flooding from river or sea). However, the existing A12 is raised above the existing ground levels by approximately 1m in the vicinity of the river, removing the A12 from Flood Zone 2. The proposed development would result in no material change at the northern edge in Flood Zone 2, and no loss of functional floodplain storage or displacement of sea or river flood water is considered to result from the proposed development.

The large majority of the site is at 'Very Low' risk of surface water flooding, an area at risk of flooding potentially associated with the existing highway was identified and is mitigated by the drainage strategy.

The flood risk from tidal, fluvial, groundwater, sewers and reservoirs are low.

The potential increase in surface water run-off from the roundabout would be managed through a sustainable drainage system. The surface water would be attenuated before either being infiltrated to ground.

The proposed Yoxford roundabout is classed as 'Essential Infrastructure' under the NPPF, which is located primarily in Flood Zone 1, with a small part in Flood Zone 2. As per the Flood Risk Vulnerability and Flood Zone Compatibility table, the development is considered appropriate in flood Zones 1 or 2 in terms of flood risk vulnerability. Therefore, it passes the Sequential Test.

Based on the information presented, the proposed mitigation measures and in accordance with NPPF guidance, the development site is considered to be appropriate in terms of flood risk.

1 Introduction

1.1 Background

1.1.1 This Flood Risk Assessment (FRA) describes the flood risk, from all sources to the proposed Yoxford roundabout and other highway improvements sites (referred to herein as the 'proposed development') and the predicted impact of the proposed development on flood risk in general. This FRA is submitted as part of the application for development consent for 'Sizewell C Project'[1].

1.1.2 The proposed development is one of the Sizewell C Project's Associated Development Sites; a total of four highway improvement sites, located around the county of Suffolk (**Table 1.1**). This FRA also considers the two sites where highway safety measures will be secured by an obligation in the Section 106 Agreement (see the **Section 106 Heads of Terms** appended to the Planning Statement (Doc Ref. 8.4) (**Table 1.2**).

1.1.3 This FRA describes how the risk of flooding would be managed and provides a number of recommendations to minimise any residual flood risk impacts associated with the proposed development.

1.1.4 The construction of Sizewell C Project would generate additional vehicular traffic on the local highway and transport networks due to the daily movement of construction workers, building materials and equipment.

1.1.5 The four highway improvement sites are proposed to mitigate the impact of construction traffic and limit the adverse transport effects, addressing capacity and safety issues on the road network. The two sites where highway safety measures are proposed are also part of the package of sustainable transport measures proposed to minimise the impact of traffic associated with the construction of the Sizewell C Project on the road network.

1.1.6 An FRA is not required for three of the highway improvement sites due to the nature of works proposed (**Table 1.1**). At these three sites, there is no proposed change to the existing impermeable footprint, with improvement activities including vegetation clearance, additional highway signage and reduction in speed limits. An FRA is not required for both sites where highway safety measures are proposed because there is no proposed change to the existing impermeable footprint, with anticipated safety measures including only vegetation clearance and additional highway signage. Only the Yoxford

[1] SZC Co.'s proposal to build and operate a new nuclear power station, comprising two UK European Pressurised Reactors™ (EPRs), at Sizewell in Suffolk, north of the existing Sizewell B power station.

roundabout site requires an FRA, as it is over 1 hectare (ha) in size and will increase the impermeable area.

Table 1.1: Summary of proposed highway improvement works

No.	Highway improvement / safety measure name.	Summary of works.	FRA Required?	Reasoning
1	A12 and B1122 east of Yoxford.	A new roundabout at the junction (referred to as the 'Yoxford Roundabout').	Yes	Significant change to existing road layout, larger than 1 ha and increased impermeable area.
2	A1094/B1069 junction south of Knodishall.	Improvements of visibility splays and provision of signage and road markings. Seek to reduce the speed limit.	No	No meaningful change to road structure or impermeable footprint.
3	A12/A144 junction south of Bramfield.	Provision of central reservation island and waiting area.	No	
4	A12/B1119 junction at Saxmundham.	Improvements of visibility splays and provision of signage and road markings.	No	

Table 1.2: Summary of proposed highway safety measures

No.	Highway improvement / safety measure name.	Summary of works.	FRA Required?	Reasoning
1	B1078/B1079 junction east of Easton and Otley College.	Improvements of visibility splays and provision of signage and road markings.	No	No meaningful change to road structure or impermeable footprint.
2	A140/B1078 junction west of Coddenham.	Improvements of visibility splays and provision of signage and road markings.	No	

2 Legislation, policy and guidance

2.1 Introduction

2.1.1 This section identifies and describes the legislation, policy and guidance of relevance to the FRA for the proposed development.

2.1.2 Legislation and policy have been considered at a national and local level. The following are relevant as they have influenced the scope and/or methodology adopted for the FRA:

- Overarching National Planning Policy Statement (EN-1) (Ref. 1.1);
- Office for Nuclear Regulation and Environment Agency Joint Advice Note: Principles for Flood and Coastal Erosion Risk Management (Ref. 1.2);
- National Planning Policy Framework (Ref. 1.3);
- National Planning Policy Guidance (Ref. 1.4);
- Flood Risk Assessments: Climate Change Allowances (Environment Agency) (Ref. 1.5).
- Flood and Water Management Act 2010 (Ref. 1.6).
- Suffolk Coastal Local Plan - Core Strategy and Development. (Ref. 1.7).
- Suffolk Coastal Local Plan - Remaining 'Saved Policies' (Ref. 1.8).
- Suffolk Coastal Local Plan – Final Draft Plan. January 2019 (Ref. 1.9).
- Suffolk Flood Risk Management Strategy (Ref. 1.10).

2.2 Legislation

a) Flood and Water Management Act 2010

2.2.1 The Flood and Water Management Act (FWMA) was enacted in 2010. It aims to improve both flood risk management and the way we manage our water resources by creating clearer roles and responsibilities. This includes a lead

role for upper tier and unitary Local Authorities in managing local flood risk (from surface water, ground water and ordinary watercourses) and a strategic overview role of all flood risk for the Environment Agency. The Flood and Water Management Act provides opportunities for a more comprehensive, risk-based approach on land use planning and flood risk management by Local Authorities and other key partners.

2.3 National policies and guidance

a) Overarching National Policy Statement for Energy EN-1

2.3.1 The Overarching National Policy Statement for Energy (EN-1) was prepared in 2011 and provides specific guidance on the development of energy infrastructure in relation to flood risk for the lifetime of the facilities. The national flood risk policies reflected in this document have since been superseded, however the guiding principles are still applicable and are also embedded in the current national policies (NPPF). EN-1 confirms that an FRA is required to assess flood risk from all sources for the lifetime of the project by competent people. The FRA would, among other aspects, need to identify flood risk reduction and management measures. Residual risks would also require assessment to consider their acceptability.

2.3.2 In relation to surface water management, EN-1 promotes the appropriate use of sustainable drainage (SuDS) to facilitate the sustainable development of energy developments. The SuDS should aim to prevent an increase in surface water flood risk associated with the increase in discharge from the site.

b) Joint Office for Nuclear Regulation and Environment Agency Principles for Flood and Coastal Erosion Risk Management Advice Note

2.3.3 The Office for Nuclear Regulation and Environment Agency joint advice note sets out "*the approach to flood risk in the nuclear new-build programme in England*.". The note states that flood hazard analysis should be reported to the Environment Agency via planning submissions in the form of Flood Risk Assessments and to the Office for Nuclear Regulation in nuclear safety cases.

2.3.4 The principle of the flood risk analysis set out in the note is that all flood risk analysis work would be suitable for both the FRA and nuclear safety case(s).

2.3.5 Appendix D of the joint advice note, confirms that for associated development site if the associated infrastructure is not critical to the day to day running of

the site, such as a road built to assist with local transport capacity improvements, "*then the most relevant climate change criteria must be applied in accordance with national planning policy*".

c) National Planning Policy Framework and Guidance

2.3.6 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England. The NPPF seeks to ensure that flood risk is considered at all stages of the planning and development process, to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk of flooding. Where there are no reasonably available sites in Flood Zone 1 the Local Planning Authority (LPA), can consider reasonably available sites in Flood Zone 2. Only when there are no reasonably available sites for development in Flood Zones 1 and 2 should the suitability of sites in Flood Zone 3 be considered.

2.3.7 In addition, the NPPF states that "*the development should be made safe for its lifetime without increasing flood risk elsewhere*." For a development to be considered acceptable with regards to flood risk, the sequential test requirements must be satisfied, along with demonstrating the development:

- within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- is appropriately flood resistant and resilient;
- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

2.3.8 Further details of the requirements for sequential testing and sustainable drainage are provided in the following two sections.

i. Sequential Testing

2.3.9 The National Planning Practice Guidance on Flood Risk and Coastal Change supports the NPPF with additional guidance on flood risk vulnerability classifications and managing residual risks. The National Planning Practice

Guidance provides further description of Flood Zones (**Table 1.3**), Vulnerability Classifications (**Table 1.4**) and Compatibility Matrix (**Table 1.5**) in order to assess the suitability of a specific site for a certain type of development.

Table 2.1: Summary of flood zone definitions

Flood zone	Probability of flooding	Return periods
1	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).
2	Medium	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%); or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%).
3a	High	Land having a 1 in 100 or greater annual probability of river flooding (≥1%); or Land having a 1 in 200 or greater annual probability of sea flooding (≥0.5%).
3b	High – Functional Floodplain.	**This zone comprises land where water has to flow or be stored in times of flood.** Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on Flood Maps)

Table 2.2: Summary of flood risk vulnerability classifications

Vulnerability Classification	Description
Essential Infrastructure.	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable.	• Police and ambulance stations; fire stations and command centers; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials

Vulnerability Classification	Description
	with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
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 and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable.	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; 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 working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water Compatible Development.	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence 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 and essential facilities such as changing rooms.

Vulnerability Classification	Description
	• Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 2.3: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required.	✓	✓
	Zone 3	Exception Test Required.	✓	×	Exception Test Required.	✓
	Zone 3b 'Functional Floodplain'.	Exception Test Required.	✓	×	×	×
Key: ✓ Development is appropriate. × Development should not be permitted.						

2.3.10 Following application of the Sequential Test, if it is not possible (consistent with wider sustainability objectives) for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied, if appropriate. For the Exception Test to be passed:

- 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; and
- a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

2.3.11 Where the Exception Test is required, both elements of the Exception Test will have to be passed for development to be allocated or permitted. Within

each flood zone, surface water and other sources of flooding also need to be taken into account in applying the sequential approach to the location of development.

ii. Sustainable drainage and surface water

2.3.12 The National Planning Practice Guidance on Flood Risk and Coastal Change supports the NPPF with additional guidance on flood risk, which states that:

> *"developers should seek opportunities to reduce the overall level of flood risk in the area and beyond. This can be achieved, for instance, through the layout and form of development, including green infrastructure and the appropriate application of sustainable drainage systems, through safeguarding land for flood risk management, or where appropriate, through designing off-site works required to protect and support development in ways that benefit the area more generally."*

2.3.13 In order to manage surface water on the site, it is necessary to consider the appropriateness of a various sustainable drainage system (SuDS) measures, using the SuDS hierarchy set out in the National Planning Practice Guidance.

2.3.14 The aim should be to discharge surface run off as high up the drainage options hierarchy as reasonably practicable. These are listed with the most favourable option first and least preferable last:

> *"1. into the ground (infiltration);*
>
> *2. to a surface water body;*
>
> *3. to a surface water sewer, highway drain, or another drainage system;*
>
> *4. to a combined sewer." (Paragraph 80,* ***Error! Reference source not found.****).*

2.3.15 The National Planning Practice Guidance acknowledges that some types of sustainable drainage systems may not be practicable in all locations. Locations may be constrained in areas of flood risk. Fluvial and coastal flood zones are defined in **Table 1.3**.

2.3.16 The Environment Agency classifies surface water flood risk (Ref. 1.20) into four categories; 'very low', 'low', 'medium' and 'high' (**Table 1.6**).

Table 2.4: Summary of flood risk from surface water definition

Probability of surface water flooding	Return periods
Very low.	Land with less than 1 in 1,000 annual probability of surface water flooding (<0.1%).
Low	Land with between 1 in 1,000 and 1 in 100 annual probability of surface water flooding (0.1% - 1%).
Medium	Land with between 1 in 100 and 1 in 30 annual probability of surface water flooding (1% - 3.3%).
High	Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%).

d) Flood Risk Assessments: Climate Change Allowances

2.3.17 The Environment Agency's online advice note 'Flood Risk Assessments: Climate Change Allowances' was published in February 2016 and amended in April 2016, February 2017 and February 2019. The guidance has since been updated in December 2019 to take account of updated guidance on:

> *"1) Updated the sea level rise allowances using UKCP18 projections.*
>
> *2) Added guidance on how to a) calculate flood storage compensation, b) use peak rainfall allowances to help design drainage systems, c) account for the impact of climate change on storm surge, d) assess and design access and escape routes for less vulnerable development.*
>
> *3) Changed the guidance on how to apply peak river flow allowances so the approach is the same for both flood zones 2 and 3.").*

2.3.18 This advice note provides guidance for determining appropriate climate change allowances for fluvial, tidal and peak rainfall intensities. The climate change allowances consider the geographical location, life span of the proposed development, flood risk, vulnerability classification associated with the type of development and critical drainage areas. The guidance on peak rainfall intensity allowances is outlined in **Table 1.7**.

Table 2.5: Peak rainfall intensity allowance in small and urban catchments (1961-90 baseline) (Source: Table 2, Environment Agency Climate Change Allowances)

	Total Potential Change Anticipated for 2010-2039	Total Potential Change Anticipated for 2040-2059	Total Potential Change Anticipated for 2060-2115
Upper End.	10%	20%	40%
Central	5%	10%	20%

2.4 Local plans

a) Suffolk Coastal Local Plan

i. Final Draft Proposed Local Plan

2.4.1 On 1 April 2019, East Suffolk Council (ESC) was created, merging the former districts of Suffolk Coastal District Council (SCDC) and Waveney District Council (WDC).

2.4.2 The ESC is in the process of replacing the former SCDC Local Plan. The final draft of the new local plan was published, and a six-week period set for the receipt of representations in relation to legal compliance and soundness between 14 January 2019 and 25 February 2019 (Ref. 1.9). The SCDC has stated that the adoption of the plan is scheduled for Spring 2020.

ii. Existing Local Plan

2.4.3 The existing SCDC Local Plan sets out how the area should be developed. It incorporates the Core Strategy and Development Management Policies and Saved Policies from the Suffolk Coastal Local Plan (incorporating the First and Second Alterations). These documents form part of the formal Development Plan and are used in the determination of planning applications.

2.4.4 Four policies within the Core Strategy and Development Management Policies document (2013) have been identified as relevant for the proposed development, as outlined within **Table 1.8**. No reference to the allocation of the proposed development site has been found in the SCDC Local Plan.

Table 2.6: Relevant Suffolk Coastal Local Plan policies

Policy Number	Policy Name	Summary
SP10	A14 & A12	The Council supports the provision of improvements to the A12.

Policy Number	Policy Name	Summary
SP12	Climate Change.	The District Council will contribute towards the mitigation of the effects of new development on Climate Change by minimising the risk of flooding and ensuring appropriate management of land within floodplains.
SP13	Nuclear Energy.	The local issues that need to be adequately addressed consist of at least the following: Transport issues such as the routing of vehicles during construction, improvements to the road system (including the A12), and use of rail and sea for access all having regard to such factors as residential amenity;
DM28	Flood Risk.	Proposals for new development, or the intensification of existing development, will not be permitted in areas at high risk from flooding, i.e. Flood Zones 2 and 3, unless the applicant has satisfied the safety requirements in NPPF (and any successor).

b) Suffolk Flood Risk Management Strategy

2.4.5 Suffolk County Council is responsible for coordinating a partnership approach to flood and coastal risk management with all risk management authorities in Suffolk. They do this through the Suffolk Flood Risk Management Partnership who produced the Local Flood Risk Management Strategy in March 2016.

2.4.6 The objective of the Strategy is *"to take a pragmatic approach to reduce the current flood risk and ensure that we do nothing to make this worse in the future."* This objective is in accordance with the principles laid out in the NPPF.

2.4.7 Seven objectives of the Local Flood Risk Management Strategy have been identified, two of which are of relevance to the proposed development site:

- Objective 3: To prevent an increase in flood risk as a result of development by preventing additional water entering existing drainage systems wherever possible.
- Objective 4: Take a sustainable and holistic approach to flood and coastal management, seeking to deliver wider economic, environmental and social benefits, climate change mitigation and improvements under the Water Framework Directive.

3 Development description and scope of this assessment

3.1 The existing site

3.1.1 The existing site covers 2.8 hectares (ha), consisting of a ghost island road junction that connects the B1122 to the A12 and land currently used as agricultural pasture. This junction is situated immediately east of the village of Yoxford. The A12 bridges the River Yox to the north of the village.

3.1.2 To the north-east of the site is a sewage treatment works. The site is situated approximately nine kilometres (km) to the north-west of the main development site.

3.2 The proposed site masterplan and design

3.2.1 The proposed Yoxford roundabout would have three-arms to replace the existing junction to the east of Yoxford, as provided in **Volume 7, Chapter 2, Figure 2.1** of the **ES**.

3.2.2 The new roundabout would be approximately 90m north of the existing junction and would include a realignment of the A12 to connect to the roundabout. The new roundabout would be in a cutting of up to 2m below the existing ground levels.

3.2.3 Approximately 220m of the B1122 would be realigned across the agricultural land.

3.2.4 A new access road would be provided off the realigned B1122 to the south of the roundabout to maintain access to the residential properties immediately to the south of the A12.

3.2.5 Between the proposed roundabout and southern access road there would be an infiltration pond. A piped drainage network would convey the surface water to the infiltration pond. The infiltration pond would attenuate the surface water, discharging to the ground. More detail of the drainage design can be found in **Volume 7, Chapter 2** of the **ES**.

3.3 Topography

3.3.1 **Figure 1** uses remotely sensed Light Detection and Ranging (LiDAR) data (Ref. 1.11) to identify the topography of the site. The proposed roundabout would be situated on a ridge of high ground that drains into two discreet catchments, to the east and the west respectively. The road will be situated in a cutting into this ridge of up to 2 metres (m). In this area the proposed

development is mostly located in Flood Zone 1 with a very small area at the northern edge in Flood Zone 2.

3.3.2 **Figure 1** shows that the highest ground levels, above 16 metres above ordnance datum (m AOD) at the centre of the site, in the field to the east of the A12. The lowest elevations are associated with the existing road on the west of the site of the A12 at slightly below 10m AOD.

3.4 Geology

3.4.1 The Suffolk Coastal and Waveney District Councils Strategic Flood Risk Assessment (SFRA) (Ref. 1.12) states that:

> *"towards the east of the District the main soil types are deep well-drained sandy soils, deep well-drained sandy often ferruginous soils and deep stone less non-calcareous and calcareous clayey soils. These soil types allow free drainage."*

3.4.2 The British Geological Survey (BGS) online geology viewer mapping shows the Crag Group (marine deposits) as the dominant solid geology types found in the study area. This type of geology presents variable permeability.

3.4.3 The BGS map records superficial geology for the northern portion of the site as Head; fragmented material moved downslope via aeolian transport, formed up to 3 million years ago in an environment previously dominated by subaerial slopes. No superficial geology was recorded for the southern half of the site.

3.4.4 The Aquifer Designation map (Ref. 1.14) indicates the bedrock geology of the area is classified as a 'Principal' aquifer. Principal aquifers are defined by The Environment Agency as:

> *"geology that exhibit high permeability and/or provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale".*

3.4.5 The Aquifer Designation Map identifies that for superficial geology, the site lies on the boundary between a 'Secondary A' and 'Secondary undifferentiated' aquifer, with the Secondary A aquifer covering the northern half of the site. Secondary A aquifers are permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. Secondary undifferentiated aquifers are defined in cases where it has not been possible to attribute either category A or B to a rock type.

3.4.6 Groundwater vulnerability classification is a product of soil type and the underlying geology; however, the depth to groundwater is not considered. The Groundwater Vulnerability map is intended to indicate: *"the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties (Ref. 1.22)*

3.4.7 The Groundwater Vulnerability Map (Ref. 1.15) identifies that the site lies on the boundary between Minor Aquifers classified as 'Intermediate' and 'High' vulnerability. The 'High' and 'Intermediate' vulnerability aquifers cover the northern and southern halves of the site respectively.

3.5 Hydrology

3.5.1 Environment Agency 'Main Rivers' are rivers and streams which the Environment Agency maintain and improve. The Environment Agency also has the powers to improve and construct work on main rivers to manage flood risk. **Figure 2** identifies all 'Main Rivers' that are near to the site boundary.

3.5.2 Ordinary Watercourses are the remaining watercourses not classified as Main River. Lead Local Flood Authorities (LLFA), Local Authorities (LAs) and Internal Drainage Boards (IDBs) have powers to carry out flood risk management work on Ordinary Watercourses. **Figure 3** shows all identified watercourses and ponds that are in proximity to or within the site boundary.

3.5.3 The site is in the Minsmere Old River catchment (Ref. 1.16).

3.5.4 The bridge at the north of the site is the boundary between the River Yox and Minsmere River, both of which are classed as Environment Agency 'Main Rivers'.

3.5.5 There is an unnamed ordinary watercourse to the south-east of the site that flows north and discharges into the Minsmere River.

3.5.6 Review of satellite imagery has identified one large pond immediately east of the site boundary. An Anglian Water wastewater treatment plant is identified 100m to the north-east of the site boundary adjacent to the River Yox.

3.5.7 Two licensed surface water abstraction points are located approximately 350m and 1.3km east of the site on the River Yox, according to the Environment Agency's Water Abstraction Licences map (Ref. 1.17).

3.5.8 The site is not in a Source Protection Zone (SPZ). The closest SPZ is approximately 3.5km to the south of the site (Ref. 1.18).

4 Flood risk appraisal

4.1 Historical flooding

4.1.1 The SFRA historic flood records maps provide location points for historic flood events from fluvial, tidal, sewer, groundwater, highway drainage and surface water sources (Ref. 1.13). Absence of record does not necessarily mean that no flooding has occurred, rather that it was not recorded.

4.1.2 The SFRA maps identify one historic case of foul or surface sewer flooding has occurred 150m to the west of the proposed Yoxford roundabout (Ref. 1.13).

4.2 Tidal / coastal flood risk

4.2.1 The Flood Map for Planning (Ref. 1.19) shows the site is almost entirely located in Flood Zone 1 (**Figure 2**). Flood Zone 1 is defined by the Environment Agency as *"land having less than 1 in 1,000 annual probability of river or sea flooding."*

4.2.2 The risk of flooding from tidal or coastal sources is considered to be low.

4.3 Fluvial flood risk

4.3.1 The Flood Map for Planning shows the site is almost entirely located in Flood Zone 1 (**Figure 2**). Flood Zone 1 is defined by the Environment Agency as *"land having less than 1 in 1,000 annual probability of river or sea flooding."*

4.3.2 The northern extent of the site boundary is in Flood Zone 2 by the A12 bridge over the River Yox. Flood Zone 2 is defined by the Environment Agency as *"Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%)"*.

4.3.3 Review of the LiDAR (Ref. 1.9) and the site masterplan, provided in **Volume 7, Chapter 2, Figure 2.1** of the **ES**, show the A12 on the site has an elevation of approximately 10.4m AOD. The Flood Zone 2 extent has an approximate level of 9.4m AOD immediately to the east of the road. Therefore, the A12 is approximately 1 metre above the existing ground level shown to be within Flood Zone 2.

4.3.4 Whilst the site boundary does intersect the Flood Zone 2 extent, the site masterplan, provided in **Volume 7, Chapter 2, Figure 2.1** of the **ES**, shows that there are no proposed changes to the existing site layout in this location.

4.3.5 Given there is no actual change proposed in the area shown as Flood Zone 2 and the A12 is 1 metre above the Flood Zone 2 level as assessed from LiDAR, the risk of flooding from fluvial sources is considered to be low.

4.4 Surface water flood risk

4.4.1 **Figure 3** shows the Environment Agency 'long term flood risk map' for the risk of surface water flooding to the site.

4.4.2 The figure indicates the majority of the site is at 'very low' risk of surface water flooding. Although there are two areas of surface water flood risk identified. One area at 'low' risk of surface water flooding on the B1122 at the eastern extent of the site boundary.

4.4.3 One area at 'high' risk of surface water flooding on the A12 at the western extent of the site boundary.

4.4.4 The proposed surface water drainage aims to reduce surface water flooding of the highway, particularly on the A12 to the west of the site.

4.5 Groundwater flood risk

4.5.1 According to the Geology of Britain viewer (Ref. 1.12) and the SFRA (Ref. 1.13), the main soil types in the area are significantly permeable. Permeable soils have the potential to present groundwater flooding problems in areas with high water table.

4.5.2 The BGS susceptibility to groundwater flooding map from the SFRA (Ref. 1.13) indicates the north of the site has potential for groundwater flooding due to proximity to the River Yox. The south of the site has limited groundwater flooding potential.

4.5.3 The proposed road alignment is on higher ground levels than the surrounding area. Although to facilitate the new roundabout, cuttings of up to 2m may be required to the east of the site.

4.5.4 A publicly available borehole scan (dated 2009) was available from the BGS (Ref. 1.12). The borehole is approximately 150m east of the proposed development and encountered water at 4.4m below borehole datum.

4.5.5 Review of LiDAR (Ref. 1.11) shows the elevation to be approximately 12.2m AOD in the vicinity of the borehole. It is estimated the groundwater is at a level of approximately 7.8m AOD.

4.5.6 It is concluded that the risk of groundwater flooding to the site is low.

4.6 Sewer flood risk

4.6.1 The SRFA (Ref. 1.13) notes that Anglian Water is responsible for management of sewage infrastructure in the area.

4.6.2 Flooding from sewers may occur if the rainfall event exceeds the capacity, becomes surcharged due to raised water levels in a river or sea, or becomes blocked by debris or sediment. Once storage capacity within the sewer system is exceeded, the water may overflow onto highways.

4.6.3 Services searches have been undertaken and indicate that three public foul sewers are present on the site. The sewers are in each of the existing roads that lead up to the existing junction. There are no sewers present in the area of the proposed roundabout. The sewers appear to be at the head of the drainage catchments and serve a small number of properties locally to them. The Anglian Water Yoxford Wastewater Treatment Works is to the east of the site.

4.6.4 Flood risk from sewers to Yoxford roundabout is considered to be low.

4.7 Flood risk from reservoirs and other artificial sources

4.7.1 Flooding from reservoirs defines the implications of a large uncontrolled release of water from registered reservoirs, i.e. greater than 25,000m^3.

4.7.2 The Flood Risk from Reservoirs map (Ref. 1.21) indicates the site is not at risk of flooding from reservoirs. Therefore the site is considered to be at low risk of reservoir flooding.

4.7.3 No other sources of flood risk have been identified in the area.

4.8 Summary of potential flood mechanisms

4.8.1 A summary of flood risk to the proposed development is provided in **Table 1.9**Error! Reference source not found..

Table 4.1: Summary of Flood Risk to Yoxford roundabout

Source of flooding	Flood Risk	Description
Tidal / Coastal.	Low	*Flood Zone 1 - Low:* less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).
Fluvial	Low: majority of the site.	*Flood Zone 1 - Low:* less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).

Source of flooding	Flood Risk	Description
	Medium: northern extent of the site.	*Flood Zone 2 – Medium:* between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%). No changes to the existing site layout in this location. However, the A12 is shown to be approximately 1m above the existing ground levels within Flood Zone 2 and therefore the road itsef is considered to be at low risk of flooding.
Surface water.	Very Low: majority of the site.	Less than 1 in 1,000 annual probability of surface water flooding in any year (<0.1%).
	Low: B1122 at eastern edge of site.	Land with between 1 in 1,000 and 1 in 100 annual probability of surface water flooding (0.1% - 1%). Risk to be reduced by proposed drainage design
	High: A12 at western edge of site.	Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%). Risk to be reduced by proposed drainage design
Groundwater	Low	Soil is permeable and has potential for groundwater flooding. However, the site is likely to be at higher ground levels than the estimated groundwater table.
Sewers	Low	Existing sewers in the existing roads although not at the existing junction. The greenfield area of the site and surrounding arable land have no sewers. No record of sewer flooding in these locations.
Reservoirs and other artificial sources.	Low	Not at risk of flooding from reservoirs or other artificial sources.

5 Flood risk management

5.1 The Sequential Test – application of flood risk vulnerability and flood zone compatibility

5.1.1 All four of the proposed highway improvements and the two highway safety measures considered within this FRA are related to improving highway safety. The developments are classified as 'Essential Infrastructure'.

5.1.2 Three of the proposed highway improvements and the two highway safety measures do not require an FRA. Only the Yoxford roundabout warrants an FRA due to the footprint of the site. The majority of the site is in Flood Zone 1. A very small area of this site is in Flood Zone 2, although the site masterplan, provided in **Volume 7, Chapter 2, Figure 2.1** of the **ES**, identifies there are no changes to the existing land use at this location.

5.1.3 Given this, the proposed development is considered to be appropriate for this flood zone in accordance with the flood risk vulnerability classification (**Table 1.4**) and flood zone compatibility (**Table 1.5**) and passes the Sequential Test.

5.2 Application of climate change

5.2.1 The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) (Ref. 1.19) do not take account of the possible impacts of climate change and consequent changes in the future probability of fluvial flooding. This also applies to the flood extents of the Flood Map for Surface Water.

5.2.2 Given the potential sources of flooding outlined, the actual flood risk posed to the site is derived from surface water sources. Therefore, the climate change allowance to be applied relates to an increase in the intensity of rainfall events likely to affect surface water.

5.2.3 The NPPF requires that the development remains safe through the development's lifetime. As an improvement to the existing highway, the proposed roundabout is anticipated to have a life span of up to and possibly beyond 2140.

5.2.4 The site is not within a Critical Drainage Area. The drainage design would include an appropriate climate change allowance in accordance with the climate change allowances guidance (Ref. 1.5).

5.3 On-site flood risk

5.3.1 The site is predominantly located in Flood Zone 1 and at low risk of fluvial flooding. A small section at the northern extent of the site intersects an area of Flood Zone 2. However, in this location there are no proposed changes to the existing site layout and the actual road level is 1 metre higher than the adjacent Flood Zone 2 level.

5.3.2 There are currently two small areas of surface water flood risk at the eastern and western ends of the road. There is sufficient space within the site boundary to construct an effective drainage network that would accommodate surface water run-off from the roundabout and existing A12 and B1122 carriageways.

5.3.3 The infiltration pond would attenuate the surface water discharging to the ground. The required size of the pond would be determined following infiltration testing to confirm the ground permeability.

5.3.4 The drainage would be designed and constructed in accordance with highway authority standards and would be offered to the Highway Authority for adoption once constructed.

5.4 Off-site flood risk

5.4.1 The site is currently a mixture of existing highways infrastructure and greenfield. The proposed development would increase the impermeable area of the road which would increase the associated surface water runoff from the site.

5.4.2 However, the proposed drainage strategy would reduce surface water flood risk from run-off that currently flows along the existing A12 into Yoxford village.

5.4.3 In the unlikely event that ground conditions prevent full use of infiltration to ground, the pond would become a combined infiltration and attenuation pond.

5.4.4 Run-off which does not infiltrate would discharge at a low controlled flow rate to the existing highway drainage network. The flow rate would be agreed with the Highway Authority and is likely to be agreed at a lower rate.

5.5 Applicability of Sustainable Drainage Systems

5.5.1 In accordance with National Planning Practice Guidance for Flood Risk and Development (Ref. 1.3), the sustainable drainage hierarchy has been applied

to the proposed development and comments on the suitability of options are provided in **Table 1.10**.

Table 5.1: Application of sustainable drainage hierarchy

Option	Comment	Viability
Into the ground infiltration.	An initial review of geological conditions on site indicates that infiltration is likely to be possible as a form of surface water disposal. However, further percolation testing is being undertaken to confirm suitability of ground conditions. It is possible that other drainage discharge options could be required.	Potential
To a surface water body.	If ground conditions prevent full use of infiltration to ground, the proposed infiltration basin would become a combined infiltration and attenuation pond.	Potential
To a surface water sewer, highway drain, or another drainage system.	Any runoff not able to infiltrate would discharge at a low controlled maximum flow rate to the existing highway drainage network such that there is a net reduction in flood risk.	Some potential.
To a combined sewer.	Sewer records were obtained. To discharge to a combined sewer is the lowest on the SuDS hierarchy and other, more suitable opportunities are to be pursued prior to investigating combined sewers.	Some potential.

5.6 Water management and drainage

5.6.1 The drainage strategy provided in **Volume 7, Chapter 2** of the **ES**, for the site provides information about the proposed surface water management and drainage for this development, including the design approach, use of SuDS and consideration of climate change. Some of these considerations are summarised below.

5.6.2 The proposed development would include sustainable drainage to manage any additional surface water run-off from it. A combination of infiltration and controlled discharge methods are proposed for the discharge of surface water run-off. Controlled discharge would be agreed at a lower rate than the existing rate of discharge. The use of petrol/oil interceptors and silt traps would be incorporated within the drainage design where considered necessary.

5.6.3 The proposed drainage would result in a reduction in surface water runoff which currently flows along the existing A12 into Yoxford at Brook Street where it is removed by the existing highway drainage network. The drainage would be designed and constructed in accordance with highway authority standards for adoption.

5.6.4 Climate change will be taken into account in the detailed drainage design through the application of the appropriate rainfall intensity allowances.

5.7 Access

5.7.1 The site accessed along the A12. The existing A12 within the site boundary is in Flood Zone 1. The existing bridge and the A12 approaching the site from the north is within the Flood Zone 2 extent.

5.7.2 On review of the LiDAR (Ref. 1.9) it shows the A12 to the north of the site an having an elevation of between 10.1m and 9.8m AOD. The existing ground levels within Flood Zone 2 to the west of the A12 has an approximate level of 8.6m AOD while to the east of the A12 the existing ground levels are approximately 8.4m AOD.

5.7.3 Therefore, the A12 is approximately 1 metre above the existing ground level shown to be within Flood Zone 2. Therefore, there will be safe access and egress to the development to the north of the A12 for a 1 in 1,000-year event.

5.7.4 Subscription to regional flood warnings from the Met Office would be considered by the site management, where necessary, to inform safe access and egress for workers during high intensity rainfall.

6 Residual risk

6.1.1 In any development there is always a potential for there to be a residual flood risk to people and property due to:

- the failure of systems and defences;
- more extreme events than those defined in the NPPF; or
- uncertainties associated with modelled water levels.

6.1.2 Residual risk may remain after flood risk management or mitigation measures have been installed. An FRA should consider the residual flood risk and the need for any further measures to ensure the residual risk is managed appropriately.

6.1.3 Climate change is a potential residual risk for the site. The flood zones shown on the Environment Agency's flood map for planning do not take account of the possible impacts of climate change and consequent changes in the future probability of fluvial flooding. This also applies to the flood extents of the flood map for surface water.

6.1.4 A flood risk emergency plan would be in place for the construction and operation of the bypass. The flood risk emergency plan would be developed in accordance with NPPF and Environment Agency guidance.

6.1.5 Monitoring of the weather would be in place to monitor storm conditions. This would probably involve the registration of appropriate staff to the Environment Agency flood warnings and Met Office weather warnings to manage the potential impacts of flooding. This could lead to, if necessary, the halting of construction.

6.1.6 Sustainable drainage and existing land drainage structures require regular maintenance to ensure continuing operation to design performance standards. Poor maintenance could result in increased risk of flooding from surface water. The sustainable drainage features would require regular maintenance to prevent blockage.

6.1.7 The drainage would be designed and constructed in accordance with highway authority standards and is due to be adopted by the Highway Authority once constructed. This will ensure an appropriate regime of maintenance for the lifetime of the development.

6.1.8 Monitoring and maintenance of the drainage system would be carried out to preserve its integrity and maintain its design capacity for the lifetime of the proposed development.

7 Summary and conclusions

7.1.1 As outlined in **Table 1.1**, due to the nature of the works being proposed at three of the four highway improvement sites and at both sites where highway safety measures are proposed, a detailed FRA was not required in respect of those sites. Only the Yoxford roundabout site was assessed in detail within this FRA.

7.1.2 This report has considered all sources of flood risk to the Yoxford roundabout proposed development.

7.1.3 The proposed development is classed as being 'Essential Infrastructure' under the NPPF and is located primarily in Flood Zone 1, with a small part in Flood Zone 2. As per the Flood Risk Vulnerability and Flood Zone Compatibility table, the development is considered appropriate in flood Zones 1 or 2 in terms of flood risk vulnerability. It therefore passes the sequential test.

7.1.4 The development is mainly in Flood Zone 1, with the existing A12 raised above the existing ground levels by approximately 1m. There is no material change at the northern edge in Flood Zone 2, and no loss of functional floodplain storage or displacement of sea or river flood water is considered to result from the proposed development.

7.1.5 The large majority of the site is at 'Very Low' risk of surface water flooding, an area of risk of flooding potentially associated with the existing highways use was identified and is mitigated by the drainage strategy.

7.1.6 **Table 1.9** shows flood risk from tidal, fluvial, groundwater, sewers and reservoirs are low.

7.1.7 The increase in impermeable area associated with the proposed development has been addressed in the drainage strategy through sustainable surface water management for any additional surface water run-off. A combination of infiltration and controlled discharge methods are proposed for the discharge of surface water runoff.

7.1.8 Based on the information presented, the proposed mitigation measures and in accordance with NPPF guidance, the development site is considered to be appropriate in terms of flood risk.

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