The Sizewell C Project

5.5 Two Village Bypass Flood Risk Assessment

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Planning Act 2008
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Contents

Tables

Plates

Figures

Appendices

Appendix A: Two Village Bypass Modelling Report

Executive Summary

This Flood Risk Assessment (FRA) presents an assessment of existing flood risk from all sources of flooding to the proposed two village bypass development (referred to as the 'proposed development') as part of the application for development consent for Sizewell C Project. The two village bypass comprises a new permanent highway route that would begin at the A12 to the west of Stratford St. Andrew, in a west to east direction, crossing the River Alde, before re-joining the A12 to the east of Farnham. 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 and presents mechanisms for managing residual risk.

The proposed development is classed as 'Essential Infrastructure' under the National Planning Policy Framework (NPPF). The site is located in Flood Zones 1, 2, 3a and 3b. Flood risk from fluvial sources is high where the bypass crosses the River Alde. Hydraulic modelling has been undertaken to assess the potential impact of the proposed development on flood risk (**Appendix A**). Results of the modelling show that the on-site risk of fluvial flooding of the crossing itself is negligible due to the level of the crossing being much higher compared to the surrounding ground levels and resulting flood levels for all considered scenarios.

The proposed development includes within its embedded design a 60m long bridge over the River Alde and eight culverts across the floodplain. There would be a culvert on the western side of the River Alde overbridge, outside of the floodplain extent (approximately 200m south-east from the existing A12), which would be 5.4m by 3m which would allow an existing watercourse and accommodation access track (used for livestock) to pass beneath the road (on their existing alignment). One culvert is also provided on the eastern side, beyond the 1 in 100-year plus 65% climate change, which will facilitate mammal access up and downstream of the proposed highway during flooding.

Fluvial modelling shows that the proposed development would result in a localised increase in flood levels upstream of the River Alde bridge, with maximum in-channel increase of 0.014m AOD during a 1 in 100-year event with 35% climate change allowance.

Modelling also shows up to 0.22m increase in flood depth in the floodplain for the 1 in 100-year event with 35% climate change allowance, due to local topographical changes. This change is very localised and does not change flood risk to any properties. The land affected on both sides of the River Alde are agricultural fields. SZC Co. is currently in talks with and will continue to engage with the landowner for the affected area, with the view to reaching an agreement for the increased flood depth, hazard and velocity.

Other sources of flood risk are assessed as low. The increase in run-off is addressed by sustainable drainage measures.

The proposed development is classed as 'Essential Infrastructure' under the NPPF which needs to pass the Exception Test due to part of it being within Flood Zones 3a

and 3b. The Sizewell C Project provides sustainability benefits to the local community in respect of local employment, skills, and businesses. The proposed development directly addresses policy SP10 from the Suffolk Coastal Local Plan through the provision of improvements to the A12. The proposed development is raised above the 1 in 100-year with 65% climate change levels and has negligible flood risk impact to adjacent land for the very high benefit it provides. As a result, it is considered to pass the Exception Test and be appropriate in accordance with the NPPF guidance.

1. Introduction

1.1 Background

1.1.1 This Flood Risk Assessment (FRA) describes the flood risk, from all sources, to the proposed two village bypass (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 permanent bypass (referred to as the 'proposed bypass route'), departing from the existing A12 to the south-west of Stratford St. Andrew, crossing the River Alde, before re-joining the A12 to the east of Farnham.

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

1.1.4 The two village bypass would create a new route around the south of Stratford St. Andrew and Farnham, bypassing the two villages. Once operational, the two village bypass is proposed to be a permanent bypass that would form a new section of the A12.

1.1.5 The two village bypass would be used by SZC Co. during the construction phase of the Sizewell C main development site, to transport construction workers and goods vehicles delivering freight to the Sizewell C main development site. It would also be open to the public.

1.1.6 The two village bypass would be located to both the south and east of the village of Farnham, covering approximately 54.8ha of mainly agricultural land as well as highway land and hard standing. The proposed development would comprise a new single carriageway road, approximately 2.4 kilometre (km) in length.

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.

[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.

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 (Ref. 1.7); and
- Suffolk Flood Risk Management Strategy (Ref. 1.8).

2.2 Legislation

a) Flood and Water Management Act 2010

2.2.1 The Flood and Water Management Act 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) (Ref. 1.1) 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 Sizewell C Project. 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 system (SuDS) to facilitate the sustainable development of energy developments. The SuDS should aim to prevent an increase in surface water flood risk associated with any increase in discharge from the site.

b) Office for nuclear regulation and environment agency principles for flood and coastal erosion risk management joint 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." (*Ref. 1.2*).* 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 such as a road constructed as part of a new build project to assist with local transport capacity improvements, *"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) (Ref. 1.3) 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, 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 that:

- 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;
- the development 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 (NPPG) on Flood Risk and Coastal Change (Ref. 1.4) supports the NPPF with additional guidance on flood risk vulnerability classifications and managing residual risks. The NPPG provides further description of Flood Zones (**Table 2.1**), Vulnerability Classifications (**Table 2.2**) and Compatibility Matrix (**Table 2.3**) 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 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

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

Vulnerability Classification	Description
	warning and evacuation plan.

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

Flood Risk Vulnerability Classification (see Table D2)		Essential Infra-structure	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 Flood plain'	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.

2.3.11 For the Exception Test to be passed it must be demonstrated that based on a site-specific flood risk assessment:

- the development provides wider sustainability benefits to the community that outweigh flood risk; and
- 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.

2.3.12 Where the Exception Test is applied, both elements of the Exception Test will have to be passed for development to be 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

2.3.13 The NPPG on Flood Risk and Coastal Change (Ref. 1.4) 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."*

2.3.14 In order to manage surface water on the site, it is necessary to consider the appropriateness of various SuDS measures, using the SuDS hierarchy set out in the NPPG (Ref. 1.4).

2.3.15 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, Ref. 1.4).*

2.3.16 The NPPG acknowledges that some types of sustainable drainage systems may not be practicable in all locations. Locations may be constrained in areas of risk flood. Fluvial and coastal flood zones are defined in **section 4** of this report.

2.3.17 The Environment Agency classifies surface water flood risk (Ref. 1.19) into four categories; 'very low', 'low', 'medium' and 'high' (**Table 2.4**).

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

2.3.18 The Environment Agency's online advice note Flood Risk Assessments: Climate Change Allowances (Ref 1.5) 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." (Ref.1.5).*

2.3.19 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.

2.3.20 Guidance is provided for determining appropriate climate change allowances for peak fluvial flows and peak rainfall intensities as presented in **Plate 2.1** and **Plate 2.2** respectively.

Plate 2.1: Extract from Table 1 of Environment Agency guidance on climate change allowances – peak river flow allowance

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

Plate 2.2: Extract from Table 2 of Environment Agency guidance on climate change allowances – peak rainfall intensity allowance

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

e) Environment Agency pre-development guidance

2.3.21 As part of the Sizewell C early engagement process, pre-development discussions were undertaken with the Environment Agency. The Environment Agency confirmed that:

> *"if the change in depth is less than 30mm (3cm), compensatory storage is not usually required. However, this must be assessed on a case by case basis and other factors such as velocity, hazard, duration, rate of onset and change in flood extent should still be assessed."* (Ref. 1.22)

2.3.22 As part of the pre-development discussions SZC Co. agreed with the Environment Agency that for the future on-site flood risk, 65% climate change allowance would be applied in relation to the flood risk to the road and safety of users. While the 35% climate change would be applied to the assessment of the impact of the road on off-site flood risk.

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). Prior to this date SCDC and WDC worked in partnership to produce various policy documents. These documents are referred to here by their published names and references authors as they were at the time of their publication. Further information is provided in **Volume 1, Chapter 3** of the **Environmental Statement** (**ES**) (Doc Ref. 6.2).

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. The SCDC have previously stated that the adoption of the plan is scheduled for Spring 2020. This local plan covers only the geographical area formerly within the SCDC boundary.

ii. Existing local plan

2.4.3 The existing SCDC Local Plan sets out how the area should be developed. It incorporates core strategy and development management policies and saved policies. This document forms part of the formal Development Plan and is used in the determination of planning applications.

2.4.4 The existing SCDC Local Plan sets out how the area should be developed. It incorporates core strategy and development management policies and saved policies. This document forms part of the formal Development Plan and is used in the determination of planning applications.

2.4.5 Two strategic policies and one development management policy have been identified as relevant for the proposed development, as outlined within **Table 2.5**. No reference to the allocation of the site has been found in the SCDC Local Plan.

Table 2.5: Relevant Suffolk coastal local plan policies

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

2.4.6 Suffolk County Council (SCC) 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.

2.4.7 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.

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

- To prevent an increase in flood risk as a result of development by preventing additional water entering existing drainage systems wherever possible;
- 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 two village bypass (herein referred to as 'the site' or 'the proposed development') is approximately 54.8 hectares (ha) and comprises predominately agricultural land (which accounts for approximately 50.4ha of the site) as well as highway land. Approximately 39.2ha of agricultural land would be required permanently for the proposed development, with a further 11.2ha required temporarily to facilitate construction.

3.1.2 The site is predominantly located on agricultural land. The route of the proposed development runs east across the River Alde and the associated floodplain. As the proposed highway crosses an unnamed road north of Pond Barn Cottages, it bends to the north continuing until re-joining the existing A12 via a new four-arm roundabout to the east of Farnham at the A12 and A1094 (Friday Street junction), to the east of Farnham. The proposed development also crosses one further unnamed road and three access tracks.

3.2 The proposed site masterplan and design

3.2.1 The proposed site layout (refer to **Volume 5**, **Figures 2.1** to **2.4** of the **ES**) (Doc Ref. 6.6) provides a preliminary layout plan, which includes a single carriageway road with necessary bridges, flooding and drainage features.

3.2.2 The proposed route of the two village bypass would comprise a new single carriageway, approximately 2.4km in length. The proposed route of the two village bypass would be 7.3 metres (m) in width, with additional 1m hardstrips and 2.5m grassed verges. Swales approximately 3-3.5m wide would also be proposed along the earthworks for the length of the proposed route of the two village bypass for highway drainage, except for the extent of the River Alde floodplain.

3.3 Bridge design

3.3.1 Through consultation between SZC Co. and stakeholders including the Environment Agency and SCC, a design for the proposed development has been prepared that does not impede in-channel river flows or morphology, minimises the impact on flood plain flows, enables passage of wildlife under the road crossing and will allow construction completion within the required timeframe. Further discussion on the alternative designs and the justification of the purposed design is provided in **Volume 5**, **Chapter 3** of the **ES** (Doc Ref. 6.6).

3.3.2 The road embankments cross the River Alde floodplain. To facilitate the river crossing, a 60m bridge with two support pillars across the River Alde is proposed. Further to this, eight large culverts (5.4m wide by 3m high) are proposed, four on each side of the River Alde to allow flood plain conveyance during a flood event.

3.3.3 There will be an additional 'dry' culvert (5.4m by 1.2m) on the east side of the flood plain, running through the road embankment, which would be outside the 1 in 100-year plus 65% climate change and 1 in 1000-year plus 65% climate change extents, which will facilitate mammal access up and downstream of the proposed highway during flooding.

3.3.4 There will also be a culvert on the western side of the River Alde overbridge, outside of the current Flood Zone 2 (approximately 200m south-east from the existing A12), which would be 5.4m by 3m which would allow an existing watercourse and accommodation access track (used for livestock) to pass beneath the road (on their existing alignment). The bridge crossing is illustrated in **Plate 3.1, Plate 3.2** and **Plate 3.3**.

Plate 3.1. Two village bypass with Environment Agency Flood Zone Map

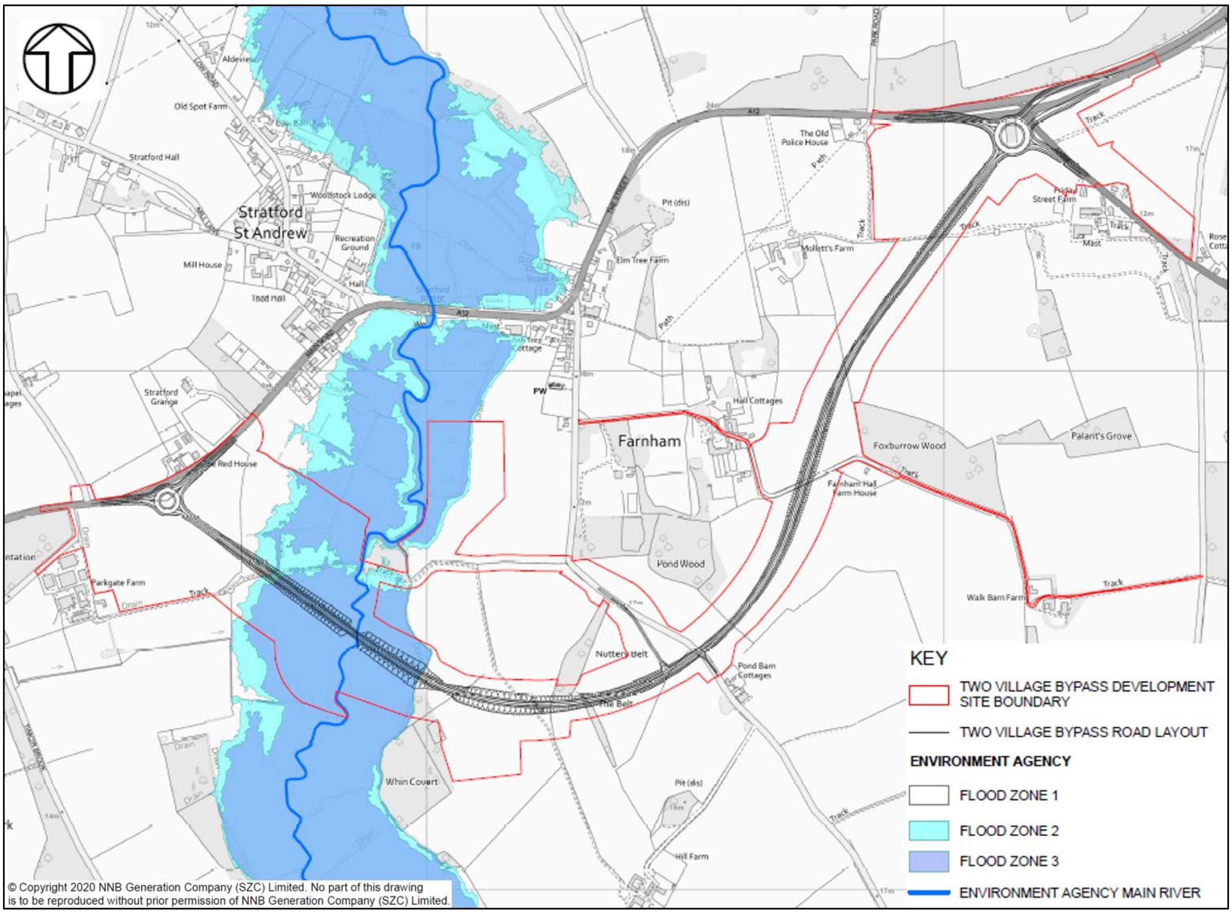


Plate 3.2. Extract from SZC Co. two village bypass drawing: SZC-SZ0204-XX-00-DRW-100297 – Location Plan: showing how piers avoid the river channel

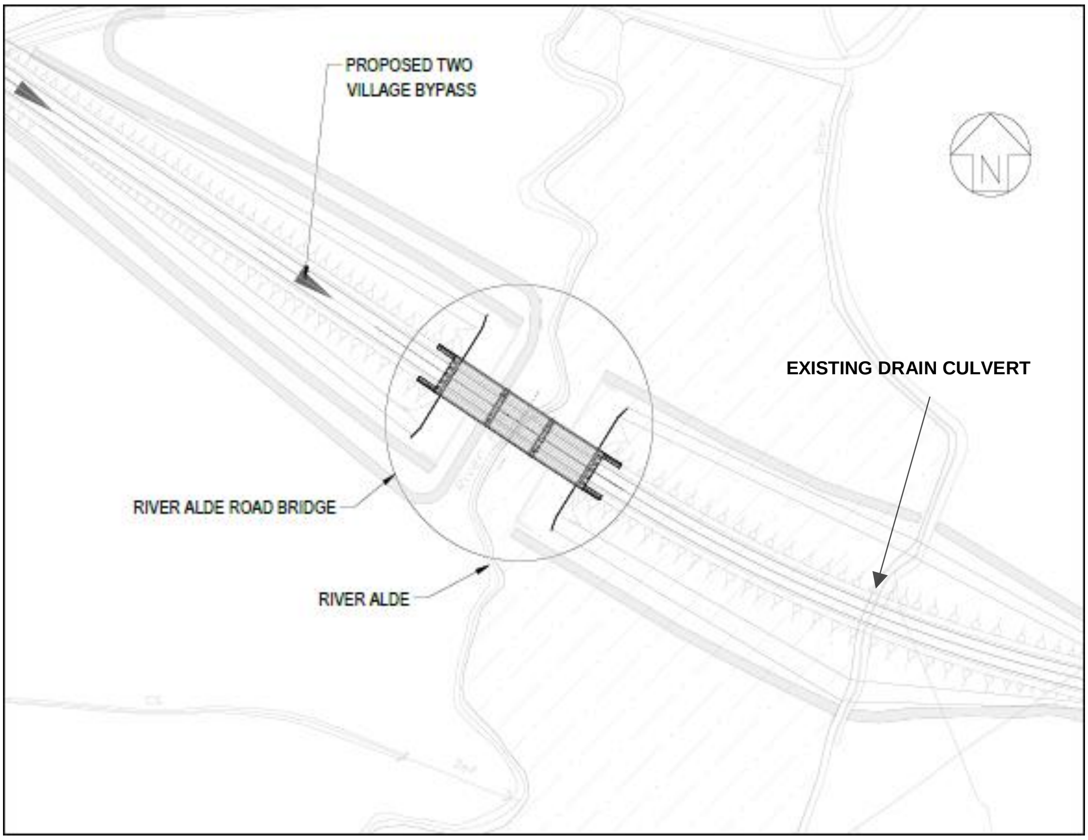
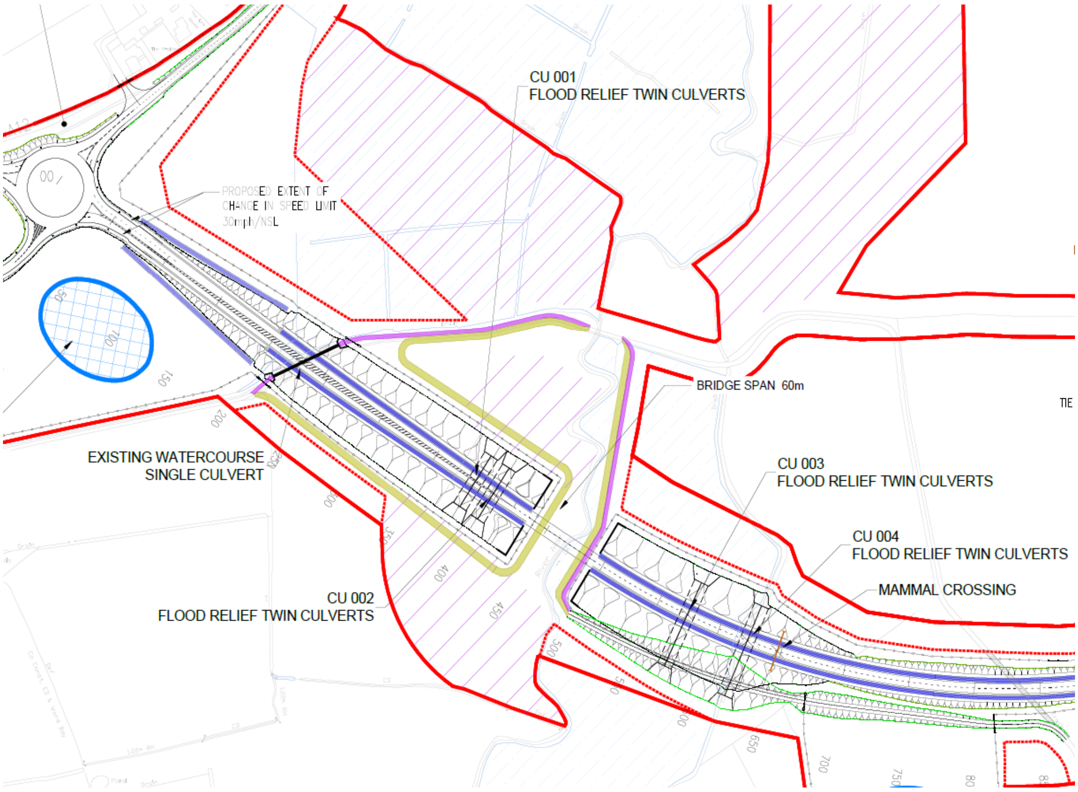


Plate 3.3. Extract from SZC Co. two village bypass drawing: SZC-SZ0204-XX-000-DRW-100038 P19 TVB Highway Layout and Profile GA: showing bridge and associated culverts



3.4 Topography

3.4.1 **Figure 1** provides remotely sensed Light Detection and Ranging (LiDAR) data (Ref. 1.9) to show the topography of the site.

3.4.2 From west to east, the proposed bypass route slopes from an elevation of approximately 10 metres above ordnance datum (m AOD) at the current A12. From there it slopes down into the River Alde floodplain, where the lowest site elevation is approximately 4.4m AOD.

3.4.3 The elevation then increases eastwards from the River Alde, reaching a site high elevation of approximately 26m AOD at the crest of the hill that continues as the road runs north.

3.4.4 The proposed bypass route then lowers to approximately 17m AOD, where the proposed roundabout would reconnect with the A12 and A1094.

3.5 Geology

3.5.1 British Geological Survey (BGS) online geology viewer mapping (Ref. 1.10) shows the site passes through three types of bedrock geology. From east to west the site comprises of; the Crag Group (marine deposits), Red Crag Group (marine deposits) and Chillesford Church Sand Member, all of which are predominantly formed of sand.

3.5.2 The BGS map shows the site passes through three types of superficial geology. From east to west the site comprises; Lowestoft Formation (sand and gravel), Lowestoft Formation (diamicton) and alluvium deposits associated with the River Alde.

3.5.3 The Suffolk Coastal and Waveney District Councils Strategic Flood Risk Assessment (Ref. 1.11) 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."*

3.5.4 The Aquifer Designation map (Ref. 1.12) 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"*

3.5.5 The Aquifer Designation map classifies the superficial geology as a mixture of 'Secondary A', 'Secondary undifferentiated' and 'Unproductive' aquifers. 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. Unproductive aquifers are geological strata with low permeability that have negligible significance for water supply or river base flow. At the resolution of freely available data, it was not possible to identify how each of these designations relate to the site boundary.

3.5.6 The Groundwater Vulnerability map (Ref. 1.13) indicates the site stretches across two areas defined as a Minor Aquifer with High and Intermediate Vulnerability, the latter being associated with the River Alde. 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. 1.23).*

3.6 Hydrology

3.6.1 The site is located across two river catchments. A small section towards the east of the site falls within the River Fromus catchment. The majority of the site falls within the River Alde catchment (Ref. 1.14).

3.6.2 Environment Agency 'Main Rivers' are typically larger rivers and streams, which they have permissive powers to maintain and improve to manage flood risk. **Figure 2** identifies all 'Main Rivers' that are near to the site boundary.

3.6.3 The River Alde is a main river that runs north to south through the centre of the site, approximately 450m south-east of the western roundabout.

3.6.4 'Ordinary Watercourses' are the remaining watercourses that are not classified as Main River. Lead Local Flood Authorities, Local Authorities and Internal Drainage Boards have powers to carry out flood risk management work on Ordinary Watercourses within their geographical areas.

3.6.5 The Ordinary Watercourses within the site boundary are associated with the floodplain of the River Alde.

3.6.6 Review of Ordnance Survey (OS) mapping has identified no ponds within the site boundary. However, there are multiple ponds within 500m of the site boundary. The proposed infiltration basins are not located in Flood Zones or areas of surface water flood risk.

3.6.7 With reference to the Environment Agency's East Anglia Water Resources Licence Trading map (Ref. 1.15), there are ten licenced groundwater abstractions identified within 1km of the site. One licenced surface water abstraction has been identified within 1km of the site.

3.6.8 The site is not located within a source protection zone. The closest is a Zone Three Total Catchment that is approximately 750m to the north-west (Ref. 1.16).

3.6.9 Hydrological assessment of the River Alde was undertaken (by JBA on behalf of the Environment Agency) in 2012 as part of the flood mapping study for the rivers Alde, Ore and Fromus to determine flood risk to the surrounding rural areas. As the most up to date assessment available, this assessment was used to inform hydraulic modelling study for this FRA, as discussed in **section 4.3** of this report. In late 2019, the Environment

Agency issued an updated version of that assessment (Ref. 1.24). However, studies for this two village bypass were already substantially underway and therefore the previous (2012) hydrology was used.

3.6.10 Although the 2012 hydrology has been applied, it is considered appropriate for assessing relative difference in flood risk as a result of the proposed development. To inform the level of change in potential impact on the flood risk as a result of the revised (2019) hydrological assessment (Ref.1.25), a comparison of fluvial flows in River Alde from the two studies was carried out. The updates included revised hydrological assessment, which included updating rating curves for the Farnham and Benhall gauging stations and as a result revised QMED and design peak flow estimations. In general, the flows are similar or slightly higher than the previous 2012 study for all rivers above the 1 in 10-year return period event.

4. Flood Risk Appraisal

4.1 Historical flooding

4.1.1 The East Suffolk Council Strategic Flood Risk Assessment historic flood record maps provide locations for recorded historic flood events from fluvial, tidal, sewer, groundwater, highway drainage and surface water sources (Ref. 1.11). The maps identify that at the eastern extent of the proposed development, on the A1094 at Friday Street Farm, there is one case each of highways and groundwater flooding recorded.

4.1.2 The absence of flood records does not necessarily confirm that no flooding has occurred.

4.2 Tidal / coastal flood risk

4.2.1 The Flood Map for Planning (Ref. 1.17) shows the site is located in Flood Zones 1, 2 and 3 (**Figure 2**). Flood Zone 3 is defined by the Environment Agency as "*Land having a 1 in 200 or greater annual probability of sea flooding (≥0.5%)*". The Flood Zones 2 and 3 extents are associated with flood risk from the River Alde, which is not a tidally influenced watercourse.

4.2.2 The flow control structure on the River Alde to the west of Snape bridge provides the tidal extent. This is confirmed in the Shoreline Management Plan 2009 (Ref. 1.18).

4.2.3 The OS 25,000 scale map confirms the normal tidal extent is located at Snape Bridge on the B1069.

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

4.3 Fluvial flood risk

4.3.1 The Flood Map for Planning shows the site is located in Flood Zones 1, 2 and 3 (**Figure 2**). Flood Zone 3 is defined by the Environment Agency as *"Land having a 1 in 100 or greater annual probability of river flooding (≥1%)."*

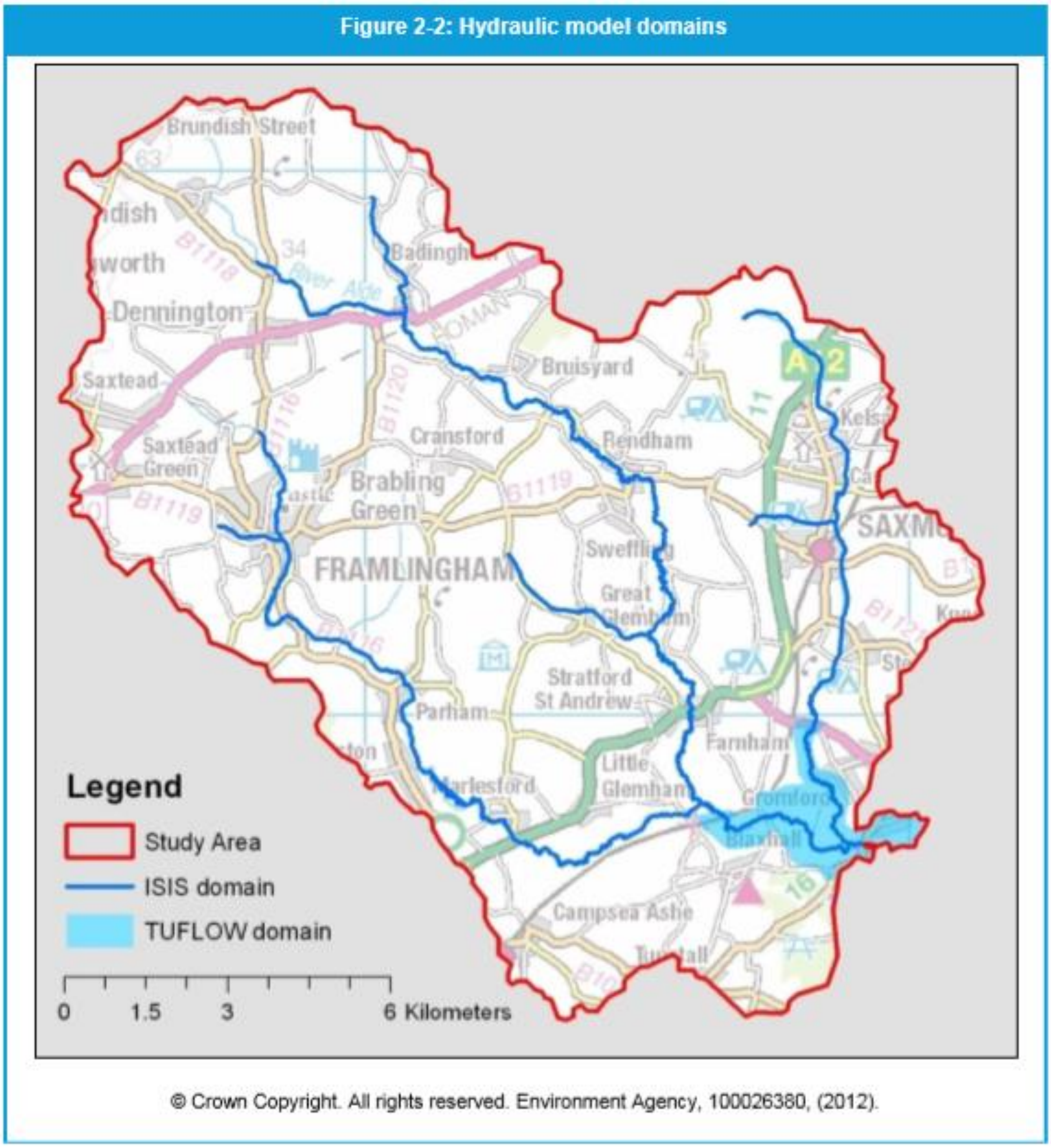
4.3.2 The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) (Ref. 1.17 and **Figure 2**) do not take account of the possible impacts of climate change and consequent changes in the future probability of fluvial flooding.

4.3.3 The risk of flooding from fluvial sources in the vicinity of the River Alde is considered to be high, with the site area crossing an area in Flood Zone 3b (functional floodplain).

4.3.4 As the proposed development crosses the River Alde, hydraulic modelling has been undertaken to support this FRA and assess impacts on fluvial flood risk to the development itself and potential off-site receptors throughout the proposed design lifetime.

4.3.5 The modelling used the latest (at the time of the assessment) available hydraulic model (1D-2D ISIS-TUFLOW model), provided by the Environment Agency which was developed by JBA consulting in 2012. **Plate 4.1** Shows the 1D and 2D model extent, where the ISIS domain is the 1D and the TUFLOW is the 2D.

Plate 4.1 Supplied model study extent (Source: Fluvial Alde, Ore and Fromus ISIS-TUFLOW model report)



4.3.6 Following completion of this hydraulic modelling based upon the 2012 model, the Environment Agency provided some results from their updated 2019 model (Ref.1.25). The 2019 Environment Agency modelled results were analysed and compared against the results obtained from the updated 2012 model to determine any potential impacts on overall model results and consequently the FRA conclusions. The main change in the 2019 model was the hydrological assessment. For that purpose a review of the flow and stage was undertaken at four locations;

- the inflow into River Alde,

- immediately upstream of the A12 bridge;
- the closest nodes upstream of the proposed road scheme; and
- the closest nodes downstream of the proposed road scheme.

4.3.7 The results for the present-day 1 in 100-year and 1 in 1,000-year return period events were compared along with a comparison of flood extents.

4.3.8 Overall, the main inflow into River Alde in the 2012 model is approximately 10% lower than in the 2019 model for the 1 in 100-year event, while the flow for the 1 in 1,000-year event remains unchanged. A comparison of the peak water levels indicates that the peak water levels in the 2012 model are lower by 0.11m for the 1 in 100-year event and 0.05m for the 1 in 1,000-year event.

4.3.9 Upstream of the A12 and upstream of the proposed crossing, the flow in the 2012 model is lower by approximately 15% for the 1 in 100-year and approximately 10% lower in the 1 in 1,000-year events respectively, with slightly higher peak water levels when compared to 2019 model. While further downstream, the flows and water levels in the updated 2012 model are slightly higher than in the 2019 model.

4.3.10 A comparison of flood extents for the present-day 1 in 100-year event and 1 in 100-year with 35% climate change allowance shows a relative consistency between the two models near the proposed development with slightly wider extents in the 2019 model upstream and downstream. However, the grid resolution in the 2019 model is 8m, whereas in the updated 2012 model the grid resolution is 4m. Therefore, it is likely that most differences in the flood extents could be attributed to the differences in grid resolution and consequently the topography representation in the two models.

4.3.11 Even though there are some differences between the two models, the updated 2012 model is deemed appropriate for this FRA, where focus is to determine the relative impact of the proposed two village bypass on flood risk. Further information on the hydraulic modelling is available in **Appendix A** to this report.

4.3.12 The supplied Environment Agency's 2012 model was updated for the baseline scenario through the addition of five 1D model cross sections (surveyed in May 2019) and extending the 2D domain up to the A12 bridge on River Alde, where the Farnham gauging station is located. This was to adequately represent flow of water through the floodplains in the vicinity of the proposed development and potential impact areas.

4.3.13 The model grid size was also reduced from 8m to 4m to represent sufficient level of detail of the topography of the terrain. Further details on the updates to the fluvial model can be found in the hydraulic modelling report (**Appendix A**).

4.3.14 The model was simulated for three return period events, namely the 1 in 20-year, 1 in 100-year and 1 in 1,000-year, each for two epochs, i.e. present day and future scenario to account for climate change allowances up to the end of the proposed development. Assessment of climate change is discussed further in **section 5** of this report.

4.3.15 The modelled flood extents and depths were developed for the 1 in 20-year (**Figure 5**) to define Flood Zone 3b present day event, the 1 in 100-year (**Figure 8**) present day event to define Flood Zone 3a and the 1 in 1,000-year (**Figure 11**) present day event to define Flood Zone 2. When compared with the Environment Agency Flood Zone Map (**Figure 2**), a strong correlation is observed between the two sets of results, with the flood extents matching. **Figure 5** to **Figure 13** highlight the relatively small change in flood extents and depths between the 20-year, 100-year and 1,000-year baseline events. These demonstrate the topography of the River Alde valley limits the extent of the floodplain in the area.

4.3.16 The modelled water level in the vicinity of the proposed crossing is approximately 4.9m AOD for the present day 1 in 100-year event.

4.3.17 The baseline scenario shows increasing areas with higher velocity flows as the significance of the event and climate change allowance rises (**Figure 14** to **Figure 22**) for both the 1 in 100-year and 1 in 1,000-year events.

4.3.18 Although the flood hazard ratings across the modelled events shows areas with ‘Low Hazard’, ‘Danger for Some’ and ‘Danger for Most’ hazard classes (**Figure 23** to **Figure 31**) there are no residential or commercial properties located within their flood extents.

4.3.19 **Figure 4** shows the 20 and 100-year event present day flood extents from the modelling. When compared with the Environment Agency Flood Zone Map (**Figure 2**) a strong correlation is observed between the two sets of results, with the flood extents matching, providing assurance in the hydraulic modelling carried out for this assessment.

4.4 Surface water flood risk

4.4.1 **Figure 3** provides the Environment Agency ‘long term flood risk map’ dataset (Ref. 1.19), which identifies the risk of surface water flooding to the proposed site. The Environment Agency’s flood map does not take account of the possible impacts of climate change and consequent changes in the future probability of surface water flooding.

4.4.2 This majority of the site is indicated to be at 'very low' risk of surface water flooding. Towards the west of the site there is a complex array of surface water flow paths associated with the River Alde floodplain. The majority of these areas of 'high' and 'medium' surface water flood risk flow in a southerly direction and drain into the River Alde to the south of the proposed bypass.

4.4.3 There are small areas of 'low' surface water flood risk crossed by the proposed highway near the River Alde (**Figure 3**). While the highway infiltration basins are designed to accept surface water run-off from the highway, areas where the local topography are not associated with the highway and/or outside of the site area may direct run-off towards these infiltration features. The infiltration basins will not be sited within the River Alde floodplain. Under common law, landowners have the right to pass on naturally occurring surface water run-off from higher ground to lower ground. In these locations, it is expected that highways drainage would collect and disperse surface water falling on the site. The proposed highway would be raised above the existing ground and removed from the existing risk of surface water flooding.

4.4.4 At the eastern extent of the site at Friday Street Farm, there is an area of existing high surface water flood risk immediately north of the A1094.

4.5 Groundwater flood risk

4.5.1 According to the Geology of Britain viewer and the Strategic Flood Risk Assessment, the main soil types in the area are permeable. Permeable soils have the potential to present groundwater flooding problems in areas with a high water table.

4.5.2 The BGS susceptibility to groundwater flooding map identifies there is potential for groundwater flooding to occur at the surface in parts of the site that cross the River Alde and the floodplain.

4.5.3 Towards the east of the site where elevation increases with distance from the River Alde floodplain, the Strategic Flood Risk Assessment indicates there is a limited potential for groundwater flooding to occur.

4.5.4 Due to the proximity of some areas of the proposed development to the River Alde, the risk of groundwater flooding to the site is high due to the possibility of groundwater emergence. Due to the elevation of the road, this risk is not expected to affect the road carriageway.

4.6 Sewer flood risk

4.6.1 The site is currently an undeveloped greenfield site with an agricultural use. There is therefore no existing risk of internal flooding from sewer sources on site.

4.6.2 The Suffolk Coastal and Waveney District Councils Level 1 Strategic Flood Risk Assessment does not identify any flooding to have occurred on site from foul or surface water sewers. The Strategic Flood Risk Assessment also does not identify any flooding from highway drainage to have occurred on site or the surrounding highway network.

4.6.3 The risk of sewer flooding to the site is therefore considered to be low.

4.7 Flood risk from reservoirs and other artificial sources

4.7.1 Flooding from reservoirs is defined as an uncontrolled release of water from registered reservoirs, reservoirs with a volume greater than 25,000m^3 held above the existing ground level.

4.7.2 The Flood Risk from Reservoirs map (Ref. 1.20) shows the site is not at risk of reservoir flooding.

4.8 Summary of potential flood mechanisms

4.8.1 A summary of flood risk to the proposed development is provided in **Table 4.1**.

Table 4.1: Summary of flood risk to the development site

Source Of Flooding	Flood Risk	Description
Tidal/coastal	Low	Less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%) and beyond the tidal extent.
Fluvial	High	Land having a 1 in 100 or greater annual probability of river flooding (≥1%); or
Surface water (pluvial)	Very Low: Majority of the site	Less than 1 in 1,000 annual probability of surface water flooding in any year (<0.1%)
	High: Areas associated with the River Alde flood plain	High: Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%).

Source Of Flooding	Flood Risk	Description
Groundwater	High	Soil is permeable, potential for groundwater flooding to occur at the surface in parts of the site that cross the River Alde and the floodplain
Sewers	Low	Low risk due to current agricultural use
Reservoirs and other artificial sources	Low	Located outside the maximum reservoir flood risk extent

5. Assessment of Climate Change

5.1.1 As outlined above, the flood risk posed to the site is mainly from fluvial and surface water sources. Therefore, the climate change allowance to be applied relates to an increase in the intensity of rainfall events and peak river flows. In addition, sea level rise allowance was applied to the downstream boundary of the hydraulic model used for the assessment.

5.1.2 In accordance with the guidance for associated development given in Appendix D of the joint advice note on flood risk (Ref. 1.2), the appropriate climate change criteria to be applied is that in accordance with national planning policy.

5.1.3 The NPPF is supported by the Environment Agency guidance on climate change allowances for increase in peak fluvial flows which considers the geographical location, lifetime of the proposed development, Flood Zone and vulnerability classification associated with the type of development.

5.1.4 The climate change allowances used in the supporting hydraulic modelling for this FRA are based on a 100-year lifetime of development for the two village bypass. 100 years is considered to be a conservative expected life of such a highway development before replacement or major works to extend its life.

a) Peak river flows

5.1.5 The site is in the Anglian river basin and climate change allowances used are specific to this river basin. The proposed development is 'Essential Infrastructure' under the NPPF criteria. Therefore, the upper end climate change scenarios are appropriate for assessment of the on-site risk on users of the road.

5.1.6 The 65% climate change allowances were used in accordance with the climate change guidance. The NPPF requires the development remains safe through the development's lifetime. The climate change allowances were applied in accordance to the on-site flood risks. For the off-site flood risk of the impact of the crossing, 35% climate change allowance was used as agreed with the Environment Agency. For epochs beyond 2115 (2080s epoch) no extrapolation was applied.

b) Rainfall intensity

5.1.7 The site is not within a Critical Drainage Area. In accordance with the guidance, both the Central and Upper End allowances (given in **Plate 2.2**) have been applied within the development of the **Outline Drainage Strategy**, see **Volume 2, Appendix 2A** of the **ES** (Doc Ref. 6.3), to account for the range of impact both on- and off-site for the 2060 – 2115 epoch.

c) Sea level rise

5.1.8 The sea level rise allowances were derived from the UK Climate Projections (Ref. 1.21) published in 2018 (UKCP18) in line with the latest Environment Agency and Office for Nuclear Regulations advice (Ref. 1.2). The allowances were obtained from the RCP8.5 projections at 95th percentile for the relevant epochs and applied to uplift the tide levels at the model boundary. Further details on assessment of climate change allowances used in the hydraulic modelling study are available in the hydraulic modelling report (**Appendix A**).

6. Application of the Sequential and Exception Test

6.1 The sequential test

6.1.1 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*" (Ref. 1.2). Appendix D of the joint advice note confirms that for associated development such as a road constructed as part of a new build project to assist with local transport capacity improvements, "*the most relevant climate change criteria must be applied in accordance with national planning policy*".

6.1.2 Using the NPPF definitions, the proposed development is classed as 'Essential Infrastructure' in accordance with **Table 2.2**. The site is located in Flood Zones 1, 2 and 3 as defined in **Table 2.1.** The proposed development is considered appropriate in Flood Zones in 1 and 2.

6.1.3 However, in Flood Zone 3 and 3b the proposed development is subject to the Exception Test in accordance with the flood risk vulnerability and flood zone compatibility table (**Table 2.3**).

6.1.4 The proposed development would need to satisfy the criteria of the Exception Test.

6.2 The exception test

6.2.1 For the Exception Test to be passed, the proposed development must provide wider sustainability benefits to the community and be supported by a site specific FRA.

6.2.2 The proposed development is required as part of delivering the wider Sizewell C Project, which is nationally critical infrastructure in terms of future energy supply at the regional and national scale.

6.2.3 The bypassing of the villages of Farnham and Stratford St. Andrew would facilitate HGV traffic to safely and efficiently access Sizewell in relation to the proposed Sizewell C Project.

6.2.4 Both directly and in support of the wider Sizewell C Project, the proposed development provides sustainability benefits to the local community in respect of local employment, skills, and businesses, as well as supporting Britain's transition to a sustainable low carbon economy. The proposed development also provides sustainability benefits to the community by addressing policy SP10 from the Suffolk Coastal Local Plan (**Table 2.5**). The construction of the highway will bypass the villages of Stratford St Andrew and Farnham, reducing through-traffic. Various routes and design alternatives were considered prior to the selection of the preferred route assessed in this FRA. Further discussion on the alternative designs and the justification of the purposed design is provided in **Volume 5, Chapter 3** of the **ES** (Doc Ref.6.6).

6.2.5 Furthermore, a site-specific hydraulic model has been prepared to support this site-specific flood risk assessment to demonstrate the development would be safe. A minor localised variation in flood risk is expected based on the modelling results. An increase in flood risk is expected in the immediate area upstream of the proposed crossing and a decrease in flood risk downstream of the bridge.

6.2.6 Further modelling details are given in **section 7.1** of this report.

6.2.7 The principle of a two village bypass requires the crossing of the River Alde. A review of viable route options was undertaken and for various reasons discussed in **Volume 5, Chapter 3** of the **ES,** the route of the proposed two village bypass was promoted. The proposed route is similar in width to the existing crossing between Farnham and Stratford St Andrews.

6.2.8 On consideration of the information provided in the flood risk assessment, supporting hydraulic modelling, the need for the Sizewell C Project, the consideration of alternative routes and methods of construction, and the potential impacts of the proposed development on the local community and environment, the development is considered to satisfy the Exception Test as it will be safe for users and does not cause a significant impact to adjacent areas.

7. Future Flood Risk

7.1 On-site flood risk

7.1.1 Part of the proposed development is in Flood Zone 3 (high risk of fluvial flooding) and 3b (functional floodplain).

7.1.2 To assess impacts of fluvial flood risk on the proposed development throughout the proposed design life, hydraulic modelling was undertaken. Further details of the construction of the fluvial model can be found in the hydraulic modelling report (**Appendix A**).

7.1.3 The proposed development was added to the baseline hydraulic model. The scheme includes a 60m span bridge with two piers, none of which are within the river channel, and eight flood relief culverts, each measuring 5.4m x 3m, as discussed in **section 3.3** of this report.

7.1.4 The proposed two village bypass is elevated above the River Alde flood plain, with the proposed lowest level of the carriageway being 9.7m AOD. With the two village bypass in place, the maximum modelled flood levels for the design scenario (1 in 100-year event with 65% allowance for climate change) adjacent to the bridge is 5.08m AOD. In terms of sensitivity to higher flows, the maximum level for the 1 in 1000-year event with 65% allowance for climate change adjacent to the bridge is 5.27m AOD. The two village bypass is therefore not at risk of flooding for the required design event for the lifetime of the development.

7.1.5 As part of the modelling, sensitivity testing was undertaken to explore whether the afflux experienced in the floodplain could be mitigated through the addition of further culverts, in addition to the eight culverts within the embedded design. However, increasing to a total of 20 culverts showed limited further reduction in flood depths. Further information regarding this can be found in the Two Village Bypass Modelling Report (**Appendix A**).

7.1.6 A dry mammal crossing is included within the embankment design on the east side of the River Alde overbridge. The mammal migration culvert (approximately 5.4m by 1.2m) is outside the 1 in 100-year plus 65% climate change extent and would not flood in this scenario. There would also be a culvert on the western side of the River Alde overbridge, outside of the current Flood Zone 2 (approximately 200m south-east from the existing A12), which would be 5.4m by 3m which would allow an existing watercourse and accommodation access track (used for livestock) to pass beneath the road (on their existing alignment).

7.1.7 The construction of the infiltration basins linked to the two village bypass road drainage have been located outside the 1 in 100-year plus 65% climate change extent to ensure they do not store flood water from the River Alde.

7.1.8 The proposed development will not be at risk of surface water flooding due to the highway drainage design.

7.2 Off-site flood risk

7.2.1 To assess impacts of fluvial flood risk posed by the proposed development throughout the proposed design life, hydraulic modelling was undertaken with the embedded design including the 60m wide bridge and eight culverts in place.

7.2.2 Modelling was carried out for the 1 in 100-year with 35% climate change allowance as the representative design scenario for off-site impacts. In addition, a broader range of return periods from 1 in 20-year to 1 in 1000-year with 65% climate change allowance were also modelled to provide a wider understanding of the impact of the proposed crossing for assessment of off-site impacts. Further details of the construction of the fluvial model can be found in the modelling report (**Appendix A**).

7.2.3 The fluvial modelling results of flood depth for a range of return periods for the baseline and with proposed development are provided as **Figure 5** to **Figure 13** and **Figure 32** to **Figure 40** respectively. The differences between the flood depths and flood extents are provided across a range of return periods in **Figure 59** to **Figure 73**. Results of flood velocity and hazard for the baseline and with proposed development are provided as **Figure 14** to **Figure 31** and **Figure 41** to **Figure 58** respectively.

7.2.4 The flood modelling results identify the 1 in 20-year flood extents with and without climate change to determine the functional floodplain (**Figure 5** to **Figure 7**). The in-channel change between the baseline and 'with scheme' (with proposed development in place) scenarios at the bridge is minimal for the 1 in 20-year, 1 in 100-year and 1 in 1,000-year with and without climate change (**Table 7.1**).

Table 7.1: Summary of modelled water levels at node ALDE 06069 (at the crossing location) for the baseline and 'with scheme' scenarios

Return Period (years)	ALDE 06069 Baseline Water Levels (m)	ALDE 06069 'with scheme' Water Levels (m)	Difference (m)
20	4.925	4.936	0.011
20 +35%CC	4.969	4.988	0.019
20 +65%CC	4.995	5.008	0.013
100	4.977	4.995	0.018
100 +35%CC	5.018	5.032	0.014
100 +65%CC	5.049	5.081	0.032
1,000	5.058	5.096	0.038
1,000 +35%CC	5.119	5.195	0.076
1,000 +65%CC	5.177	5.266	0.089

7.2.5 **Table 7.1** shows that the 1 in 100-year with 35% climate change allowances shows a maximum afflux as a result of the proposed crossing of 0.014m. With this afflux being less than 30mm and even the 1 in 100 year with 65% climate change allowance being 32mm, the embedded mitigation is appropriate to limit the impact of the proposed development and no flood plain compensation or further mitigation is required, and the impact is deemed to be negligible.

7.2.6 Due to the undulating floodplain topography, the design scenario for the proposed development leads to higher, but localised increases in flood depths within the floodplain immediately upstream of the crossing.

7.2.7 **Figure 59** to **Figure 64** show there is little difference in flood extents for the baseline and 'with scheme' runs under the design scenario for the different return periods with 35% for climate change. This suggests the proposed development would not flood any new areas. However, there are some localised changes to the flood depth, velocity and hazard. The 1,000-year event shows that with the scheme in place, the flood extents are still similar to the baseline scenario for the 1 in 1,000-year event.

7.2.8 In the 'with scheme' 1 in 100-year event with 35% allowance for climate change, the right bank of the River Alde (western floodplain) shows depths are increased by up to 220mm with very small patch of increase up to 320mm near the flood relief culvert. These depths extend less than 80m upstream of the proposed bridge and covers an area of 0.65ha (**Figure 69**). On the left bank of the River Alde (eastern floodplain), depths of up to

140mm extend 25m upstream of the proposed bridge and cover an area of 0.15ha (**Figure 69**).

7.2.9 The 1 in 1,000-year with 35% for climate change scenario indicates that a depth of up to 350mm would occur on the right bank and would extend approximately 80m upstream of the bridge. Beyond the 80m upstream of the bridge, the change in depth of up to 200mm would extend approximately 100m to the north. While on the left bank, the change in flood depth of up to 250mm extend 25m upstream of the proposed bridge (**Figure 72**).

7.2.10 The increase in flood depth as a result of the proposed crossing becomes insignificant well before the Farnham Gauging station. At the nearest model node to the gauging station, the difference between the baseline and with bypass model runs show a very small difference of between 2mm higher and 8mm lower across a range of return periods from 20 to 100-year with 65% climate change allowance. This are very small changes well within the tolerance of the model. As a result, it is considered that there is negligible impact on the function of the gauging station. Further information regarding this can be found in the Two Village Bypass Modelling Report (**Appendix A**).

7.2.11 The difference in the baseline and 'with scheme' flood velocities shown in **Figure 74** to **Figure 82** show that upstream of the site red line boundary, there are some areas of change in velocity of the floodplain. The majority of the area has no change in the velocity, however there are local areas of minor changes in velocity.

7.2.12 **Figure 83** to **Figure 88** show the difference between the baseline and 'with scheme' flood hazards for the design scenario. The differences in flood hazard show a localised increase in the hazard rating, primarily in the area with increased flood depth immediately upstream of the proposed crossing.

7.2.13 The flood hazard for the baseline scenario shows there are existing areas of 'low hazard', 'danger to some' and 'danger to most' for all the return periods and climate change scenarios. The 'danger to all' category is very limited and mostly associated with a local area on the left bank upstream of the proposed embankment crossing.

7.2.14 The 'with scheme' hazard maps showing the 'danger to all' areas remain similar for the 1 in 1,000-year with 35% climate change event, while the majority of the change is associated with the extension of areas of flood hazard from danger to some' and 'danger to most'. Downstream of the proposed crossing, the reduction of the hazard level is mostly a reduction of the danger to some' and 'danger to most' areas. However, these areas of off-site change are small and scattered.

7.2.15 A review of the National Receptor Database in conjunction with the modelled results confirms that there is no change in the number of properties affected by fluvial flooding for the 1 in 20, 1 in 100 or 1,000-year events with 35% and 65% climate change as a result of the proposed crossing. There is no residential property or buildings within the local area affected by the change.

7.2.16 The lands affected by the proposed development are agricultural fields. As the above assessment illustrates, the modelled in-channel afflux due to the River Alde crossing at 1 in 100 year with 35% climate change is less than 30mm, limited and the scale of change in the flood extent, depth, velocity, and hazard in the floodplain is localised. Therefore, it is considered that the impact of the two village bypass as mitigated by the embedded design is not significant. Floodplain compensation areas or flood mitigation are therefore considered not to be necessary for the proposed development.

7.2.17 In response to consultation in respect of flood risk, the Environment Agency has stated that written consent from the landowner must be obtained for the increased flood depth, hazard and velocity in these localised areas. SZC Co. is currently in talks with and will continue to engage with the landowner for the affected area, with the view to reaching such an agreement. However, this agreement has not been obtained at this time. Therefore, although it is considered that flood compensation areas are not necessary for the proposed development, the site includes areas to the north of the proposed bridge that could be used to provide flood compensation in case the Secretary of State disagrees with this position and takes the view that such flood mitigation is in fact required.

7.3 Applicability of sustainable drainage systems

7.3.1 In accordance with NPPG for Flood Risk and Development (Ref. 1.3), the sustainable drainage hierarchy has been applied and the comments on suitability are given in **Table 7.2**.

Table 7.2: Application of sustainable drainage hierarchy

Option	Comment	Viability
Into the ground (infiltration)	Runoff to be collected in swales and held temporarily allowing infiltration into the ground. Vegetation, soil and subsoil within the swale to provide treatment of the runoff reducing pollution impact. An initial review of geological conditions on site indicate that the rate of infiltration will vary. However further infiltration tests will be undertaken to determine suitability. Current assumptions as to a suitable footprint	Potential

Option	Comment	Viability
	for the swale is a required width of 3.5 m with side slopes of no steeper than 1 in 3 and a flat base of 1 metre, to provide an above ground storage volume. If insufficient, there is potential for an additional filter trench in the base of the swale, which would provide additional storage volume. At the roundabouts at either end of the bypass, where there is a greater concentrated connected impermeable area, the current layout provides additional infiltration basins, providing additional temporary storage and mitigating any the impact of highway on overland flow routes. Should infiltration into the ground prove ineffective, the swales would discharge at a controlled rate to the watercourse.	
To a surface water body	While an uncontrolled discharge to a watercourse is undesirable, it is possible at some locations to use a controlled discharge to the watercourse as a reserve option. Any such discharge will be limited to greenfield run-off.	Potential
To a surface water sewer, highway drain, or another drainage system	The area around the development is primarily rural with a low likelihood of sewers being present. Anglian water sewer records have not been consulted. Therefore, it is not known whether there are any public surface water sewers close to the site.	No potential
To a combined sewer	The area around the development is primarily rural with a low likelihood of sewers being present. Anglian water sewer records have not been consulted, therefore it is not known whether there are any public combined sewers close to the site.	No potential

7.4 Water management and drainage

7.4.1 The majority of the existing site is currently 'greenfield' with no impermeable surfaces and small localised areas of surface water flood risk. Therefore, the proposed highway development would significantly increase the impermeable area on the site. Without effective measures, this increase in impermeable area has the potential to increase the surface water run-off and the associated flood risk both on and off site.

7.4.2 Sustainable urban drainage systems (SuDS) would be implemented to attenuate surface water run-off and minimise sediment generation and provide water treatment. It is envisaged that surface water run-off would be contained within the site, with drainage to ground via infiltration using infiltration basins and swales.

7.4.3 Swales would be provided alongside the proposed route of the two village bypass road, except along the River Alde overbridge and along the embankment within the floodplain. The swales would attenuate and infiltrate to ground the surface water runoff.

7.4.4 It is envisaged that three infiltration basins would be located along the length of the route. The exact location, footprint and depth of the infiltration basins will be confirmed at the detailed design stage. It is proposed that the infiltration basins would be designed to cater for a 1 in 100-year flood event plus a 40% allowance for climate change.

7.4.5 The section of road between the eastern end of the embankment and the River Alde bridge would be drained either by underground drainage or drainage channel towards the bridge and then outfall with discharge into the river. Discharge would be fixed at greenfield rates and infrastructure for the removal of highway runoff pollutants would be provided, if required as determined at detailed design stage.

7.4.6 The section of road between the River Alde bridge and the western end of the embankment would be drained either by underground drainage or drainage channel to the west and then discharge into the infiltration basin. Further details are provided in the site **Outline Drainage Strategy**, see **Volume 2, Appendix 2A** of the **ES** (Doc Ref. 6.3).

7.4.7 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. Subject to the adoption of the highway, highway maintenance would be carried out by the highway authority. However, prior to the adoption, SZC Co. would be responsible for this.

7.5 Access

7.5.1 The Environment Agency and Office of Nuclear Regulation joint advice note (Ref. 1.2) requires safe access and egress for nuclear sites. For associated development sites such as the two village bypass, the requirement is to be in line with planning policy, in this case a 1 in 100 year with 65% climate change allowance.

7.5.2 The proposed highway would be raised above the existing topography and the future fluvial flood risk. The future modelled water levels for the 1 in 100-year event with 65% climate change allowance is 5.08m AOD. While the 1 in 1,000-year event with 65% climate change allowance water level is 5.27m AOD. Access and egress will be along the proposed road, which has a minimum carriageway level of 9.7m AOD along the River Alde floodplain, rising even higher towards the east. Therefore, the road has been designed to provide safe and dry access.

7.5.3 During construction and operation, the proposed development would be accessed from roundabouts off the existing A12 at Parkgate Farm and Friday Street Farm, both of which are situated in Flood Zone 1. An infiltration basin is located near Friday Street Farm and would manage the local surface water run-off and associated future flood risk.

7.5.4 An appropriate flood risk emergency plan would be in place for the construction and operation of the bypass as set out in the in the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11). The flood risk emergency plan would be developed in accordance with NPPF and Environment Agency guidance.

7.6 Flood risk activity permit

7.6.1 A Flood Risk Activity Permit will be required from the Environment Agency for the permanent and temporary works for the crossing of the main river and other associated works that fall in, under, over or within 8m of the River Alde main river.

8. Management of Residual Risk

8.1.1 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.

8.1.2 Climate change is a potential residual risk for the site as the current future projections may not be met. Due to the elevation difference between the modelled flood extents and the proposed road layout, the risk of fluvial flooding when taking into account climate change to the site is still considered to be low.

8.1.3 Hydraulic modelling undertaken to assess the impact of the proposed development was run for more extreme events such as the 1 in 100-year and the 1 in 1,000-year events with 35% and 65% allowances for climate change.

8.1.4 During construction, the construction phasing would be planned to minimise the floodplain constraints beyond those identified within the final design. The embankments would be constructed with the proposed culverts in situ rather than constructing the culverts after the construction of the embankment.

8.1.5 A flood risk emergency plan would be in place for the construction and operation of the bypass as set out in the in the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11). The flood risk emergency plan would be developed in accordance with NPPF and Environment Agency guidance and would include procedures to ensure people on-site are safe in the event of a flood.

8.1.6 Monitoring of the weather would be in place to monitor storm conditions, as part of the flood risk emergency plan. This would likely 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 and the site temporarily evacuated.

8.1.7 During the construction phase, the flood risk emergency plan could include the provision of temporary pumping to mitigate the impact of any temporary floodplain loss.

8.1.8 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. There is potential residual risk for the site should blockages occur for the culverts under bypass. In addition, other sustainable drainage features will require regular maintenance to prevent blockage.

8.1.9 During construction, the site traffic is likely to transfer loose sediment onto the vehicles that may be washed off into the swales and could reduce the volume capacity and the infiltration potential. In addition, any surface water treatment facility may also fill up with sediment. This may lead to a minor increase in the associated flood risk due to the loss of attenuation capacity.

8.1.10 In addition, a review of the exceedance flow routes would be necessary to consider the surface water flow routes and any impacts around the proposed development as part of the drainage design.

8.1.11 An appropriate surface water drainage maintenance and cleaning schedule would be undertaken to maintain the swale design capacity and capability. Further information regarding SuDS maintenance requirements would be given in the **Outline Drainage Strategy**, see **Volume 2**, **Chapter 2, Appendix 2A** of the **ES**.

9. Summary and Conclusions

9.1.1 This report has considered all sources of flood risk and identified the mitigation measures included in the site layout.

9.1.2 **Table 4.1** shows flood risk from tidal, groundwater, sewers and reservoirs are low.

9.1.3 The proposed two village bypass is elevated above the River Alde flood plain, with the proposed lowest level of the carriageway being 9.7m AOD. Compared with the maximum modelled flood levels for the on-site design scenario (1 in 100-year event with 65% allowance for climate change) adjacent to the bridge is 5.08m AOD, the bypass bridge will therefore provide dry access over the River Alde flood plain.

9.1.4 Fluvial flood risk is high where the proposed two village bypass crosses the River Alde and the associated floodplain. Hydraulic modelling has been undertaken to assess the potential impact of the proposed development on flood risk. For the off-site design scenario (100-year event with 35% allowance for climate change) in channel afflux was limited to 14mm.

9.1.5 With this afflux being less than 30mm and even the 1 in 100 year with 65% climate change allowance being 32mm, it is considered that the embedded mitigation is appropriate to limit the impact of the proposed development to negligible, and that no floodplain compensation or further mitigation is required.

9.1.6 There is very little difference in flood extents for the baseline and 'with scheme' runs under the design scenario for the different return periods with 35% for climate change. This suggests the proposed development would not flood any new areas. However, there are some local changes to the flood depth, velocity and hazard.

9.1.7 Modelling shows localised increases in flood depth and flood hazard immediately upstream of the proposed crossing compared to the baseline. For the 1 in 100-year event with 35% allowance for climate change, the right bank of the River Alde shows depths are increased by up to 220mm; while on the left bank of the River Alde to depths of up to 140mm. The extents of these increases are limited, and the impact does not affect the function of Farnham Gauging station upstream of the crossing.

9.1.8 A review of the National Receptor Database in conjunction with the modelled results confirms that there is no change in the number of properties affected by fluvial flooding for the 1 in 20, 1 in 100 or 1,000-year events with 65% for climate change. There is no residential property or other buildings within the area affected by a change in flood extent as a result of the proposed development.

9.1.9 The localised area affected by the increase in flood depth is agricultural land. SZC Co. is currently in talks with and will continue to engage with the landowner for the affected area, with the view to reaching an agreement for the increased flood depth, hazard and velocity.

9.1.10 A dry mammal crossing is included within the embankment design on the east side of the River Alde overbridge. The mammal migration culvert (approximately 5.4m by 1.2m) outside the 1 in 1,00-year plus 65% climate change extent and would not flood in this scenario.

9.1.11 The infiltration basins linked to the two village bypass road drainage have been located outside the 1 in 100-year plus 65% climate change extent.

9.1.12 Flood risk from surface water is variable across the site. The large majority of the site is at 'very low' risk of flooding, however an isolated pocket of land at 'high' risk of flooding was identified.

9.1.13 The proposed development is classed as being 'Essential Infrastructure' under the NPPF and is located in Flood Zones 1, 2, 3a and 3b. As per the Flood Risk Vulnerability and Flood Zone Compatibility table, the development was considered as being required to pass the Exception Test.

9.1.14 The Exception Test is considered to be passed as it was demonstrated the proposed development provides wider sustainability benefits and the flood risk assessment demonstrates it will be safe for the users and does not result in any significant off site increase in flood risk.

9.1.15 The increase in impermeable area associated with the proposed development will require sustainable management of surface water run-off. This is being addressed by sustainable drainage through the drainage strategy.

9.1.16 Based on the information presented, the proposed mitigation measures and in line with NPPF guidance, it is considered that the development site is appropriate in terms of flood risk.

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